DRAFT CITY OF MALDEN
HAZARD MITIGATION PLAN
2022 UPDATE

Draft for
MEMA & FEMA Review
August 5, 2022

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ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the City of Malden 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) Pre-Disaster Mitigation Grant Program, as administered by the Massachusetts Emergency Management Agency.

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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. With climate change, intense storms and extreme heat are of increasing concern, and this plan also considers how our changing climate will affect natural hazards. Warming temperatures will fuel changing precipitation patterns, sea level rise, and an increasing frequency and intensity of severe storms. 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 Malden's previous Hazard Mitigation Plans, which were approved by FEMA in 2008 and 2017. Planning for this Malden Hazard Mitigation Plan 2022 Update was led by the Malden Local Hazard Mitigation Team, composed of staff from a number of different City Departments, listed in the section below. The team met four times, on December 9, 2021, February 24, 2022, April 14, 2022, and May 26, 2022. Team meetings focused on reviewing the impacts of natural hazards that affect the City, goals for addressing these impacts, and hazard mitigation measures that would benefit the City by increasing its resilience to hazards.

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. Two advertised public meetings were held; the first hosted remotely by the Malden Conservation Commission on May 3, 2022, and the second hosted by the Malden Emergency Management Committee on June 15, 2022, at City Hall, also with remote access available. The draft Plan was posted on the City's website for public review and comment following the second public meeting. Both meetings included a description of the hazard mitigation planning process, an overview of the plan and proposed mitigation actions, as well as directions on how the public could access the draft plan on the City website and make comments. The public had the opportunity to ask questions and provide comments at both public meetings.

RISK ASSESSMENT

The Malden Hazard Mitigation Plan assesses the potential impacts to the City from multiple natural hazards, including flooding, high winds, severe storms, drought, extreme temperatures, sea level rise, brush fire, and geologic hazards. Flooding, as a result of hurricanes, nor'easters, and other severe storms, clearly presents the greatest hazard to the City. The Malden Local Committee identified those areas where flooding most frequently occurs, comprising .12 sites, which are described in Section 4 of this plan and mapped in the hazard map series in Appendix A. there are eight repetitive loss properties in Malden.

The Malden Hazard Mitigation Team identified 132 Critical Facilities, including 91 from the 2017 plan and 41 additional facilities for this 2022 plan update. These are shown on the map series and listed in Table 34, identifying which facilities are located within the mapped hazard zones.

Hazards U.S. – Multihazards (HAZUS-MH) is a standardized methodology developed by FEMA that utilizes Geographic Information Systems (GIS) to estimate physical, economic, and social impacts of disasters. The HAZUS-MH analysis for Malden estimates property damages from hurricanes of 100-year and 500-year frequency (approximately Categories 2 and 4) from $38.8 million to $174.7 million; see Table 17 for the hurricane Saffir-Simpson Scale defining hurricane categories. HAZUS-MH estimates property damage from earthquakes of magnitudes 5 and 7 from $1.03 billion to $7.04 billion); see Table 28 for the Richter Scale defining earthquake severity. The estimated property damage from the 1% chance of flooding is $$69,.3 million. An explanation of the annual chance or annual exceedance probability of floods can be found at: https://www.usgs.gov/special-topics/water-science-school/science/100-year-flood

HAZARD MITIGATION GOALS

The Malden Hazard Mitigation Team endorsed the following hazard mitigation goals at the February 24, 2021, team meeting. The first four goals were carried over from the 2017 plan, and goals 5 through 12 are new goals added to this 2022 updated plan by the local team.

Goal 1. Prevent and reduce 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 significant flood hazard areas.

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 Town to develop, review and implement the hazard mitigation plan.

Goal 9: Work with surrounding communities 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 resiliency into the City's planning and policies.

HAZARD MITIGATION STRATEGY

The Malden Local Committee identified a number of mitigation measures that would serve to reduce the City's vulnerability to natural hazard events. Largely these are related to maintaining the integrity of the drainage system through addressing maintenance, reconstruction, and replacements issues. There is also an emphasis on preventative measures such as working with utility companies to trim trees around utility lines so that both hazard mitigation and emergency response can be handled efficiently and effectively.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Malden 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 the accompanying changes to precipitation and extreme temperatures will impact the City's vulnerability even more 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 other related plans and policies.

PLAN REVIEW & UPDATE PROCESS

The process for updating Malden's Hazard Mitigation Plan is summarized in Table 1:

Table 1. Plan Review and Update

Section	Reviews and Updates
Section 3 – Public Participation	The Malden Hazard Mitigation 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 team meeting. During plan development, the draft plan was twice presented at city-hosted public meetings. The draft plan was also available on the City's website for public review and comment.
Section 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 and assessed the potential impacts of flooding using the latest data.
Section 5 - Goals	The Hazard Mitigation Goals were reviewed, updated, and endorsed by the Malden Hazard Mitigation Team.

Section 6 – Existing Mitigation	The list of existing mitigation measures was updated to reflect current mitigation activities in the City.
Sections 7 & 8 – Hazard Mitigation Strategy	Mitigation measures from the 2027 plan were reviewed and assessed as to whether they were completed, on-going, or deferred. The Malden Hazard Mitigation Team determined whether to carry forward measures into this plan update, modify them for this update, or delete them. The Team also considered several new mitigation measures that were not in the 2017 plan and incorporated five new measures that had been identified by the City's Municipal Vulnerability Preparedness (MVP) project. The Hazard Mitigation Team provided cost estimates where available, time frames for implementation, and prioritized the mitigation measures based on current conditions.
Section 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 to update the plan in 2027.

Review of 2017 Natural Hazard Mitigation Plan

As indicated in more detail on Table 40, Malden made progress on implementing mitigation measures identified in the 2017 Hazard Mitigation Plan, including:

- The Malden DPW addressed flooding at Bowman and Durso Streets by conducting a project to clear the stream of debris to increase drainage capacity and reduce stormwater backups
- The City has approved a $40,000 line item to address rodent problems related to the Town Line Brook area
- The City hired a Tree Warden to address issues related to high winds and winter storm power outages and general urban tree management.
- The City operates three cooling centers at the Senior Center and two schools
- The City has installed generators in the Senior Center and the Salemwood School
- The City built new Police and Fire Stations since 2017 that provide updated communications capabilities
- The City adopted an updated Zoning Ordinance requiring more trees in parking areas,

The City continues to seek funding to implement the larger infrastructure improvement projects. Moving forward into the next five-year plan implementation period several of the projects currently in progress will be completed and there will be more opportunities to incorporate hazard mitigation into the City's decision-making processes. The City will document any actions taken within this iteration of the Hazard Mitigation Plan on challenges met and actions successfully adopted as part of the ongoing plan maintenance to be conducted by the Malden Hazard Mitigation Team, as described in Section 9, Plan Adoption and Maintenance. Malden has designated its Emergency Management Director to coordinate and implement hazard mitigation planning and updates going forward.

SECTION 2: INTRODUCTION

PLANNING REQUIREMENTS UNDER THE FEDERAL DISASTER MITIGATION ACT

The Federal Disaster Mitigation Act, passed in 2000, requires that after November 1, 2004, 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).

Massachusetts has taken a regional approach and has encouraged municipalities to work with their regional planning agencies and other partners to prepare and update their Hazard Mitigation Plans. The City of Malden contracted with the Metropolitan Area Planning Council (MAPC), to assist the City in updating its third Hazard Mitigation Plan, which was first adopted in 2008 updated in 2017.

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. This plan also incorporates consideration of future risks due to projections for the increased frequency and severity of extreme weather fueled by a warming planet.

PREVIOUS FEDERAL/STATE DISASTERS

Since 1991, Malden has experienced 22 natural hazards that triggered federal or state disaster declarations. These are listed in Table 2 below. The vast majority of these events involved flooding, while others were due to hurricanes or nor'easters, and severe winter weather.

Table 2. Previous Federal/State Disaster Declarations

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

Disaster Name	Date of Event	Declared Areas
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	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
Snowstorm	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
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 Winter Storm, Snowstorm; Flooding	February, 2013	Statewide
Severe winter storm, snowstorm, 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

FEMA FUNDED MITIGATION PROJECTS

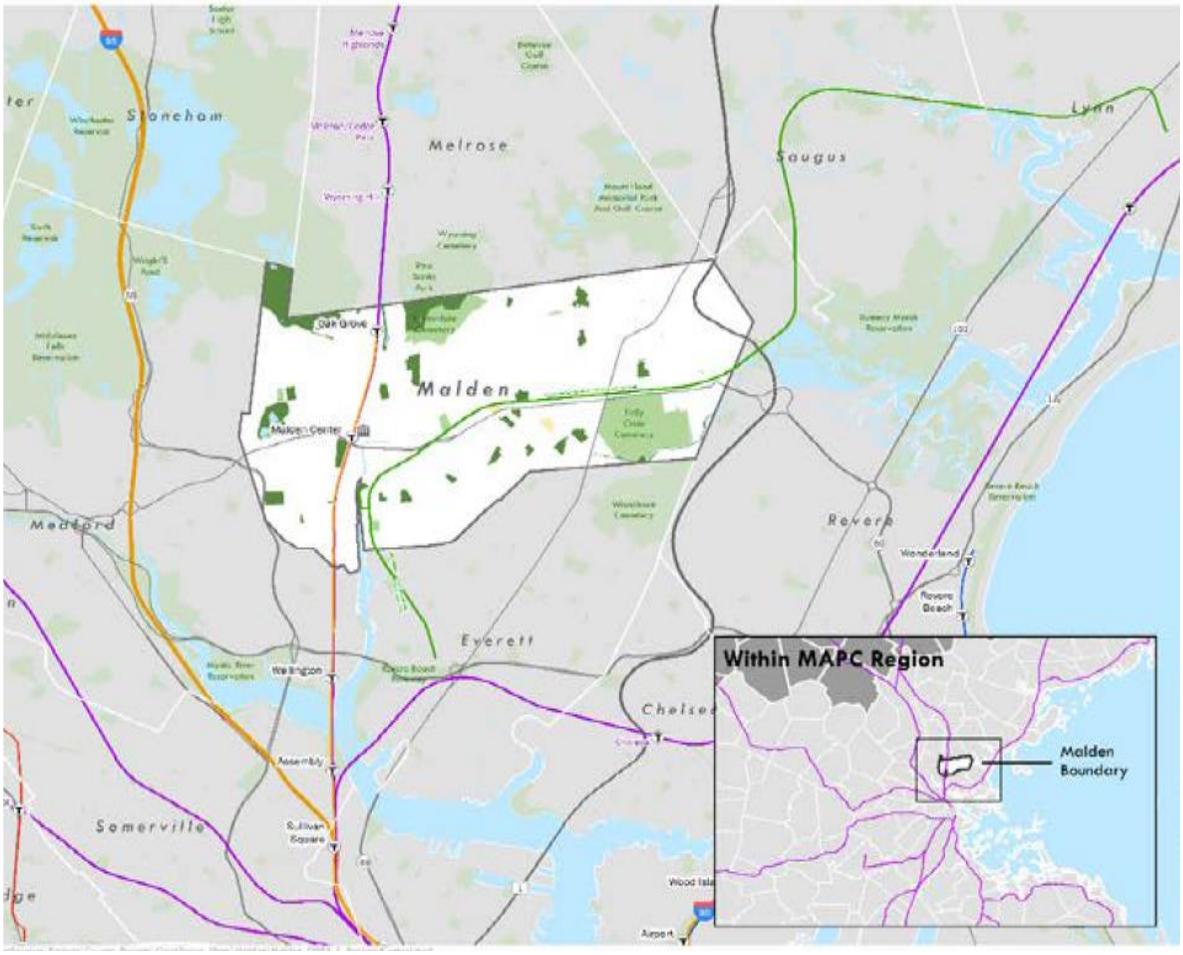
Over the last 25 years the City of Malden has not received funding from FEMA for any mitigation projects under the Building Resilient Infrastructure and Communities, Pre-Disaster Mitigation, or Hazard Mitigation Grant Program.

COMMUNITY PROFILE

Located in Middlesex County, Malden is five miles northwest of Boston with a population of approximately 66,263 residents (US Census 2020). It is bordered by Melrose on the north, Stoneham on the northwest, Medford on the west, Everett on the south, Revere on the east and Saugus on the northeast. Malden is in Middlesex County and comprises 5.12 square miles.

Malden has proximity to major highways, rail transit, and Logan International Airport (Figure 1). A lively and diverse City, Malden has distinct neighborhoods with a variety of housing. The equally diverse business community includes 1,800 firms specializing in such areas as finance, light manufacturing, education, biotechnology, food industry, social services, and retail.

Figure 1: Malden Regional Location Context



Source: Malden Open Space and Recreation Plan, 2017

Malden's proximity to natural resources has been a driving force behind its commercial and economic success since its founding. Early settlers relied on the Malden and Mystic Rivers for industry and commerce. That tradition continues today. River's Edge, the tri-city redevelopment of a 30-acre former brownfields site alongside the Malden River, is an example of economic development, guided by the Mystic Valley Development Commission, created by the cities of Malden, Medford, and Everett.

Overall Population Characteristics

After significant growth in the first half of the 20th century, Malden reached a peak population of 59,804 in 1950, then declined I the decades that followed to a low of 53,884 in 1990. Malden's population increased since 1990 to its current level of 66,263 residents (2020 US Census). The population is expected to continue grow over the next decade at least. Figure 2 shows Malden's population trends from 1950 to 2010, based on the US Census, along with MAPC's projections to the year 2030. Key demographic characteristics of the City are summarized in Table 3:

Table 3. Malden Demographic Characteristics

Population = 66,263

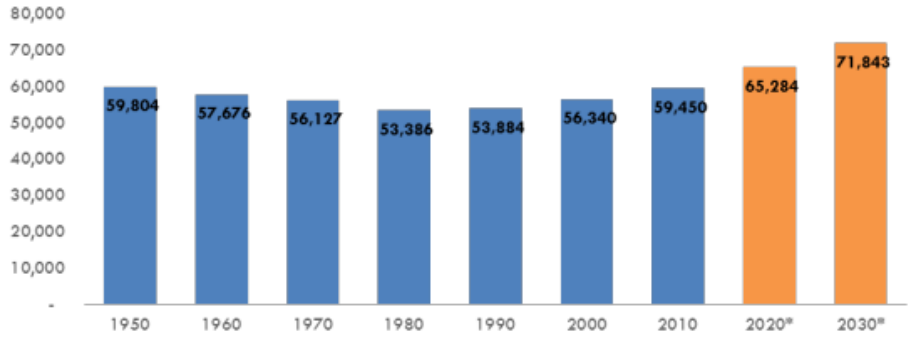
- 6.0% are under age 5
- 18.4% are under age 18
- 13.1% are age 65 and over
- 6.3 are age 75 and over
- 1.8% are age 85 and over
- 10.5% have a disability
- 38.2% of those over age 65 have a disability
- 42.3% are foreign born
- 49% speak a language other than English at home
    - 19.0% speak an Asian/Pacific Islander language
    - 18.5 % speak another Indo-European language
    - 6.8% speak Spanish
    - 4.7% speak other languages
- 26.8% speak English less than "very well"
- 15.6% with income below the poverty level
- 19.8% of households have no vehicle

Number of Occupied Housing Units = 23,367

- 58% are renter-occupied housing units
- 49.9% of housing units were built 1939 or earlier
- 61.0% of housing units were built 1959 or earlier

Source: U.S. Census Bureau, 2020 and American Community Survey, 2019

Figure 2. Malden Population Trends

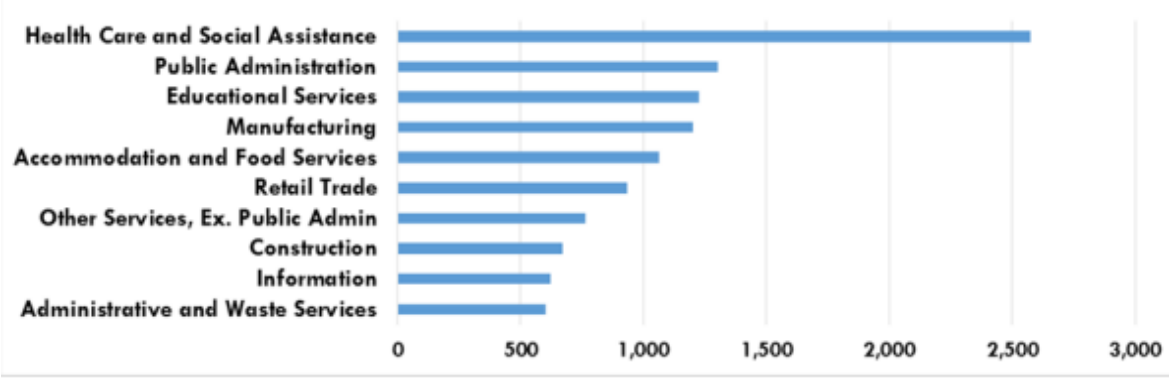


Source: U.S. Census; MAPC Population Projections

Jobs and Income

Malden has a diversified employment base, including industry and health care. Top employers in the City are Massachusetts Department of Elementary and Secondary Education, National Grid, Cambridge Health Alliance, Prospect Building Services Corporation, Super Stop and Shop and New England Coffee. Figure 3 breaks jobs down by occupational group. The Health Care and Social Assistance categories provide the largest employment opportunities in Malden, followed by Public Administration, Educational Services and Manufacturing. Together, these occupational groups account for over 5,000 jobs. Source: Massachusetts Executive Office of Labor and Workforce Development (EOLWD).

Figure 3. Malden Employment by Occupation, Top 10 Industries



Source: Massachusetts Executive Office of Labor and Workforce Development (EOLWD)

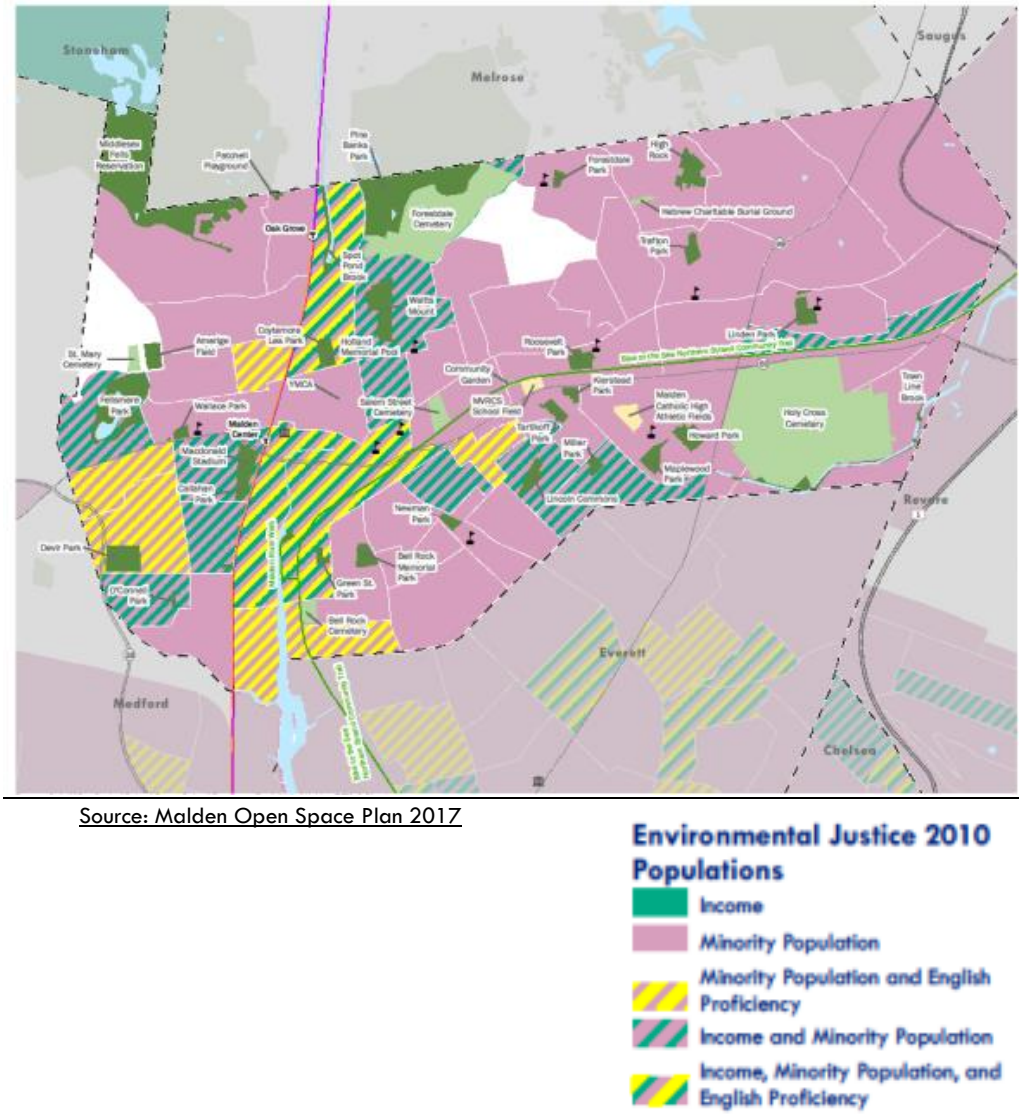
Environmental Justice Communities

Malden is one of 137 communities in the Commonwealth of Massachusetts that includes an Environmental Justice (EJ) population, as identified through analysis by MassGIS. EJ populations in Massachusetts are determined by the following criteria:

- Households earn 65% or less of the statewide household median income; or
- 25% or more of the residents are minority; or
- 25% or more of the residents are foreign-born; or
- 25% or more of the residents are lacking English language proficiency.

The EJ Populations by Census Block Group Map indicates that 97% of Malden's population is located in EJ block groups. All except for two block groups (not colored on the following map) include 25% or more residents of Malden that meet one or more criteria that define an EJ population, as depicted in Figure 4.

Figure 4: Malden Environmental Justice Populations



Source: Malden Open Space Plan 2017

Water Resources

The eastern portion of Malden is located within the North Coastal Watershed, which is part of the Rumney Marsh Area of Critical Environmental Concern (ACEC). In Malden, the Townline Brook and the Linden Brook create connections to the tidal system in neighboring Revere. This tidal activity has an impact on drainage and stormwater management in many neighborhoods in the southeastern portion of Malden.

Malden does not contain any public water supply aquifers or recharge area. In addition to the wetland areas along portions of the Malden River, Town Line Brook, and the Forest Dale

Cemetery, some isolated wetlands exist in the Middlesex Fells Reservation and the undeveloped highlands of Malden.

Malden River and other Surface Waters

The first Europeans in Malden settled along the banks of the Malden River. The river served as the major means of transportation and trade during Malden's early development. Today, the River is viewed as having great potential to become a recreational resource for the City.

The Malden River lies toward the southwestern part of Malden near Medford. The river once ran through the downtown section of Malden north of Charles Street until the 1960's when this section was placed in a closed culvert. The portion of the River near the Oak Grove MBTA station is located in an open culvert. South of Charles Street adjacent to Canal Street, the River continues as open water for 1.3 miles (0.7 miles in Malden) until joining the Mystic River near the Wellington MBTA Station.

The construction of the Amelia Earhart Dam in the 1960's changed the character of the Malden River. The dam blocked the tidal flushing of the river, so today; the river has characteristics more of a lake or a reservoir.

The U.S. Army Corps of Engineers (USACE) in partnership with the Mystic Valley Development Commission (MVDC) developed the "Malden River Ecosystem Restoration Detailed Project Report and Environmental Assessment." Restoration of the Malden River ecosystem to the "highest quality that it can reasonably support and sustain" is the overriding project goal for both the MVDC and the USACE. Numerous ecosystem restoration components were developed and evaluated as building blocks for a comprehensive strategy designed to restore the environmental quality of the Malden River ecosystem. These measures are directed toward three primary restoration objectives: wetlands restoration, aquatic habitat restoration and riverine migratory restoration.

Town Line Brook

Town Line Brook lies on the east side of Malden near the border of Revere and Everett. The brook is a 1.7 mile (1.0 mile in Malden) long surface water body that runs from Broadway to Rumney Marsh in Revere.

Even though the predecessor agency to the current state Department of Conservation and Recreation (DCR) placed the brook in an open concrete culvert for its entire length the brook remains subject to periodic tidal flows. DCR has completed an upgrade to the floodgate near the Revere Cinemas to better control flood tides and to allow regular tidal flows. The tidal flows greatly influence groundwater levels in some adjoining Malden and Revere neighborhoods. The Linden neighborhood could be subject to flooding if the tide gates become ineffective.

Historic, Cultural and Archeological Resources

Established in 1634, Malden history is deeply rooted in business and commerce. Located just outside of Boston, early Malden settlers were too far from deep water for shipbuilding and the land proved too rocky for any significant, long-term farming. As a result, Malden became a mill and factory town. It is this focus on industry that has propelled Malden's evolution through its more than 380 years.

Malden Sites on the National Register of Historic Places

Since 1977, the City of Malden has surveyed more than 500 properties, areas, and sites of architectural and historical significance throughout the City, including private residences, civic buildings, religious institutions, schools, parks, landscapes, neighborhoods, and commercial properties. The most recent Citywide Inventory was recently completed in June 2017. The City of Malden has nine sites listed on the National Register of Historic Places:

1. Bell Rock Cemetery (c. 1649) on Medford Street: Located at Green Street, Medford Street and Converse Avenue.
2. Bell Rock Memorial Park (1908) on Main Street: A public open space since 1648,
3. Marcia P. Browne Junior High School (1905) at 295 Broadway
4. Converse Memorial Building (1884) at 36 Salem Street: Home of the Malden Public Library and Art Gallery
5. Charles A. Daniels School (1906) at 20 Daniels Street: Designed in Tudor Revival-style by the Boston architectural firm Brainerd
6. Wilbur Fiske Haven House (c. 1866) at 339 Pleasant Street: One of the City's earliest examples of the high-style, Italianate/Mansard or Second Empire.
7. Odd Fellows Building (1907) at 442 Main Street: Designed in Second Renaissance Revival style by Boston architect and Malden resident, Louis C. Newhall
8. Saint Paul's Parish Church (1860) at 26 Washington Street: Designed in the Modern Gothic style by architect Ralph Adams Cram.
9. Waitt Brick Block (1848) at 422-424 Main Street: Designed in Greek Revival style, this commercial block is the only surviving structure from the period.

Planning Context

The City of Malden has several unique characteristics to keep in mind while planning for natural hazards:

- Malden has been proactive in addressing the impact of climate change on natural hazards. The City conducted a Municipal Vulnerability Preparedness project in 2018 and has been designated by the MA Executive Office of Energy and Environmental Affairs as an MVP certified community.

- Malden is an active member of the Metro Mayors Climate Task Force, a group of 15 urban core communities that collaborate on climate resilience initiatives locally and regionally.

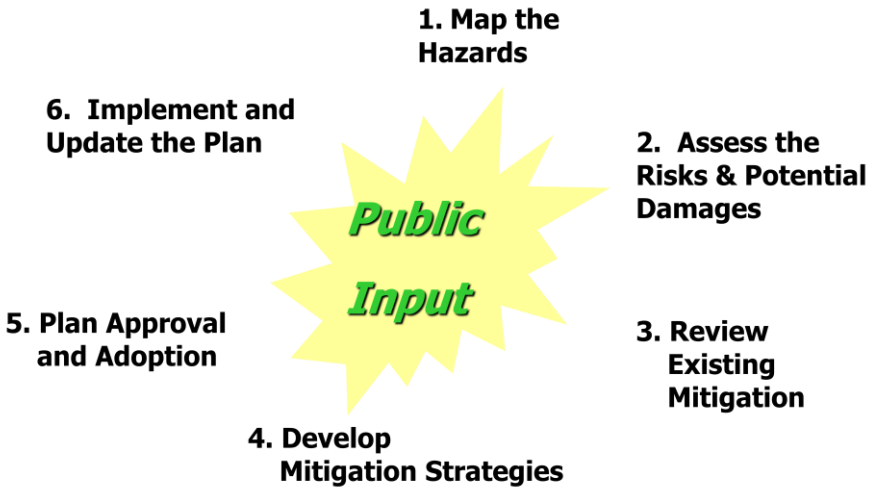
- Malden is located in the Mystic River watershed. The City collaborates with cities of Boston, Everett, Somerville, Revere and Winthrop in the Resilient Mystic Collaborative, which prepared the Lower Mystic Regional Climate Assessment.

- Records of flood damages from the major storms of 2010 show that flood damage occurred throughout the city, with 140 disaster flood claims filed with FEMA, 93% of which were located outside the FEMA 1% chance flood zone.

SECTION 3: PLANNING PROCESS & PUBLIC PARTICIPATION

PLANNING PROCESS SUMMARY

The six-step planning process outlined below is based on the guidance provided by FEMA's Local Multi-Hazard Mitigation Planning Guidance. Public participation is a central element of this process, which attempts to focus on local problem areas and identify needed mitigation measures based on where gaps occur in the existing mitigation efforts of the municipality. MAPC supports participation by the general public and other plan stakeholders through two public meetings, posting of the plan to the City's website, and invitations sent to neighboring communities, city boards and commissions, and other local or regional entities to review the plan and provide comment. For plan updates, the process described below 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.



1. **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, which is collected and mapped with the local Hazard Mitigation Team. The maps can be found in Appendix A.

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

- City of Malden, *Community Resilience Building Summary of Findings*, 2020
- City of Malden, *Open Space and Recreation Plan*, 2017
- City of Malden, Zoning Ordinance
- Blue Hill Observatory
- FEMA, Flood Insurance Rate Maps for Middlesex County, MA, 2010-2016
- FEMA, Hazards U.S. Multi-Hazard (HAZUS-MH), 2021
- FEMA, Local Mitigation Plan Review Guide, October 2011
- Fourth National Climate Assessment, 2018
- Massachusetts Drought Management Plan, 2019
- Massachusetts Office of Dam Safety, Inventory of Massachusetts Dams 2018
- Massachusetts State Hazard Mitigation Plan, 2013
- Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018
- National Weather Service
- Nevada Seismological Library
- New England Seismic Network, Boston College Weston Observatory
- NOAA National Centers for Environmental Information
- Northeast Climate Adaptation Science Center
- Northeast States Emergency Consortium
- Resilient Mystic Collaborative, Lower Mystic Regional Climate Assessment, 2021
- Tornado History Project
- Urban Land Institute, Living with Heat
- US Census, 2020 and American Community Survey 2019, 5-Year Estimates
- USGS, National Water Information System

3. **Review Existing Mitigation** – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as many 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.

4. **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 7.

5. **Plan Approval and 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 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.

6. **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. Section 9 includes more detailed information on plan implementation.

2017 PLAN IMPLEMENTATION & MAINTENANCE

The 2017 City of Malden Hazard Mitigation Plan contained a risk assessment of identified hazards for the city and mitigation measures to address the risk and vulnerability from these hazards. Since approval of the plan by FEMA and local adoption progress has been made on implementation of several mitigation measures. The City completed or partially completed the following mitigation measures:

- The Malden DPW addressed flooding at Bowman and Durso Streets by conducting a project to clear the stream of debris to reduce stormwater backups
- The City has approved a $40,000 line item to address rodent problems related to the Town Line Brook area
- The City hired a Tree Warden to address issues related to high winds and winter storm power outages and general urban tree management.
- The City operates three cooling centers at the Senior Center and two schools
- The City has installed generators in the Senior Center and the Salemwood School
- The City built new Police and Fire Stations since 2017 that provide updated communications capabilities
- The City adopted an updated Zoning Ordinance requiring more trees in parking areas

In addition, the City completed a Municipal Vulnerability Preparedness project and has been certified as an MVP Community by the state. Malden also collaborates with surrounding communities in the Metro Mayors Climate Task Force and the Resilient Mystic Collaborative.

THE LOCAL HAZARD COMMUNITY PLANNING TEAM

MAPC worked with local community representatives to organize a local Hazard Mitigation Planning Team for Malden. MAPC briefed the local committee 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, review, and update existing mitigation measures, and help to develop new mitigation measures for this plan update. The Local Hazard Mitigation Team membership is listed in Table 4. The team was coordinated by Captain Glenn Cronin, Emergency Management Director.

Table 4 Malden Local Committee

City Department	Team Member/Position
Malden Emergency Management	Captain Glenn Cronin, Emergency Management Director
Malden Fire Department	William P. Sullivan, Fire Chief
Malden Planning Department	Michelle Romero, City Planner
Malden Board of Health	Christopher Webb, Director of Public Health
Malden Public Works Department	Robert Knox, Director of Public Works
Malden Building Department	Nelson Miller, Building Commissioner

The Team members listed above attended meetings on December 9, 2021, February 24, 2022, April 14, 2022, and May 26, 2022 (see meeting agendas in Appendix B).

At the first meeting on December 9, 2021, the Team reviewed and updated local data on Critical Facilities, land use and development trends, and locally-identified flood hazard areas. At the February 24, 2022, meeting, the team reviewed and updated the plan's mitigation goals and updated information on the City's existing mitigation measures. The April 14, 2022, meeting focused on updating the status of the recommended mitigation measures from the 2017 plan, and at the final meeting on May 26, 2022, the team developed the recommended mitigation strategy for this 2022 updated plan, including mitigation priorities, estimated costs, lead agencies, time frames, and potential funding sources. The team also identified stakeholders to invite to the public meeting scheduled for June 15, 2022, with the Emergency Management Committee.

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 and one after a complete draft plan was available for review.

Natural hazard mitigation plans unfortunately rarely attract much public involvement in the Boston region, unless there has been a recent hazard event. One of the best strategies for overcoming this challenge is to include discussion of the hazard mitigation plan on the agenda of a key municipal board or commission. The City of Malden hosted two public meetings with the Conservation Commission and the Emergency Management Team. With this strategy, the meeting receives more widespread advertising and a guaranteed audience, including board members and members of the public who attend the meeting. The municipal board and commission members represent an engaged audience that is informed on many of the issues that relate to hazard mitigation planning, 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 municipal meetings frequently receive press coverage, thereby expanding the audience that has the opportunity to hear the presentation and provide comments.

The public had an opportunity to provide input to the planning process during a meeting of the Malden Conservation Commission on May 3, 2022, held remotely via Zoom. The draft plan was presented for public comment at a public meeting of the Emergency Management Committee on June 15, 2022, at Malden City Hall, and also available for remote participation via Zoom. Both meetings were advertised as public meetings under the Massachusetts Open Meeting Law. A Media Advisory was distributed to the local press outlets. The meeting agendas and public meeting notices are found in Appendix C. MAPC set up a dedicated email address to receive public comments on the draft plan, resilientmalden@mapc.org

The City received three comments during review of the draft plan. City Councilor Steve Winslow submitted by email several detailed maps of additional problem areas for drainage and flooding. These are included in Appendix C, and the areas of concern have been added to this plan's hazard maps (Maps 3 and 8 in Appendix A).

Comments were also received by email from a Malden resident, Lisa Sulda, who noted that there is a more recent tree inventory for Malden than the 1999 inventory referenced in the draft plan, and also suggested the importance of more permeable surfacing and reducing the amount of non-permeable surfaces as measures to mitigate the effects of flooding, extreme temperature, and drought. This comment is also in Appendix C.

Finally, at the June 15 public meeting hosted by the Malden Emergency Management Team, a resident gave oral remarks expressing concern about need for trimming trees to mitigate the potential hazard of falling trees along Forest Street, which runs parallel to the Forestdale Cemetery. The Public Works Director requested that she reach out to him after the meeting in order to identify the areas that she was concerned with.

LOCAL STAKEHOLDER INVOLVEMENT

The City's Communications Director assisted the Malden Hazard Mitigation Planning Team in reaching out to local stakeholders that might have an interest in the Hazard Mitigation Plan including agencies, businesses, nonprofits, and other interested parties. Key City departments as well as neighboring communities were also notified of the public meetings and were invited to review the Hazard Mitigation Plan and submit comments to the city. In addition, meeting notices were submitted to the local press and posted on the city's website and its social media platform. Copies of the meeting notices are included in Appendix C. The draft plan was posted on the City's website for the second public meeting and was available following the meeting for public review and comment. The following organizations, departments, and neighboring communities were invited to attend the public meeting:

- City of Everett
- City of Medford
- City of Melrose
- City of Revere
- Town of Saugus
- Cambridge Health Alliance
- Cataldo Ambulance
- Eversource
- Friends of the Malden River
- Malden Chamber of Commerce
- Mystic River Watershed Association
- Malden Mayor's Office
- Malden City Council
- Malden Housing Authority
- Malden Public Facilities
- Malden Public Schools
- Malden School Committee
- Malden Senior Center
- Malden Strategic Planning & Comm. Dev.
- Mystic Valley Development Commission

See Appendix C for public meeting notices and agendas. The draft Malden Hazard Mitigation Plan 2022 Update was posted online for the second public meeting. Members of the public could access the draft document and submit comments or questions to the city.

CONTINUING PUBLIC PARTICIPATION

Following the adoption of the plan update, the local 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 town's understanding of local hazards. As updates and a review of the plan are conducted by the Hazard Mitigation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Team will be publicly noticed in accordance with town and state open meeting laws.

PLANNING TIMELINE, 2021-2022

December 9, 2021	1st Meeting of the Malden Hazard Mitigation Team
February 24, 202	2nd Meeting of the Malden Hazard Mitigation Team
April 4, 2022	3rd Meeting of the Malden Hazard Mitigation Team
May 3, 2022	First Public Meeting hosted by the Malden Conservation Commission
May 26, 2022	4th Meeting of the Malden Hazard Mitigation Team
June 15, 2022	Second Public Meeting hosted by the Emergency Management Comm.
August 5, 2022	Draft Plan Update submitted to MEMA
TBD	Draft Plan Update submitted to FEMA
TBD	Notice of Approvable Pending Adoption sent by FEMA
TBD	Plan Adopted by the City of Malden
TBD	FEMA final approval of the plan for 5 years

IMPLEMENTATION AND PLAN UPDATE TIMELINE, 2022-2027

2024	Conduct Mid-Term Plan Survey on Progress
2025	Seek FEMA grant to prepare next plan update
2026	Begin process to update the plan
2027	Submit Draft 2027 Plan Update to MEMA and FEMA
2027	FEMA approval of 2027 Plan Update

SECTION 4: RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the City of Malden s 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 Malden's 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. MAPC also used the most recent version of HAZUS-MH (described below). This updated 2022 plan also incorporates for the first time current information on climate change trends and projections in order to better inform the City of potential future changes to natural hazards related to the warming planet.

CLIMATE CHANGE AND NATURAL HAZARDS

With the adoption of the State Hazard Mitigation and Climate Adaptation Plan 2018 (SHMCAP), Massachusetts became the first state to integrate climate projections into a state hazard mitigation plan. Following the state model, the projected impacts of our warming climate on natural hazards are integrated throughout the risk assessment for Malden. Key impacts include rising temperatures, which in turn affect precipitation patterns, sea level, and extreme weather.

> *"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)

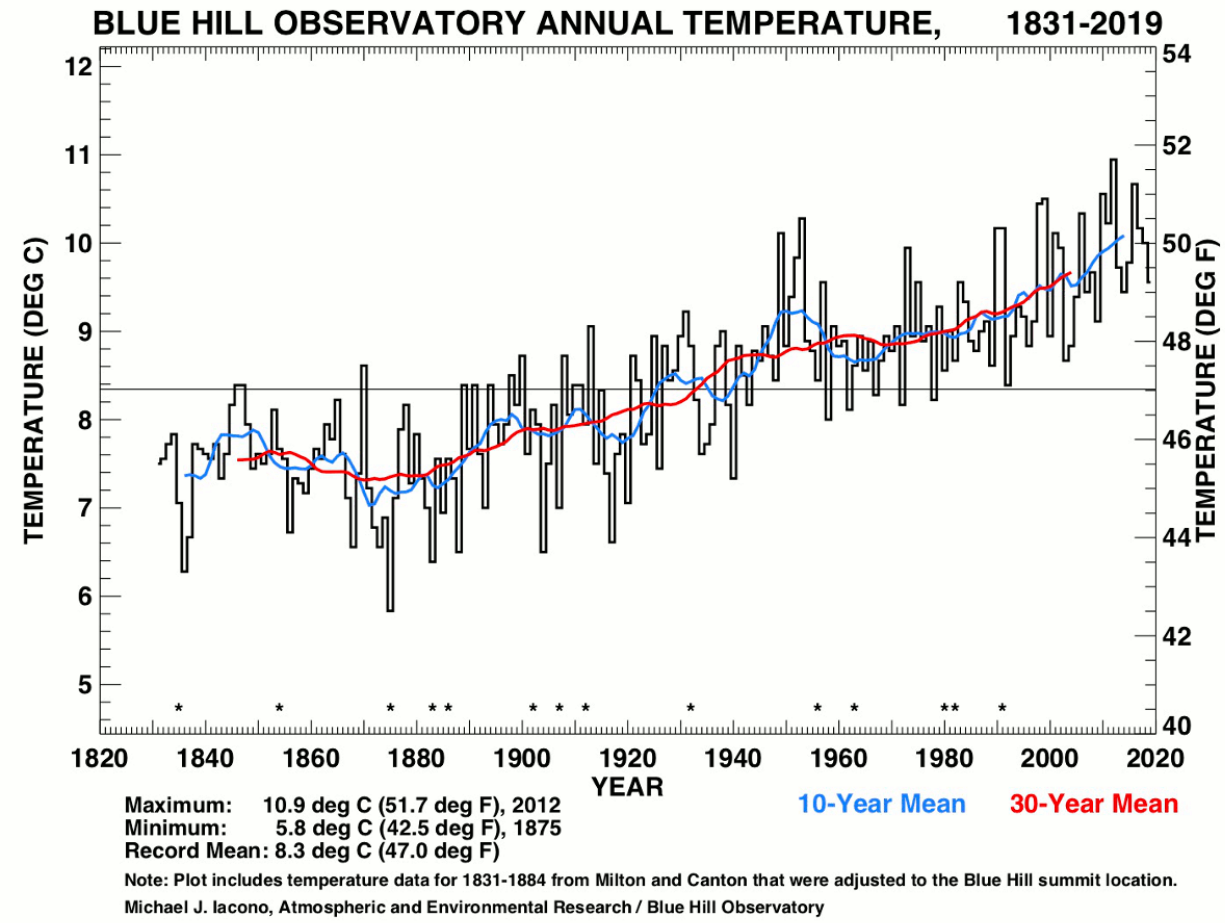
Climate change observations come from a variety of data sources that have measured and recorded changes in recent decades and centuries. Climate change projections, however, predict future climate impacts and, by their nature, cannot be observed or measured. As a result of the inherent uncertainty in 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 (Figure 5).

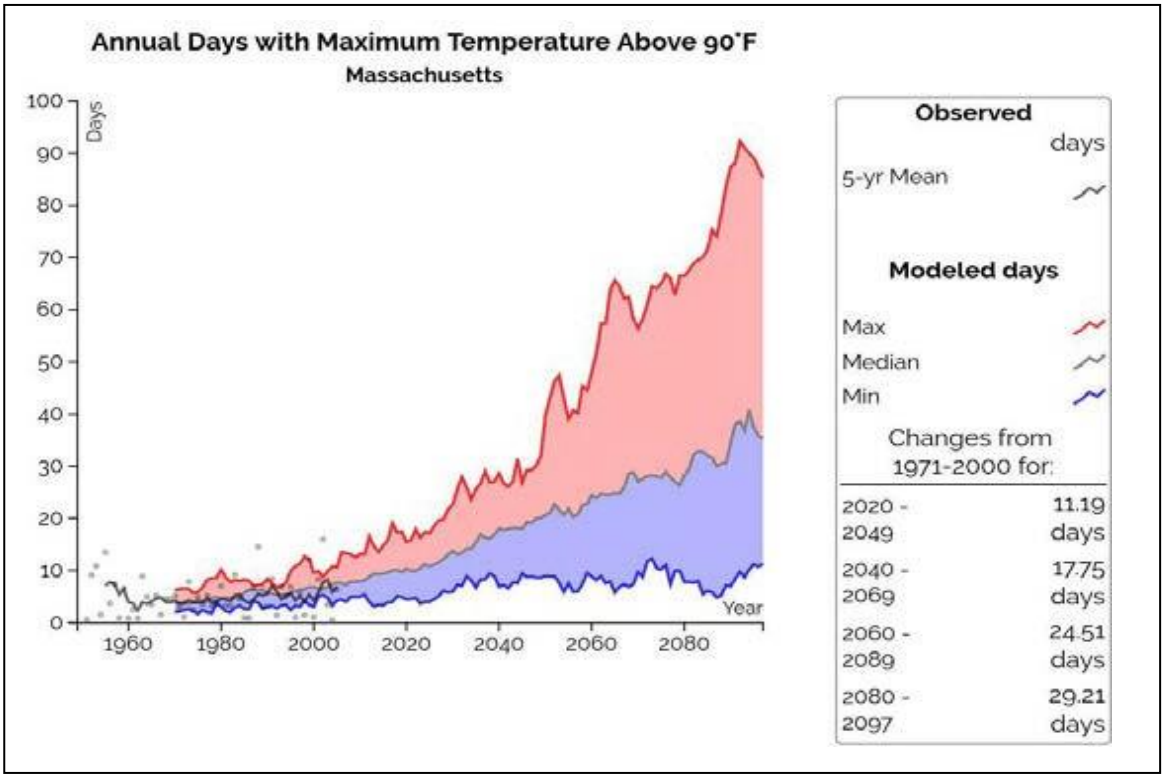
Figure 5: Observed Increase in Temperature



Source: Blue Hills Observatory

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. The Northeast Climate Adaptation Science Center (NECASC) projects average temperatures in Massachusetts will increase by 5 degrees F by mid-century and nearly 7 degrees F by the end of the century. Figure 6 shows the NECASC range of projections for increases in the number of days over 90 degrees annually.

Figure 6: Projected Increase in Annual Days Over 90 Degrees F



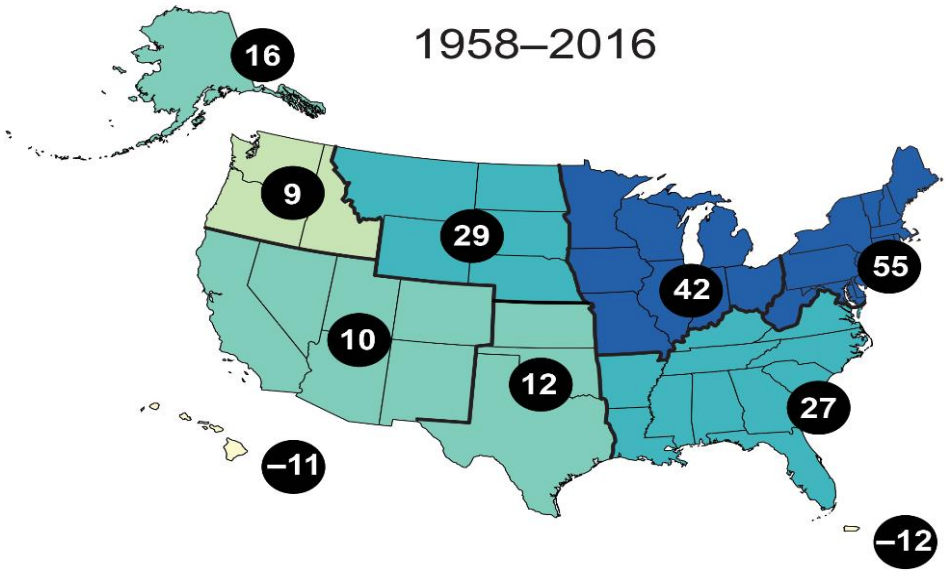
Source: Northeast Climate Adaptation Science Center

Precipitation Patterns

Annual precipitation in Massachusetts has increased by approximately 10% in the fifty-year period from 1960 to 2010 (MA Climate Adaptation Report, 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 (Figure 7). Changes in precipitation are fueled by warming temperatures which increase evaporation and, therefore, the amount of water vapor in the air.

Total annual precipitation in Massachusetts is projected to increase by 1 to 6 inches by mid-century, and by 1.2 to 7.3 inches by the end of this century (SHMCAP p. 2-22). The Fourth National Climate Assessment predicts that the pattern of increasing frequency and intensity of extreme rain events will continue. By 2070 to 2099, (relative to 1986 to 2015) they project a 30-40% increase in total annual precipitation falling in the heaviest 1% of rain events (Figure 8).

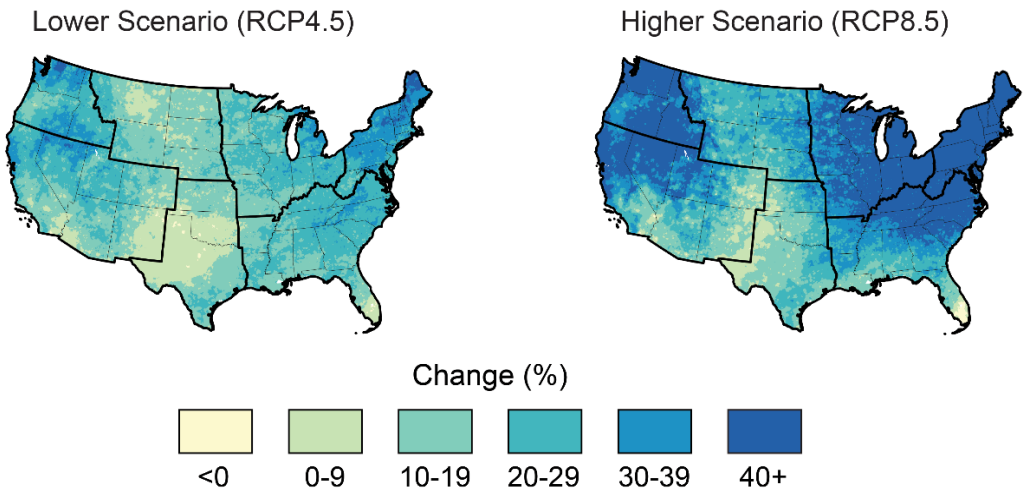
Figure 7: Observed Change in Total Annual Precipitation Falling in the Heaviest 1% of Events



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

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.

Figure 8: Projected Change in Total Annual Precipitation Falling in the Heaviest of 1% of Events for 2070-2099

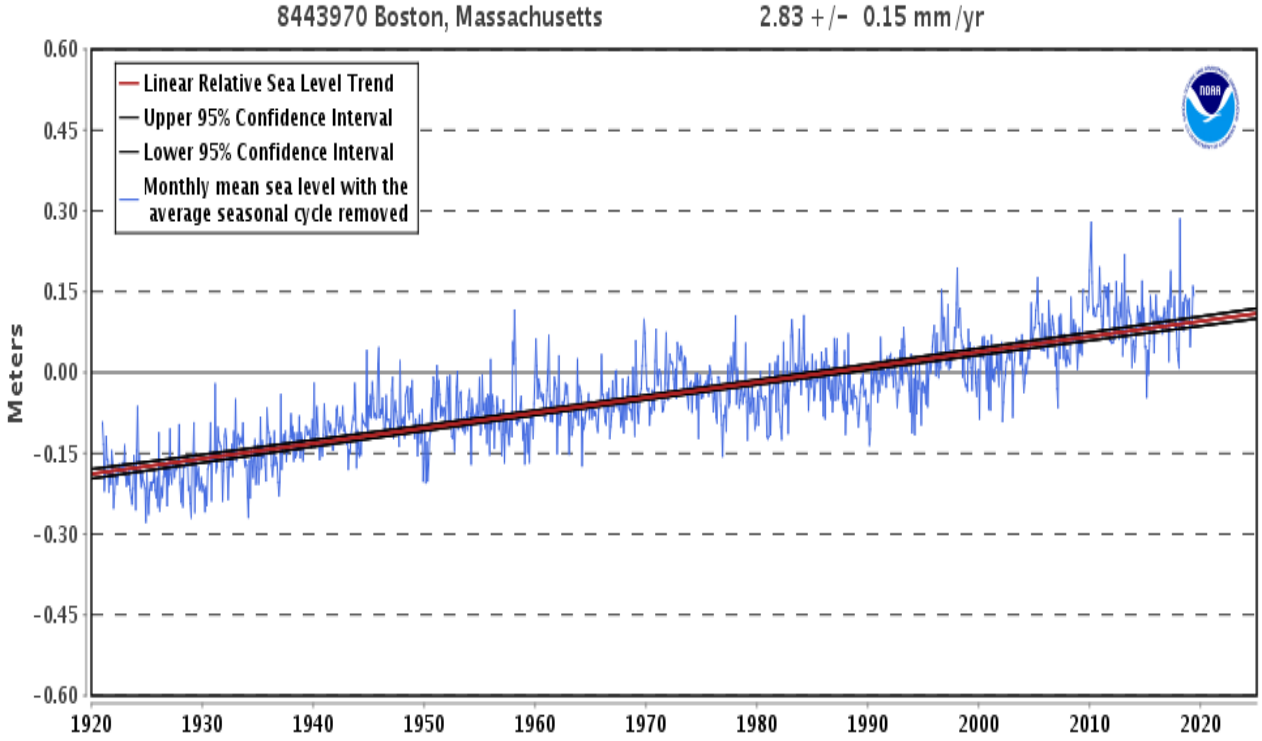


Source: Fourth National Climate Assessment, 2018

Sea Level Rise

Records from the Boston Tide Station show nearly one foot of sea level rise in the past century (Figure 9). 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.

Figure 9: Observed Increase in Sea Level Rise



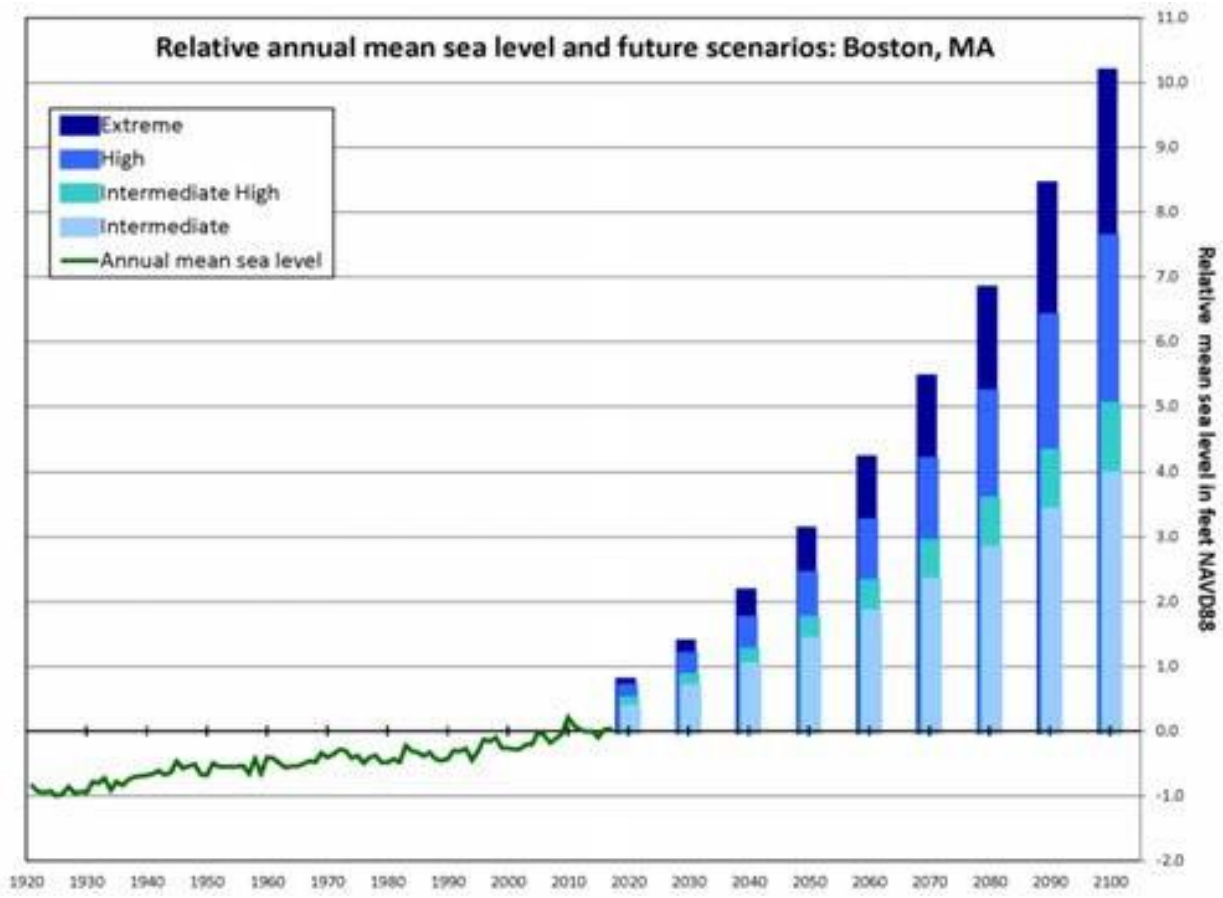
Source: NOAA

Projections of sea level rise through 2100 vary significantly depending on future greenhouse gas emissions and melting of land-based glaciers. Currently sea level is rising at an increasing rate. Figure 10 shows the recent rate of sea level rise, and a range of sea level rise scenarios. Projections for 2100 range from 4 feet to 10 feet. With ten feet representing the most extreme scenario. For 2050, the projections range approximately 1.5 to 3 feet.

Following the outline of the 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. Table 5 below, from the SHMCAP, summarizes the natural hazards reviewed in this plan, climate interactions, and expected impacts.

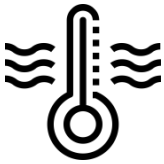
Figure 10: Recent and Projected Increase in Sea Level Rise

1



Source: SHMCAP

Table 5: Climate Change and 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 & Precipitation)		
Non-Climate-Influenced Hazards	Earthquake	Not Applicable	There is no established correlation between climate change and this hazard

OVERVIEW OF HAZARDS AND IMPACTS

In order to update Malden's natural hazards risk assessment, MAPC gathered the most recently available hazard and land use data and met with the local Hazard Mitigation Team to identify changes in locally-identified hazard areas. MAPC also used the most recently available version of HAZUS-MH (described below) to estimate potential impacts of flooding using the latest data.

Table 6 summarizes the frequency and severity of hazard risks for the City of Malden compared to the state as a whole. The assessment of frequency and severity of hazard events is based on the Massachusetts State Hazard Mitigation Plan, modified to reflect local conditions in Malden using the definitions for hazard frequency and severity listed below.

Table 6: Hazards Risk Summary

Hazard	Frequency		Severity	
	Massachusetts	**Malden**	**Massachusetts**	**Malden**
Flooding	High	High	Serious	Serious
Coastal Hazards	High	Medium	Serious	Minor
Extreme Temperatures	Medium	High	Minor	Serious
Nor'easters	High	High	Serious	Serious
Winter storms/blizzards	High	High	Minor	Minor
Severe Thunderstorms	High	High	Minor	Minor
Hurricanes/Tropical Storms	Medium	Medium	Serious	Serious
Ice storms	Medium	Low	Minor	Minor
Drought	Low	Low	Minor	Minor
Earthquakes	Very Low	Very Low	Extensive	Extensive
Tornadoes	Medium	Low	Serious	Serious
Dam failures	Very Low	N/A	Extensive	N/A
Brush fires	Medium	Very Low	Minor	Minor
Landslides	Low	Low	Minor	Minor
Tsunami	Very Low	N/A	Extensive	N/A

Source: Massachusetts State Hazard Mitigation Plan, modified to reflect conditions for Malden

Definitions used in the Commonwealth of Massachusetts State Hazard Mitigation Plan

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

Severity
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.

CHANGING PRECIPITATION PATTERNS

INLAND FLOODING

Inland flooding is generally caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms. Nor'easters can occur at any time of the year, but they are most common in winter. Hurricanes are most common in the summer and early fall. 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.

Inland flooding can be associated with overflowing rivers and streams, but more commonly in Malden flooding is related to stormwater associated with impervious surfaces and urban stormwater infrastructure. Malden is subject to two kinds of inland flooding: inland/riverine flooding where the rate of precipitation and/or amount of stormwater runoff overwhelms the capacity of natural or structured drainage systems, and urban flooding in which precipitation causes the water table to rise and leads to flooding of low-lying areas such as streets and basements. These types of flooding are often combined as storm events lead to large amounts of draining stormwater, which can be blocked by elements of the built environment and can be backed up when drainage locations (ponds, streams, etc.) are at or above capacity.

Previous Occurrences and Extent of Flooding
There have been a number of major regional floods that have affected the Metro Boston area over the last fifty years. Significant historic flood events have included:

- March 1968
- The blizzard of 1978
- January 1979
- April 1987
- October 1991 ("The Perfect Storm")
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010

The best available local data on the previous occurrences of flooding are from the National Centers for Environmental Information, which are provided by county. Malden is part of Middlesex County, for which historic flood events from 2010 through 2021 were compiled and are summarized in Table 7. Middlesex County experienced 49 flood events from 2010 through 2020. No deaths or injuries were reported, and the total reported property damage was $36.5 million dollars. Nearly all of the damage is attributed to the storm events of March 2010.

Table 7: Middlesex County Flood Events, 2010 through 2021

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	5000
10/14/2011	0	0	0
6/8/2012	0	0	0
6/23/2012	0	0	15000
7/18/2012	0	0	5000

10/29/2012	0	0	0
6/7/2013	0	0	0
7/1/2013	0	0	0
7/23/2013	0	0	0
9/1/2013	0	0	10000
3/30/2014	0	0	35000
3/30/2014	0	0	0
7/27/2014	0	0	0
8/31/2014	0	0	0
10/22/2014	0	0	20000
10/23/2014	0	0	0
12/9/2014	0	0	35000
5/31/2015	0	0	0
8/4/2015	0	0	0
8/15/2015	0	0	125000
9/30/2015	0	0	0
4/6/2017	0	0	0
6/27/2017	0	0	1000
7/12/2017	0	0	1000000
7/18/2017	0	0	0
8/2/2017	0	0	5000
10/25/2017	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	15000
8/8/2018	0	0	35000
8/12/2018	0	0	30000
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
8/7/2019	0	0	300
9/2/2019	0	0	0
6/21/2020	0	0	0
6/28/2020	0	0	5000
7/23/2020	0	0	0
9/10/2020	0	0	3000
07/09/2021	0	0	0
09/02/2021	0	0	0
11/12/2021	0	0	5000
TOTAL	**0**	**0**	**$36,589,300**

Source: NOAA, National Centers for Environmental Information

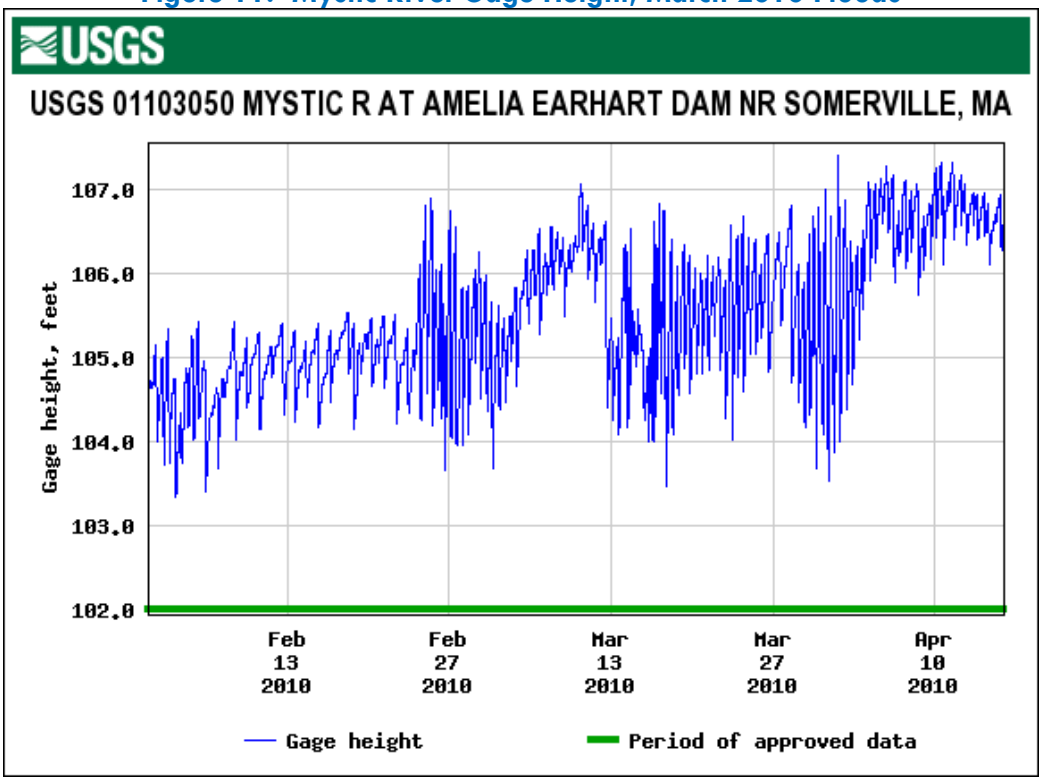
The vulnerability analysis conducted by MAPC using FEMA's HAZUS-MH model estimates damages from flooding in Malden at $$69.3 million for a 100-year storm (see Table 37). The analysis estimates other impacts of flooding, such as debris generation and evaluation and sheltering needs.

The most severe recent flooding occurred during the major storms of March 2010. The Blue Hill Observatory recorded 17.7 inches of rain from three storms in the 19 days from March 13 to 31. 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.

One indication of the extent of flooding is the level of flow in the Mystic River during this record flood. The Malden River is a tributary of the Mystic, and the closest USGS gage to the City is located at the Amelia Earhart Dam on the Mystic River. Based on USGS gage height data, Figure 11 shows that the Mystic River at the Amelia Earhart Dam exceeded 107 feet after the first storm on March 10, and again after the storm on March 31. The cumulative impact of multiple storms kept river levels high into April.

The historic March 2010 rainstorms fit the profile of a type of event expected to increase in frequency as the climate warms. That is, significant precipitation, falling in late winter as rain rather than snow, on ground saturated with snow melt, and while vegetation is still dormant. These conditions favor less recharge and more rapid runoff and overland flow of the stormwater.

Figure 11. Mystic River Gage Height, March 2010 Floods



Source: USGS National Water Information System

The March 2010 storms were a federally declared disaster making federal assistance available to residents who did not carry flood insurance. Based on the claims, Malden experienced significant flood damage, with 141 disaster claims. All but 10 of the claims, representing 93% of the total, were located *outside* of FEMA Special Flood Hazard Areas, and most were not associated with waterways or wetlands. This is not unusual in urbanized areas. See Appendix A for a map of the geographic pattern of the locations of the 2010 claims in Malden.

Overview of City-Wide Flooding

Flooding was the most prevalent serious natural hazard identified by local officials in Malden. Some flooding in Malden is caused by deficiency in the drainage system rather than location within the floodplain. However, some flooding is experienced within the floodplain of Town Line Brook, a brook located along the eastern border of Malden next to Revere.

Malden is located partially within the Mystic River watershed and partially within the Saugus River watershed. The City is not subject to coastal flooding as it is located inland from the coast on the Malden River, and above the area of tidal influence, which is controlled by the Amelia Earhart Dam, downstream from Malden in Everett. It should be noted, however, that under some more extreme future sea level projections, a large storm event could cause a storm surge as far upstream as the Malden River as well as on Town Line Brook on the east side of the City (see the section on Coastal Flooding/Sea Level Rise below).

As with future sea level rise, global climate change has the potential to increase the frequency and severity of rainstorms and snowstorms, which would be a continuation of trend observed over the past several decades.

Overview of the Drainage System

West Malden generally does not experience flooding because water levels are controlled by the Amelia Earhart Dam. Limited areas along the Malden River lie in the flood zone. The channeling of the river and the Amelia Earhart Dam limit the extent of these flood areas. The eastern area of the City that drains into Town Line Brook does experience flooding.

Townline Brook lies on the east side of Malden near the border of Revere and Everett. The brook is a 1.7 mile (1.0 miles in Malden) long surface water body that runs from Broadway to Rumney Marsh in Revere. The Metropolitan District Commission (now DCR) placed the brook in a concrete culvert for its entire length; however, the brook remains subject to tidal flows. The tidal flows greatly influence groundwater levels in some adjoining Malden and Revere neighborhoods. The Linden neighborhood in Malden has the most substantial flooding problems as a result. Lands along this brook in Malden are within the 100-year flood hazard zones and this area is subject to tidal surges of seasonal storms and hurricanes. Areas of Forestdale Cemetery and Roosevelt Park (immediately behind the Salemwood School) are also within flood hazard zones.

Much of the flooding in Malden is in the Town Line Brook watershed. In 2000, the Massachusetts Environmental Trust hired GeoSyntec Consultants to prepare a Town Line Brook Hydraulics and Hydrology Study, which was completed in 2002. The Town Line Brook watershed consists of 2,500 acres of urbanized area in Revere, Malden, Everett, and Melrose. The main channel of the brook is 2.5 miles long and was under tidal influence until the late 1950s. The upper part of the channel was excavated and lined with concrete as part of a flood mitigation project. Linden Brook (a

tributary) was almost completely enclosed in a system of culverts. A proposed detention facility and pump station were never built but tide gates were placed at the most downstream culvert to limit tidal flows into Town Line Brook. Currently, the main channel drains through a set of tide gates to Rumney Marsh and are subject to partial tidal influence.

The Town Line Brook study looked at nine mitigation strategies in various combinations. To the extent possible, these were modeled using a continuous simulation model. The alternatives that comprise the preferred approach include the following:

- Install tide gates at the Linden Brook culvert to make available additional storage at high tide when the SRT are not set closed. This has been completed.
- Install tide gates on Trifone Brook culvert to protect upstream areas from excessive downstream water surface elevations. This has been completed.
- Set SRTs to close at elevation 2' NGVD. This has been completed.
- Create approximately 76.8 acre-feet of offline storage on the main channel in combination with wetland restoration consistent with adjusted SRT closing elevation. This is unlikely to occur because it would require work being done in the environmentally sensitive Rumney Marsh which has been designated by the state as an Area of Critical Environmental Concern (ACEC). This has not been completed.
- Dredge the channel of approximately 4000 cubic yards of sediment that have accumulated in lined reaches. This has not been completed.
- Increase flood dike height to 9' NGVD at all locations. This is a recommendation for Revere. This has not been completed.

Flood Hazard Areas

Information on flood hazard areas was taken from two sources. The first was the current National Flood Insurance Rate Maps, dated June 4, 2010 for most of Malden, with two map panels on the eastern side of Malden dated July 16, 2014 and March 16, 2016. The FIRM flood zones are shown on Map 3 in Appendix B and defined below.

Flood Insurance Rate Map Zone Definitions

Zone A (Also known as Unnumbered A Zones): Special Flood Hazard Areas where, because detailed hydraulic analyses have not been performed, no Base Flood Elevations or depths are shown.

Zones AE: Special Flood Hazard Areas that are subject to inundation by the base flood determined using detailed hydraulic analysis. Base Flood Elevations are shown within these zones.

Zone AO: Special Flood Hazard Areas that are subject to inundation by types of shallow flooding where average depths are between 1 and 3 feet. These are normally areas prone to shallow sheet flow flooding on sloping terrain.

Zone VE, V1-30: Special Flood Hazard Areas along coasts that are subject to inundation by the base flood with additional hazards due to waves with heights of 3 feet or greater. Base Flood Elevations derived from detailed hydraulic analysis are shown within these zones.

Zone X (shaded): Zones where the land elevation as been determined to be above the Base Flood Elevation, but below the 500-year flood elevation. These zones are not Special Flood Hazard Areas.

Locally Identified Areas of Flooding

The second source of flooding information was the Malden Hazard Mitigation Team. The 12 Locally Identified Areas of Flooding described below were identified by City staff as areas where flooding is known to occur. These areas do not necessarily coincide with the flood zones from the FIRM maps. They 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, "Hazard Areas". The numbers do not reflect priority order. Areas vulnerable to local flooding include:

1. ***Area adjacent to Town Line Brook****:* Tide gate height issue at the Route 1 gate. Flooding only during high precipitation.

2. ***Eastern Avenue near Holy Cross Cemetery:*** Drainage backs up along Eastern Avenue and blocks the roadway during high precipitation events.

3. ***Broadway Trailer Park****:* Flooding generally occurs when there is a storm event with three or more inches of rain. There is a small creek running through the property which drains into a Massachusetts Highway Department drain. This creek is also owned by the state and is too small to handle higher rain events. MassDOT has agreed to dredge the creek, but this has not happened yet. The City notes that a neighboring parcel (FW Webb property) has some excellent drainage features (large rain garden) that have helped but not completely resolved the issues.

4. **Area east of Route 60 east of Malden High:** Low lying area, experiences drainage backups and floods during normal to high precipitation.

5. ***Bowman and Durso*:** This residential neighborhood is drained by a 48-inch culvert underground. This culvert drains to the Revere tide gate but not through the channel. The area floods due to runoff from the ledge in the Mt. View section of the city and is subject to tidal back up from the tide gate. This area is not within a flood plain.

6. ***Area near Fellsway and Pleasant Street:*** Area floods due to open brook that backs up during high precipitation.

7. ***Linden Area Neighborhood near Morris and Cleveland Street:*** This neighborhood in the Town Line Brook watershed continues to have flooding issues during high volume precipitation events combined with high tides. Storm water is prevented from draining out to sea via Town Line Brook by the Route 1 due to insufficient storm water storage capacity and backs up into the neighborhood. The area suffers floods during times of high precipitation and high tides.

8. ***Hanover Street/Marlborough/Kennard*:** In 2008 the homes in this area experienced backyard and basement flooding caused by lack of storage behind the tide gate and backups at high tide. Improvements have been done to this area to ameliorate the problem. Drain lines were cleaned and GPS documentation of the drain lines was created.

9. ***Mountain Avenue at Everett Street***: intersection floods; apartment at northeast corner floods.

10. ***Lower Pearl Street near Medford & Oakland Streets***: street and intersection flooding.

11. ***800 Eastern Ave, Police Station:*** high water at front door of Police Station; west end of building

12. ***332 Pleasant Street, Fire Station:*** Water flows down to cellar, west side of Fire Station. Highland Ave.

In addition to the areas of flooding concern identified by the team, several additional areas that have been prone to flooding during storms were submitted by City Councilor Steve Winslow during review of the draft plan. The city is investigating these areas to better determine why they flood, and they hope to have plans prepared by fall 2022 on what to do in the most flood prone areas. These areas have been added to the final plan's listing of local flood areas below, and to the hazard maps (Maps 3 and 8 in Appendix A). Detailed schematics of each of these areas are found in Appendix C.

13. Highland Ave
14. Fellsway/Highland Ave./ Pearl St.
15. Washington St./Main St./Pierce St.
16. Bowman St./Broadway
17. Spruce St./Webster St./Broadway/Eastern Ave.
18. Wescott St./Beach St./Lynn St.
19. Hadley St./Pines River

When flooding does occur in the city, the levels of flooding will vary depending on the topography of the location. Typically, the flooding results in several inches to a couple of feet of standing water. In certain locations, flooding can exceed several feet of water due to the low elevation beneath underpasses.

Based on the record of previous occurrences, floods in Malden are high frequency events as defined by the Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Repetitive Loss Properties

As defined by the Community Rating System (CRS) of 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/txt/rebuild/repetitive_loss_faqs.txt

There are eight (8) repetitive loss structures in Malden, which have experienced a total of 12 losses. with a total of $35,038 in losses. Four of the five properties are residential and the fifth is

commercial. Of the residential properties, two are multi-family homes, and two are single family homes. One of the multi-family properties is located in a Zone A flood hazard zone and both of the single-family homes are located in Zone AE flood hazard zones

Table 8 summarizes the number and type of repetitive loss structures located within Malden and the number of losses and total claims associated with them as of January 21, 2022.

Table 8 Summary of Repetitive Losses in Malden

	AE, A1-30, AO, AH, A	VE, V1-30, V	B,C,X	Total
Number of Properties	6	0	2	8
Number of Losses	8	0	4	12
Value of Building Losses	$86,896.91	0	$10,218.95	$97,115.86
Value of Contents Losses	$3,630.28	0	$6,791.89	$10,422.17
Total Losses	**$90,527.19**	**0**	**$17,010.84**	**$107,538.03**

Source: Department of Conservation and Recreation, FEMA Repetitive Loss data

ICE JAMS

Ice jams occur in cold weather when normally flowing water freezes, effectively damming the waterway and causing localized flooding. Flooding may also occur when ice jams break up and ice may pile up at culverts or around bridges. There is no record of ice jams in Malden, and the local team did not identify this hazard as an issue for the City.

CLIMATE CHANGE IMPACTS ON FLOODING

Precipitation-based Flooding

As the climate continues to warm, precipitation events are projected to become more severe. There has already been a well-documented trend of increasing storm intensity over the last several decades (Figure 7). A study prepared by the neighboring City of Somerville's, the *Climate Change Vulnerability Assessment,* addresses the projected future impacts of climate change on both inland and coastal flooding. This assessment utilized projections for future increases in precipitation to assess the potential impacts of climate change on the city. The study employed climate change projections that are consistent with analyses that have been conducted recently by the Cities of Cambridge and Boston, so the projections are useful at a regional scale for communities in the metropolitan Boston area.

Table 9 displays the anticipated increases in precipitation in the years 2030 and 2070 for the 10-year, 24-hour and the 100-year, 24-hour design storm. These are the standard storms used to design stormwater drainage facilities for new development, redevelopment, and municipal infrastructure. The table shows that the 10-year storm will increase by 1.5 inches by 2070, a 30 percent increase in the amount of precipitation that stormwater systems will need to handle on a regular basis (on average, every 10 years). Given that portions of the existing stormwater systems in virtually all communities do not fully manage today's larger precipitation events, this projection underscores the need to upgrade existing stormwater infrastructure.

Table 9: Precipitation Projections

Design Storm	Present-day	2030	2070
10-year, 24-hour	4.9 in	5.6 in	6.4 in
100-year, 24-hour	8.9 in	10.2 in	11.7 in

Source: Somerville Climate Change Vulnerability Assessment, 2017

The projected precipitation for the "100-year" storm shows a slightly higher increase of 31.5 percent over present day storms of this magnitude. Most stormwater systems are not designed to accommodate even the present-day 100-year storm, so an additional 2.8 inches by the year 2070 would certainly cause significantly more flood damage, although this has not yet been quantified. Flood modelling to estimate the future areas of inundation and flood damage due to climate change have only recently begun to be prepared. When they become available, they should be incorporated into future editions it the Hazard Mitigation Plan.

Coastal Flooding/Sea Level Rise

Higher sea levels increase the frequency and extent of coastal flooding. In the past 100 years, the relative change in sea level in Boston Harbor has been about one foot (Figure 9). Climate change is accelerating the rate of global sea-level rise primarily by warming the oceans, causing the water to expand in volume, and also by warming the land and air, causing ice on land (glaciers, ice sheets) to melt and flow into the ocean. Projections of future Sea Leve Rise in the State Hazard Mitigation and Climate Adaptation Plan (Figure 10), estimate a range of approximately 1.5 to 3 feet for the yar 2050. For the year 2100, the range is 4 feet to 10 feet.

Coastal flooding occurs when the wind and tides overtop the shoreline and inundate low-lying areas. However, Malden currently has no direct exposure to tidal flooding due to the Amelia Earhart Dam, which limits tidal influence on the Mystic River above the dam, including the Malden River (Figure 12). Prior to the dam's construction, the Malden River was a tidally influenced tributary of the Mystic River, meaning that a very large coastal storm surge could potentially reach upstream from Boston Harbor, through the Mystic River, to the Malden River. Before the Amelia Earhart Dam was constructed, there is evidence of coastal flooding as far back as 1933, extending upstream into Malden and Medford.

Given the City's reliance on the Amelia Earhart Dam to protect against tidal storm surges, the Somerville *Climate Change Vulnerability Assessment* mentioned above provides useful analysis relevant to Malden. The assessment utilized projections for future increases in sea level rise and storm surge to assess the potential impacts of climate change on the dam. In the Boston metro region, sea level is projected to rise approximately 4-8" by 2030 and 15-36" by 2070.

There is no evidence that the Amelia Earhart Dam has been overtopped or breached since its construction. However, the modeling for this area suggests that the dam may be regularly flanked during 1% annual storm events (100-year storms) as early as 2035 and could be overtopped as early as 2055.

Figure 12: Amelia Earhart Dam

Source: Somerville Climate Forward Plan, 2018

The *Climate Change Vulnerability Assessment* lists several key areas of vulnerability to coastal flooding of regional significance, as follows:

•The Amelia Earhart Dam could be regularly flanked by coastal storm events as early as 2035.

• Major commuter corridors and key transportation infrastructure, including Routes I-93 and 28, Assembly Square Station, the Commuter Rail, the Orange Line, and the Commuter Rail Maintenance facility in addition to several bike paths and bus stops may be at risk from coastal flooding as early as 2030 and may be significantly impacted by 2070.

• The Mystic Generating Station in Everett, which is critical to the region's electricity supply, along with other energy (5 substations) and fuel facilities, are likely to experience impacts from coastal flooding by 2070.

DROUGHT

At the other end of the hydrologic spectrum from extreme precipitation is drought. 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 inches 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 2019 Massachusetts Drought Management Plan divides the state into seven regions: Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape Cod, and Islands. Malden is located in the Northeast region. Drought is a potential city-wide hazard in Malden.

The MA Drought Management Plan was revised in 2019 to change the state's classification of droughts by establishing four levels to characterize drought severity: Mild Drought, Significant Drought, Critical Drought, and Emergency. These levels are based on conditions of natural resources and provide information on the current status of water resources. The levels provide a framework from which to take actions to assess, communicate, and respond to drought conditions. The Massachusetts drought levels are shown in comparison to the U.S. Drought Monitor levels in Table 10. The two sets of drought indices are similar, but Massachusetts combines the USDM's level D2 and D3 into one category, Critical Droughts.

Table 10: MA Statewide Drought Levels Compared to US Drought Monitor

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

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. Drought levels are used to coordinate both state agency and local response to drought situations.

As dry conditions can have a range of different impacts, a number of drought indices are available to assess these various 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 six 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 11 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.

Table 11: 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

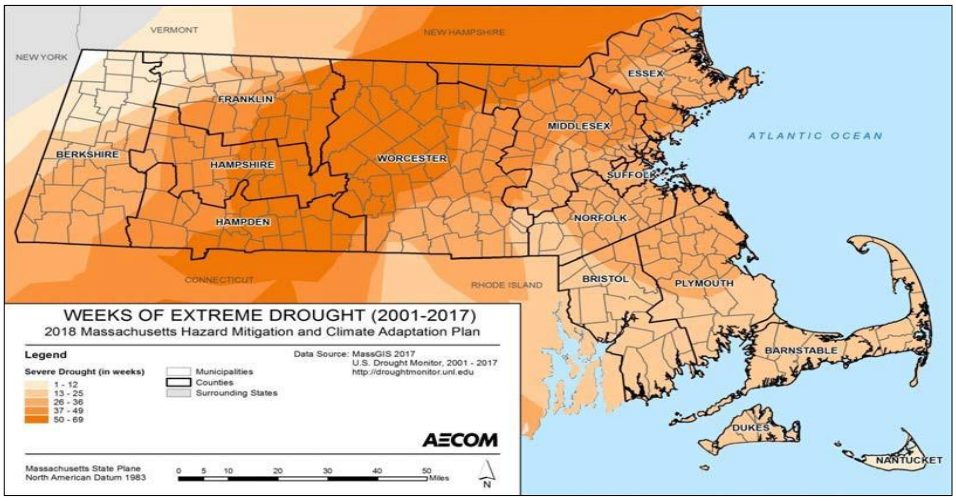
Determinations regarding the end of a drought or reduction of the drought level focus on two key drought indicators: precipitation and groundwater levels. These two factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture and potential for forest fires.

Previous Occurrences of Drought

Drought emergencies have been reached infrequently, with five events occurring between 1850 and 2012: 1883, 1911, 1941, 1957, and 1965 to 1966. Due to its long duration, the drought from 1965 to 1966 is viewed as the most severe drought to have occurred in Massachusetts in modern times. The drought that extended from July 2016 to April 2017 reached the Drought Warning level.

The U.S. Drought Monitor characterizes droughts as moderate, severe, extreme, or exceptional. Severe drought is characterized by likely crop and pasture losses, water shortages, and water restrictions. As shown in Figure 13 below, Malden experienced between 26 and 36 weeks of severe drought between 2001 and 2017.

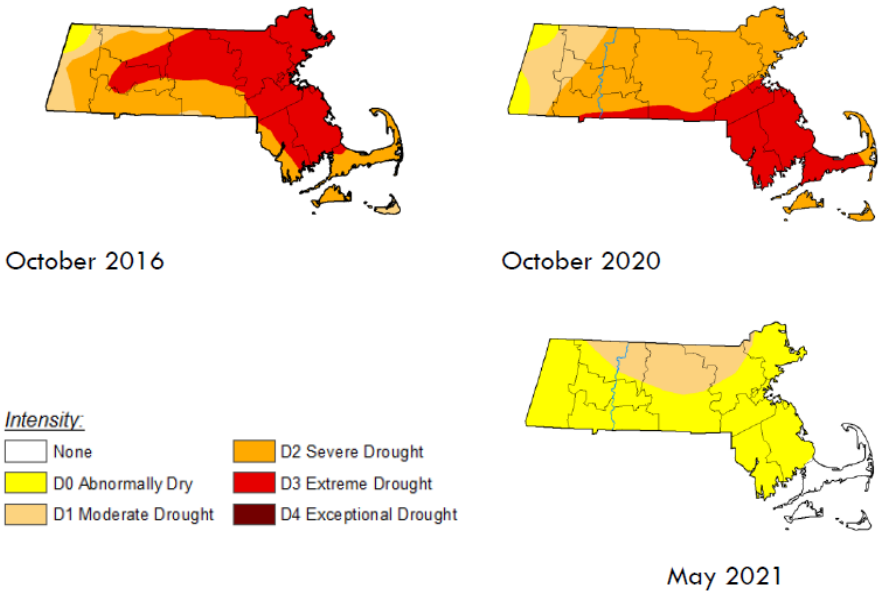
Figure 13: Weeks of Severe Drought (2001-2017)



Source: SHMCAP

In the last six 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 14). This was followed by another drought just four years later in 2020, which was most severe in Southeastern Massachusetts and somewhat less so in Malden. 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 14: Recent Drought Events (2016-2021)



Source: U.S. Drought Monitor

Potential Drought Vulnerability

Malden's potential vulnerability to a severe long-term drought could be a reduction in the availability of water supplies, which in turn could affect public health and economic activity. Potential damages could include losses of landscaped areas if outdoor watering is restricted and potential loss of business revenues if water supplies were severely restricted for a prolonged period. As this hazard has never occurred in Malden, there are no data on potential damages, but under a severe drought scenario it would be reasonable to expect a range of damages from several million to tens of millions of dollars. However, given the resilience of the MWRA water system due to its large amount of storage in the Quabbin and Wachusett Reservoirs (equivalent to five years of water demand), severe impacts on the city are unlikely. For example, even during the multi-year drought of record in the1960s, there were no severe limitations of supply from the regional water system, which at the time was operated by the Metropolitan District Commission

Table 12: Frequency of Massachusetts Drought Levels

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

Probability of Future Occurrences

Because drought tends to be a regional natural hazard, this plan references state data as the best available data for drought. Drought is a city-wide hazard in Malden. 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 (Table 12).

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. Drought impacts can include reduced groundwater and surface water levels, affecting water quality and quantity, and the organisms that rely on aquatic resources. Drought also increases stress on plant communities and, the likelihood of forest and brush fires. Communities may be affected by water use restrictions, affecting drinking water supply and outdoor water use. Economic sectors impacted could include recreation, agriculture, and forestry.

LANDSLIDES

According to the U.S. Geological Survey, "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; earthquake created stresses that make weak slopes fail; excess weight from accumulation of rain or snow; and stockpiling of rock or ore from waste piles or man-made structures. 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.

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. Drought may also increase the likelihood of landslides if loss of vegetation decreases soil stability.

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 the destructiveness. Table 13 summarizes the estimated intensity for a range of landslides. Fast moving rock falls have the highest intensity while slow moving landslides have the lowest intensity.

Table 13 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 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. According to the SHMCAP, factors that influence landslide severity include soil properties, topographic position and slope, and historical incidence.

Malden is classified as having a low incidence of landslides, with the northwest section designated low incidence and moderate susceptibility (see Map 4, Appendix A). Although potentially a city-wide hazard, here have been no recorded landslides in Malden. Should a landslide occur in the future, the type and degree of impacts would be highly localized. The city's vulnerabilities could include localized damage to structures, damage to transportation and other infrastructure, and localized road closures. Potential damages would depend on how many properties were affected. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Malden. 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.

RISING TEMPERATURES

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 extended periods of time where there is a long stretch of excessively hot or cold weather. Malden 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 that are far outside of the normal seasonal ranges for Massachusetts.

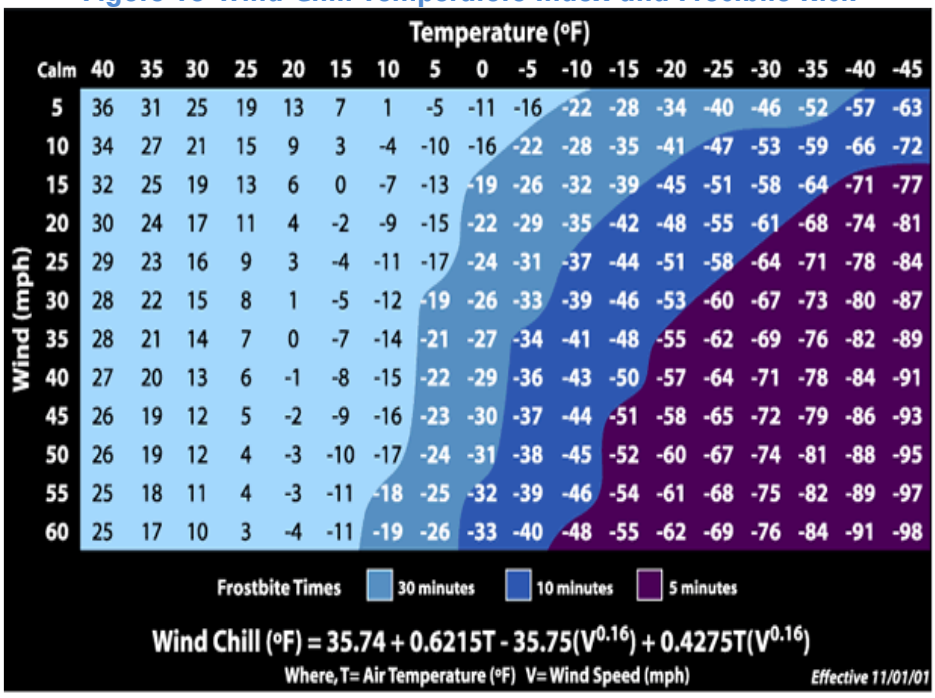
EXTREME COLD

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 15 below. A Wind Chill warning is issued when the Wind Chill Index is forecast to fall below -25 degrees F for at least 3 hours.

Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter, those who are stranded, or those who live in homes that are poorly insulated or without heat.

The best available local data on extreme cold events are recorded for Middlesex County through the National Centers For Environmental Information (NCEI). As shown in Table 14, there have been three reported extreme cold events in the past six years, which caused no deaths, no injuries, or property damage. This is an average of one event every 3.5 years. Extreme cold is a city-wide hazard for Malden.

Figure 15 Wind Chill Temperature Index and Frostbite Risk



Source: National Weather Service

Table 14: Middlesex County Extreme Cold Occurrences 2010 through 2022

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

Source: NOAA, National Centers for Environmental Information

Impacts and Vulnerabilities of Extreme Cold

Malden's vulnerability to extreme cold events is primarily related to vulnerable populations, including children, the elderly, and those who have a physical disability or certain medical conditions. Extreme cold 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 would be a power outage, which could temporarily leave many residents without heat. In Malden, 6.0% of residents are under the age of 5 and 13.1% are 65 years of age or older. Those with disabilities represent 10.5% of the population.

EXTREME HEAT

A heat wave in Massachusetts is defined as three or more consecutive days above 90°F. Another measure used for identifying extreme heat events relies on the Heat Index. According to the National Weather Service (NWS), the Heat Index is a measure of how hot it really feels relative humidity is factored in with the actual air temperature. The NWS issues an advisory when the heat index (Figure 16) is forecast to exceed 100°F for two or more hours; an excessive heat advisory is issued if the forecast predicts the temperature will rise above 105°F.

Figure 16: 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.

b

Source: National Weather Service

The best available local data on extreme temperatures in the Boston area are available from NOAA's NOWData (NOAA Online Weather Data). Historic records of the number of days per year with high temperatures 90F or more for the last 100 years were compiled and are displayed graphically in Figure 17. The long-term trend is for more extreme heat in recent years.

Figure 17: Annual Number of Days > 90F in the Boston Area1920 - 2021

YEAR	#DAYS	YEAR	#DAYS	YEAR	#DAYS	YEAR	#DAYS
1920	5	1946	10	1972	9	1998	8
1921	13	1947	10	1973	19	1999	16
1922	9	1948	12	1974	7	2000	4
1923	12	1949	22	1975	15	2001	16
1924	14	1950	8	1976	17	2002	27
1925	13	1951	6	1977	18	2003	6
1926	6	1952	17	1978	9	2004	4
1927	6	1953	15	1979	12	2005	14
1928	16	1954	10	1980	22	2006	11
1929	15	1955	28	1981	11	2007	18
1930	19	1956	11	1982	7	2008	8
1931	17	1957	11	1983	30	2009	6
1932	7	1958	5	1984	18	2010	25
1933	16	1959	22	1985	4	2011	13
1934	5	1960	8	1986	4	2012	12
1935	4	1961	14	1987	9	2013	18
1936	10	1964	5	1988	25	2014	8
1937	16	1963	16	1989	7	2015	14
1938	10	1964	9	1990	10	2016	22
1939	10	1965	9	1991	27	2017	12
1940	7	1966	10	1992	2	2018	23
1941	18	1967	3	1993	20	2019	15
1942	6	1968	10	1994	22	2020	14
1943	17	1967	11	1995	17	2021	24
1944	21	1970	14	1996	3		
1945	8	1971	15	1997	19		

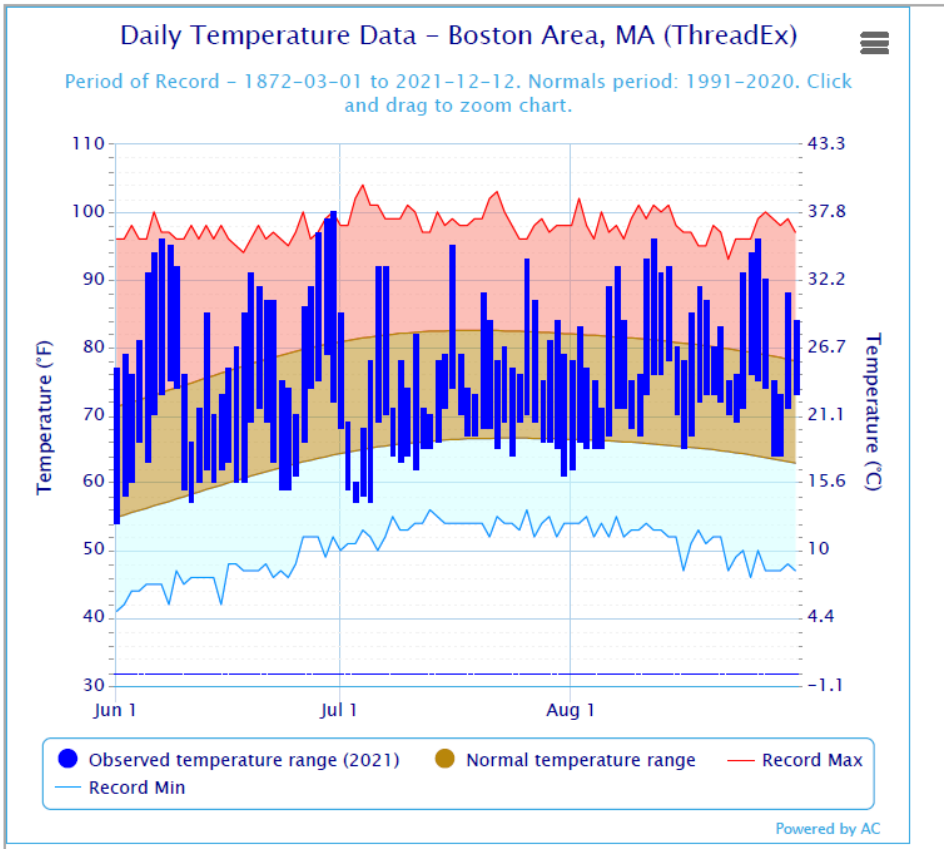
Source: NOAA Online Weather Data (NOWData), compiled by MAPC

0-10 DAYS	11-15 DAYS	16 – 20 DAYS	20 -30 DAYS

Heat Waves

While the number of 90F+ days per year is a broad indication of extreme temperatures, an indicator that relates more directly to public health impacts is the occurrence of multiple-day heat waves, defined at three or more consecutive days with high temperatures 90F or higher. The most recent summer of 2021 was an example of this, as shown in Figure 18.

Figure 18: Summer 2021 Temperatures, Boston Area



Source: NOAA

The summer of 2021 was particularly hot, with four heat waves, two in June and two in August. Two of these lasted for five days, one lasted four days, and one lasted three days. Overall, there were 24 days 90F or more, 17 of which occurred during the four heat waves. Reviewing similar records for the last decade, the number and duration of heat waves from 2010 to 2021 is summarized in Table 15.

Table 15: Heat Waves, 2010-2021, Boston Area

Year	Number of Heat Waves	Number of Days 90F+
2010	3	25
2011	2	13
2012	2	12
2013	3	18
2014	0	8
2015	1	14
2016	1	22
2017	2	12
2018	2	25
2019	2	15
2020	3	14
2021	4	24

Source: NOAA

Urban Heat Island

Due to what is termed the Urban Heat Island effect (UHI), areas with less shade and more dark 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 10 in Appendix A 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. Additionally, Malden is a densely settled municipality that is mostly urbanized, so city as a whole experiences vulnerability to extreme temperatures due to urban heat island effects.

Hot summer days can also worsen air pollution. In areas of the Northeast that face problems with smog, inhabitants are likely to experience more days that fail to meet air quality standards. Heat waves and lower air quality can threaten the health of vulnerable populations.

Extreme Heat Impacts and Vulnerabilities

The impacts of extreme heat were evaluated by the Urban Land Institute in "Living With Heat," prepared in 2019. The report summarizes some of the key impacts as follows:

The rise in temperature in metropolitan areas is leading to an increase in health-related problems, particularly for children, the elderly, and economically disadvantaged groups. During extremely hot and humid weather, the ability of the body to cool itself is greatly diminished. So, when the body heats too rapidly to cool itself properly, the body temperature rises, which can lead to fatigue, muscle cramps, heat exhaustion, fainting, and heat stroke. A series of consecutive days with warmer-than-average temperatures often results in more hospital admissions for respiratory, cardiovascular, and kidney-related diseases.

Many deaths are not directly attributed to heatstroke, but drastic increases in temperatures can turn preexisting conditions such as heart problems or lung disease fatal. In the Northeast, we can expect approximately 650 deaths per year by 2050.

Disparate impacts on Vulnerable Populations

Like many environmental health issues, the impacts of extreme heat are felt disproportionately across society. Unequally vulnerable communities include those who are challenged by poverty or homelessness, the elderly, young, socially isolated, and those who have preexisting medical conditions. African-American, Latino, and Asian communities are also considered higher risk groups, as are outdoor workers, including the construction industry.

Low-income communities are often underserved by green spaces that can mitigate urban heat and by civic amenities such as cooling facilities. Low-income communities are also less likely to have access to air conditioning and cooler recreational facilities such as swimming pools or gyms.

Effects of Extreme Heat on Cognition

While much of the research regarding health issues triggered by extreme heat focuses on the most vulnerable populations, there is also a significant impact on healthy adults and children in the form of impaired cognitive functioning, according to recent studies.

According to Dr. Joseph Allen, director of the Healthy Buildings Program at the Harvard T.H. Chan School of Public Health "We are all susceptible to the effects of heat stress and heat waves, even the young and healthy, and there are impacts beyond mortality, such as impaired cognitive functioning experienced as a result of indoor heat waves. This has implications for students as well as the business community."

Business Continuity

Extreme heat can contribute to other adverse events such as electrical grid failures, transportation interruptions, wildfires, and water shortages, all of which can cause human harm, business disruptions, and economic losses. Buildings and developments designed to be more prepared for these events have the potential to be more attractive to tenants, particularly in Class A office space, and may also eventually be eligible for preferable insurance rates. These types of weather-related continuity events also present risks because of potential property losses, tenant defaults, or both.

A report prepared for the nearby City of Somerville, *The Wellbeing of Somerville* (2017) describes how extreme heat has disproportionate health impacts on both the young and the elderly:

Young children are more vulnerable to extreme heat, poor air quality and insect-borne diseases. One reason for this is their limited ability to communicate when overheating or left in dangerous situations. These impacts on children often have a ripple effect on families and economics. If schools or daycares are closed due to weather, parents need to find alternative childcare options. This may impact the ability of parents to work and, therefore, impact the family's income.

Increases in temperature linked to climate change are projected to cause a correlating increase in the risk of insect-borne diseases such as Lyme disease and West Nile virus. Impacts to children's health can include a wide range of ongoing physical, behavioral, and cognitive problems.

Elderly residents often have greater physical limitations during a climate event. These limitations include higher overall health vulnerability. As a result of these vulnerabilities, older individuals – across all income brackets – have a greater reliance on support services, including senior centers and cooling centers during high heat events. Elderly residents that live alone may be more socially isolated and lack reliable access to transportation, which can make it more difficult for them to access support services or evacuate during emergency events.

Exposure to poor air quality, which is impacted by heat, traffic pollution and rising pollen levels, can be linked to cardiac and lung problems, as well as cognitive and memory issues in seniors, altering quality of life, as well as longevity. Older adults, especially frail or immune compromised adults, may also be more at risk for the increasing presence of insect borne diseases.

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

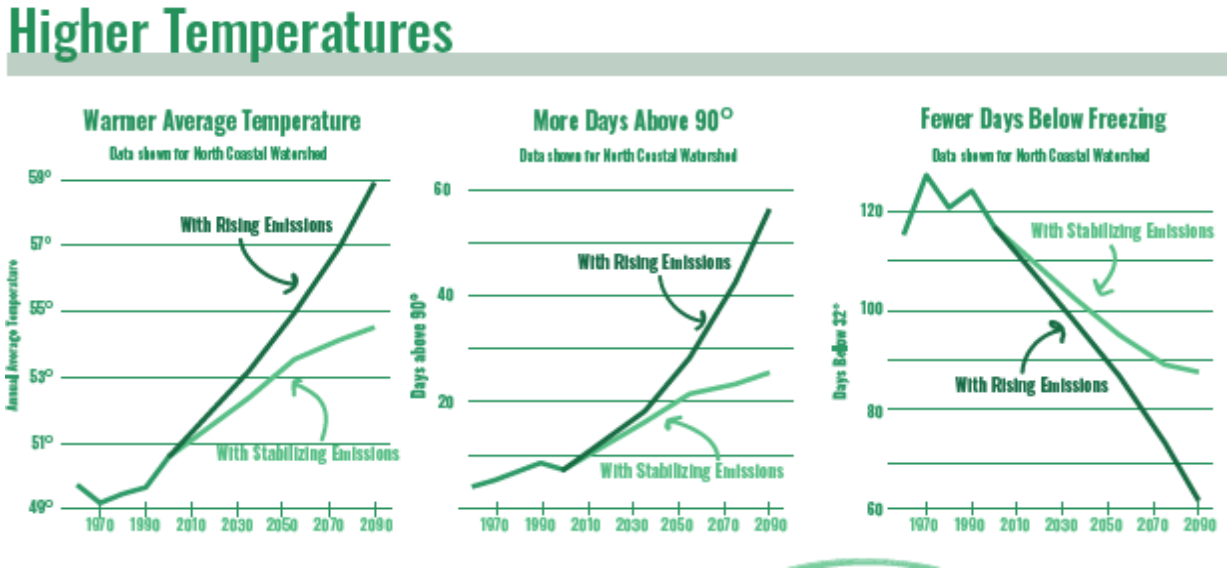
Probability of Future Occurrences

Based on the record of previous occurrences, extreme temperatures are a high frequency event as defined by the Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years, or a greater than 20% chance per year.

CLIMATE CHANGE AND EXTREME TEMPERATURES

Extreme cold events are predicted to decrease in the future, while extreme heat days, as well as average temperatures are projected to increase (Figure 19). Average temperatures in Massachusetts are projected to increase by 3.8 to 10.8 degrees by the end of the century (SHMCAP). Over time our climate will become more similar to areas south of New England as far south as Virginia and North Carolina.

Figure 19: Massachusetts Projected Temperatures for Climate Scenarios to 2100



Source: ResilientMA.org

The Somerville Climate Change Vulnerability Assessment presents temperature projections for the City based on the Cambridge Climate Change Vulnerability Assessment (Table 16), which are useful for surrounding communities since temperature is a regional phenomenon. Annual average temperatures are projected to increase by 2-3°F by 2030 and could increase by as much as 7-8°F (under the high emissions scenario) by 2070. By the end of the century, average summer temperatures are expected to experience proportionally greater temperature increases than winter temperatures. Winters will likely still be cold in Malden, but summers could be much hotter than today.

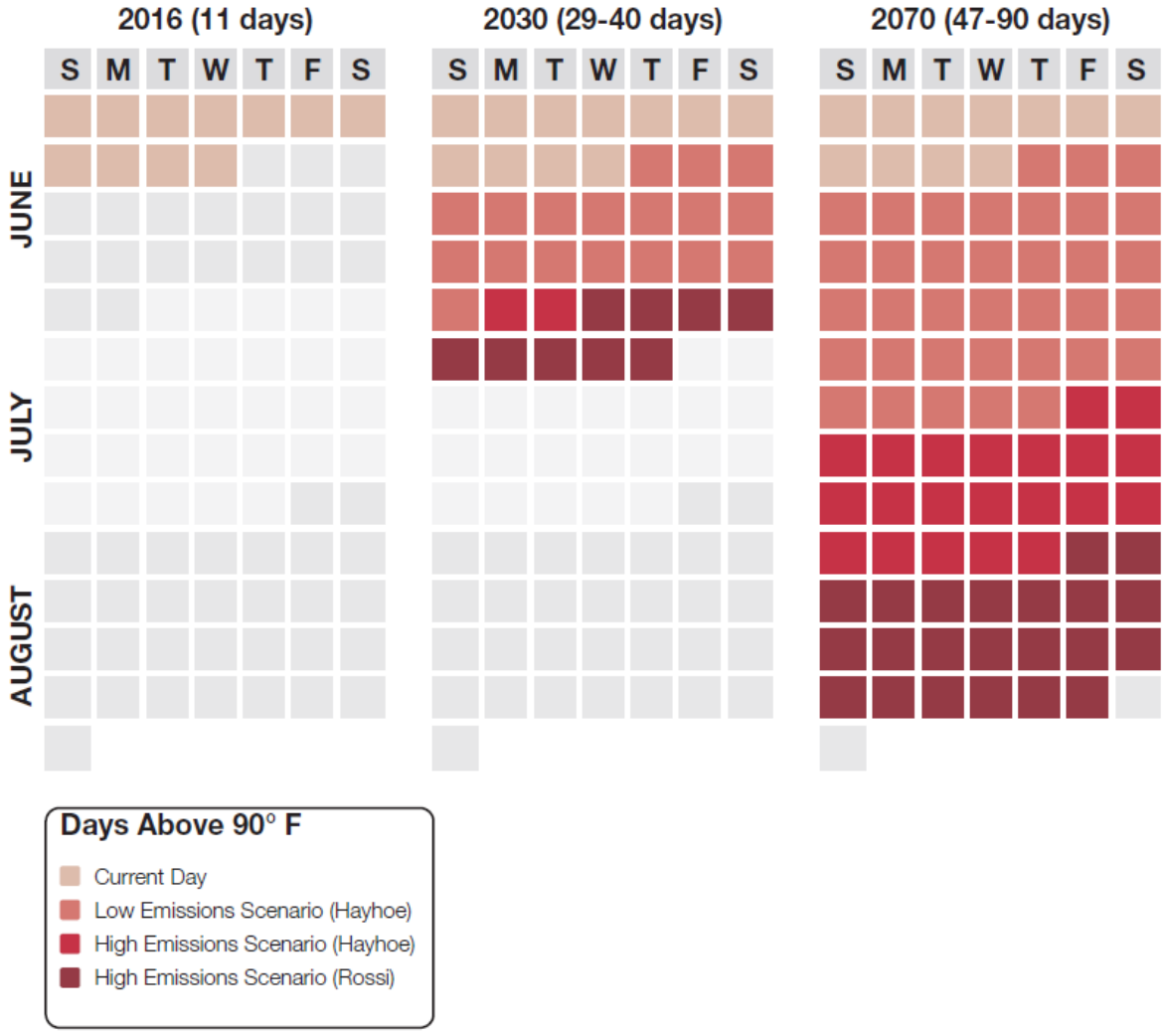
Extreme heat days are also projected to increase; by 2030, it is anticipated that the region could experience as many as 29-40 days over 90°F and, by 2070, that number could increase to 47-90 days over 90°F. By 2070, it is possible that the entire summer will be marked by temperatures above 90°F. (Figure 20).

Table 16: Projected Temperatures for Climate Scenarios to 2070

	1971-2000 Average	2030 RCP4.5	2030 RCP8.5	2070 RCP4.5	2070 RCP8.5
Average Annual Temperature	50.0	53.0	53.5	55.8	58.7
Average Summer Temperature	70.6	74.5	74.8	77.4	80.6
Average Winter Temperature	29.8	32.2	33.0	34.6	38.0

Source: Somerville Climate Change Vulnerability Assessment

Figure 20: Comparison of Days Above 90F for Low and High Emission Scenarios



Source: Somerville Climate Change Vulnerability Assessment

WILDFIRE HAZARDS

A wildfire is a non-structure fire occurring in a forested, shrub or grassland area. In the Boston region these fires rarely grow to the size of a wildfire, as seen more typically in the western U.S or even more rural areas of Massachusetts. A more likely occurrence is brush fires that typically burn no more than the underbrush of a forested area or an area of Phragmites. There are three different classes of wildfires:

- Surface fires 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.

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. Wildfire season can begin in March and usually ends in late November. The majority of wildfires typically occur in April and May, when the majority of 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.

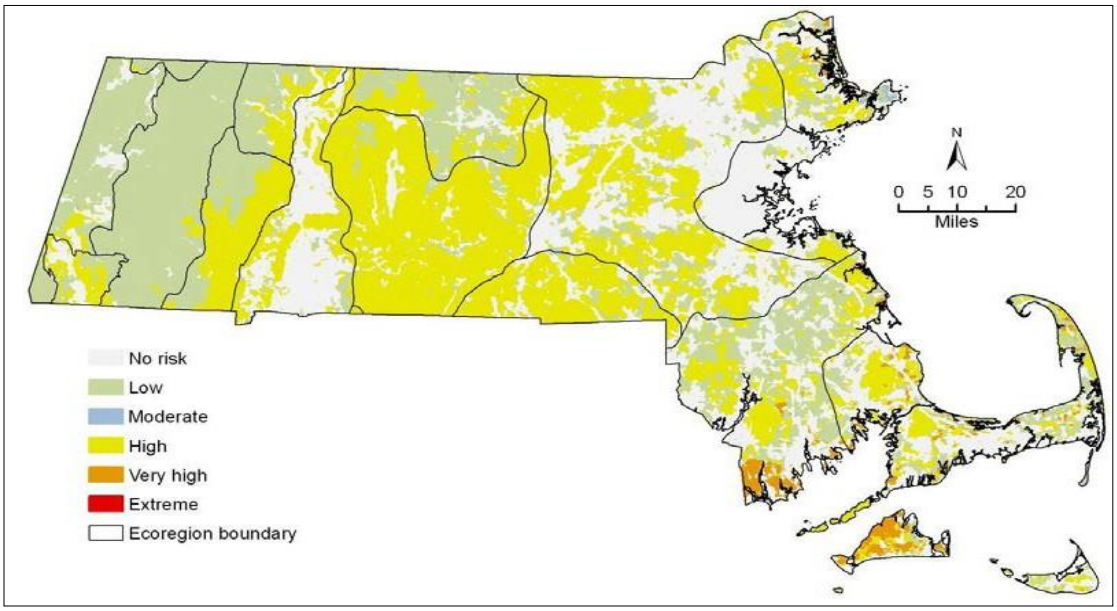
Fires can present a hazard where there is the potential to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire the spread into homes. Protecting structures from fire poses special problems and can stretch firefighting resources to the limit. If heavy rains follow a fire, other natural disasters can occur, including landslides, mudflows, and floods. If **a** wildfire destroys the ground cover, then erosion becomes one of several potential problems. Should a wildfire occur in Malden 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.

Potential Wildfire Hazard Areas

The SCHMCAP depicts statewide fire risk incorporating three risk components: fuel, wildland-urban interface, and topography (Figure 21). The wildland-urban interface reflects communities where housing and vegetation intermingle, and fire can spread from structures to vegetated areas. The most susceptible fuels are pitch pine, scrub oak and oak forests.

In Malden, when wildfires occur, they are typically limited to small, vegetated pieces of land. The Malden Fire Department has provided a record of responses to outdoor fires from 2013 to 2022, which includes several categories: natural vegetation; forest, woods, and wildlands; grass fires, and brush or brush and grass mixture, which is by far the most common type in Malden. (Appendix D). The Fire Chief observed that the area of the City that is potential most vulnerable to wildfires is the "Urban-Wildland Interface," where open vegetated land is in proximity to developed areas. In Malden this is limited to areas in the north and west of the City that are adjacent to the Middlesex Fells Reservation and Pine Banks Park. Thirteen of the fires recorded since 2013 are in one of these areas including East Border Road, West Border Road, Fellsway East, and Forest Street, However, past incidences of brushfires have not spread to adjacent buildings or caused significant property damage.

Figure 21: Wildfire Risk Areas in Massachusetts



Source: SHMCAP

Potential vulnerabilities to brushfire include damage to structures and other improvements, injuries and loss of life, and impacts on natural resources. 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. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. However, in Malden, the extent and frequency of brushfires is low, and the City has not experienced serious impacts.

Based on past occurrences, brushfires in Malden are of Medium frequency, events that can occur from once in 5 years to once in 50 years (2% to 20% probability per year).

EXTREME WEATHER

HURRICANES AND TROPICAL STORMS

A hurricane is a violent wind and rainstorm with wind speeds of 74 to 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 land. A tropical storm has similar characteristics, but wind speeds are between 34 and 73 miles per hour. 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. Hurricanes are seasonal events that occur between June and November.

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. Table 17 gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

Table 17: Saffir/Simpson Scale

Scale No.	Winds (mph)	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

Previous Occurrences

The region has been impacted by hurricanes throughout its history, starting with the Great Colonial Hurricane of 1635. Since 1900, 39 tropical storms have impacted New England (NESEC), and Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane. Hurricanes in Massachusetts since 1938 are shown in Table 18.

As shown on Map 5 in Appendix A, no hurricanes have tracked directly through Malden. A hurricane storm track is the line that delineates the path of the eye of a hurricane or tropical storm. However tropical storms and hurricanes have regional impacts, and Malden can experience the impacts of the wind and rain from hurricanes and tropical storms regardless of whether a storm track passes directly through the city. The hazard mapping indicates that the 100-year wind speed in Malden is 110 miles per hour.

Falling trees and branches are a significant impact of the high winds of hurricanes, which often results in power outages or block traffic and emergency routes when they fall on roads. Rainfall associated with hurricanes can cause flooding In the city's rivers and streams, as well as localized urban drainage flooding. Potential hurricane damages to Malden have been estimated using HAZUS-MH. Total damages are estimated at $38.8 million for a 100-year frequency hurricane and $174.7 million for a 500-year hurricane. Table 37 summarizes other impacts such as storm debris and evacuation needs of hurricanes.

Table 18: Hurricane Records for Massachusetts 1938-2018

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 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

Source: National Oceanic and Atmospheric Administration

Hurricanes are a city-wide hazard in Malden.

Based on records of previous occurrences, hurricanes in Malden 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.

SEVERE WINTER STORM/NOR'EASTER

Nor'easters

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 (see Figure 22) and these storms feature sustained winds of 10 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rain or snow, depending on temperatures.

Previous Nor'easter Occurrences

Previous occurrences of nor'easters include the storm events shown on Table 19. 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.

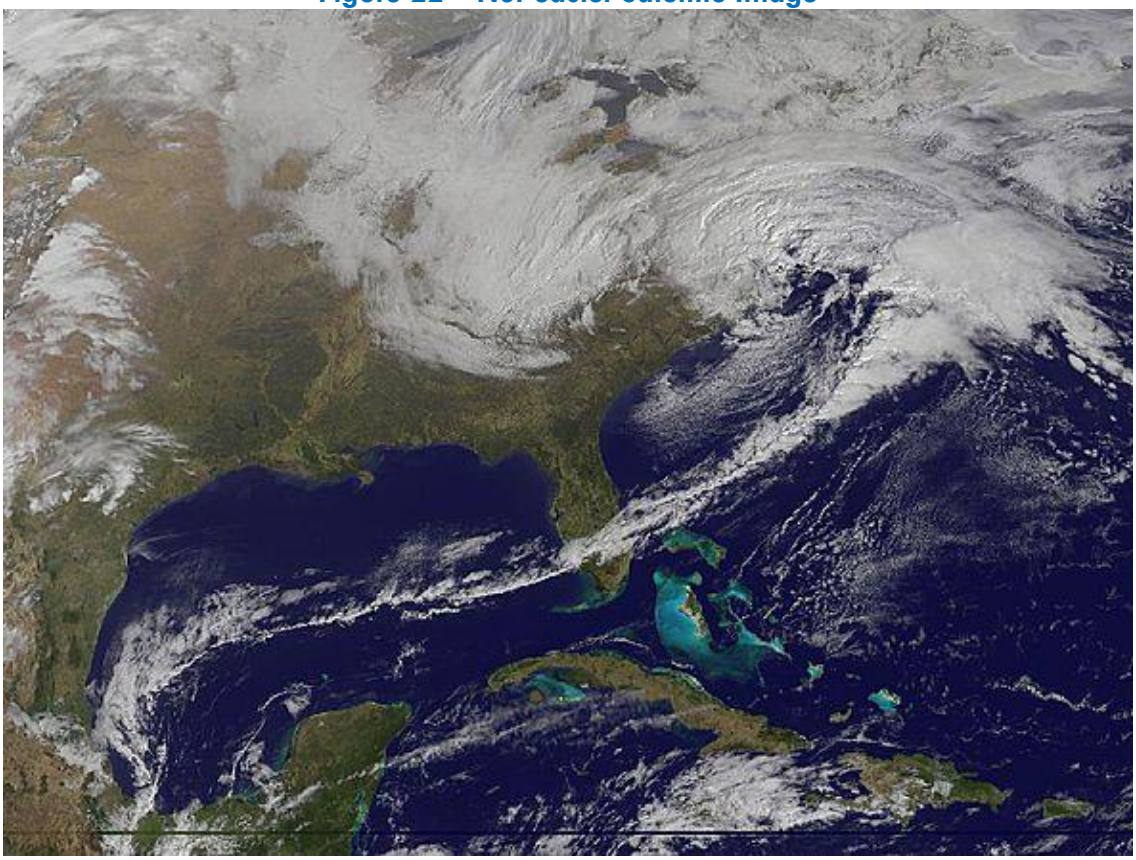
Table 19: Nor'easter Events for Massachusetts, 1978 to 2021

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
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'easter
January 2018	Nor'easter
March 2018	Nor'easter

Malden is vulnerable to both the wind and precipitation that accompany 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 Malden is potentially at risk to the impacts of nor'easters.

Figure 22 – Nor'easter Satellite Image



Source: The Geostationary Operational Environmental Satellite Program (GOES), A joint effort of NASA and NOAA.

Based on previous occurrences, nor'easters in Malden are high frequency events. This hazard may occur more frequently than once in five years (greater than 20% chance per year).

Blizzards and Heavy Snow

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.

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. Blizzards and winter storms are often associated with a nor'easter event, a large counterclockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain (see nor'easters 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 condition 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 20.

Table 20: 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: SHMCAP, 2018

The most significant winter storm in recent history was the "Blizzard of 1978," which resulted in over three feet of snowfall and multiple day closures of roadways, businesses, and schools. Table 21 shows the blizzards and severe winter storms that were declared disasters since 1966:

Table 21: Severe Winter Storm Disaster Declarations in Eastern MA

Storm Event	Date
Severe Winter Storm and Snowstorm	March 2018
Severe Winter Storm, Snowstorm, Flooding	January 2015
Severe Winter Storm, Snowstorm, Flooding	February 2013
Severe Storm and Snowstorm	October 2011
Severe Winter Storm and Snowstorm	January 2011
Severe Winter Storm and Flooding	December 2008
Blizzard	December 1992
Winter Coastal Storm	October 1991
Blizzard of 1978	February 1978
Coastal Storm, Flood, Ice, Snow	January 1966

Source: FEMA

The best available local data on past occurrences and impacts of winter storm events are reported for Middlesex County by the National Centers for Environmental Information (NCEI). From 2010 through 2022, Middlesex County experienced 20 heavy snowfall events, resulting in no injuries or deaths, and over a million dollars in property damage, as shown in Table 22.

Heavy snow is considered to be high frequency events based on past occurrences, as there have been 20 events in the past eleven years, for an average of almost 2 events each winter.

Table 22: Heavy Snow Events in Middlesex County, 2010 through 2022

Date	Deaths	Injuries	Property Damage ($)
12/26/2010	0	0	0
1/12/2011	0	0	50000
1/18/2011	0	0	0
1/21/2011	0	0	0
2/1/2011	0	0	1109500
2/29/2012	0	0	0
3/1/2012	0	0	0
12/17/2016	0	0	0
1/7/2017	0	0	0
2/9/2017	0	0	0
2/12/2017	0	0	0
12/9/2017	0	0	0
1/4/2018	0	0	3000
2/17/2018	0	0	0
3/7/2018	0	0	25000
3/13/2018	0	0	10000
1/19/2019	0	0	0
3/3/2019	0	0	0
2/1/21	0	0	0
1/28/22	0	0	0
Total	**0**	**0**	**1,197,500**

Source: NOAA, National Centers for Environmental Information

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. Snow-covered sidewalks force people to walk in streets, which are already less safe due to snow, slush, puddles, and ice. 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.

During winter storms, there can be an increased risk of fire due to loss of electricity and the associated use of portable heaters, gas stoves, candles, and other flammable sources of heat and light. Fire during winter storms presents a potential danger because water supplies may freeze, and it may be difficult for firefighting apparatus to get to a fire.

Other vulnerabilities include catch basins being buried and sometimes clogged, water service pipes bursting, and shut-off valves being buried (more common when cold and windy), fire hydrants being buried by snow, older water mains bursting, and dangerous icicles forming on buildings. Snow can also block building ventilation, increasing the risk of indoor carbon monoxide poisoning and cause damage to structures due to heavy snow loads and ice dams. Automobile and other transportation accidents are the leading cause of death during winter storms. The rapid melting of snow after major storms, combined with rainfall, is a common flooding threat.

Winter storms are a potential city-wide hazard in Malden. Map 6 in Appendix A indicates that the average annual average snowfall in most of Malden is between 48 and 72 inches.

Based on the record of previous occurrences, blizzards and heavy snow in Malden are high frequency events. This hazard may occur more frequently than once in 5 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 (see a description of hail in the Other Severe Weather section below)

The best available local data on previous ice storm events are recorded for Middlesex County through the National Centers for Environmental Information (NCEI). Middlesex County experienced three documented ice storm events from 2000 through 2022, as shown in Table 23. These events resulted in $3.165 in property damage, one injury and no deaths. However, given the regional nature of ice storms, most of the damages occurred in the portions of Middlesex county farther inland and at a higher elevation than Malden. The City's location in the milder coastal region makes it somewhat less vulnerable to ice storms.

Table 23: Middlesex County Ice Storm Events, 2000 through 2022

Date	Type	Deaths	Injuries	Property Damage
11/16/2002	Ice Storm	0	0	150.00K
01/15/2007	Ice Storm	0	1	15.00K
12/11/2008	Ice Storm	0	0	3.000M

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.

The City's overall vulnerability to winter storms is primarily related to restrictions to travel on roadways, temporary road closures, school closures, and potential restrictions on emergency vehicle access. Other vulnerabilities include power outages due to fallen trees and utility lines, and damage to structures due to heavy snow loads.

Ice storms are considered medium frequency events in Malden based on past occurrences. This hazard occurs once in 5 to 50 years, with a 2% to 20% chance of occurring each year. There is some indication that as winters warm, conditions may be more likely to produce icing conditions.

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

Tornado damage severity is measured by the Enhanced Fujita scale, which is based on the amount of damage created (Figure 23). As of February 1, 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 Figure 23.

The frequency of tornadoes in eastern Massachusetts is low; on average, there are six tornadoes that touchdown somewhere in the Northeast region every year. According to NOAA's Severe Weather Database, since 1950 there have been 177 tornadoes in Massachusetts, 111 of these occurred in central and western parts of the state. Four of these were F4 tornadoes, six were F3, 36 were F3, and 91 were F1.

The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC). This F4 tornado was 35 miles long and resulted in 94 deaths and 1245 injuries. A more recent significant tornado event in central Massachusetts occurred in 2011; an EF3 tornado touched down in Springfield tracked for 35 miles through six communities. The tornado outbreak included 7 confirmed tornadoes with a maximum rating of EF3 and lasted for 3 hours and 42 minutes as

they swept through eight communities across western and central Massachusetts. The town of Monson was hit particularly hard. More than 230 buildings were damaged in Monson with a third classified as total losses. These tornadoes also resulted three deaths, 200 injuries, and $227 million in damages.

Figure 23: Enhance Fujita Scale

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

Recent tornado events in the metropolitan Boston area occurred in in neighboring Chelsea and Revere in 2014, and in Concord in 2016.

An EF2 tornado struck parts of Chelsea and Revere on July 28, 2014. The tornado touched down at 9:32 AM in Chelsea just south of Route 16 (Revere Beach Parkway), where a window was blown out on Dudley Street. However, the overwhelming majority of damage occurred in Revere. After touching down in Chelsea, the tornado moved north into Revere's business district along Broadway, past Revere City Hall, and ended at 9:36 AM near the intersection of Routes 1 and 60 (see Figure 24). The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour.

Most of the damage was rated EF-1, but EF-2 rated damage did occur near Revere Beach Parkway. Windows were blown out of Revere City Hall and the roof was damaged. Sixty-four

structures sustained damage that ranged from siding torn off to roofs lifted or blown off. Thirteen of these structures (6 - 1 & 2 family homes, 3 - multifamily homes, and 4 commercial buildings) were deemed uninhabitable. Trees fell on cars, a few of these crushed. Revere High School also sustained damage.

Figure 24 – Path of Everett-Revere Tornado, July 28, 2014

Source: Boston Globe

Police reported a car that had been overturned at the intersection of Revere Street and Carleton Avenue. Near the rotary at Route 60 and Broadway, a billboard was blown onto several cars. The city set up a shelter at a local school for displaced residents. National Grid reported that 3,000 homes were without power.

On August 22, 2016, an F1 tornado passed through part of the Town of 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 (Route 2) and headed northeast. 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. Only one house suffered significant structural damage. The historical home of Louisa May Alcott and her family was right next to the tornado path but was not damaged.

Since 1950, there have been 20 tornadoes in Middlesex County recorded by the National Centers for Environmental Information. None of the tornados impacted Malden. There have been two F3 and four F2, nine F1, and two EF0 tornados. The 20 tornadoes resulted in a total of one fatality and 6 injuries. Damage estimates from all 20 tornadoes totaled $4.89 million, as summarized in Table 24.

Table 24 Tornado Records for Middlesex County

Date	Fujita	Fatalities	Injuries	Damage
10/24/1955	1	0	0	2.50K
6/19/1957	1	0	0	25.00K
6/19/1957	1	0	0	0.25K
7/11/1958	2	0	0	250.00K
8/25/1958	2	0	0	2.50K
7/3/1961	0	0	0	25.00K
7/18/1963	1	0	0	25.00K
8/28/1965	2	0	0	250.00K
7/11/1970	1	0	2	25.00K
10/3/1970	3	1	0	250.00K
7/1/1971	0	0	0	25.00K
11/7/1971	1	0	0	0.25K
7/21/1972	2	0	4	2.500M
9/29/1974	3	0	1	250.00K
7/18/1983	0	0	0	0.25K
9/27/1985	1	0	0	0.25K
8/7/1986	1	0	0	250.00K
8/22/2016	1	0	0	1.000M
8/23/2021	0	0	0	8.00K
8/23/2021	0	0	0	10.00K
TOTAL		**1**	**6**	**4.89M**

Source: NOAA, National Centers for Environmental Information

Although tornadoes are a potential city-wide hazard in Malden, tornado impacts are relatively localized compared to widespread damages related to severe storms and hurricanes. Buildings constructed prior to current building codes may be more vulnerable to damages caused by tornadoes. Depending on the track of a tornado in Malden, damages could be high due to the prevalence of older construction, as well as the density of development. Chelsea was fortunate that the 2014 tornado did not strike a densely developed area, but neighboring Revere was not so lucky, and provides an example of the variations damages that are possible within a localized area.

Evacuation of impacted areas may be required on short notice. As was the case in Revere, sheltering efforts may be required along with debris clearance. In severe events, search and rescue, and other emergency fire and medical services may need to be deployed. Key routes

may be blocked by downed trees and debris, and widespread power outages are also typically associated with tornadoes.

Based on the record of previous occurrences, tornadoes in Malden are a low frequency event. This hazard may occur once in 50 to100 years, with a 1% to 2% probability per year.

OTHER SEVERE WEATHER

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. A thunderstorm typically features lightning, strong winds, 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.

The best available data on previous occurrences of thunderstorms in Malden is for are recorded for Middlesex County through the National Centers for Environmental Information (NCEI). For the years 2015 through 2022, NCEI records show 50 thunderstorm events in Middlesex County (Table 25). These storms resulted in a total of $1.72 million in property damage. There were no injuries or deaths reported.

Table 25: Middlesex County Thunderstorm Events, 2015 through 2022

Date	Max. Wind Speed (mph)	Deaths	Injuries	Property Damage
5/28/2015	45	0	0	7000
8/4/2015	40	0	0	110000
8/15/2015	45	0	0	85000
2/25/2016	50	0	0	201000
3/17/2016	45	0	0	10000
7/22/2016	50	0	0	60000
7/23/2016	50	0	0	295000
8/22/2016	50	0	0	51000
9/11/2016	50	0	0	120000
5/18/2017	50	0	0	3000
6/13/2017	52	0	0	37000
6/23/2017	50	0	0	29500
6/27/2017	50	0	0	2000
7/12/2017	50	0	0	19000
8/2/2017	50	0	0	14000
9/6/2017	50	0	0	8000
5/15/2018	40	0	0	12000

Date	Max. Wind Speed (mph)	Deaths	Injuries	Property Damage
6/18/2018	50	0	0	59500
6/25/2018	43	0	0	12000
7/17/2018	45	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	10000
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	50	0	0	21700
5/15/2020	60	0	0	285000
6/6/2020	50	0	0	7600
6/21/2020	50	0	0	38200
6/28/2020	50	0	0	6000
7/2/2020	50	0	0	15300
7/5/2020	50	0	0	12800
7/23/2020	50	0	0	40600
7/30/2020	50	0	0	4400
8/22/2020	50	0	0	6000
8/23/2020	50	0	0	25600
8/27/2020	50	0	0	1600
10/7/20	56	0	0	6000
11/15/20	50	0	0	4500
5/26/31	50	0	0	800
6/30/21	50	0	0	3000
7/6/21	50	0	0	18500
7/7/21	50	0	0	9600
7/27/21	52	0	0	33800
8/19/21	50	0	0	1300
9/13/21	50	0	0	400
TOTAL		**0**	**0**	**$1,72M**

Source: NOAA, National Centers for Environmental Information

Severe thunderstorms are a city-wide hazard for Malden. The city's vulnerability to severe thunderstorms is similar to 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 Malden are high frequency events as defined by the Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

As noted previously, the intensity of rainfall events has increased significantly, and those trends are expected to continue. The SHMCAP does not 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 and reports may report hail size through comparisons with real-world objects that correspond to certain diameters as shown in Table 26:

Table 26: 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

The best available local data on previous hail events are recorded for Middlesex County through the National Centers for Environmental Information (NCEI). There were 27 hail events recorded from 2010 through 2022, as shown in Table 27. There was no property damages and no injuries or deaths reported for any of these hail events. Potential damages from larger-size hail could include damage to vehicles, windows, and other structures. These damages have not been reported in Malden.

Table 27: Middlesex County Hail Events, 2010 through 2020

Date	Hail Size	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	0.88	0	0	0
6/23/2012	0.75	0	0	0
7/18/2012	1.75	0	0	0
10/30/2012	1	0	0	0
6/17/2013	0.75	0	0	0
5/25/2014	1	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	2	0	0	0
8/15/2015	0.88	0	0	0
7/23/2016	0.88	0	0	0
7/23/2016	0.75	0	0	0
6/27/2017	1	0	0	0
8/2/2017	0.75	0	0	0
6/22/2019	0.75	0	0	0
6/29/2019	0.75	0	0	0
6/6/2020	1	0	0	0
6/28/2020	1	0	0	0
7/30/2020	0.75	0	0	0
8/23/2020	1	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 Malden. Based on the record of previous occurrences, hail events in Malden are high frequency events occurring more frequently than once in 5 years, or a greater than 20% per year.

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).

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 28.

Table 28: 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

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 29.

Table 29: Historic Earthquakes in Massachusetts or Surrounding Area

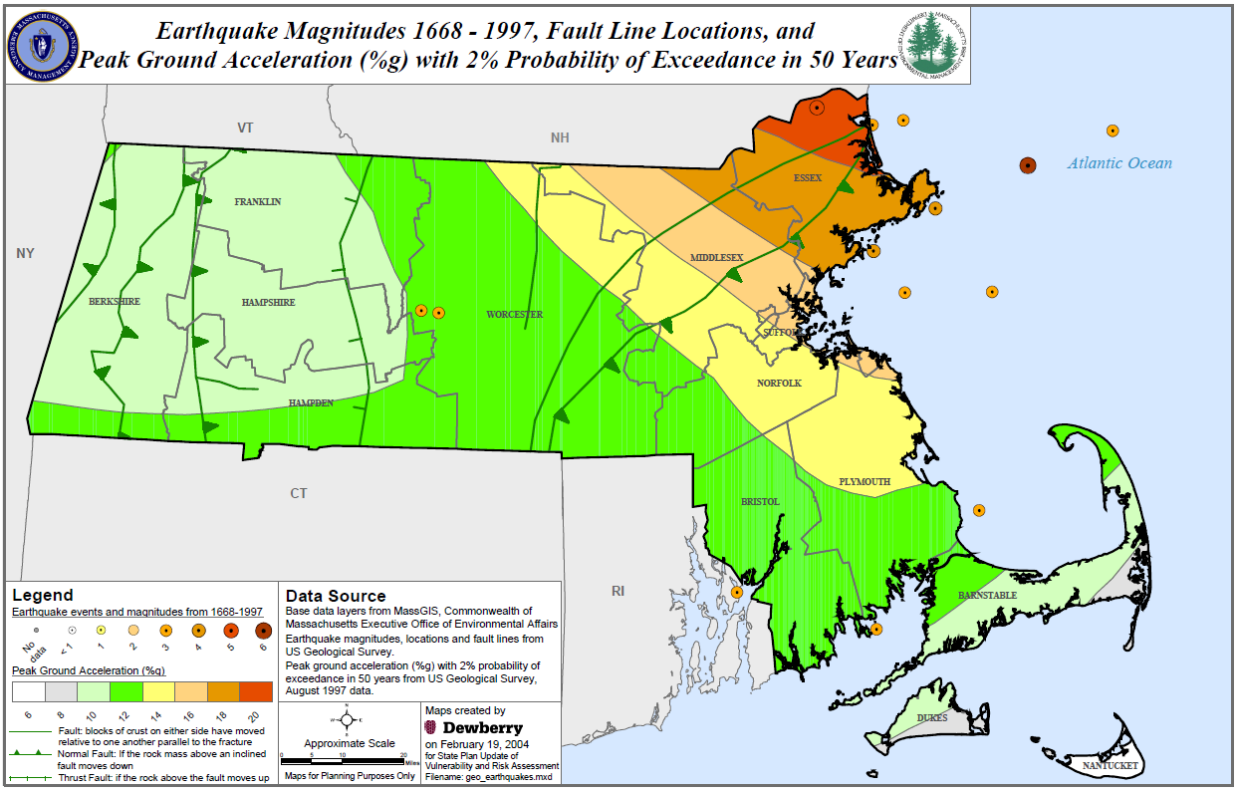
Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA – Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA – Salem	7/1/1744	NA
MA - Off Cape 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

Location	Date	Magnitude
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. Malden is in the 16 %g to 18 %g range, making it a moderate area of earthquake risk relative to the state, although the 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 Malden.

Figure 25: Massachusetts Earthquake Probability Map



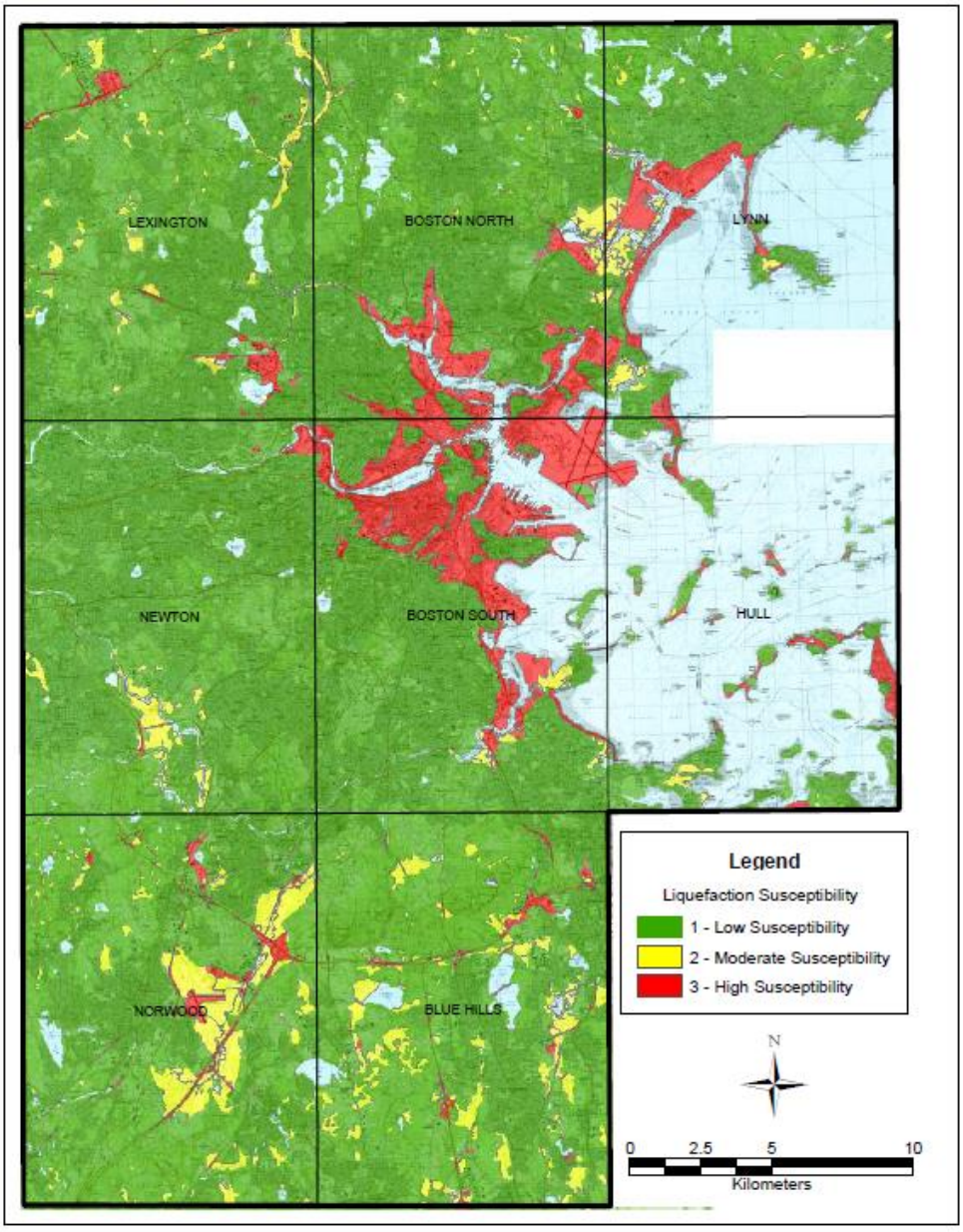
Source: MA Hazard Mitigation Plan 2013

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 can also trigger landslides.

One additional impact that is of particular concern in the Boston metropolitan area is liquefaction. Liquefaction poses a risk in areas of soft clays or filled land, which are found in areas bordering the Malden River (see Figure 2). During an earthquake event these soils may become unstable, effectively liquefying, destabilizing the buildings above and potentially leading to ruptured utilities, and other related impacts. An earthquake with a magnitude of 5.5 or greater can trigger liquefaction.

Figure 26 - Liquefaction Susceptibility of the Boston Metropolitan Area



Source: Baise, Laurie G.; and Charles M. Brankman, Tufts University

Earthquakes are a potential city-wide hazard in Malden. Although new construction under the most recent building codes generally will be built to seismic standards, much of the development in the city pre-dates the most recent building code. Potential earthquake damages to Malden have been estimated using HAZUS-MH. Total building damages are estimated at $1.03 billion for a 5.0 magnitude earthquake and $7.04 billion for a 7.0 magnitude earthquake. Other potential impacts estimated by HAZUS are shown in Table 36.

Based on previous occurrences, earthquakes are very low frequency events in Malden, occurring less frequently than once in 100 years, or a less than 1% per year.

LAND USE

Existing Land Use

The most recent land use statistics available from the state are from aerial imagery completed in 2016. Table 30 shows the acreage and percentage of land in 16 categories. If the various residential categories are aggregated, residential uses make up 1,576 acres, nearly half of the City at 48.5% of the total land area, making residential the largest land use category. The next largest category is Right-of-Way, which at 638 acres represents nearly 20% of the total area. Commercial and industrial uses combined make up 222 acres, or 10% of the city. Various open space categories occupy 16 % of the City, including developed open space, forest and shrub, and open and bare land.

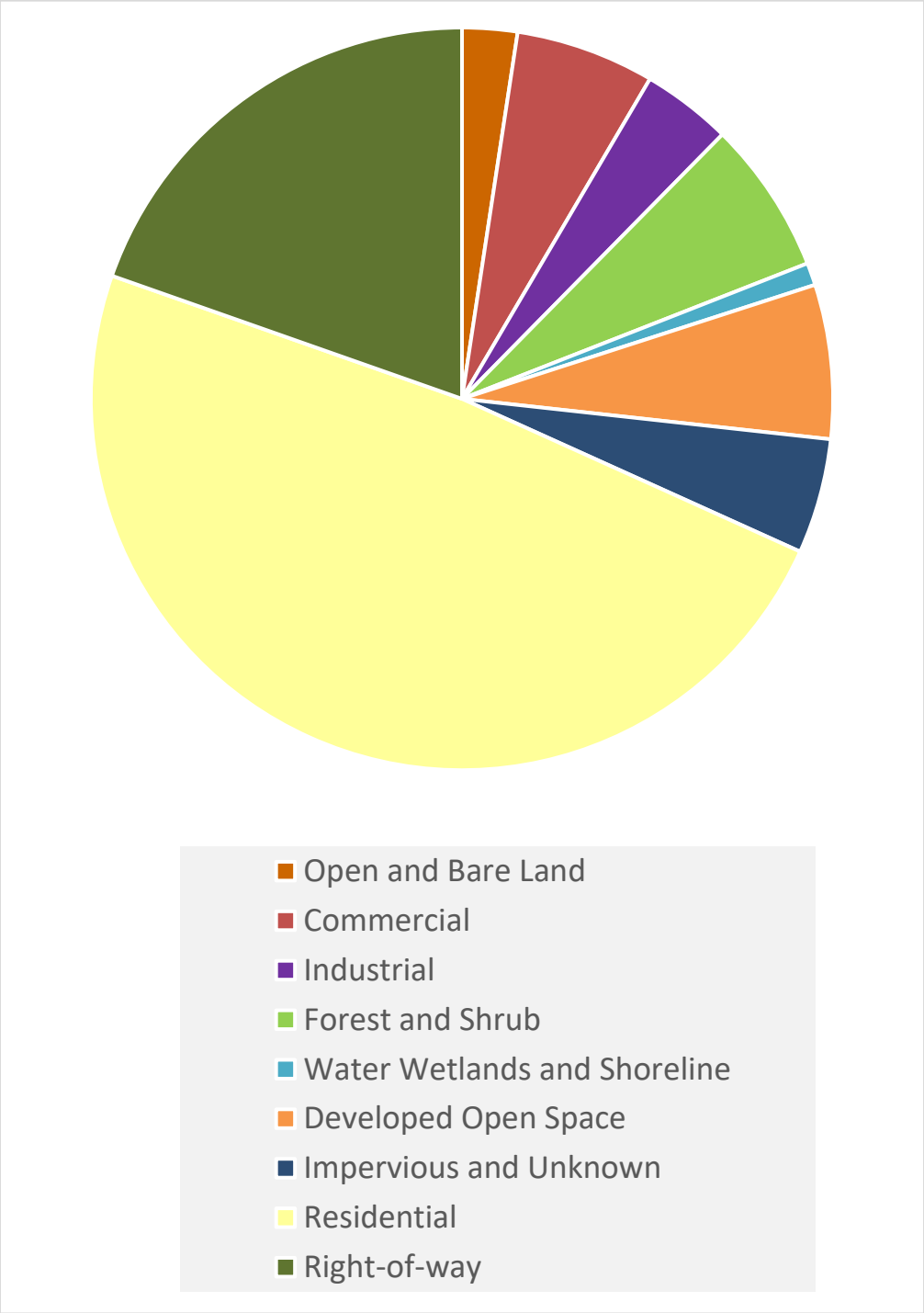
The breakdown of the major land use categories is illustrated in Figure 27 below, and a land use map is included in Appendix A, Map 2.

Table 30: Malden Land Use, 2016

Land Use Type	Acres	Percentage
Open and Bare Land	81	2.4
Commercial	195	6.0
Industrial	127	3.9
Agriculture	0	0.0
Forest and Shrub	216.2	6.7
Wetlands and Shoreline	24	0.7
Developed Open Space	217	6.7
Impervious and Unknown	157	4.9
Mixed use, primarily residential	36	1.1
Residential - single family	743	22.9
Residential - multi-family	796	24.6
Residential, other	1	0.03
Mixed use, other	5	0.15
Mixed use, primarily commercial	1	0.04
Right-of-way	636	19.60
Water	8.0	0.2
TOTAL	**3244**	**100**

Source: MassGIS 2016 Land Use Database

Figure 27 - Malden Land Use 2016



Community and Economic Development

Since the 1990s, the City of Malden has undertaken several economic development projects throughout the city: in Malden Square, in neighborhood squares, at the edge of the city in the River's Edge development, and in revitalization efforts citywide. A major focus of the City's economic development priorities has been redevelopment and revitalization of downtown Malden, or Malden Square. Several redevelopment projects have occurred throughout the city in the past several years... A major mixed-use regional economic development initiative called River's Edge encompasses 200 acres of underutilized land in the cities of Everett, Malden and Medford adjacent to the Malden River. The Small Squares Initiative focused on revitalization of neighborhood centers with the goal of encouraging development to benefit the long-term interests of the City while balancing and protecting the interests of abutting commercial and residential areas.

Downtown Malden has two distinct retail areas, each serving different needs within the same market area. One is the historical, small-scale retail that was part of the original downtown. The other is a retail corridor that has emerged along Centre Street. The corridor represents significant new retail expansion and investment. Unlike most commercial corridors, however, it abuts a traditional retail core. From one perspective, the growth of the Centre Street retail corridor appears to provide competition for the traditional retail core, but it serves a different market.

The traditional retail core is primarily located along Main Street, Pleasant Street and the north side of Exchange Street. Pleasant Street, in particular, has been the focus retail activity, and the development of a new City Hall and municipal offices. Beyond the downtown, there are many older centers throughout Malden that have a residential component, usually represented by apartments over stores.

Development Trends-New Developments 2016-2021

Under current zoning, the City of Malden is largely built out. Much of the land area is occupied by existing residential neighborhoods, commercial or industrial areas, recreation and conservations land, and undevelopable wetlands and floodplain areas. The development that is occurring in the City is largely redevelopment.

MAPC consulted with the Malden City Planner to inventory recently completed developments as well as new developments that are in the planning stage or under construction. The city identified 19 new developments from 2016 to 2021, including six Multifamily Residential projects, five **Mixed Use Developments with Multifamily residential & business**, and eight Business and Industrial projects, shown in Table 31. These new development sites were mapped and are shown on Map 8 in Appendix A. The letter codes in the Map# column of Table 31 correspond to the sites shown on the map.

Development Trends-New Developments in Progress

The City Planner also provided an inventory of new developments in progress, either currently under construction, in the permitting process, or in the planning process. The City identified 16 development sites, shown in Table 32. These sites are also shown on Map 8 in Appendix A. The letter codes in the Map# column of Table 32 correspond to the sites shown on the map.

Table 31 Summary of Malden Developments 2016-2021

Map #	Property Location	Multifamily Residential Dwellings	Permit
A	51 Overlook Ridge Drive	326 dwelling units	2018
B	15 Quarry Lane	119 dwelling units	2017
C	4 Stone Lane	173 dwelling units	2017
D	180 Eastern Avenue	86 dwelling units	2017
E	10 Florence Street	22 dwelling units	2019
F	960 Salem Street	12 dwelling units	2017
		Mixed Use Developments: Multifamily residential dwelling & business	
	180 Eastern Avenue	86 dwelling units	2017
G	100-150 Exchange Street, 140 Centre Street	210 dwelling units; restaurant (1,600 SF)	2017
H	2 Commercial Street, 185 Exchange Street,	320 dwelling units; City Hall-general offices (44,000 SF)	2020
I	7 & 17 Florence St; 190, 205, 215 & 230 Pleasant St.	restaurant, retail sales and services (22,000 SF)	2020-2021
J	126, 138, 142 & 150 Pleasant Street	69 dwelling units; bank, offices, retail services (4,000 SF)	2018
		Business and Industrial Development	
K	99 Bryant Street	self-storage facility (14,600 SF)	2018
L	295 Canal Street, a.k.a. 171 Medford Street	general offices (70,000 SF)	2018
M	277 Commercial Street	community health center (14,000 SF)	2019
N	326 Commercial Street	326 Commercial Street	2020
O	490 Eastern Avenue	self-storage facility (127,500 SF)	2018
U	32-54 Ferry Street	retail sales, pharmacy with drive-through (12,000 SF)	2016
Q	50 Pleasant Street	restaurant and brewery, offices (24,000 SF)	2020
R	94 Pleasant Street	gaming café/recreation for gainful business (5,300 SF)	2020

Source: Malden City Planner

Table 32 Summary of Malden Pending New Developments

Map #	Address	Zoning	New Development Under Construction/Permitted/Planned, 2022	Status	New or Reuse
S	75 Broadway	HB	fast-food restaurant with drive-thru (3,500 SF)	under construction	reuse
T	735 Broadway	HB	warehouse, wholesale & distribution facility (94,000 SF)	in permitting process	new construction
V	11 Charles Street	CB	office building (81,000 SF)	under construction	new construction
W	36 Charles Street	I2	recreational (non-medical) marijuana establishment: retail (10,400 SF)	in permitting process	reuse
X	323 Commercial Street	I2	recreational (non-medical) marijuana establishment: retail sales (7,200 SF)	under construction	reuse
Y	11 Dartmouth Street	CB	office building (150,000 SF) w/retail (3,000 SF)	in permitting process	new construction
P	54 Eastern Avenue	HB	offices, food pantry/dining/meals program (6,600 SF) & 14 dwelling units	in permitting process	new construction
Z	950-970 Eastern Avenue	I1	self-storage facility (81,700 SF)	in permitting process	new construction
AA	1130 Eastern Avenue	I1	non-med/rec. mj establishment:retail sales, wholesale,cultivation (12,600 SF)	in planning process	reuse
AB	200 Exchange Street	CB	offices, research & development (325,000 SF total); restaurants (13-14,000 SF)	under construction	reuse
AC	7 Linehurst Road	HB	non-medical/rec. marijuana establishment: retail sales (3,000 SF)	under construction	new construction
AD	109-121 Madison Street	I1	light mfg, mfg, bldg/contracting, r & d (12,600 SF addition)	in permitting process	new construction
AE	100 Maplewood Street	I1	retail sales & services, offices (10,000 SF)	under construction	new construction
AF	6-22 Pleasant Street	CB	retail, offices, research & development (SF TBD)	in planning process	new construction
AG	368 Pleasant Street	RO	30 Cohousing dwelling units	under construction	new construction
AH	1 Salem Street	CB	retail, offices & multifamily dwelling (SF TBD)	in planning process	new construction

Vulnerability Assessment

In order to characterize any change in the town's vulnerability associated with recent and new developments, a GIS mapping analysis was conducted which overlaid the development sites with the mapped hazards. The analysis is summarized in Table 33. This shows that four of the 35 development sites are located partially within one of the FEMA special flood hazard areas. Typically, development sites that partially straddle a flood zone have structures sited on the portion of the site outside of a flood zone. Of the four sites in Malden, three have 25% or less area in the flood zone. One site, which has 61% in a flood zone, is a small site, 0.7 acres.

The analysis also considered areas potentially subject to inundation from future sea level rise under different scenarios. With one foot of sea level rise, portions of two of the development sites would be partially inundated. However, with 10 feet of sea level rise, which is an extreme scenario for the year 2100, 24 sites would be inundated, and 15 of these would be 98% to 100% inundated.

Thirteen of the sites are located within "Hot Spots," the hottest 5% land surface temperatures in the region. For landslides, three of the sites are in the "Low Incidence" category, and the rest are rated "Low Incidence and moderate susceptibility." With respect to wind, there is also no variation across Malden; the entire city is in the same category, which is a 100-year wind maximum speed of 110 miles per hour. Overall, Malden's new development is not significantly increasing the city's vulnerability to natural hazards.

Table 33 Relationship of Development Sites to Hazard Areas

Map#	Development Sites	Acres	FEMA Flood Zones	Sea Level Rise 1 Foot	Sea Level Rise 10 Feet	Hot Spots (Top 5% hottest land surface temperature in MAPC)	Landslide Susceptibility and Incidence
NEW DEVELOPMENTS 2016-2021							
A	Residences at 51 Overlook Ridge Dr.	1.2				22.27% in top 5% hottest	Low Incidence and moderate susceptibility
B	Residences at 15 Quarry Lane	3.4				91.37% in top 5% hottest	Low Incidence and moderate susceptibility
C	Residences at 4 Stone Lane	6.2				73.85% in top 5% hottest	Moderate susceptibility and low incidence
D	Residences at 180 Eastern Ave.	0.9			100.0% inundated		Low Incidence and moderate susceptibility
E	Residences at 10 Florence St.	0.6				0.03% in top 5% hottest	Low incidence
F	Residences at 960 Salem St.	0.4				99.34% in top 5% hottest	Low Incidence and moderate susceptibility
G	100-150 Exchange Street, 140 Centre Street	2.1			100.0% inundated		Low Incidence and moderate susceptibility
H	2 Commercial Street, 185 Exchange Street	1.6			2.57% inundated	3.02% in top 5% hottest	Low Incidence and moderate susceptibility
I	7/17 Florence St; 190, 205, 215 & 230 Pleasant St.	0.6				10.5% in top 5% hottest	Low incidence
J	126, 138, 142 & 150 Pleasant St.	0.6			20.62% inundated		Low Incidence and moderate susceptibility
K	99 Bryant Street	0.5			100.0% inundated	100.0% in top 5% hottest	Low Incidence and moderate susceptibility
L	295 Canal Street	2.3	7.31% in AE: 1% Annual Chance	1.86% inundated	100.0% inundated		Low Incidence and moderate susceptibility
M	277 Commercial Street	1.1			98.93% inundated		Low Incidence and moderate susceptibility
N	326 Commercial Street	5.2	12.39% in AE: 1% Annual Chance	14.47% inundated	100.0% inundated		Low Incidence and moderate susceptibility
O	490 Eastern Avenue	1.6			100.0% inundated	100.0% in top 5% hottest	Low Incidence and moderate susceptibility
Q	50 Pleasant Street	0.3			80.83% inundated		Low Incidence and moderate susceptibility
R	94 Pleasant Street	0.2			26.13% inundated		Low Incidence and moderate susceptibility
U	32-54 Ferry Street	1.2			61.07% inundated		Low Incidence and moderate susceptibility

Map#	Development Sites	Acres	FEMA Flood Zones	Sea Level Rise 1 Foot	Sea Level Rise 10 Feet	Hot Spots (Top 5% hottest land surface temperature in MAPC)	Landslide Susceptibility and Incidence
DEVELOPMENTS IN PROGRESS 2022							
P	Residences at 54 Eastern Ave.	0.3			99.63% inundated		Low Incidence and moderate susceptibility
S	75 Broadway	0.7	61.74% in AE: 1% Annual Chance		100.0% inundated	43.34% in top 5% hottest	Low Incidence and moderate susceptibility
T	735 Broadway	2.7				61.61% in top 5% hottest	Low Incidence and moderate susceptibility
V	11 Charles Street	1.1			100.0% inundated		Low Incidence and moderate susceptibility
W	36 Charles Street	0.3			100.0% inundated		Low Incidence and moderate susceptibility
X	323 Commercial Street	0.6			100.0% inundated		Low Incidence and moderate susceptibility
Y	11 Dartmouth Street	0.1					Low Incidence and moderate susceptibility
Z	950-970 Eastern Avenue	0.9			11.66% inundated	100.0% in top 5% hottest	Low Incidence and moderate susceptibility
AA	1130 Eastern Avenue	0.5			99.67% inundated		Low Incidence and moderate susceptibility
AB	200 Exchange Street	2.4			98.56% inundated		Low Incidence and moderate susceptibility
AC	7 Linehurst Road	0.5	25.45% in A: 1% Annual Chance				Low Incidence and moderate susceptibility
AD	109-121 Madison Street	1.6			100.0% inundated		Low Incidence and moderate susceptibility
AE	100 Maplewood Street	0.7			2.56% inundated	100.0% in top 5% hottest	Low Incidence and moderate susceptibility
AF	6-22 Pleasant Street	0.9			76.87% inundated		Low Incidence and moderate susceptibility
AG	368 Pleasant Street	0.8			4.73% inundated		Low incidence
AH	1 Salem Street	0.1					Low Incidence and moderate susceptibility

CRITICAL FACILITIES

Critical Facilities include several categories of facilities and functions: those that provide utility for municipal operations or to provide emergency response (such as emergency operations centers, fire stations, public works yards, etc.); facilities that may require assistance during an emergency (such as nursing homes, elderly housing, day care centers, etc.), and critical infrastructure such as bridges, transit facilities, water supply and wastewater pumping stations, and communications and energy facilities. The City identified 132 critical facilities, which are listed in Table 34 and are shown on the maps in Appendix A.

Critical Infrastructure in Hazard Areas

MAPC conducted a GIS mapping analysis in order to determine where critical facilities are located in one or more of the mapped hazard areas, to better understand which facilities may be vulnerable to particular natural hazards. The results of this analysis are also shown in Table 34.

The hazards included are FEMA flood hazard areas, locally-identified flood areas, annual snowfall, hot spots (hottest 5% surface temperatures in the MAPC region), areas subject inundation with 10 feet of sea level rise, snowfall, and wind speed, and landslide risk.

It should be noted that none of the Critical Facilities would be affected by the lower sea level rise scenarios of one foot or 3 feet.

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

Explanation of Columns in Table 34

- ***Column 1: MAP #:*** The first column is an ID number which appears on the maps that are part of this plan. See Appendix A.

- ***Column 2: Facility Name****:* The second column is the name or address of the facility

- ***Column 3: Facility Type****:* The third column is the type or category of the facility

- ***Column 4: FEMA Flood Zone*****:** The fourth column addresses the risk of flooding according to FEMA's Special Flood Hazard Areas. A "No" entry means that the site is not within a flood zone on the FIRM maps. If there is an entry, it indicates the type of flood zone as follows:

    - **Zone** A Areas subject to inundation by the 1-percent-annual-chance flood event. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
    - **Zone AE** Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations (BFEs) are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
    - **Zone AH.** Mandatory flood insurance purchase requirements and floodplain management Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are 1–3 feet. BFEs derived from detailed hydraulic analyses are shown in this zone standards apply.
    - **Zone X (shaded)** Moderate risk areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by a levee. No BFEs or base flood depths are shown within these zones. (formerly Zone B)
    - **Zone X (unshaded)** Minimal risk areas outside the 1-percent and .2 percent-annual-chance floodplains. No BFEs or base flood depths are shown within these zones. (formerly Zone C)

- Column 5: **Locally Identified Flood areas,** identified and mapped by the Hazard Mitigation Team

- Column 6: **Annual Snowfall** in two categories, 36" – 48" and 48" – 72". Data from NESEC.

- Column 7: **Hot spots** indicates areas that are within the 5% of hottest areas in the MAPC region based on infrared satellite data from 2016

- Column 8: **Areas Inundated by 10 feet of Sea Level Rise** from the Boston Harbor SLR model

- Column 9: **Landslide Risk:** the degree of landslide risk for that site. This information came from NESEC based on mapping of geological formations.

Table 34 Critical Facilities and Relationship to Hazard Areas

MAP#	FACILITY	TYPE OF FACILITY	FEMA Flood Zone	Local Flood Area	Annual Snowfall (inches)	Hot Spot (Top 5%)	Sea Level Rise (10')	Landslide Risk
1	14-16 Clement Street SRO	Assisted Living	No	No	48.1 - 72.0	No	No	Low incidence
2	13 Rockland Avenue	Assisted Living	No	No	48.1 - 72.0	No	No	Low incidence
3	Springdale Elder Housing	Elder Housing	No	No	36.1 - 48.0	No	No	Low Incidence/Mod. susceptibility
4	Graham Elder Housing - D	Elder Housing	No	No	48.1 - 72.0	No	No	Low incidence
5	Malden Street & Water Commission	Municipal	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
6	Malden City Yard	Municipal	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
7	Malden Traffic Maintenance	Municipal	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
19	City Cemetery	Cemetery	No	No	48.1 - 72.0	No	No	Low incidence
20	Hallmark Health Hospice	Elder Housing	No	No	48.1 - 72.0	No	No	Low incidence
21	Davenport Memorial Home	Elder Housing	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
22	Forest Hill Park	Assisted Living	No	No	48.1 - 72.0	No	No	Low incidence
23	Irish American Association	Place of Assembly	No	No	48.1 - 72.0	No	Yes	Low incidence
24	Loyal Order of Moose	Place of Assembly	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
28	Fire Station-West Side-District 3	Fire Station	No	Yes	48.1 - 72.0	No	No	Low incidence
29	City Hall	Municipal	No	No	48.1 - 72.0	No	No	Low incidence
30	Police Station/Emergency Operations Ctr.	Municipal	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
31	Fire Station-Central--District 1	Fire Station	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
32	Mystic Valley Charter School	Fire Station	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
33	Beebe School	School	No	No	48.1 - 72.0	No	No	Low incidence
34	Mystic Valley Charter School	School	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
35	Heritage Apartments	Elder Housing	No	No	48.1 - 72.0	No	No	Low incidence
36	120 Mountain Avenue	Elder Housing	No	No	48.1 - 72.0	No	No	Low incidence
37	Malden Housing Authority	Elder Housing	No	No	48.1 - 72.0	No	No	Low incidence

MAP#	FACILITY	TYPE OF FACILITY	FEMA Flood Zone	Local Flood Area	Annual Snowfall (inches)	Hot Spot (Top 5%)	Sea Level Rise (10')	Landslide Risk
38	89 Pearl Street	Elder Housing	No	No	48.1 - 72.0	Yes	Yes	Low incidence
39	Cuticura Apartment	Elder Housing	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
40	Mass Electric	Power Plant	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
41	Salem Towers	Elder Housing	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
42	Salemwood School	School	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
43	Maplewood Elderly High-rise	Elder Housing	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
44	Linden School	School	No	No	36.1 - 48.0	No	Yes	Low Incidence/Mod. susceptibility
45	Malden High School	School	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
46	Valley Forum II	Cold Storage	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
47	Ferryway School	School	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
48	Early Learning Center	Child Care	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
49	Forestdale School	School	No	No	48.1 - 72.0	No	No	Low incidence
50	Graham Elder Housing - B	Elder Housing	No	No	48.1 - 72.0	No	No	Low incidence
51	Graham Elder Housing - A	Elder Housing	No	No	48.1 - 72.0	No	No	Low incidence
52	Department of Public Works	Municipal	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
52	Graham Elder Housing - C	Elder Housing	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
53	Suffolk Manor	Elder Housing	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
54	Fire Dept. Training & Safety Director	Fire Dept. Facility	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
55	Alternative High School	School	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
56	Tennessee Gas Pipeline	Gas Distribution	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
57	Mass Electric Substation	Power Substation	No	No	48.1 - 72.0	Yes	Yes	Low Incidence/Mod. susceptibility

MAP#	FACILITY	TYPE OF FACILITY	FEMA Flood Zone	Local Flood Area	Annual Snowfall (inches)	Hot Spot (Top 5%)	Sea Level Rise (10')	Landslide Risk
58	Maplewood Place	Elder Housing	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
59	Pump Station 1	Water Pump Station	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
60	Pump Station 2	Water Pump Station	No	No	48.1 - 72.0	No	No	Low incidence
61	Dexter House Nursing Home	Elder Housing	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
62	AT&T Switching Station	Telecommunications	No	No	48.1 - 72.0	No	No	Low incidence
63	Post Office	Post Office	No	No	48.1 - 72.0	No	No	Low incidence
65	Malden Medical Facility Center	Medical Facility	No	No	48.1 - 72.0	No	No	Low incidence
66	Malden Catholic High School	School	No	No	48.1 - 72.0	Yes	Yes	Low Incidence/Mod. susceptibility
68	F. M. Callahan	Hazardous Materials	No	No	48.1 - 72.0	Yes	Yes	Low Incidence/Mod. susceptibility
70	Arco Welding	Hazardous Materials	No	No	36.1 - 48.0	No	Yes	Low Incidence/Mod. susceptibility
72	ABC Nursery and Day Care Center	Child Care	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
73	Edsolutions Incorporated at Mystic Valley	Child Care	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
74	Salemwood School Aged Child Care Program	Child Care	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
75	Kids Place at North Shore Assembly of God	Child Care	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
76	Metro North Child Learning	Child Care	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
77	International Child Care Exchange	Child Care	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
78	Tri Cap Head Start	Child Care	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
79	Sunshine Christian Day Care	Child Care	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
80	Tri Cap Head Start	Child Care	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
81	YMCA Outreach School Age Program	After School Program	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
82	YMCA Outreach School Age Program	After School Program	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility

MAP#	FACILITY	TYPE OF FACILITY	FEMA Flood Zone	Local Flood Area	Annual Snowfall (inches)	Hot Spot (Top 5%)	Sea Level Rise (10')	Landslide Risk
83	YWCA After School Day Care	Child Care	No	No	48.1 - 72.0	No	No	Low incidence
84	Sunshine Bilingual Child Care	Child Care	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
85	Rockland Nursery School	Child Care	No	No	48.1 - 72.0	No	No	Low incidence
86	Mystic Valley Charter High School	School	No	No	48.1 - 72.0	No	Yes	Low incidence
87	Monsignor Negle Apartments	Elder Housing	No	No	48.1 - 72.0	No	No	Low incidence
88	Independence Route Day Care	Child Care	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
89	The Kids' Stop	Child Care	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
90	Cheverus School	School	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
91	Malden Housing Authority	Municipal	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
92	Little Miracles Daycare	Child Care	A: 1% Annual Chance	No	36.1 - 48.0	Yes	Yes	Low Incidence/Mod. susceptibility
93	Sunflower Family Daycare	Child Care	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
94	My little Best Friends Daycare	Child Care	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
95	One Childhood Early Learning Center	Child Care	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
96	New S. Cover Health Center	Medical Facility	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
97	Social Security Office	Govt. Office	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
98	Dept. of Transitional Services	Social Services	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
99	Church of the Nazarene	House of Worship	No	No	48.1 - 72.0	Yes	No	Low incidence
100	Malden Warming Center	Warming Center	No	No	48.1 - 72.0	Yes	No	Low incidence
101	Caring for Haitian Seniors	Elder Day Care	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
102	Mystic Valley Elder Services	Elder Services	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
103	ABCD-Head Start	Early Childhood Center	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility

MAP#	FACILITY	TYPE OF FACILITY	FEMA Flood Zone	Local Flood Area	Annual Snowfall (inches)	Hot Spot (Top 5%)	Sea Level Rise (10')	Landslide Risk
104	Oak Grove T Station/Bus hub	Public Transportation	No	No	48.1 - 72.0	No	No	Low incidence
105	Malden Center T Station	Public Transportation	No	No	48.1 - 72.0	No	No	Low incidence
106	McDonald Stadium	Sports Facility	No	No	48.1 - 72.0	No	Yes	Low incidence
107	YMCA	Place of Assembly	No	No	48.1 - 72.0	No	No	Low incidence
108	Triangle, Inc.	Social Services	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
109	Hibernian Hall	Place of Assembly	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
110	Italian American Citizens Club	Place of Assembly	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
111	American Legion	Place of Assembly	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
112	Potter's House Christian Fellowship Church	House of Worship	No	No	48.1 - 72.0	No	No	Low incidence
113	Hope Christian Church	House of Worship	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
114	Good Shepard United Methodist Church	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
115	Congregation Beth Israel	House of Worship	No	No	48.1 - 72.0	No	No	Low incidence
116	Synagogue	House of Worship	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
117	First Lutheran Church	House of Worship	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
118	CAVA Church @ Malden Catholic HS	House of Worship	No	No	48.1 - 72.0	Yes	Yes	Low Incidence/Mod. susceptibility
119	First Baptist Church of Malden	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
120	Christ United Methodist Church	House of Worship	No	No	48.1 - 72.0	Yes	Yes	Low Incidence/Mod. susceptibility
121	Freedom Hill Community Church	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
122	Seven Mile Road Church	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
123	St. Joseph's Parish	House of Worship	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
124	Forestdale Community Church	House of Worship	No	No	48.1 - 72.0	No	No	Low incidence
125	Highrock Malden	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility

MAP#	FACILITY	TYPE OF FACILITY	FEMA Flood Zone	Local Flood Area	Annual Snowfall (inches)	Hot Spot (Top 5%)	Sea Level Rise (10')	Landslide Risk
126	International Seventh-day Adventist Church	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
127	TDM Church–Igreja Evangelica	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
128	First Parish in Malden	House of Worship	No	No	48.1 - 72.0	No	No	Low incidence
129	Core Youth Ministries	House of Worship	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
130	Sacred Heart Parish	House of Worship	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
131	Malden Portuguese Foursquare Church	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
132	Mystic Side Congregational Church	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
133	Imani Temple	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
134	Grace Church of God	House of Worship	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
135	Chinese Christian Church of Grace	House of Worship	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
136	Bethel Church	House of Worship	No	No	48.1 - 72.0	No	Yes	Low Incidence/Mod. susceptibility
137	Christian Church Logos of God	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
138	Iglesia del Nazareno Chelsea	House of Worship	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
139	North Shore Rescue Mission	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
140	Immaculate Conception Church	House of Worship	No	No	48.1 - 72.0	No	No	Low incidence
141	Boston Nepali Church	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
142	Casa de Fe y Alabanza	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
143	Bethany Haitian Seventh Day Adventist	House of Worship	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility
144	Xia Qin Xiaoyun Congregational	House of Worship	No	No	48.1 - 72.0	No	No	Low incidence
145	Philadelphia SDA Church	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility

MAP#	FACILITY	TYPE OF FACILITY	FEMA Flood Zone	Local Flood Area	Annual Snowfall (inches)	Hot Spot (Top 5%)	Sea Level Rise (10')	Landslide Risk
146	Spanish Seventh-Day Adventist Church	House of Worship	No	No	36.1 - 48.0	No	Yes	Low Incidence/Mod. susceptibility
147	Pefa Church	House of Worship	No	No	48.1 - 72.0	No	No	Low incidence
148	Kingdom Hall of Jehovah's Witnesses	House of Worship	No	No	48.1 - 72.0	No	No	Low Incidence/Mod. susceptibility
149	Temple Beth Israel	House of Worship	No	No	48.1 - 72.0	Yes	No	Low Incidence/Mod. susceptibility

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 through the HAZUS-MH software available from FEMA.

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 https://www.fema.gov/hazus/

"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 Malden, 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-MH software was used to model potential damages to the community from a 100 year and 500-year hurricane event; storms that are 1% or 0.1 and 0.2% or 0.002 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 Town, 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 35: Estimated Damages from Hurricanes

	100-Year	500_Year
Building Characteristics		
Estimated total number of buildings	14,593	
Estimated total building replacement value (2014 $)	6,783,000,000	
Building Damages		
# of buildings sustaining minor damage	499	2,510
# of buildings sustaining moderate damage	77	623
# of buildings sustaining severe damage	3	37
# of buildings destroyed	0	10
# Total building with damages	579	3,180
Population Needs		
# of households displaced	5	159
# of people seeking public shelter	3	90
Debris		
Total Debris (tons)	5,548	21,926
Building debris generated (tons)	1,234	3,623
Tree debris generated (tons)	4,314	18,303
# of truckloads to clear Building Debris		732
Value of Damages		
Property damage (buildings and content)	36,440,610	158,499,210
Losses due to business interruption	2,402,300	16,171,140
Total of All Losses	38,842,910	174,670,350

ESTIMATED DAMAGES FROM EARTHQUAKES

The HAZUS-MH 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 a magnitude 7.0. Historically, major earthquakes are rare in New England, though a magnitude 5 event occurred in 1963.

Table 36: Estimated Damages from Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	14,593	
Estimated total building replacement value (2014 $)	6,783,000,000	
Building Damages		
# of buildings sustaining slight damage	4,169	537
# of buildings sustaining moderate damage	2,508	2,792
# of buildings sustaining extensive damage	828	3,690
# of buildings completely damaged	227	7,514
# Total building with damages	7,732	
Population Needs		
# of households displaced	1,784	16,718
# of people seeking public shelter	1,087	10,166
Debris		
Total Building debris generated (tons)	220,000	1,530,000
Brick/Wood Building debris generated (tons)	90,000	610,000
Reinforced Concrete/Steel Building debris generated (tons)	130,000	920,000
# of truckloads to clear debris (@ 25 tons/truck)	8,640	61,480
Value of Damages		
Property damage (buildings and contents)	$863,130,900	6,115,193,100
Losses due to business interruption	$169,164,300	923,934,100
Total of All Losses	$1,032,300,000	7,039,130.000

ESTIMATED DAMAGES FROM FLOODING

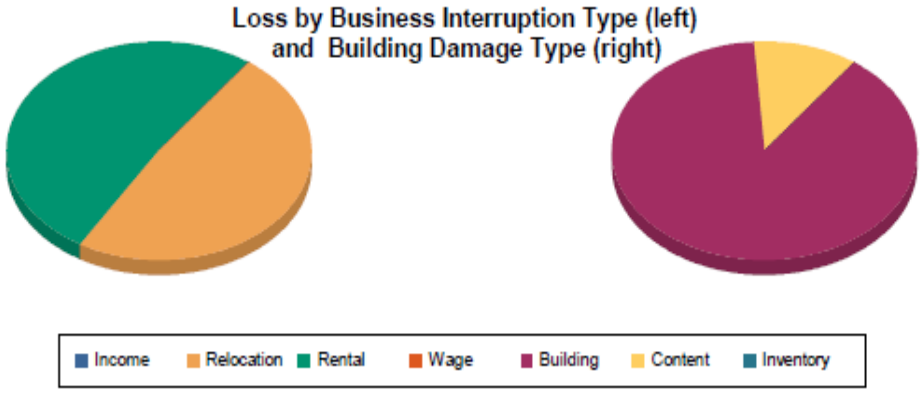
The HAZUS flooding module allows users model the potential damages caused by a 100-year flood event and a 500-year flood event.

Table 37: Estimated Damages from Flooding

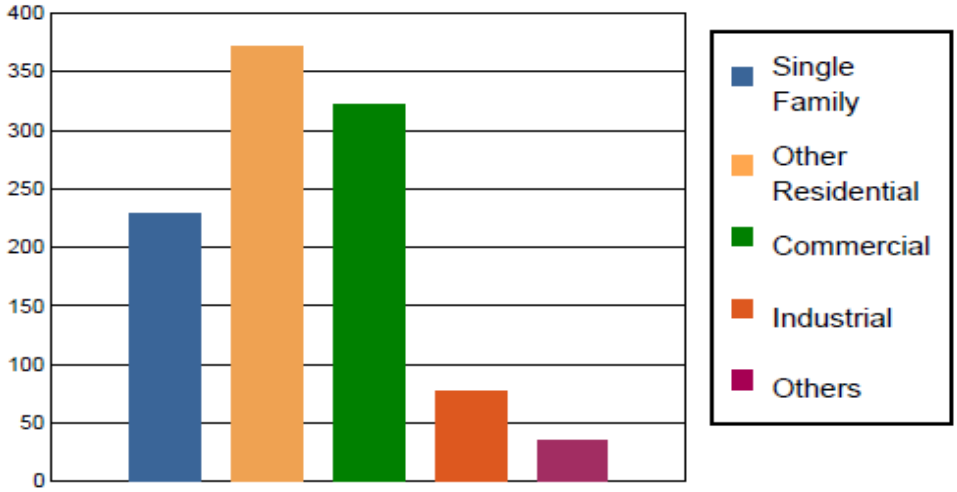
	100-Year Flood	500-Year Flood
Building Characteristics		
Estimated total number of buildings	14,593	
Estimated total building replacement value	6,783,000,000	
Building Damages		
# of buildings sustaining limited damage	95	
# of buildings sustaining moderate damage	31	
# of buildings sustaining extensive damage	1	
# of buildings substantially damaged	0	
# Total building with damages	127	
Population Needs		
# of households displaced	408	
# of people seeking public shelter	74	
Value of Damages		
Building Losses	$26,670,000	
Losses due to business interruption	$42,680,000	
Total of All Losses	$69,350,000	

Figure 28: HAZUS Loss Estimates by Type

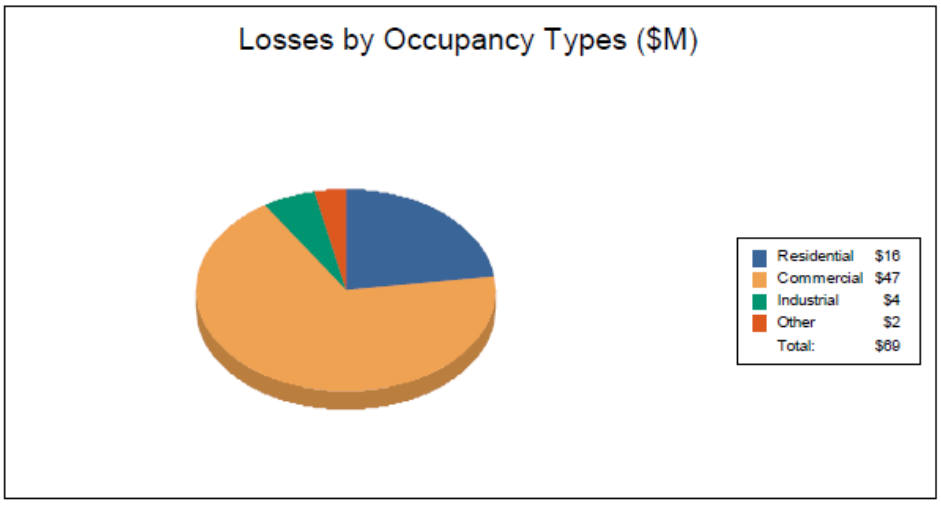
28-A Hurricane Losses by Business and Occupancy Type (100-Year)



28-B Earthquake Losses by Occupancy Type (Magnitude 5)



28-C Flood Losses by Occupancy Type (100-Year)



IMPACTS ON PEOPLE AND VULNERABLE POPULATIONS

Just as some locations in Malden will be more vulnerable to natural hazard and climate change impacts than others, it is also true that these hazards will not affect all residents of Malden equally.

People who may be more susceptible to negative health effects can include older adults, young children, pregnant women, people with disabilities, and people with pre-existing health conditions, as they are more likely to be physically vulnerable to the health impacts of extreme heat and poor air quality. Individuals with physical mobility constraints may need additional assistance with emergency response. Older adults are often at elevated risk due to a high prevalence of pre-existing and chronic conditions. People who live in substandard housing and in housing without air conditioning have increased vulnerability to heat-related illnesses. Black and Latino residents in Massachusetts are hospitalized for asthma at considerably higher rates than the population as whole, reflecting the reality that longstanding societal inequities can lead to differential health outcomes based on race and ethnicity.

Low-income people are often more susceptible to financial shocks, which can occur after extreme weather, and which can impact financial security and the ability to secure safe shelter and meet medical needs. Social and linguistic isolation can also influence vulnerability, as it limits access to critical information, municipal resources, and social support systems. In the absence of strong social support networks and translation services, people living alone and those with limited English language proficiency may experience social isolation. Certain occupations may also experience more severe impacts. People who work outdoors, or in unregulated temperatures, are at increased risk for heat-related illnesses.

In developing mitigation measures the City will need to continue to address the needs of all of its residents. Characteristics of the population are summarized in Table 3. In Malden 15.6% of residents are below the poverty level. Over 26.8% of residents are limited English speakers, and 49% speak a language other than English at home. Residents over age 65 represent 13% of the City's population, and 10.5% of residents have a disability. (American Community Survey, 2019). While this is challenging, the City is making efforts to address these needs, partnering with initiatives such as the Resilient Mystic Collaborative and the Mystic Valley Public Health Coalition.

In addition to social impacts, the built environment and natural resources are vulnerable to the impacts of natural hazards and climate change. Table 38 summarizes overall hazard risks across all three categories of impacts.

Table 38: 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 Malden Hazard Mitigation Team reviewed the goals from the 2017 Hazard Mitigation Plan and retained them for this updated plan. The Team also decided to add 8 additional goals for this 2022 Plan (goals # 5 through 12 below). All the goals are considered critical for the city, and they are not listed in order of importance.

Goal 1. Prevent and reduce 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 public awareness of the benefits of hazard mitigation through outreach and education.

Goal 5. Identify and seek funding for measures to mitigate or eliminate significant flood hazard areas.

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 Town to develop, review and implement the hazard mitigation plan.

Goal 9: Work with surrounding communities 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 resiliency into the City's planning and policies.

SECTION 6: EXISTING MITIGATION MEASURES

The existing protections in the City of Malden 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, while large scale capacity problems may require pipe replacement or invert elevation modifications. These more expensive projects are subject to the capital budget process and lack of funding is one of the biggest obstacles to completion of some of these.

The City's existing mitigation measures are listed by hazard type here and are summarized in Table 39 below. Upgrades to existing measures and new measures are noted as well.

Multi-Hazard Mitigation

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 Regional Emergency Planning Committee and other regional collaborations.

1. ***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. These plans contain important information regarding flooding, dam failures and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to many of the hazards discussed in this plan.

2. ***Enforcement of the state building code*** – The 9th Edition of the Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing and snow loads. The building code can be viewed in its entirety at http://www.mass.gov/bbrs/newcode.htm. A 10th Edition is currently being prepared.

3. ***Participation in the Mystic Regional Emergency Planning Committee (REPC)*** - The Mystic REPC serves as the emergency planning committee for 19 cities and towns. These include Arlington, Burlington, Chelsea, Everett, Lynn, Lynnfield, Malden, Medford, Melrose, North Reading, Reading, Revere, Saugus, Somerville, Stoneham, Wakefield, Winchester, Winthrop, and Woburn. The Mystic REPC's 19 member cities and towns work together to develop plans to educate, communicate, and protect their communities in case of natural and man-made emergencies. The Mystic REPC is the first regional planning committee to be certified by State of Massachusetts.

4. **Participation in Additional Regional Emergency Preparedness and Response Organizations** - Malden also participates in additional regional organizations that address emergency preparedness and response including:

- *Northeast Homeland Security Regional Advisory Council*, which includes 85 municipalities and is responsible for developing a regional Homeland Security Plan and overseeing related grant program expenditures.

- *METROFIRE*, which is an association of Fire Departments in the Metropolitan Boston area to coordinate Mutual Aid and act as a common entity for improving the overall effectiveness of their Fire and Emergency Medical Services
- *Mystic Valley Public Health Coalition – MDPH Region 3E* (Medford, Malden, Melrose, Wakefield, Stoneham and Reading (2011) has been working as a preparedness coalition since 2004.
- *Mystic Valley Medical Reserve Corps* (2005) – The corps is a volunteer organization of pre-credentialed volunteers to assist the Public Health Departments in the event of an emergency or a public health initiative. The MRC serves the same six (6) cities and towns of the Public Health Coalition.

5. ***Malden River Group*** – New initiative since the previous plan. Conducts river clean-up events; trash boom across the river recently deployed

Flood Hazard Mitigation Measures

6. **Zoning ordinance** –Chapter 12 of the General Ordinances of the City of Malden.

Section 12.04.010 ***(A)*** describes the purpose of the ordinance and (B) states the purposes of the Floodplain District: "to ensure public safety through reducing the threats to life and personal injury; eliminate new hazards to emergency response officials; prevent the occurrence of public emergencies resulting from water quality, contamination and pollution due to flooding; avoid the loss of utility services which if damaged by flooding would disrupt or shut down the utility network and impact regions of the community beyond the site of flooding; eliminate costs associated with the response and cleanup of flooding conditions; and reduce damage to public and private property resulting from flooding waters."

Section 12.08.040 defines the Floodplain District:

A. Flood Plain District: The Floodplain District is herein established as an overlay district. The District includes all special flood hazard areas within the City of Malden designated as Zone A or AE, on the Middlesex County Flood Insurance Rate Map (FIRM) issued by the Federal Emergency Management Agency (FEMA) for the administration of the National Flood Insurance Program.

B. Base Flood Elevation and Floodway Data:
1. Floodway Data In A and AE Zones, along watercourses that have not had a regulatory floodway designated, the best available federal, state, local or other floodway data shall be used to prohibit encroachments in floodways which would result in any increase in flood levels within the community during the occurrence of the base flood discharge.
2. Base Flood Elevation Data In A Zones, base flood elevation data is required for subdivision proposals or other developments of 3 or more lots or more than 15,000 square feet, whichever is the lesser.

Section 12.12.110 specifically addresses building in the floodplain:

A. All development in the floodplain district, including structural and non-structural activities must be in compliance with all the following: Mass. Gen. Laws Ch. 131 § 40; the Flood Resistant Construction sections of the Massachusetts State Building Code; and the Wetlands Protection Regulations, Inland Wetlands, Restrictions, Coastal Wetlands Restrictions of DEP.

B. Minimum Requirements for the Subsurface Disposal of Sanitary Sewage as promulgated by the Department of Environmental Protection.

C. No variances from the provisions and requirements of the above referenced regulations may be granted except in accordance with the variance procedures outlined therein.

Along watercourses that have a designated Regulatory Floodway, encroachments which would result in any increase in flood levels within the community during the occurrence of the base flood discharge. In Zone A the Building Inspector shall obtain, review, and reasonably utilize any floodway data available as criteria for requiring that development meet the floodway requirements of this section.

The following uses of low flood damage potential and causing no obstructions to flood flows are encouraged provided that they are permitted in the underlying district and do not require structures, fill, or storage of materials or equipment:

Agricultural uses; Forestry and nursery uses; Outdoor recreational uses; Conservation of water, plants or wildlife; Wildlife management areas; Temporary non-residential structures used in connection with fishing, growing, harvesting, storage, or sale of crops raised in the premises.

In a riverine situation, no site work may be initiated that will result in the alteration or relocation of a watercourse until the following have been notified:

Adjacent communities; the National Flood Insurance Plan Coordinator for the Massachusetts Office of Water Resources; the National Flood Insurance Plan Program Specialist for FEMA Region I

Section 12.12.040 regulates the placement of manufactured homes in the floodplain district.

Section 12.12.100 regulates structures greater than six stories. It states that the City Council must find that water, sewer, and drainage systems will be adequate after development. It further defines an adequate drainage system as one that "is sufficient to accept post-development runoff resulting from a 10-year storm.

Section 12.12.130 (O) states that any project proponents submitting applications within the Residential Incentive Overlay district shall demonstrate that drainage systems will be adequate following project construction (i.e., must be able to accept post-development runoff resulting from a 10-year storm.)

Section 12.12.14S0 relates to site plan submission and states that the drainage portions of submitted site plans must be stamped by a registered engineer. The site plan must show areas subject to the 100-year flood.

Section 12.12.050 states that existing natural features such as brooks and drainage channels shall be retained whenever possible. Retention of the maximum amount of such features consistent with the use of the property shall be required as recommended by the Planning Board.

Section 12.28.130 regulates alteration of grade and/or ledge removal : Excluding routine utility work, any alteration of the grade of any required yard area by 25% or more; any property where the grade of any required yard area is 25% or more before construction or development; or any removal or excavation of ledge or other material from any property by chipping or blasting or any other means, shall require a special permit from the Planning Board, including an erosion prevention plan, drainage calculation, a stormwater management plan, and installation of underground and surface drainage facilities to prevent surface erosion, undermining, flooding, and post-development run-off that exceeds pre-development run-off.

The Zoning Ordinance has a new section adopted on June 29, 2021, Malden River Site Plan Review, summarized in excerpts below:

12.12.200 Malden River Site Plan Review

A. Purpose and Intent: To ensure that the design and layout of new development and redevelopment will protect and conserve the Malden River and expand public access and use. The intent of the Site Plan Review process is to regulate rather than prohibit use of properties that abut the Malden River through reasonable conditions which may be recommended by the Site Plan Review Committee (SPRC).

B. Applicability: A Site Plan Review is required for any work requiring a permit of a value that amounts to 5% or more of the City assessed value of the building, excluding upgrades that comply with the Massachusetts Energy Code, or any reuse of an existing building on property that abuts the Malden River…in accordance with the provisions below.

D. Site Plan Submission Criteria: At a minimum, the submittal materials shall include the following items as applicable:

- parcel lot lines…and all easements' boundaries, if any;
- proposed parking plan, access, and egress; location of snow storage areas;
- location of existing and proposed buildings and public/private ways;
- location of solid waste containers, if any;
- location of Malden River and existing and proposed topography, including locations of culverts, and water bodies, if any;
- proposed landscaping;
- location of open space;
- fencing, walls, and existing and proposed lighting;
- location, material, and size of all signs.
- All required improvements specified in Section J herein below.

J. Site Plan Review Criteria: The SPRC shall review all site plans, at a minimum, for conformance with the following required improvements:

1 Public Pedestrian Access. Install and maintain public pedestrian access to the Malden River that complies with the following:

a) Continuous pedestrian connections must be provided between all major points of

2 Riverfront Walkway. Install and maintain pedestrian walkway adjacent to the Malden River that has a minimum width of ten (10) feet,

3 Buffer Area. Install and maintain landscaped buffer area adjacent to river that complies with the following:

a) Planted with native, non- invasive species, and rehabilitated to remove invasive species, with the exception of any invasive trees greater than a 4" caliper, measured by diameter breast height; and any invasive removal strategy shall include a sapling replanting strategy.
b) Public access areas abutting the Malden River must be designed to reduce the level of storm water runoff into the river and with special attention to the provision of wildlife habitat.
c) Trees: A minimum of one canopy tree shall be provided for every 30 feet of riverfront public pathway and supplemental public access area.

4 Setbacks. Any new construction not required by the Malden River Site Plan Review Ordinance shall be set back a minimum of 100 feet from the Malden River; provided, however, that the Site Plan Review Committee may allow Water Dependent uses, as defined by M.G.L. Chapter 91, within the set back.

5 Parking. No surface parking is permitted within 75 feet of the Malden River. Any required parking that is removed pursuant to this provision does not need to be replaced on-site and a Traffic Demand Management Plan is required.

7. Storm Water Management - Chapter 11 of the General Ordinances of the City of Malden

Section 11.28.020 requires for disturbance of one acre or more of land:

- Storm Water Management Plan including:
  - delineation of existing stormwater conveyances, impoundments, and wetlands;
  - delineation of 100-year flood plains, if applicable;
  - estimated seasonal high groundwater elevation in areas to be used for stormwater retention, detention, or infiltration;
  - existing and proposed vegetation and ground surfaces with runoff coefficients;
  - an area drainage map showing pre-construction and post-construction watershed boundaries, drainage area and stormwater flow paths;
  - description and drawings of all components of the proposed drainage system including
- A Land Disturbance Permit
- An Erosion and Sediment Control Plan
- A Post- Construction Storm Water Management Plan
- Operation and Maintenance Plans

8. **Subdivision Rules and Regulations** – In addition to the usual requirements that plan submissions must include information on drainage, watercourses, etc. the Malden subdivision rules and regulations contain additional provisions noted below.

   Section V.F. 1b – The Planning Board may require that the developer make improvements to correct drainage deficiencies.

   Section IV -10 – The regulations state that "an evacuation plan indicating alternate vehicular access and escape routes be filed with appropriate Disaster Preparedness Authorities for mobile home parks and mobile home subdivisions located within the special flood hazard areas".

   Section V.D.3 – This section states that "any alterations to watercourses shall necessitate notification of same to abutting communities' conservation commissions and planning boards, and such alterations shall be designed so as to maintain the carrying capacity of the original waterway".

   Section V.E – This section regulates subdivisions in the flood plain. It states that "all subdivisions shall be reviewed to determine whether such proposals will be reasonably safe from flooding. If any part of a subdivision proposal or other new development is located within the Flood Plain District established under the Zoning Ordinance, it shall be reviewed to ensure that:

      a) The proposal is designed consistent with the need to minimize flood damage.

      b) All public utilities and facilities, such as sewer, gas, electrical and water systems shall be located and constructed to minimize or eliminate flood damage and minimize infiltration.

      c) Adequate drainage systems shall be provided to reduce exposure to flood hazards.

      d) Base flood elevation (the level of the 100-year flood) data shall be provided for proposals greater than 50 lots or 5 acres, whichever is the lesser, for that portion within the Flood Plain District.

      e) There shall be no encroachment in floodways, including fill, new development, or substantial improvements that will result in any increase in flood levels during base flood discharge.

   Section VI -4 – This section recommends that consideration be given to placing of telephone and electrical lines underground. Subsection a states that "underground and surface drainage facilities should be adequate to prevent surface erosion, undermining, or flooding in the opinion of the City Engineer. Pipes, culverts, catch basins, manholes and paved waterways shall be constructed to current standards of the Public Works Department. Provision is to be made for proper projection of the drainage into adjacent property.

9. **Catch basin cleaning** – The City purchased a $250,000 Jet-Vac truck for catch basin cleaning. Prior to this purchase, the City used to contract out catch basin cleaning on an as-needed basis. Having the proper equipment will enable the City to start a program of

regular cleaning. Catch basins are cleaned on a schedule that complies with the MS4 Stormwater Permit issued by EPA under the Clean Water Act.

10. **Street sweeping** – The schedule for street sweeping complies with the MS4 Stormwater Permit issued by EPA under the Clean Water Act. To reduce sedimentation, the City does not apply sand to the roads in the winter.

11. **Water main replacement** – The City has been using the Massachusetts Water Resources Authority 0% loan program to replace old water pipes on an on-going basis. The City has borrowed $1 million for this purpose.

12. **Valve/gate exercising** – The City owns a valve exerciser/torque machine and regularly opens and closes gates to make sure all gates are operable, and none are shut in the closed position. Gate exercising also occurs when the DPW crew is responding to leaks.

13. **Participation in the National Flood Insurance Program** – 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 January 1, 1978, through January 22, 2022. The following information is provided for the City of Malden.

Flood insurance policies in force	137
Coverage amount of flood insurance policies	$34,251,800.00
Premiums paid	$186,731
Closed losses (Losses that have been paid)	83
Total payments (Total amount paid on losses)	$359,240.58

The breakdown of insured properties by development type shows that all but two of them are residential, with single-family the largest category, followed by 2-4 family, and other residential.

Type	Policies	Premiums Paid	Coverage amount	Losses Paid	Total Payments
Single Family	61	$112,575	$15,218,600	64	$274,776.53
2-4 Family	41	$51,874	$9,713,100	15	$77,732.16
Other Residential	33	$17,229	$7,170,100	0	$0.00
Non-Residential	2	$5,053	$1,100,000	4	$6,731.89
Total	**137**	**$186,731**	**$33,201,800**	**83**	**$359,240.58**

14. **Pump Stations** – The city owns and operates pump stations at Neal Street and at McCormick and East Border Road. There is also a privately owned pump station at the Granada Highlands development. All of the pump stations are in good operating condition.

15. **Route 1 Revere Town Line Brook tide gates** (MHD) – Short term repairs were recently completed on these tide gates, but they need to be replaced. A State budget earmark is being sought by the State Senator to provide funding of replacement tide gate

16. **Town Line Brook** – Cleanup has been performed and repairs to concrete masonry has begun.

Wind Hazard Mitigation Measures

17. **Street tree inventory** – In 1999, the City of Malden, with the assistance of the Department of Environmental Management's Urban Forestry Program, conducted a city-wide survey of city-owned and controlled trees. This survey is included as an appendix in the Open Space Plan. The survey determined that 61% of the trees (3,122 trees) were in fair to poor condition and requires attention to eliminate hazards. The report made a number of recommendations related to maintenance.

18. **Tree trimming program** – The Parks & Forestry Department has a tree trimming program.

Existing Winter Storm Hazard Mitigation Measures

19. **Snow disposal sites** – The City has sufficient snow storage space.

20. **Snow storage requirements** – Section 500.2.14 of the zoning bylaw requires 40 square feet of lot area for each parking space to be provided for the storage of plowed snow. This requirement is for all developments other than single and two-family homes.

21. **Plowing, snow and ice removal** – The City has Snow Removal Regulations. The Department of Public Works is responsible for snow removal, plowing and sanding of the City's streets and property owners are responsible for clearing sidewalks abutting their property. Vehicles must not be parked so as to impede snow removal and any vehicles obstructing snow removal may be moved to another location by the City.

Existing Geologic Hazard Mitigation Measures

22. **Massachusetts State Building Code** – The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is "to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake". This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be "prudent and economically justified" for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, cannot be achieved economically for most buildings.

Brushfire Mitigation Measures

23. **Prohibition on outdoor burning** – The City does not allow outdoor burning.

24. **Subdivision review** –The Fire Department reviews subdivision plans to ensure adequate access for fire trucks and an adequate water supply

Mitigation Capabilities and Local Capacity for Improvements

Under the Massachusetts system of "Home Rule," the City of Malden is authorized to adopt and from time to time amend local ordinances and regulations that support the city's capabilities to mitigate natural hazards. These include Zoning Ordinances, Subdivision and Site Plan Review Regulations, Wetlands Regulations, Health Regulations, Public Works regulations, and local enforcement of the State Building Code. Local Ordinances may be amended by a vote of the City Council to improve the city's capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission The City of Malden has recognized several existing mitigation measures that require implementation or improvements, and has the capacity based on these Home Rule powers within its local boards and departments to address these. The City can improve its hazard mitigation capabilities with the following measures:

• The Malden Department of Public Works will address the needs for catch basin cleaning, repairs and upgrades to drainage infrastructure, particularly in the Town Line Brook, the Linden area, and Bowman and Durso Streets.

• The City's Planning Board will address the updates to the Master Plan and implementation of the Zoning Ordinance, Floodplain District, and Subdivision Rules and Regulations.

• The Conservation Commission will oversee implementation of the Wetlands Regulations and the Open Space Plan.

• The Tree Warden will coordinate with the utility companies to maximize the benefits of tree trimming to mitigate both wind and winter hazards.

• In reviewing and permitting new development projects, refer to the Hazard Mitigation Plan for guidance to incorporate mitigation into site design and construction.

• The City can update the Floodplain Ordinance to incorporate the next edition of the Flood Insurance Rate Maps, which are expected to be released by FEMA when the new Middlesex County maps are completed.

• The City can consider participating in the Community Rating System to enhance its mitigation capabilities while provide reduced flood insurance rates to residents and businesses.

• When preparing the City's next Master Plan, incorporate Hazard Mitigation and Climate Resilience as a formal component of the plan, equivalent to other components traditionally included in a Master Plan such as Land Use, Transportation, Housing, and Economic Development.

• When preparing the City's Open Space and Recreation plan, incorporate Hazard Mitigation and Climate Resilience goals and measures as a component of the plan. Identify opportunities for open space protection and land acquisition that would have specific hazard mitigation co-benefits, such as managing stormwater to reduce flooding, protecting vegetation for shade to mitigate extreme heat, and managing wetlands and tree canopy to mitigate climate impacts.

• Expand the City's tree trimming operations, in coordination with the utilities, to reduce vulnerability to high winds and winter storms and the City's risk of power outages.

• In reviewing and permitting new development projects, refer to the Hazard Mitigation Plan for guidance to incorporate mitigation into site design and construction.

• The City can review and update its water conservation plan to enable a more robust mitigation of drought, which has occurred more frequently in the last decade and is projected to increase in the future due to climate change.

• Consider adopting a Stormwater Utility or stormwater user fee to provide a dedicated, predictable revenue stream to finance upgrades to the stormwater infrastructure, many of which are needed to mitigate flooding risks.

• Regional collaboration: Take advantage of opportunities to collaborate on regional mitigation issues. Regularly coordinate with the Metro Mayors Climate Task Force and the Resilient Mystic Collaborative to work with neighboring cities and state agencies such as DCR to address issues beyond the borders of the City that could impact Malden.

• Financing the implementation of mitigation measures: the City can incorporate a program of its highest priority mitigation measures into its Capital Investment Program to ensure that these receive priority along with other categories of municipal investment such as roadways and municipal buildings.

TABLE 39: SUMMARY OF MALDEN EXISTING MITIGATION MEASURES

Mitigation Measure/Hazard Category	Area Covered	Effectiveness	Improvements Needed	Updates/changes for 2022
MULTIPLE HAZARDS				
1. Comprehensive Emergency Management Plan (CEMP)	City-wide	Effective; emphasis is on emergency response	None	No Changes
2. Enforcement of the **Massachusetts State Building Code**	City-wide	Effective for new construction. Many buildings pre-date the most recent, more stringent code	None	9th Edition of the MA State Building Code is currently in effect; a 10th Edition is being prepared.
3. Participation in the **Mystic Region Emergency Planning Committee**.	City-wide, Regional	Provides a forum for regional cooperation on issues related to natural and man-made disasters	None	No Changes
4. Participation in Additional Regional Emergency Preparedness Organizations: • NE Homeland Security Reg. Adv. Council • METROFIRE • Mystic Valley Public Health Coalition • Mystic Valley Medical Reserve	City-wide, Regional	Provides opportunities for regional review, planning and coordination for emergency preparedness and response	None	No changes

Mitigation Measure/Hazard Category	Area Covered	Effectiveness	Improvements Needed	Updates/changes for 2022
5. Malden River Group	Malden River clean ups, trash boom across the river;	Effective	None	New initiative since the previous plan.
FLOOD HAZARD/				
5. Zoning Ordinance – Chapter 12: Floodplain Overlay District • Sec. 100: Areas identified on FIRM • Sect. 200.4: Building in the floodplain • Sec. 300.21: Floodplain Districts • Sec. 300.26.12: Residential Overlay • Sec. 300.27.4: Site Plans • Sec. 700.5: Retention of natural features	All special flood hazard areas designated on the FIRM maps issued by FEMA	Effective.	None	Section numbers have changed due to Ordinance revisions Malden River Site Plan Review Erosion control and ledge removal provisions.
6. Subdivision Rules and Regulations • Sec. V.F.1b: Correct drainage deficiencies • Sec. IV.10: Evacuation plan/routes • Sec. V.D.3: Alteration to watercourses • Sec. V.E: Subdivisions in floodplains • Sec. VI.4: Underground utilities		Effective	None	No changes
7. Catch basin cleaning The City has a Jet-Vac truck for catch basin cleaning	City-wide	Effective. Catch basin cleaning performed as required by the MS4 Stormwater Permit	None	Catch basin cleanings scheduled to comply with the updated 2016 EPA MS4 Stormwater Permit

Mitigation Measure/Hazard Category	Area Covered	Effectiveness	Improvements Needed	Updates/changes for 2022
8. Street sweeping The City has two street sweepers and is in the process of purchasing two more. Sand is not applied to streets.	City-wide	Effective. Street sweeping performed as required by the MS4 Stormwater Permit	None	Street sweeping scheduled to comply with the updated 2016 EPA MS4 Stormwater Permit
9. Water Main Replacement **T**he City uses MWRA loan program to replace old pipes on an ongoing basis.	City-wide	Effective	None	No changes
10. Valve exercising The City owns a valve exerciser/torque machine and regularly opens and closes gates	City-wide	Effective	None	No changes
11. National Flood Insurance Program	Flood hazard areas on FIRM maps	Effective for post-flooding response for eligible property-owners	Make sure all eligible property-owners know about the program.	Updated policy and claims date in the plan
12. Pump stations	Specific locations to serve drainage basins	All pump stations are in good operating condition	None.	No changes
13. Route 1 Revere Town Line Brook tide gate	Town Line Brook drainage basin	Has been effective in reducing flooding from tidal surges	None.	Short term repairs recently completed, but tide gate replacement is needed. State budget earmark is being sought by State Senator to provide funding of replacement tide gate.

Mitigation Measure/Hazard Category	Area Covered	Effectiveness	Improvements Needed	Updates/changes for 2022
14. Town Line Brook Hydraulics and Hydrology Study	Town Line Brook drainage	A number of the recommendations have been implemented	Funding to implement the recommendation regarding dredging the channel.	Cleanup has been performed and repairs to concrete masonry has begun.
WIND HAZARDS				
15. Street tree inventory	City-wide.	Effective at providing a baseline of data.	Need funding and manpower to implement recommendations	No Changes
16. Tree trimming program	City-wide.	Effective.	Manpower and funding needed for maximum effectiveness.	No changes
WINTER HAZARDS				
17. Snow Disposal	City-wide.	Effective.	None	Snow removal regulations
18. Snow storage requirements	City-wide.	Effective.	None	No Changes
19. Snow Plowing	City-wide.	Effective.	None	No Changes

Mitigation Measure/Hazard Category	Area Covered	Effectiveness	Improvements Needed	Updates/changes for 2022
GEOLOGIC HAZARDS				
20. The Massachusetts State Building Code	City-wide.	Effective for new development for most situations	None	9th Edition of the MA Building Code is currently in effect; a 10th Edition is being prepared.
BRUSH FIRE HAZARDS				
21. Ban on outdoor burning	City-wide.	Effective.	None	No changes
22. Development review by Fire Dept. for fire safety	City-wide.	Effective.	None	No changes

SECTION 7: MITIGATION MEASURES FROM PREVIOUS PLAN

IMPLEMENTATION PROGRESS ON THE PREVIOUS PLAN

The City of Malden has taken steps to implement recommendations of the 2017 Hazard Mitigation Plan, including adoption of site design guidelines requiring more trees in parking areas, provision of cooling centers at three locations, completion of new Fire and Police stations that include updated communications capabilities, drainage work at Bowman and Durso Streets, and appropriation of $40,000 to address rodent problems in the Town Line Brook Area. The largest stormwater infrastructure improvements still outstanding are largely in the purview of the state through the Department of Conservation and Recreation and the Massachusetts Department of Transportation.

At a meeting of the Malden Hazard Mitigation Team, City staff reviewed the mitigation measures identified in the 2017 Malden Hazard Mitigation Plan and determined whether each measure had been completed, partially completed, revised, or not completed. Of those measures that had not been completed, the Team evaluated whether the measure should be deleted, carried forward into this Hazard Mitigation Plan 2022 Update, or carried forward with revisions.

The decision on whether to delete or retain a particular measure was based on the team's assessment of the continued relevance or effectiveness of the measure and whether the deferral of action on the measure was due to the inability of the City to take action on the measure due to funding or other constraints. Table 40 summarizes the current status of mitigation measures from the 2017 plan.

The challenges the City of Malden faces in implementing these measures are primarily due to limited funding and available staff time. This 2022 plan update should help the City prioritize the best use of its limited resources for enhanced mitigation of natural hazards.

As indicated in Table 40, Malden made progress implementing several mitigation measures identified in the 2017 plan. Two mitigation actions have been completed and five have been partially completed and are in progress.

Completed measures:

- Three cooling centers at the Senior Center and two schools
- New Police and Fire Stations that provide updated communications capabilities

Mitigation partially completed/in progress:

- Bowman/Durso area: Malden DPW conducted a project to clear the stream of debris to increase drainage capacity and reduce stormwater backups.
- Town Line Brook: The City approved a $40,000 line item to address rodent problems
- Site Design Guidelines: The City adopted Zoning that increases trees in parking areas
- The City has installed generators in the Senior Center and the Salemwood School
- The City hired a Tree Warden, who is coordinating with the utility

The City reevaluated the mitigation measures from the 2017 plan that had not been completed or were partially completed and took the opportunity to revise several of them to meet current needs for this updated 2022 plan. The 12 mitigation measures that have been carried over from the 2017 plan include five measures that have been revised for this updated 2022 and seven measures that have not been revised.

The five revised mitigation measures include:

- Conduct inspections of public buildings to determine potential risk of earthquake damage
- Provide additional staff to expand the City's capacity for tree maintenance
- Implement/enforce the new State Net Zero Energy Code pending Jan. 2023
- Revise to provide more comprehensive guidelines for increased tree plantings along public ways and other locations
- Install generators in five additional schools: Malden High School, four K-8 schools, and the Early Learning Center

Seven mitigation recommendations will be carried over to this plan with no revisions:

- Dredge the Town Line Brook channel
- Linden Area: increase the storage capacity behind the Revere floodgate
- Increase storage capacity at Bowman/Durso Streets by install underground storage tanks or constructing a parallel second culvert
- Address rodent problems in the Town Line Brook area
- Complete flood mitigation work at the Townline Estates Trailer Park
- Promote drought tolerant landscaping and site design measures
- Shelter generator hook-ups

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, as described Section 9. The challenges the city faces in implementing these measures are primarily due to limited funding and available staff time. This plan should help the city prioritize the best use of its limited resources for enhanced mitigation of natural hazards.

Table 40: Status of Mitigation Measures from the 2017 Malden Plan

Table 40: Status of Recommended Mitigation Measures from the 2017 Malden Hazard Mitigation Plan					
Mitigation Measure	**Description**	**Lead Agency**	**Estimated Cost*** (see key below)	**Current Status** • Completed • Partially Completed • To be Revised • Not Completed	**2022 Plan Update** 1. Retain in 2022 Plan? 2. Revise for 2022? 3. Delete in 2022 Plan?
FLOODNG HAZARDS					
A. Dredge the Town Line Brook channel	One of the recommendations of the Town Line Brook study is to dredge the channel (owned by the state Division of Conservation and Recreation) of approximately 4,000 cubic yards of sediment that have accumulated in the lined reaches of the channel. The City believes that the lack of storage capacity in the channel is a major contributor to flooding in the Linden neighborhood and the Hanover Street neighborhood. Sedimentation is not the only problem with the culvert. The sides of the culvert are concrete panels that have been popping out, allowing the banks of the culvert to be undermined.	Mass Highway, MA DEP, Army Corps of Engineers	High Approx. $10 million	**Not Complete**d State facility owned by the Dept. of Conservation and Recreation; City of Malden has met with Senator Lewis to seek cooperation and funding for improvements	**YES**
B. Linden Area- increase the storage capacity behind the Revere floodgate	In order to mitigate flooding in this neighborhood it will be necessary to increase the storage capacity behind the Revere floodgate. This would include increased storage in Revere and Malden. Solving the flooding in this area is directly related to dredging the culvert.	Department of Conservation and Recreation (DCR)	High >$250,000	**Not Completed** State facility owned by the Dept. of Conservation and Recreation; City of Malden has conducted multiple meetings and site visits to discuss groundwork for improvements	**YES**

Table 40: Status of Recommended Mitigation Measures from the 2017 Malden Hazard Mitigation Plan					
Mitigation Measure	**Description**	**Lead Agency**	**Estimated Cost*** (see key below)	**Current Status** • Completed • Partially Completed • To be Revised • Not Completed	**2022 Plan Update** 1. Retain in 2022 Plan? 2. Revise for 2022? 3. Delete in 2022 Plan?
C. Increase storage capacity at Bowman/Durso Streets by install underground storage tanks or constructing a parallel second culvert	The solution to flooding in this area would be to install underground storage tanks or to construct a second parallel culvert to increase capacity.	Malden DPW	High Approx. $200,000	**Partially Completed;** City of Malden DPW has conducted a project to clear the stream of debris to increase drainage capacity and reduce stormwater backups.	**YES**
D. Address Rodent Problem in the Town Line Brook Area	The rodent issue is a byproduct of the lack of maintenance of the physical structure of the Brook. The culvert is failing and leaching storm water runoff and is holding large amounts of contaminated road sediment. This has an effect on the rodent harborages in and around the culvert. The obvious rodent problem locations start at Broadway and continue to the Revere line. The solution will be two-part. An extermination program is needed and should be performed in the problem areas. To prevent the issue from reoccurring, however, the larger issue of dredging the culvert will need to take place.	Malden Board of Health, MA DEP, Mass Highway, Army Corps of Engineers	Extermination: Low <$50,000 Culvert repair High >$250,000	**Partially Completed** The City has approved a $40,000 line item to address rodent problems related to the Town Line Brook area	**YES**

Table 40: Status of Recommended Mitigation Measures from the 2017 Malden Hazard Mitigation Plan					
Mitigation Measure	**Description**	**Lead Agency**	**Estimated Cost*** (see key below)	**Current Status** • Completed • Partially Completed • To be Revised • Not Completed	**2022 Plan Update** 1. Retain in 2022 Plan? 2. Revise for 2022? 3. Delete in 2022 Plan?
E. Complete flood mitigation work at the Townline Estates Trailer Park on Broadway	Broadway generally floods when there is a storm event with three or more inches of rain. There is a trailer park on Broadway in the northeastern corner of Malden near Rowe's Quarry. There are approximately 70 trailers and the entire trailer park had to be evacuated on one occasion due to flooding. There is a small creek running through the property which drains into a Massachusetts Highway Department drain.	Malden DPW	High >$250,000	**Partially Completed**	**YES**
WIND HAZARDS					
F. Tree Warden Coordination with Utility Companies on wind hazards	Have the Tree Warden coordinate with utility companies on tree trimming to reduce potential for the downing of overhead lines during storm events.	Malden DPW	Medium 10,000 to $50,000	**Partially Completed Revised** The City has hired a Tree Warden, who is coordinating with National Grid	**YES, Revised** Provide additional staff to expand the City's capacity for tree maintenance
WINTER STORM HAZARDS					
G. Tree Warden Coordination with Utility Companies on winter hazards	Snow loading on trees has led to falling branches and the downing of electrical and other overhead utility lines. The Tree Warden should investigate where these impacts have occurred and coordinate with utility companies on tree trimming to reduce potential for the downing of overhead lines during storm events.	Malden DPW	Medium 10,000 to $50,000	**Partially Completed Revised** The City has hired a Tree Warden, who is coordinating with National Grid	**YES, Revised** The City's Tree Warden coordinates with National Grid to identify vulnerable trees. This work should continue and expand, with resources recommended in #F above

Table 40: Status of Recommended Mitigation Measures from the 2017 Malden Hazard Mitigation Plan					
Mitigation Measure	**Description**	**Lead Agency**	**Estimated Cost*** (see key below)	**Current Status** • Completed • Partially Completed • To be Revised • Not Completed	**2022 Plan Update** 1. Retain in 2022 Plan? 2. Revise for 2022? 3. Delete in 2022 Plan?
GEOLOGIC HAZARDS					
H. Distribute Map of Areas Susceptible to Liquefaction to City Departments and developers	The City should provide a copy of the map of areas susceptible to liquefaction to all relevant City departments and developers to assist in planning and evaluating development proposals and for earthquake resilience.	Building Department, Engineering	Medium 10,000 to $50,000	**Not Completed; To be Revised** To be replaced with different measure; see 2022 Plan Update	**YES, Revise** Conduct inspections of public buildings to determine potential risk of earthquake damage
EXTREME TEMPERATURE HAZARDS					
I. Adopt Site Design Guidelines to increase tree plantings	Site Design guidelines for new development and redevelopment to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways.	Planning Dept, Conservation Commission	Low <$50,000	**Partially Complete** The City adopted Zoning amendments that increase trees in parking areas	**YES, Revise** Revise Site Design Guidelines to provide more comprehensive guidelines for increased tree plantings along public ways and other locations
J. Promote Green Building and Cool Roof designs		Building Department, Planning Dept.	Low <$50,000	**Not Completed, To Be Revised** Building requirements are the jurisdiction of the MA State Building Code. Revised State code pending Jan. 2023; City to enforce	**YES, Revise** Implement/enforce the new State Net Zero Energy Code pending Jan. 2023

Table 40: Status of Recommended Mitigation Measures from the 2017 Malden Hazard Mitigation Plan					
Mitigation Measure	**Description**	**Lead Agency**	**Estimated Cost*** (see key below)	**Current Status** • Completed • Partially Completed • To be Revised • Not Completed	**2022 Plan Update** 1. Retain in 2022 Plan? 2. Revise for 2022? 3. Delete in 2022 Plan?
K. Provide a facility for vulnerable populations	Provide a facility for additional vulnerable populations (such as disabled populations and in addition to senior residents) during extreme temperature event	Emergency Management Coordinator	Medium 10,000 to $50,000	**Completed** The City operates three cooling centers at the Senior Center and two schools	**NO**
DROUGHT HAZARDS					
L. Promote drought tolerant landscaping and site design measures	Adopt site development guidelines promoting drought-tolerant landscaping and site design measures.	Planning Dept, Conservation Commission	Low <$50,000	**NO** Site design revisions since 2017 plan did not include this requirement. Retain for the 2022 plan.	**YES** Revise and update existing site design guidelines on drought tolerant landscaping
MULTI-HAZARDS					
M. Shelter generator hook-ups	Malden has a number of shelters for which they have back-up generators, but the generators have not been hooked up. A potential mitigation measure would be to secure funding to complete the hook-up of these generators.	Emergency Management Coordinator	Low <$50,000	**Partially Complete** The City has installed generators in the Senior Center and the Salemwood School	**YES** Install generators in five additional schools: Malden High School, four K-8 schools, and the Early Learning Center
N. Regional communications and GIS capability	Fire Department to complete a project to create regional communications and GIS capability.	Fire Dept.	Medium 10,000 to $50,000	**Completed** The City built new Police and Fire Stations since 2017 that provide updated communications capabilities	**NO**

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 (HMGP), the Building Resilient Infrastructure and Communities (BRIC) grant program, 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/bric
https://www.fema.gov/flood-mitigation-assistance-grant-program

Hazard Mitigation 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. (Source: FEMA Local Multi-Hazard Mitigation Planning Guidance)

RECOMMENDED MITIGATION MEASURES

The recommended mitigation measures for this plan update are listed below and summarized in Table 41 (showing prioritization) and Table 42 (showing lead agencies, cost estimates, timelines, funding sources).

Upon reviewing the 12 mitigation measures carried over from the 2017 plan, the Malden Hazard Mitigation Team determined that 9 of them will retain the same priority for this 2022 plan update. Three measures will have their priorities revised for this updated 2022 plan: one will change from Medium to High (Increase storage capacity at Bowman and Durso Streets), and two will change from High to Medium (Site Design guidelines to increase tree plantings and Promote drought-tolerant plantings and site design).

In addition to the 12 mitigation measures retained from the 2017 plan, the Malden Hazard Mitigation Team decided to include six new measures that were not in the previous plan. These are summarized below, with the priorities assigned to them by the Team:

- Identify resiliency improvements to the City-wide Stormwater Infrastructure, including preparation of comprehensive vulnerability assessment and action plan (High)
- Develop a City-wide Heat Mitigation/Tree Plantings Resilience Program (Medium)
- Conduct public education on outdoor fire safety (Medium)
- Install generators at six facilities (High)
- Prepare a Department of Public Works Site Resiliency Project (High)
- Identify and implement resiliency improvements to Public Housing (High)
- Conduct a Resiliency in Zoning Assessment (Medium)

Of the total 18 recommended mitigation measures in this 2022 plan update, 9 are High priority, 8 are Medium priority, and one is Low priority, as detailed in Table 41.

The recommended mitigation measures below are grouped by their hazard categories, with several of them in a "multi-hazard" category.

Regional and Inter-Community Considerations

Regional Issues

Some hazard mitigation issues are strictly local. The problem originates primarily within the municipality and can be solved at the municipal level (e.g., capacity issues in local drainage system). Other issues are inter-community issues that involve cooperation between two or more municipalities (e.g., downstream issues related to upstream flooding on the Mystic River). There is a third level of mitigation which is regional; involving a state, regional or federal agency or an issue that involves three or more municipalities (e.g., any potential issues related to the Amelia Earhart Dam, which is owned by the DCR).

Regional Partners and Hazard Mitigation Coordination

In the densely developed communities of the metropolitan Boston area, mitigating natural hazards, particularly flooding, is often more than a local issue. The drainage systems that serve these communities are a complex system of storm drains, tide gates, roadway drainage structures, pump stations and other facilities owned and operated by a wide array of agencies including but not limited to the City of Malden, the Department of Conservation and Recreation (DCR), the Massachusetts Water Resources Authority (MWRA), Massachusetts Department of Transportation (MassDOT) and the Massachusetts Bay Transportation Authority (MBTA).

The planning, construction, operations 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 numerous competing priorities. One of the key regional issues affecting Malden is the Town Line Brook on the Malden/Revere border. The Town Line Brook channel and the Revere tide gates are critical facilities owned by the Department of Conservation and Recreation. The inadequate storage capacity in the Town Line Brook channel is one cause of much of the flooding in Malden. To alleviate this flooding would require action by the Division of Conservation and Recreation and the provision of additional storage capacity in Revere. This is one of the key mitigation recommendations in this plan (see Table 42).

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 reduce and limit future risks of natural hazards. Taking into consideration the City's Floodplain Zoning District enforced for new development, the Stormwater Management Ordinance requirements enforced for development, the Subdivision Rules and Regulations enforced for new development, the Building Code enforced for development by the Inspectional Services Division, the Wetlands Protection Act enforced for development by the Conservation Commission, the Open Space and Recreation Plan, the Master Plan, and the Resilient Mystic Collaborative initiative,

, 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 new development and redevelopment. As a mature city with older infrastructure, the major priorities that emerged for the City are strategic infrastructure upgrades in the most problematic areas. The major priorities for the City are improvements to key areas such as Townline Brook and storage capacity at locations such as the Revere floodgate and Bowman and Durso Streets. These upgrades will provide greater capacity to reduce hazard risks for both existing and new development as well as redevelopment in the City. This is the focus of several of this plan's recommended mitigation measures in the following section.

Proposed Hazard Mitigation Measures

Flood Hazard Mitigation

A) **Town Line Brook dredging** – One of the recommendations of the Town Line Brook study is to dredge the channel (owned by the state Division of Conservation and Recreation) of approximately 4,000 cubic yards of sediment that have accumulated in the lined reaches of the channel. The City believes that the lack of storage capacity in the channel is a major contributor to flooding in the Linden neighborhood and the Hanover Street neighborhood. The flooding problem has decreased since the tide gate was fixed but since that time, the City has not experienced a major storm, so the ultimate effectiveness of this measure alone remains to be seen.

   Sedimentation is not the only problem with the culvert. The sides of the culvert are concrete panels that have been popping out, allowing the banks of the culvert to be undermined. In recent years, at least six cars have been removed from the culvert as well. Although this mitigation measure would be under the jurisdiction of DCR, the City estimates that the total cost would be approximately $5 million to complete. The first step would be to complete a study to determine the extent of dredging needed and the costs. This would be necessary to determine the cost-effectiveness of this measure.

B) **Linden Area** – In order to mitigate flooding in this neighborhood it will be necessary to increase the storage capacity behind the Revere floodgate. This would include increased storage in Revere and Malden. Solving the flooding in this area is directly related to dredging the culvert.

C) **Bowman/Durso Streets** – The solution to flooding in this area would be to install underground storage tanks or to construct a second parallel culvert to increase capacity.

D) **Rodent Problem in the Town Line Brook Area** – The rodent issue is a byproduct of the lack of maintenance and general failure of the physical structure of the Brook. The culvert is failing and leaching storm water runoff and is holding large amounts of contaminated road sediment. The capacity is altered during each rain even which then has an effect on the rodent harborages in and around the culvert. The entirety of the culvert is in failure, but the obvious rodent problem locations start at Broadway and continue to the Revere line adjacent to the new Harley Davidson dealership. The solution will be two-part. An extermination program is needed and should be performed in the problem areas. To prevent the issue from reoccurring, however, the larger issue of dredging the culvert will need to take place.

E) **Townline Estates Trailer Park on Broadway** – Complete flood mitigation work in this area. Broadway generally floods when there is a storm event with three or more inches of rain. There is a trailer park on Broadway in the northeastern corner of Malden near Rowe's Quarry. There are approximately 70 trailers and the entire trailer park had to be evacuated on one occasion due to flooding. There is a small creek running through the property which drains into a Massachusetts Highway Department drain.

F) **Identify resiliency improvements to the City-wide Stormwater Infrastructure**. Conduct a Stormwater Vulnerability Assessment and Resilience Feasibility Action Plan that includes the

City-wide stormwater infrastructure including 1) Tide Gates, 2) Culverts specifically at Hadley, Russell, Bowman Streets, 3) areas for upsizing of undersized pipes and cleaning of the system.

Wind Hazards Mitigation

G) **Enhanced Tree management:** the City's Tree Warden coordinates with utility companies on tree trimming to reduce potential for the downing of overhead lines during high wind events. The City should provide additional staff to expand capacity for tree maintenance.

Winter Storm Hazard Mitigation

H) **Tree Warden Coordination with Utility Companies** to mitigate electric grid vulnerability to winter storm hazards. Snow loading on trees has led to falling branches and the downing of electrical and other overhead utility lines. The Tree Warden coordinates with utility companies on tree trimming to reduce potential for the downing of overhead lines during storm events. The City should provide additional staff to expand the City's capacity for tree maintenance.

Geologic Hazards Mitigation

I) **Inspections of public buildings for earthquake vulnerability** The City should conduct inspections of public buildings to assess potential risk of earthquake damage; and evaluate feasible upgrades, if any. The City has conducted façade inspections of commercial buildings.

Extreme Temperatures Mitigation

J) **Develop a City-wide Heat Mitigation/Tree Plantings Resilience Program**: Prepare a City-Wide Parks Feasibility Study for Heat Island Impacts and Heat Mitigation. Consider Tree Plantings and Pervious Surface Mitigation/Resilience Solutions

K) **Site Design guidelines to increase tree plantings:** Adopt Site Design guidelines for new development and redevelopment to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways. The City adopted Zoning amendments that increase trees in parking areas. Revise to provide comprehensive guidelines for increased tree plantings and landscaping and limiting impervious surfaces.

L) **Promote Green Building and Cool Roof designs.** Mitigate urban heat by implementing designs for green buildings and cool roofs. Implement new State Net Zero Energy Code pending January 2023.

Drought Hazards

M) **Promote drought tolerant landscaping and site design measures**: Adopt site development guidelines promoting drought-tolerant landscaping and site design measures.

Brushfire Hazards Mitigation

N) **Public Education on outdoor fire safety:** Conduct public education on maintaining property vegetation buffers to reduce the risk of wildfires and the spread of fire to adjacent structures.

Multi-Hazard Mitigation

O) **Install generators at six facilities.** Malden has several sites at which back-up generators have been installed, including the Senior center and two of the schools. The City should Install generators in six additional sites: Malden High School, four K-8 schools, and the Early Learning Center.

P) **Prepare a Department of Public Works Site Resiliency Prototype Project** that will support and build from the Malden River Works resiliency work underway to include flood protection, stormwater improvement and energy resiliency at the DPW site.

Q) I**dentify and implement resiliency improvements to Public Housing.** Conduct a City-Wide Public Housing Resiliency Feasibility Study & Risk Assessment for Improvements of Housing Authority Properties: 1) 887 Total Elder Disabled Housing Units and 2) 458 Total Family Housing Units. Include a vulnerability assessment and identification of resilience and adaptation strategies and projects to improve community resilience.

R) **Conduct a Resiliency in Zoning Assessment** to 1) Evaluate How current Zoning furthers or hinders Climate Resiliency; and 2) Identify ways in which Current Zoning could be Amended to Encourage Climate Resiliency

Prioritization of Mitigation Activities

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 Local Hazard Mitigation Committee has limited access to detailed analyses of the cost and benefits of any given measure, so prioritization is based on the committee 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 committee and through subsequent review by committee members and public comment. 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.

Table 41 below demonstrates the prioritization of recommended mitigation measures. 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:

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

Costs

High	Estimated costs greater than $250,000
Medium	Estimated costs between $50,000 to $250,000
Low	Estimated costs less than $50,000 and/or City staff time

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 23 below, and the project type, implementing responsibility, timeframe, and potential funding sources are shown in the following table, Table 41.

Table 41: Mitigation Measure Prioritization

Mitigation Action	Geographic Area	Benefit	Estimated Cost	Priority
Flood Hazards				
a) Dredge the Town Line Brook channel	East side of Malden near the border of Revere and Everett	High	High, Approx. $10 million	High
b) Linden Area- increase the storage capacity behind the Revere floodgate	Linden Neighborhood, Morris and Cleveland Streets	High	High >$250,000	High
c) Increase storage capacity at Bowman and Durso Streets by installing underground storage tanks or constructing a parallel second culvert.	Bowman and Durso Streets neighborhood	High	High, Approx. $250,000	High

Table 41: Mitigation Measure Prioritization

Mitigation Action	Geographic Area	Benefit	Estimated Cost	Priority
d) Rodent Problem in the Town Line Brook Area	The entirety of the area around the Town Line Brook culvert but the obvious rodent problem locations start at Broadway and continue to the Revere line adjacent to the new Harley Davidson dealership.	High	Extermination - Low <$50,000 Culvert repair High >$250,000	High
e) Complete flood mitigation work at the Townline Estates Trailer Park on Broadway	Broadway in the northeastern corner of Malden near Rowe's Quarry	Medium	High	Medium
f) Identify resiliency improvements to the City-wide Stormwater Infrastructure, including preparation of comprehensive vulnerability assessment and action plan	City-wide	High	Medium	High
Wind Hazards				
g) Provide additional staff resources for the managing of wind hazards for trees	City wide	Medium	Medium	Medium
Winter/Snow Hazards				
h) Coordinate with Utilities to mitigate electric grid vulnerability to winter storm hazards	City wide	Medium	Medium	Medium
Geologic Hazards				
i) Inspections of public buildings for earthquake vulnerability	City wide	Low	Medium	Low

Table 41: Mitigation Measure Prioritization

Mitigation Action	Geographic Area	Benefit	Estimated Cost	Priority
Extreme Temperature Hazards				
j) Develop a City-wide Heat Mitigation/Tree Plantings Resilience Program.	City-wide	Medium	Medium	Medium
k) Site Design guidelines to increase tree plantings near buildings and along public ways.	City wide	Medium	Low	Medium
l) Promote Green Building and Cool Roof designs (new Building Code, Jan. 2023)	City wide	High	Low	High
Drought Hazards				
m) Promote drought tolerant landscaping and site design measures	City wide	Medium	Low	Medium
Brushfire Hazards				
n) Conduct Public education on outdoor fire safety	City wide	Medium	Low	Medium
Multi-Hazard Mitigation Measures				
o) Install generators at six facilities	City wide	High	High	High
p) Prepare a Department of Public Works Site Resiliency Project	Public Works Facility	High	High	High
q) Identify and implement resiliency improvements to Public Housing.	Public Housing facilities	High	Medium	High
r) Conduct a Resiliency in Zoning Assessment	City-wide	Medium	Low	Medium

Notes on Mitigation Measures Table (Table 42)

Implementation Responsibility – The designation of implementation responsibility was done by MAPC based on a general knowledge of what each municipal department is responsible for. It is likely that most mitigation measures will require that several departments work together and assigning staff is the sole responsibility of the governing body of each community.

Estimated Costs: Projects that have been evaluated and costed show their specific cost estimates. Most proposed mitigation projects are shown in a three-tier cost estimate based upon best available knowledge of the local Hazard Mitigation Team:

High:	Greater than $250,000
Medium:	Between $50,000 to $250,000
Low:	Less than $50,000 and/or City staff time

Time Frame – The time frame was based on a combination of the priority for that measure, the complexity of the measure and whether or not the measure is conceptual, in design, or already designed and awaiting funding. Because the time frame for this plan is five years, the timing for all mitigation measures has been kept within this framework. The identification of a likely time frame is not meant to constrain a community from taking advantage of funding opportunities as they arise.

Potential Funding Sources – This column attempts to identify the most likely sources of funding for a specific 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. MEMA and DCR assisted MAPC in reviewing the potential eligibility for hazard mitigation funding. 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. Upon adoption of this plan, the local committee responsible for its implementation should begin to explore the funding sources in more detail.

Additional information on funding sources – The best way to determine eligibility for a particular funding source is to review the project with a staff person at the funding agency. The following websites provide an overview of programs and funding sources.

Army Corps of Engineers (ACOE) – The website for the North Atlantic district office is http://www.nae.usace.army.mil/. The ACOE provides assistance in a number of types of projects including shoreline/streambank protection, flood damage reduction, flood plain management services and planning services.

Massachusetts Emergency Management Agency (MEMA) – The grants page http://www.mass.gov/dem/programs/mitigate/grants.htm has a useful table that compares eligible projects for the Hazard Mitigation Grant Program and the Flood Mitigation Assistance Program.

United States Department of Agriculture – The USDA has programs by which communities can get grants for firefighting needs. See the link below for some examples. http://www.rurdev.usda.gov/rd/newsroom/2002/cfg.html

Table 42: Malden Recommended Mitigation Strategies

Table 42: Mitigation Strategy Recommendations for the Malden 2022 Hazard Mitigation Plan						
Mitigation Action	**Description**	**Priority**	**Lead Agency**	**Estimated Cost**	**Estimated Timeframe 2022-27**	**Potential Funding Sources**
FLOOD HAZARDS						
A. Dredge the Town Line Brook channel	One of the recommendations of the Town Line Brook study is to dredge the channel (owned by the state Division of Conservation and Recreation) of approximately 4,000 cubic yards of sediment that have accumulated in the lined reaches of the channel. The City believes that the lack of storage capacity in the channel is a major contributor to flooding in the Linden neighborhood and the Hanover Street neighborhood. Sedimentation is not the only problem with the culvert. The sides of the culvert are concrete panels that have been popping out, allowing the banks of the culvert to be undermined.	High	Mass Highway, MA DEP, Army Corps of Engineers	High Approx. $10 million	2024-27	MA State DEP, Mass Highway, Army Corps of Engineers, Department of Conservation and Recreation (DCR), FEMA
B. Linden Area- increase the storage capacity behind the Revere floodgate	In order to mitigate flooding in this neighborhood it will be necessary to increase the storage capacity behind the Revere floodgate. This would include increased storage in Revere and Malden. Solving the flooding in this area is directly related to dredging the culvert.	High	Department of Conservation and Recreation (DCR)	High >$250,000	2024-27	Department of Conservation and Recreation (DCR)/FEMA
C. Increase storage capacity at Bowman/Durso Streets by install underground storage tanks or constructing a parallel second culvert	The solution to flooding in this area would be to install underground storage tanks or to construct a second parallel culvert to increase capacity.	High	Malden DPW	High Approx. $250,000	2024-27	City General Fund, HMGP, FMA

Table 42: Mitigation Strategy Recommendations for the Malden 2022 Hazard Mitigation Plan						
Mitigation Action	**Description**	**Priority**	**Lead Agency**	**Estimated Cost**	**Estimated Timeframe 2022-27**	**Potential Funding Sources**
D. Rodent Problem in the Town Line Brook Area	The rodent issue is a byproduct of the lack of maintenance of the physical structure of the Brook. The culvert is failing and leaching storm water runoff and is holding large amounts of contaminated road sediment. This has an effect on the rodent harborages in and around the culvert. The obvious rodent problem locations start at Broadway and continue to the Revere line. The solution will be two-part. An extermination program is needed and should be performed in the problem areas. To prevent the issue from reoccurring, however, the larger issue of dredging the culvert will need to take place.	Medium	Malden Board of Health, MA DEP, Mass Highway, Army Corps of Engineers	Rodent control $40,000 line item Culvert repair High >$250,000	2022-27	City General Fund, MA State DEP, Mass Highway and Army Corps of Engineers
E. Complete flood mitigation work at the Townline Estates Trailer Park on Broadway	Broadway generally floods when there is a storm event with three or more inches of rain. There is a trailer park on Broadway in the northeastern corner of Malden on the Melrose line. There are approximately 70 trailers and the entire trailer park had to be evacuated on one occasion due to flooding. There is a small creek running through the property which drains into a Massachusetts Highway Department drain.	Medium	Malden DPW, City Engineer	High >$250,000	2022-24	MADOT/ City General Fund
F. Identify resiliency improvements to the City-wide Stormwater Infrastructure, including preparation of comprehensive vulnerability assessment and action plan	Conduct a Stormwater Vulnerability Assessment and Resilience Feasibility Study that includes the City-wide stormwater infrastructure including 1) Tide Gates, 2) Culverts specifically at Hadley, Russell, Bowman Streets, 3) areas for upsizing of undersized pipes and cleaning of the system.	High	Public Works Dept.	Medium $50,000 to $250,000	2023-25	City General Fund; MVP Action Grant

Table 42: Mitigation Strategy Recommendations for the Malden 2022 Hazard Mitigation Plan						
Mitigation Action	**Description**	**Priority**	**Lead Agency**	**Estimated Cost**	**Estimated Timeframe 2022-27**	**Potential Funding Sources**
WIND HAZARDS						
G. Provide additional staff resources for the management of wind hazards for trees	The City's Tree Warden coordinates with utility companies on tree trimming to reduce potential for the downing of overhead lines during high wind events. The City should provide additional staff to expand capacity for tree maintenance.	Medium	Malden DPW, Tree Warden	Medium $50,000 to $250,000	2022-27	City General Fund
WINTER HAZARDS						
H. Coordinate with Utilities to mitigate electric grid vulnerability to winter storm hazards	Snow loading on trees has led to falling branches and the downing of electrical and other utility lines. The Tree Warden will coordinate with utility companies on tree trimming to reduce potential for the downing of overhead lines during storm events. The City should provide additional staff to expand the City's capacity for tree maintenance.	Medium	Malden DPW, Tree Warden	Medium $50,000 to $250,000	2022-27	City General Fund
GEOLOGIC HAZARDS						
I. Inspections of public buildings for earthquake vulnerability	The City should conduct inspections of public buildings to assess potential risk of earthquake damage; and evaluate feasible upgrades, if any. The City has conducted façade inspections of commercial buildings.	Low	Building Department, Engineering	Medium $50,000 to $250,000		City General Fund

Table 42: Mitigation Strategy Recommendations for the Malden 2022 Hazard Mitigation Plan						
Mitigation Action	**Description**	**Priority**	**Lead Agency**	**Estimated Cost**	**Estimated Timeframe 2022-27**	**Potential Funding Sources**
EXTREME HEAT HAZARDS						
J. Develop a City-wide Heat Mitigation/Tree Plantings Resilience Program.	Prepare City-Wide Parks Feasibility Study for Heat Island Impacts and Heat Mitigation. Consider Tree Plantings and Pervious Surface Mitigation/Resilience Solutions.	Medium	Conservation; OSPCD	Medium $50,000 to $250,000	2023-26	City General Fund; MVP Action Grant
K. Adopt Site Design Guidelines to increase tree plantings	Adopt Site Design guidelines for new development and redevelopment to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways. The City adopted Zoning amendments that increase trees in parking areas. Revise to provide comprehensive guidelines for increased tree plantings and landscaping and limiting impervious surfaces.	Medium	City Council; Planning Dept, Conservation Commission	Low <$50,000	2022-24	City General Fund
L. Promote Green Building and Cool Roof designs	Mitigate urban heat by implementing designs for green buildings and cool roofs. Implement new State Net Zero Energy Code pending Jan. 2023.	High	Building Department, Planning Dept.	Low <$50,000	2023	City General Fund
DROUGHT HAZARDS						
M. Promote drought tolerant landscaping and site design measures	Adopt site development guidelines promoting drought-tolerant landscaping and site design measures.	Medium	City Council; Planning Dept, Conservation Commission	Low <$50,000	2022-24	City General Fund
FIRE HAZARDS						
N. Public education on outdoor fire safety	Conduct public education on maintaining property vegetation buffers to reduce the risk of wildfires and the spread of fire to adjacent structures.	Medium	Fire Department	Low <$50,000	2023-25	City General Fund

Table 42: Mitigation Strategy Recommendations for the Malden 2022 Hazard Mitigation Plan						
Mitigation Action	**Description**	**Priority**	**Lead Agency**	**Estimated Cost**	**Estimated Timeframe 2022-27**	**Potential Funding Sources**
MULITI-HAZARDS						
O. Install generators at six facilities	Malden has several sites for which they have installed back-up generators, including the Senior center and two of the schools. Install generators in six additional schools: Malden High School, four K-8 schools, and the Early Learning Center.	High	Emergency Management Coordinator	High >$250,000	2022-24	City General Fund; FEMA
P. Prepare a Department of Public Works Site Resiliency Prototype Project	Prepare a DPW Site Resiliency Prototype Project that will support and build from the Malden River Works resiliency work underway to include flood protection, stormwater improvement and energy resiliency at the DPW site.	High	Public Works Dept; Office of Strategic Planning and Comm. Dev., Engineering	High >$250,000	2025-27	City General Fund; MVP Action Grant
Q. Identify and implement resiliency improvements to Public Housing.	Conduct a City-Wide Public Housing Resiliency Feasibility Study & Risk Assessment for Improvements of Housing Authority Properties: 1) 887 Total Elder Disabled Housing Units and 2) 458 Total Family Housing Units. Include a vulnerability assessment and identification of resilience and adaptation strategies and projects to improve community resilience.	High	Housing Authority; Public Works	Medium $50,000 to $250,000	2024-27	City General Fund; MVP Action Grant, CPA funding
R. Conduct a Resiliency in Zoning Assessment	Conduct a Resiliency in Zoning Assessment to: 1) Evaluate How current Zoning furthers or hinders Climate Resiliency; and 2) Identify ways in which Current Zoning could be Amended to Encourage Climate Resiliency	Low	Planning Board; OSPCD Conservation Commission	Low <$50,000	2023-25	City General Fund; MVP Action Grant

Abbreviations Used in Table 42

ACOE = Army Corps of Engineers.

DCR = MA Department of Conservation and Recreation

DHCD = MA Department of Housing and Community Development

DHS/EOPS = Department of Homeland Security/Emergency Operations

EPA/DEP (SRF) = Environmental Protection Agency/Department of Environmental Protection (State Revolving Fund)

FEMA Mitigation Grants includes:
BRIC = Building Resilient Infrastructure and Communities
FMA = Flood Mitigation Assistance Program.
HMGP = Hazard Mitigation Grant Program.

Mass DOT = Massachusetts Department of Transportation

MBTA = Massachusetts Bay Transportation Authority

MVP = Municipal Vulnerability Preparedness (EEA grant)

SECTION 9: PLAN ADOPTION & MAINTENANCE

PLAN ADOPTION

The *Malden Hazard Mitigation Plan 2022 Update* was adopted by the Malden City Council on [*ADD DATE*]. See Appendix E 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 Malden Hazard Mitigation Team to prepare this plan. This group will continue to meet on an as-needed basis to coordinate the implementation and maintenance of this plan. The Malden Emergency Management Director will be designated as the team coordinator. Additional members could be added to the local team from 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 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.

IMPLEMENTATION AND EVALUATION SCHEDULE

Mid-Term Survey on Progress – The coordinator of the Hazard Mitigation Team will prepare and distribute a survey in year three of the plan. The survey will be distributed to all the local 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.

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 Team will have primary responsibility for tracking progress, evaluating, and updating the plan.

The City of Malden will work to integrate the content of the Hazard Mitigation Plan into other planning efforts. This integration will enable more timely annual reports of mitigation action status.

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. Given the lead time needed to secure funding for planning and conduct the planning process, the Hazard Mitigation Team will begin to prepare for an update of the plan in year three. 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 Building Resilient Infrastructure and Communities (BRIC) 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, contract with the Metropolitan Area Planning Council to update the plan or to hire another consultant to assist the City. However, if the Hazard Mitigation Team decides to update the plan, the city will need to review the current FEMA hazard mitigation plan guidelines for any changes in requirements for hazard mitigation plans since the previous plan. Once the next plan update is prepared, the City will submit it to MEMA and FEMA for review and approval and adopt the updated plan in order to obtain formal FEMA approval of the plan.

INTEGRATION OF THE PLANS WITH OTHER PLANNING INITIATIVES

The City of Malden has taken steps to implement recommendations of the 2017 Hazard Mitigation Plan, including adoption of site design guidelines requiring more trees in parking areas, provision of cooling centers at three locations, completion of new Fire and Police stations that include updated communications capabilities, drainage work at Bowman and Durso Streets, and appropriation of $40,000 to address rodent problems in the Town Line Brook Area. The largest stormwater infrastructure improvements still outstanding are largely in the purview of the state through the Department of Conservation and Recreation and the Massachusetts Department of Transportation.

Upon FEMA's approval of the Malden Hazard Mitigation Plan 2022, the Local 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. Discussions will focus on how recommendations in the approved plan can be integrated into the City's capital improvement planning program, master plan, and other City process. Implementation of the plan will be reviewed with the following departments:

- Fire Department
- Emergency Management
- Police Department
- Department of Public Works
- Strategic Planning and Community Development
- Engineering
- Building
- Capital Projects
- Conservation Commission
- Health

Other groups that will be coordinated with include large institutions, Chambers of Commerce, Community Based Organizations, land conservation organizations, public health and social service providers that serve Environmental Justice and other vulnerable population, and watershed groups like the Friends of the Malden River and the Mystic River Watershed Association. The plan and any updates will be posted on the City's website. The posting of the plan on the website will include a mechanism for citizen feedback such as an e-mail address to send comments.

SECTION 10: LIST OF REFERENCES

City of Malden, *Community Resilience Building Summary of Findings*, 2020

City of Malden, *Open Space and Recreation Plan*, 2017

City of Malden, *Master Plan*, 2010

City of Malden, Zoning Ordinance

Blue Hill Observatory

FEMA, Flood Insurance Rate Maps for Middlesex County, MA, 2010-2016

FEMA, Hazards U.S. Multi-Hazard (HAZUS-MH), 2021

FEMA, *Local Mitigation Plan Review Guide*, October 2011

FEMA. Local Multi-Hazard Mitigation Planning Handbook, 2013

Fourth National Climate Assessment, 2018

Massachusetts *Drought Management Plan*, 2019

Massachusetts Geographic Information System, 2016 Land Use maps

Massachusetts Office of Dam Safety, Inventory of Massachusetts Dams 2018

Massachusetts *State Hazard Mitigation Plan*, 2013

Massachusetts *State Hazard Mitigation and Climate Adaptation Plan*, 2018

National Weather Service

Nevada Seismological Library

New England Seismic Network, Boston College Weston Observatory

NOAA National Centers for Environmental Information

Northeast Climate Adaptation Science Center

Northeast States Emergency Consortium

Tornado History Project

Urban Land Institute, *Living with Heat, 2019*

US Census, 2020 and American Community Survey 2019, 5-Year Estimates

USGS, National Water Information System

APPENDIX A: HAZARD MAPPING

The MAPC GIS (Geographic Information Systems) Lab produced a series of maps depicting multiple hazards as well as land use and demographic data. 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 documentation for some of the hazard maps was incomplete as well.

The hazard map series consists of 10 maps as follow:

Map 1.	Population Density
Map 2.	Potential Development
Map 3.	Flood Zones
Map 4.	Earthquakes and Landslides
Map 5.	Hurricanes and Tornadoes
Map 6.	Average Snowfall
Map 7.	Composite Natural Hazards
Map 8.	Hazard Areas
Map 9	Hot Spots
Map 10	Sea Level Rise

Reduced-scale PDF copies of the map series are included in this Appendix for general reference. Full sized higher resolution PDFs of the maps are available from MAPC upon request.

Map1: Population Density – This map uses the US Census block data 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 2: Land Use – This map shows 2016 land use patterns in Malden from the statewide land use assessment prepared from interpretation of aerial imagery. The land use mapping is available from Mass. GIS.

Map 3: Flood Zones – This map shows the flood zones used by the current Federal Insurance Rate Maps (FIRMs), prepared by the National Flood Insurance Program. 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. Also shown on this map are the flood assistance and flood insurance claims related to the major storms of 2010, categorized by depth of flooding. The flood zone map for each community also shows critical facilities

Map 4: Earthquakes and Landslides – 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 – This map shows a number of different items. 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.

Map 6: Average Snowfall - - This map shows the average snowfall and open space. It also shows storm tracks for nor'easters, if any storms tracked through the community.

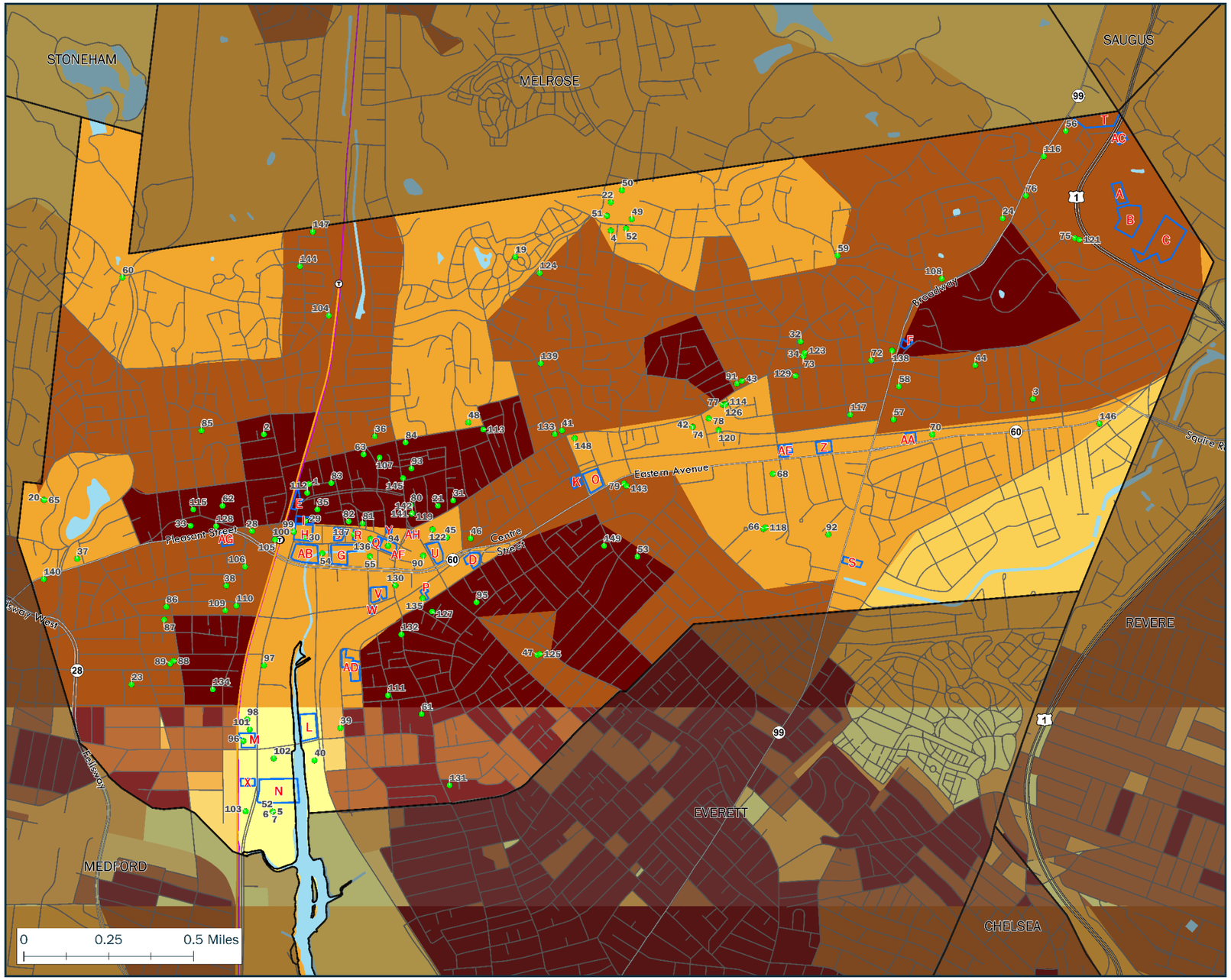
Map 7: Composite Natural Hazards - This map shows four categories of composite natural hazards for areas of existing development. The hazards included in this map are 100-year wind speeds of 110 mph or higher, low and moderate landslide risk, FEMA Q3 flood zones (100 year and 500 year) and hurricane 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: Hazard Areas – For each community, locally identified hazard areas are overlaid on an aerial photograph. The critical infrastructure sites are also shown. The source of the aerial photograph is Mass GIS.

Map 9: Hot Spots: The hottest 5 percent land surface temperatures in the MAPC region based on infrared satellite imager from July 2015.

Map 10: Sea Level Rise: - Areas that would be inundated by four Sea Level Rise scenarios based on 1, 3. 6, and 10 feet of Sea Level Rise.

Map 11: Coastal Flooding: - Annual chance of coastal flooding, present day scenario, based on the Massachusetts Coastal Resilience Model (MA-CRM) prepared by the Woods Hole Group for the Massachusetts Department of Transportation, 2021.



Map 1: Population Density

FEMA Hazard Mitigation Planning Grant

MALDEN, MA

Sites
- Critical Infrastructure*
- Development Areas

* See details in separate table

Water Bodies

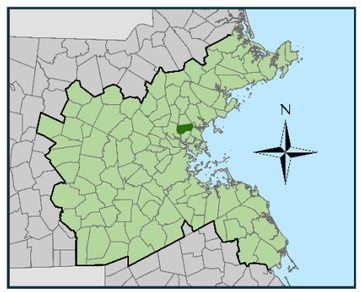
Population Density

Census 2020 Block Groups

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

All Roads
- Interstate
- U.S. Highway
- State Route
- Street

Rail
- Stations
- Commuter Rail



The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

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
MALDEN, MA

Date: 6/1/2022

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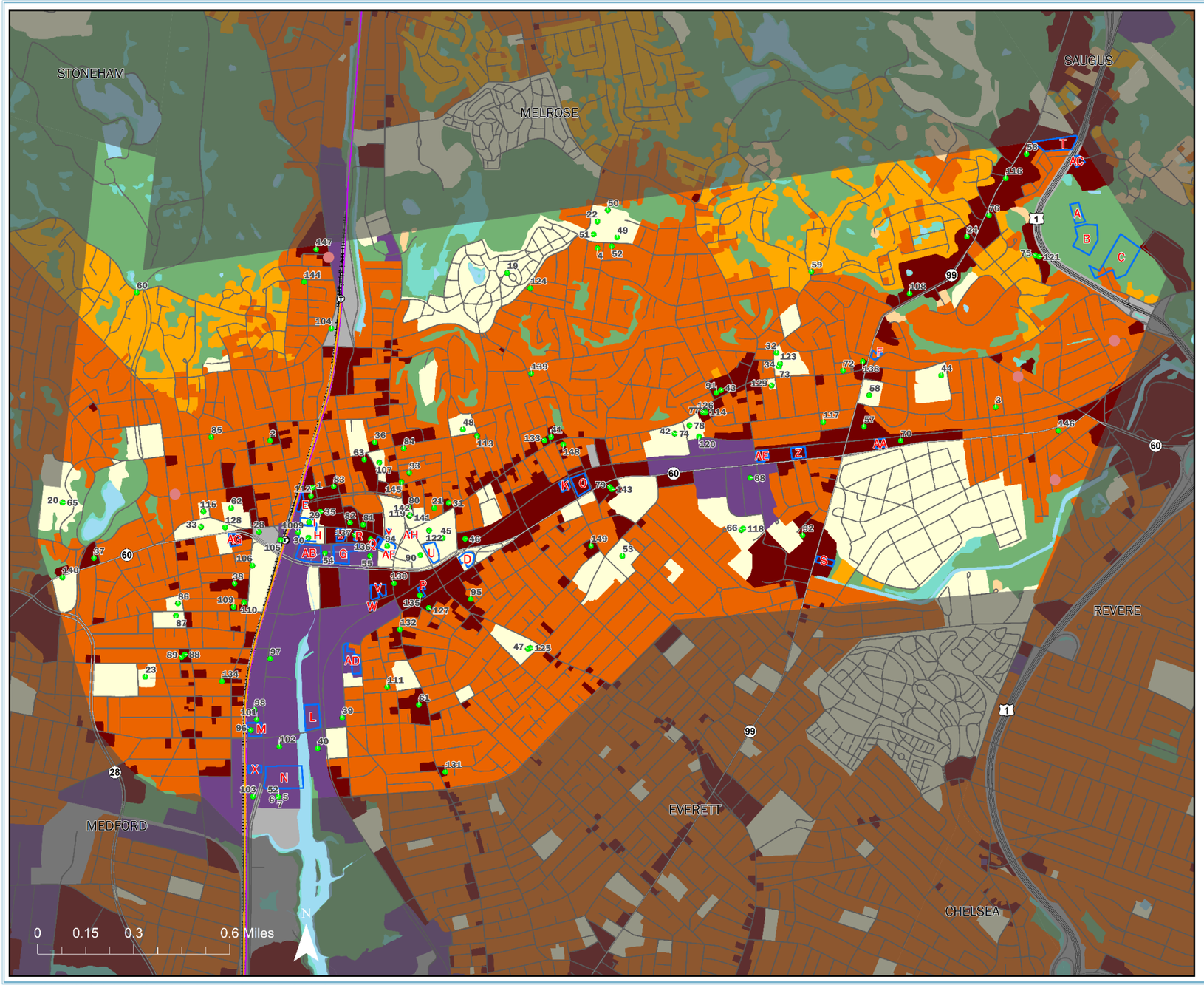


Map 2: Land Use

MAPC dcr

FEMA Hazard
Mitigation Planning Grant
MALDEN, MA

Sites
- Critical Infrastructure
- RepetitiveLossSites
- Development Areas

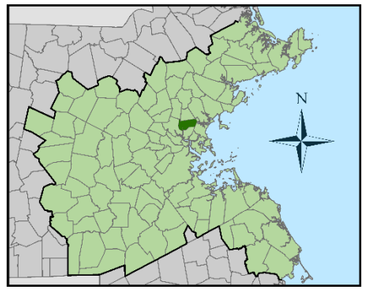
* See details in separate table

Water Bodies

Land Use
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Non-Residential Developed
- Commercial
- Industrial
- Transportation
- Agriculture
- Undeveloped
- Undeveloped Wetlands

All Roads
- Interstate
- U.S. Highway
- State Route
- Streets

Rail
- Stations
- Commuter Rail



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Data Sources:
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Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)

MALDEN, MA

Date: 6/1/2022

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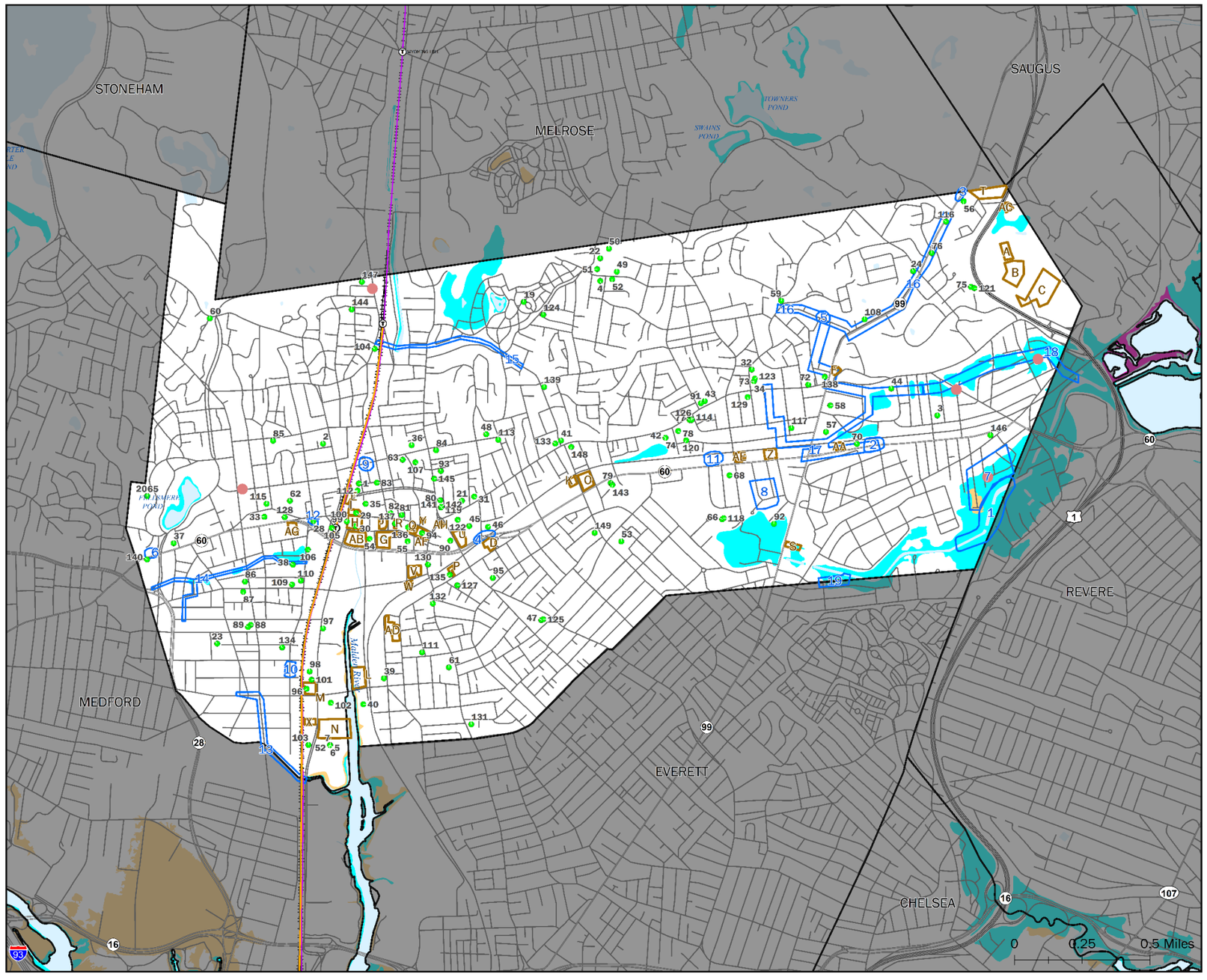


MAPC dcr

FEMA Hazard Mitigation Planning Grant
MALDEN, MA

Map 3: Flood Zones

Sites
- Critical Infrastructure*
- Repetitive Loss Sites
- Development Areas
- Locally Identified Flooding

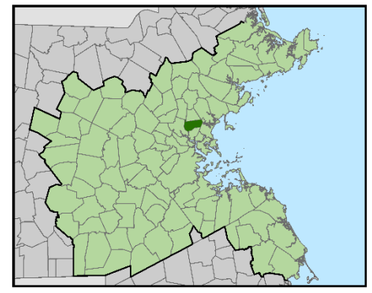
* See details in separate table

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

Water Bodies

All Roads
- Interstate
- U.S. Highway
- State Route
- Streets

Rail
- Stations
- Commuter Rail
- Trains



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Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)

Flood Zones datalayer updated by MassGIS October 2013 from finalized data provided by Federal Emergency Management Agency (FEMA)

MALDEN, MA
Date: 7/5/2022

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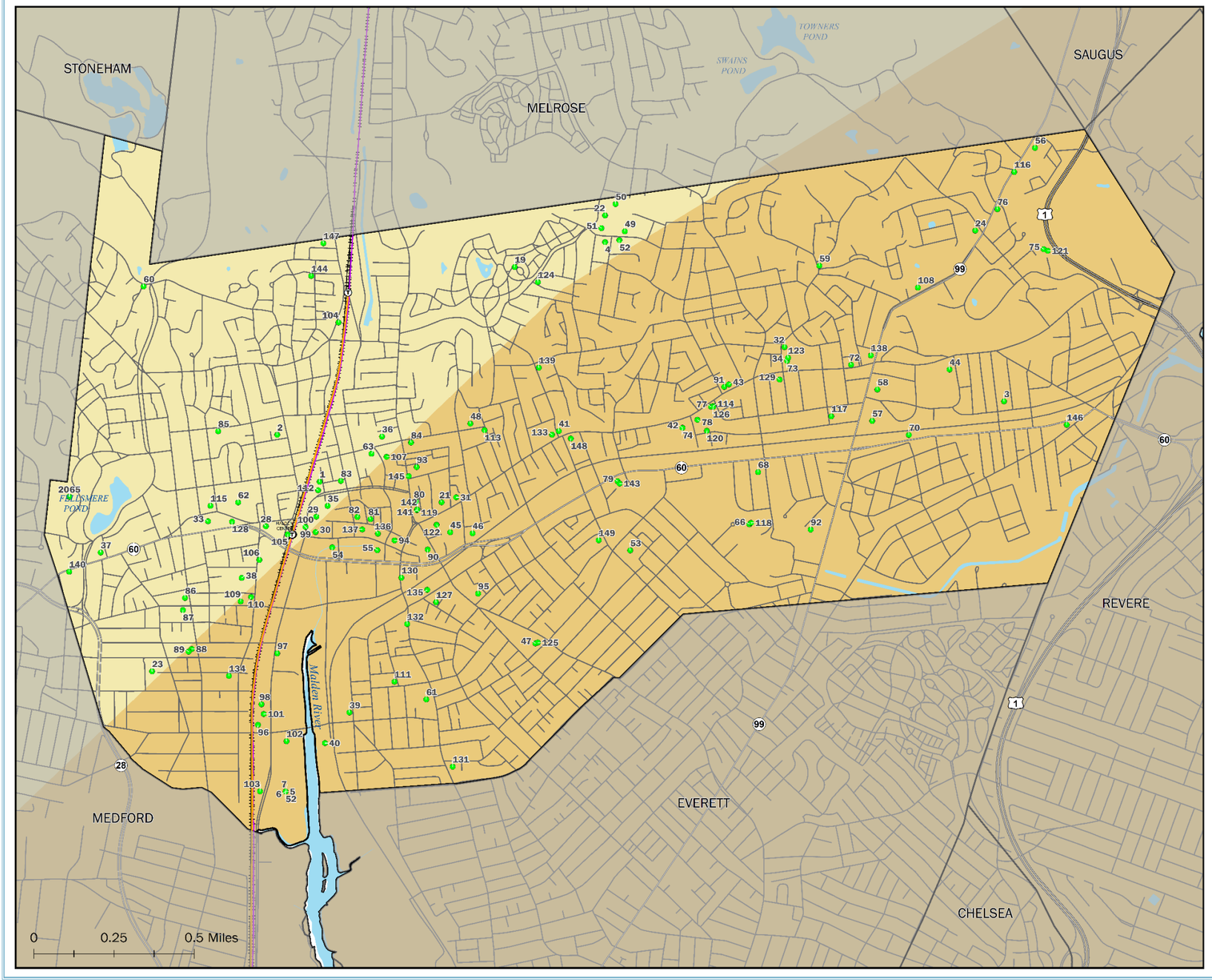


Map 4: Earthquakes / Landslides

MAPC dcr

FEMA Hazard Mitigation Planning Grant

MALDEN, MA

Sites
- Critical Infrastructure Sites*

* See details in separate table

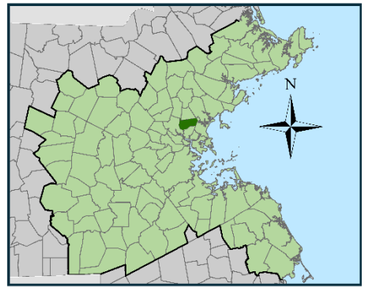
- Train Stations
- Commuter Rail Lines
- Trains

- Water Bodies

All Roads
- Interstate
- U.S. Highway
- State Route
- Street

Earthquakes
- Epicenters

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



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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. Geological Survey (USGS)

Date: 6/1/2022
MALDEN, MA

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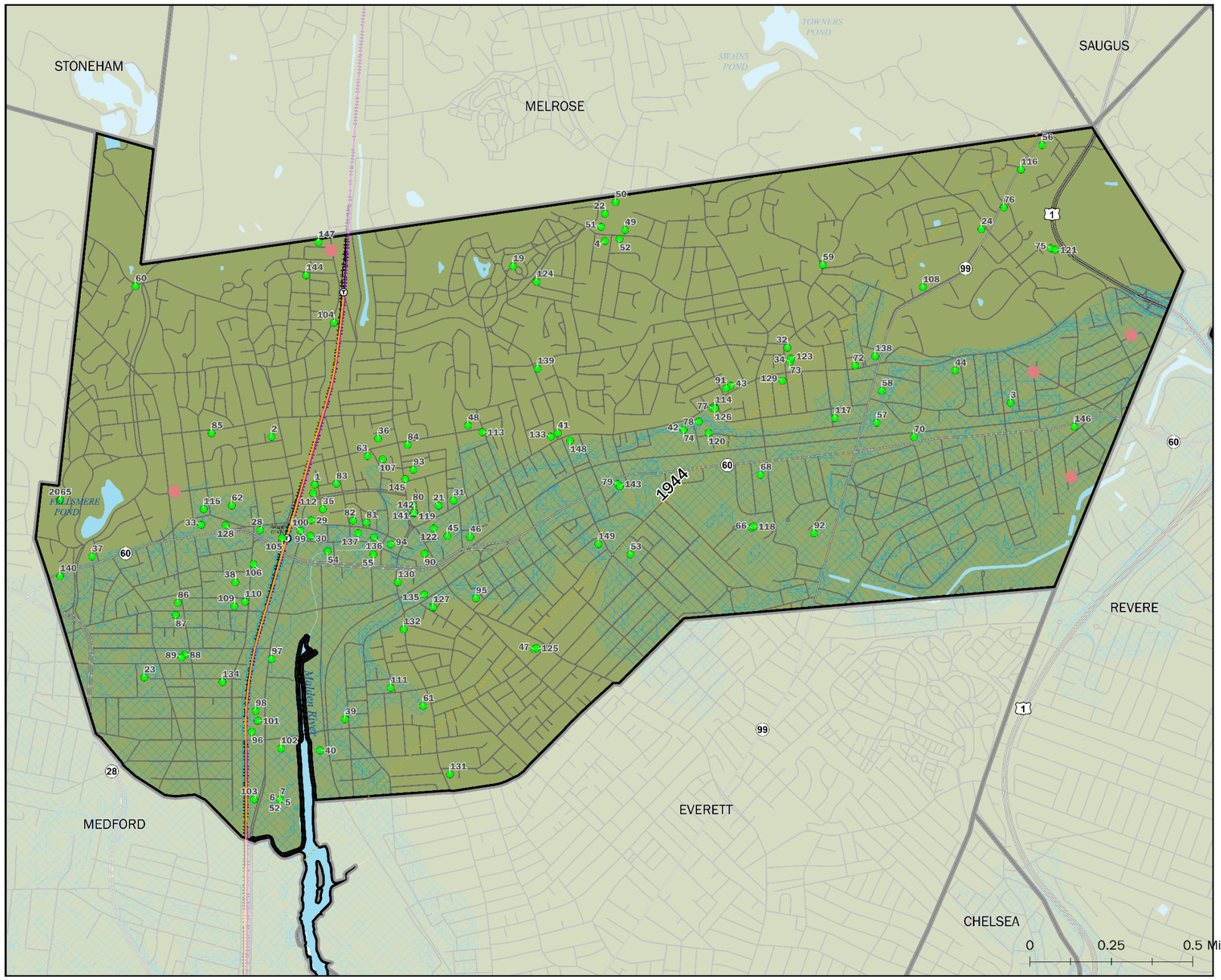


MAPC dcr

FEMA Hazard Mitigation Planning Grant
MALDEN, MA

Map 5: Hurricanes / Tornadoes

Sites
- Critical Infrastructure Sites*
- Repetitive Loss Sites

* See details in separate table

- Train Stations
- Commuter Rail Lines
- Trains

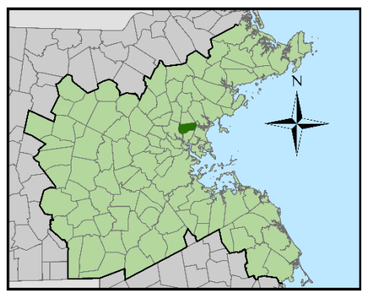
Tornadoes
- Tornado

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

Year of storm noted on map

- Hurricane Surge Inundation Area
- Water Bodies

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



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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)
National Oceanographic and Atmospheric Administration (NOAA)
Date: 6/1/2022

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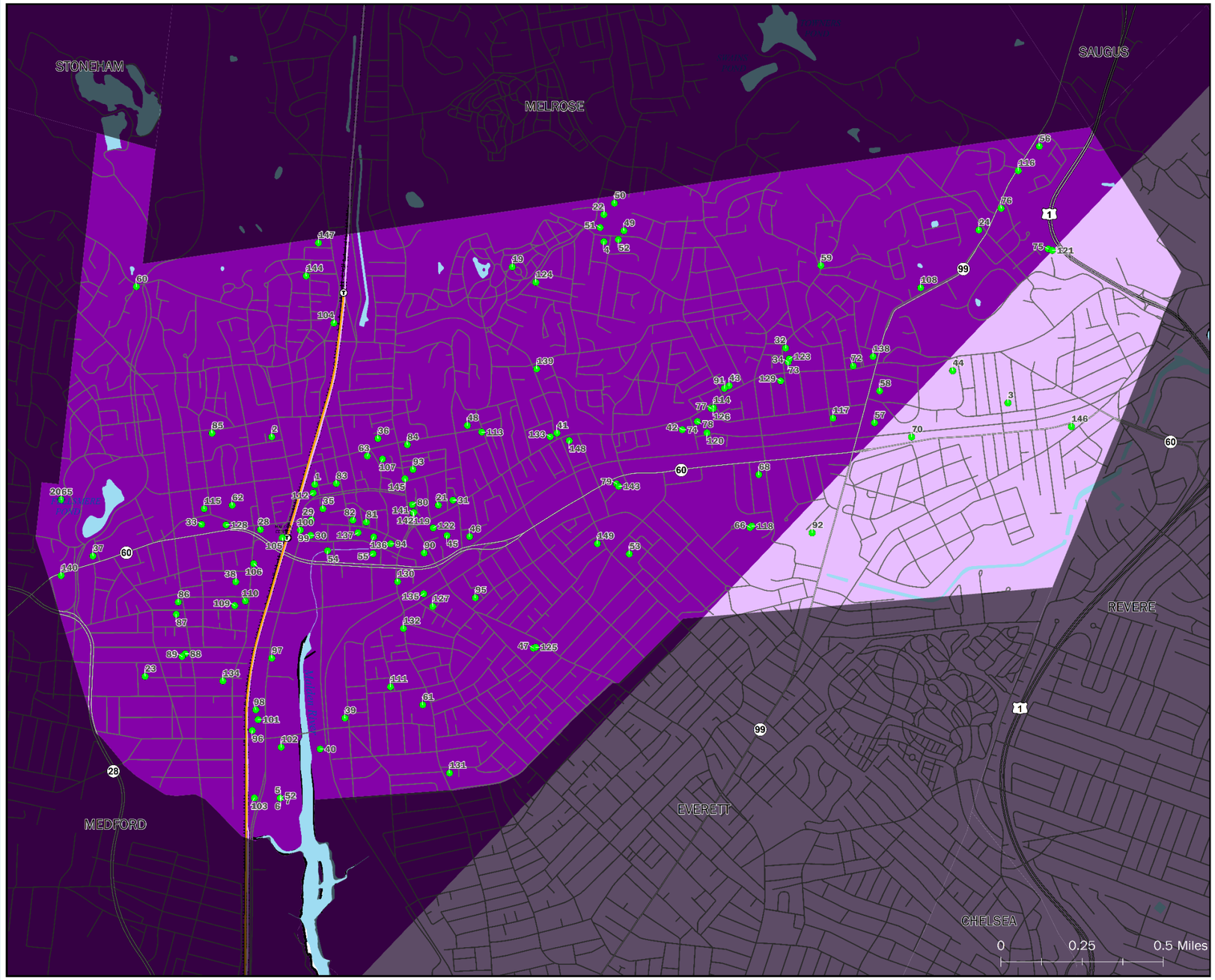


Map 6: Average Snowfall

FEMA Hazard Mitigation Planning Grant

MALDEN, MA

Sites

- Critical Infrastructure Sites*

* See details in separate table

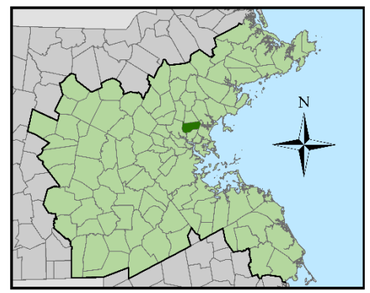
Average Annual Snowfall

- 36.1 to 48.0 inches
- 48.1 to 72.0 inches

- Water Bodies
- Train Stations
- Commuter Rail Lines
- Trains

All Roads

- Interstate
- U.S. Highway
- State Route
- Street



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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)

MALDEN, MA

Date: 6/1/2022

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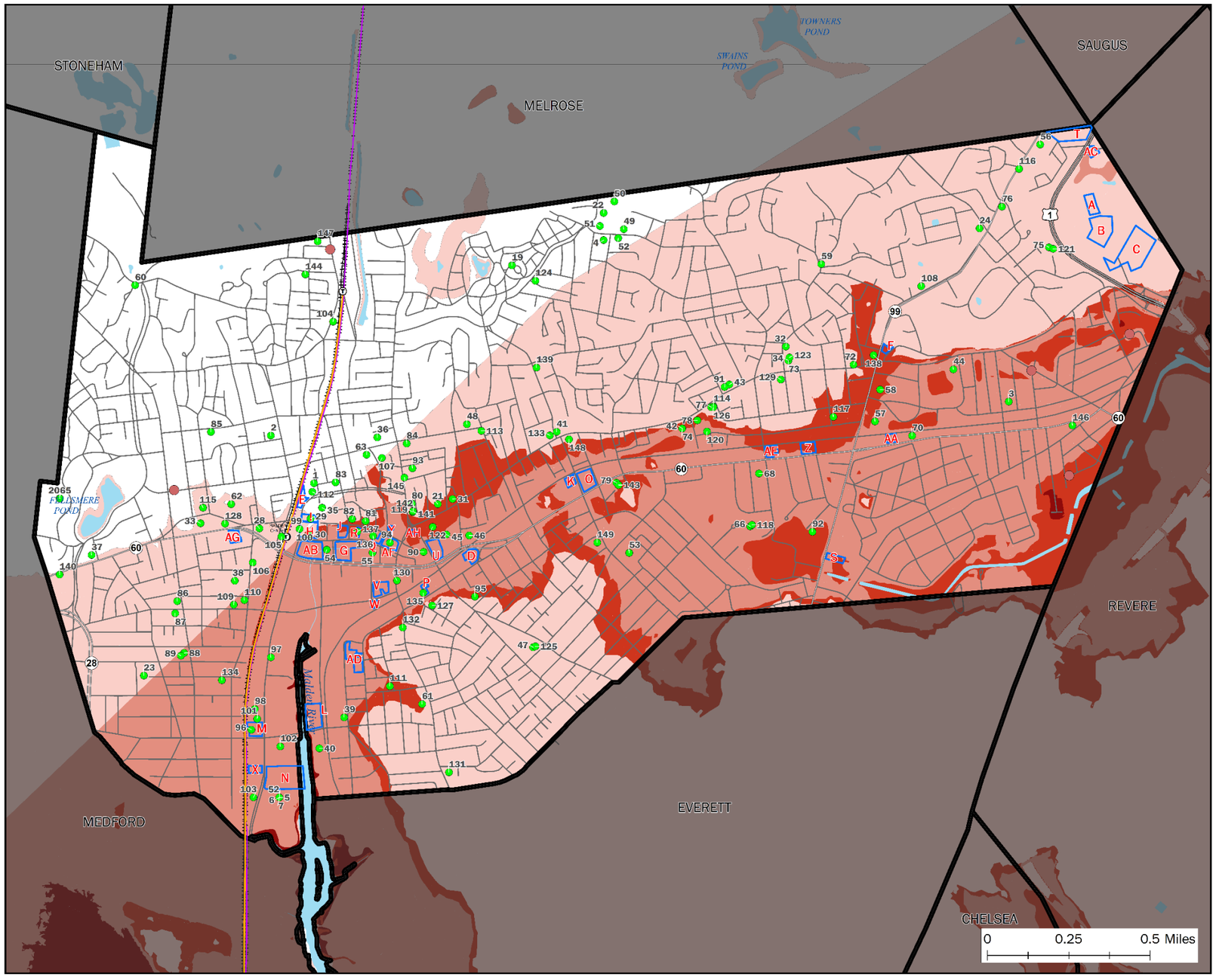


Map 7: Composite Natural Hazards

MAPC dcr

FEMA Hazard Mitigation Planning Grant

MALDEN, MA

Sites

- Critical Infrastructure
- Repetitive Loss Sites
- Development Areas

* See details in separate table

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 innundation areas

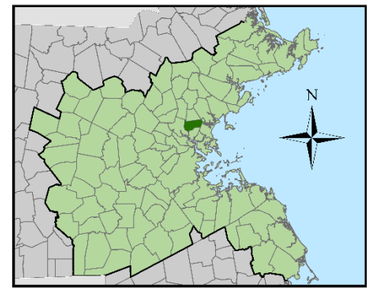
- Water Bodies

All Roads

- Interstate
- U.S. Highway
- State Route
- Street
- Train Stations
- Commuter Rail Lines
- Trains

Subway Lines

- Blue
- Green
- Orange
- Red
- Silver



The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

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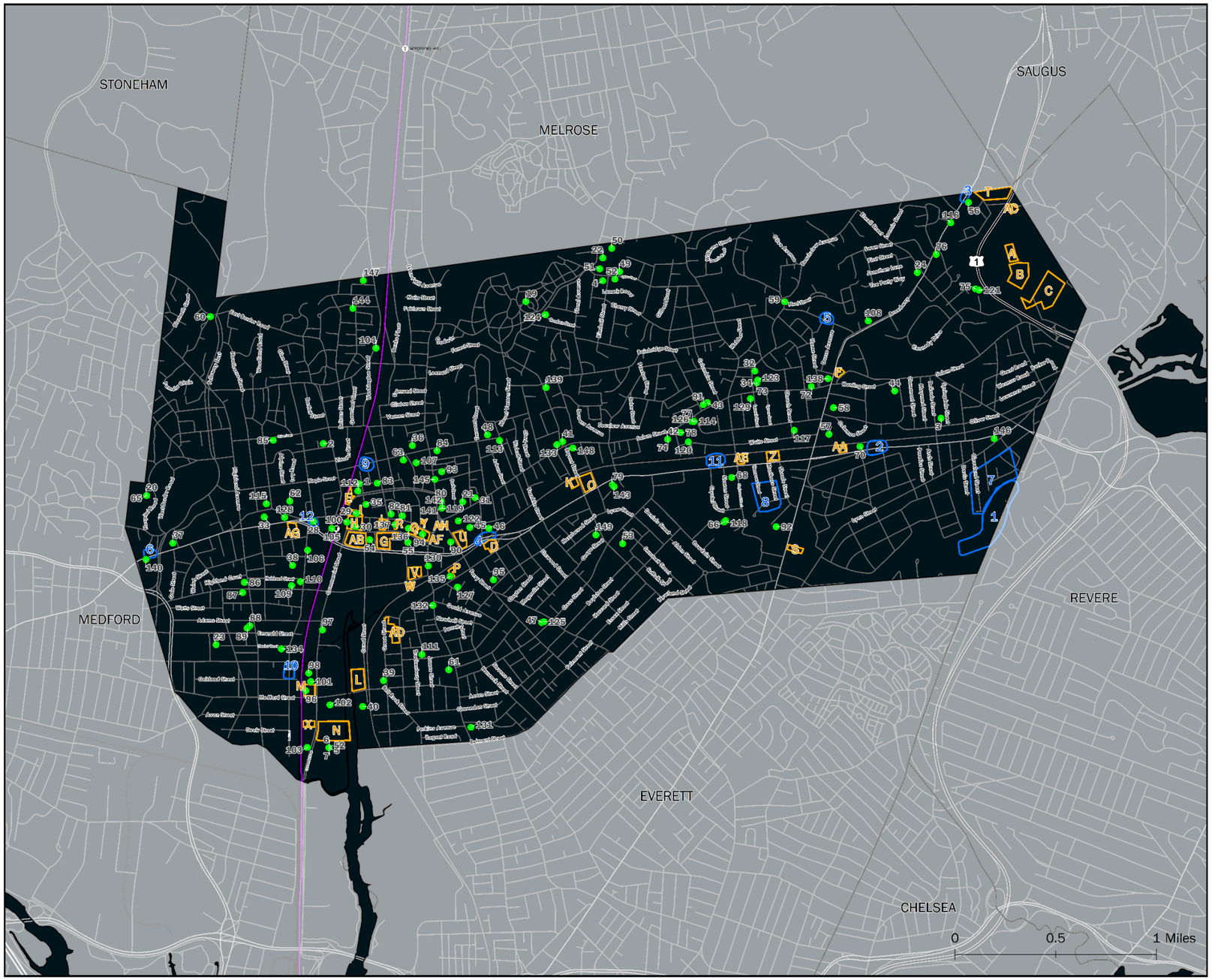
Data Sources

Composite Natural Hazard:
Wind, Landslide Risk, Snow -Northeast States Emergency Consortium (NESEC)
Flood Zones - 2013 FEMA/MassGIS
Hurricane Surge - 2013 U.S. Army Corps of Engineers, New England District
Roads/Trains: MassDOT/ CTPS
Repetitive Loss Sites: DCR/Office of Flood Hazard Management
Critical Infrastructure: Metropolitan Area Planning Council (MAPC) /

MALDEN, MA

Date: 6/1/2022

Path: \\cara-00 \public\DataServices\Projects\Current_Projects\Environment\FEMA project_files\FEMA_Map7.m



Map 8: Local Hazard Areas

MAPC

dcr

FEMA Hazard Mitigation Planning Grant

MALDEN, MA

Sites

- Critical Infrastructure Sites*
- Repetitive Loss Sites

* See details in separate table

Locally Identified Hazard Areas

- Brush Fires
- Flooding
- Other

* See Section IV Risk Assessment

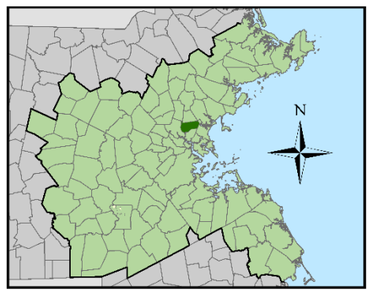
- Development Sites

* See details in separate table

- Train Stations
- Commuter Rail Lines
- Trains

All Roads

- Interstate
- U.S. Highway
- State Route
- Street



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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)
Imagery © DigitalGlobe, 2015

MALDEN, MA

Date: 6/1/2022

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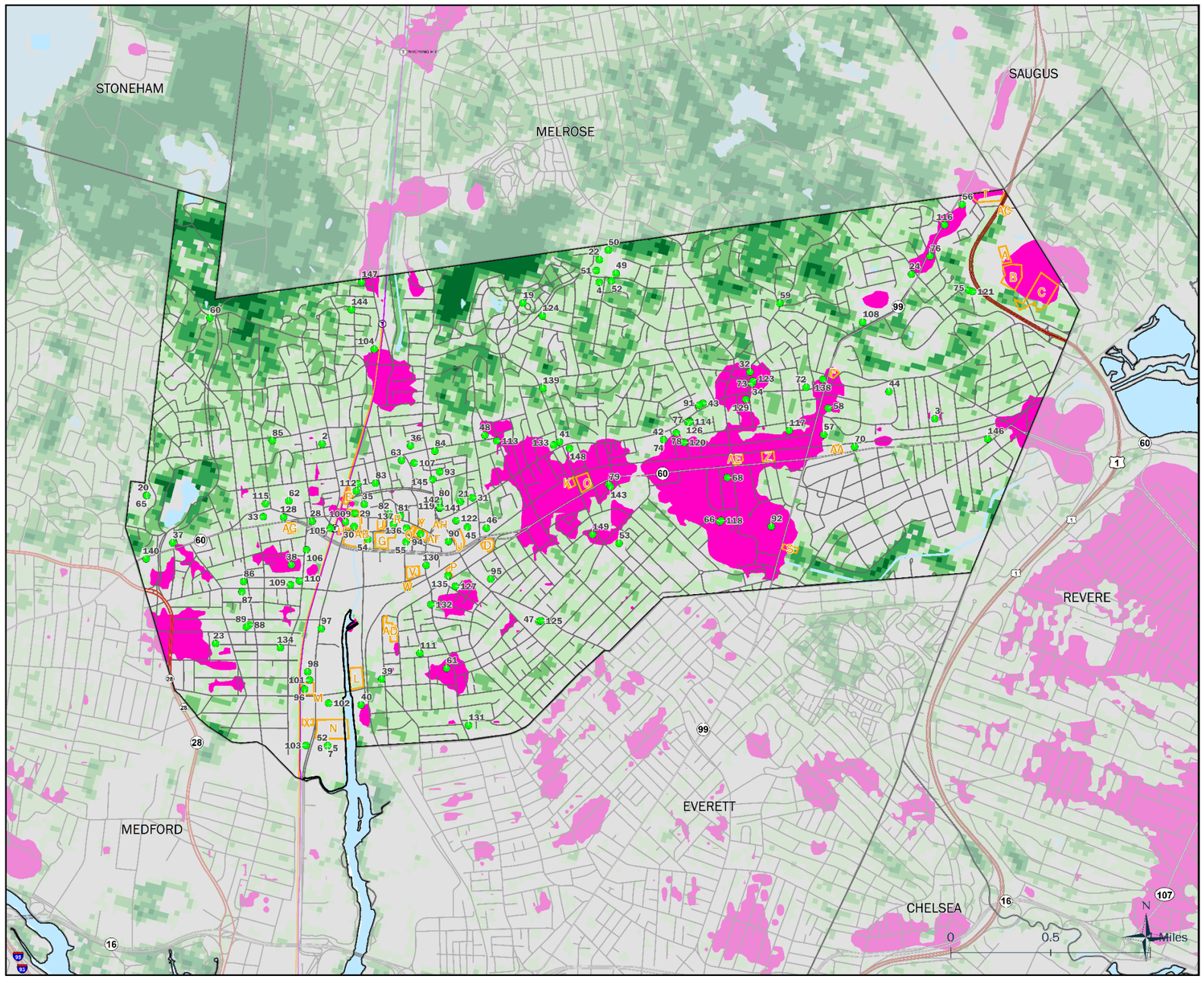

Map 9: High Land Surface Temperature

MAPC

FEMA Hazard Mitigation Planning Grant

MALDEN, MA

Tree Canopy Coverage

- 0%
- 1-25%
- 26-50%
- 51-75%
- 76 - 100%

Climate Hazards

- Hottest 5% of region's land area

Sites

- Critical Infrastructure*
- Development Areas

* See details in separate table

Transportation

- Rail Stations
- Commuter Rail

Roads

- Interstate
- U.S. Highway
- State Route
- Streets

Hydrography

- Perennial Stream
- Intermittent Stream
- Ditch/Canal
- Aqueduct
- Water Bodies

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Data Sources:
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Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
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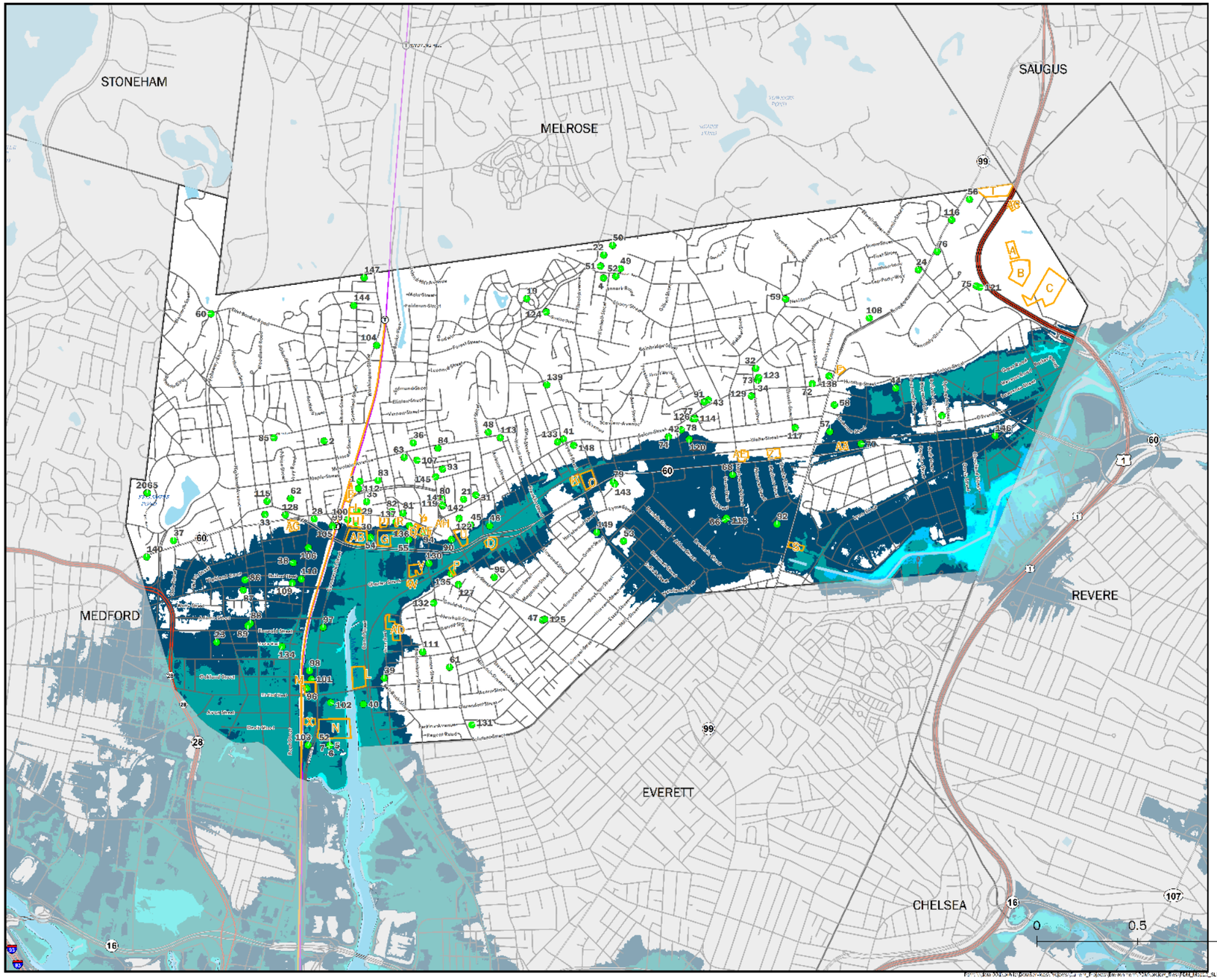
Date: 6/1/2022



Map 10: Sea Level Rise

MAPC dcr

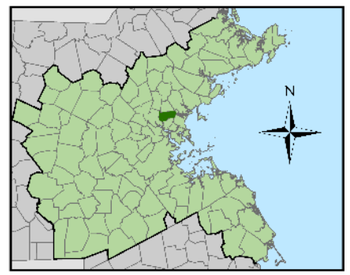
FEMA Hazard Mitigation Planning Grant

MALDEN, MA

Sites
- Critical Infrastructure Sites*
- Repetitive Loss Sites
- Development Sites
- Train Stations
- Commuter Rail Lines
- Trains

Future Coastline
- Sea Level Rise (1 ft.)
- Sea Level Rise (3 ft.)
- Sea Level Rise (6 ft.)
- Sea Level Rise (10 ft.)

All Roads
- Interstate
- U.S. Highway
- State Route
- Street



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Data Sources:
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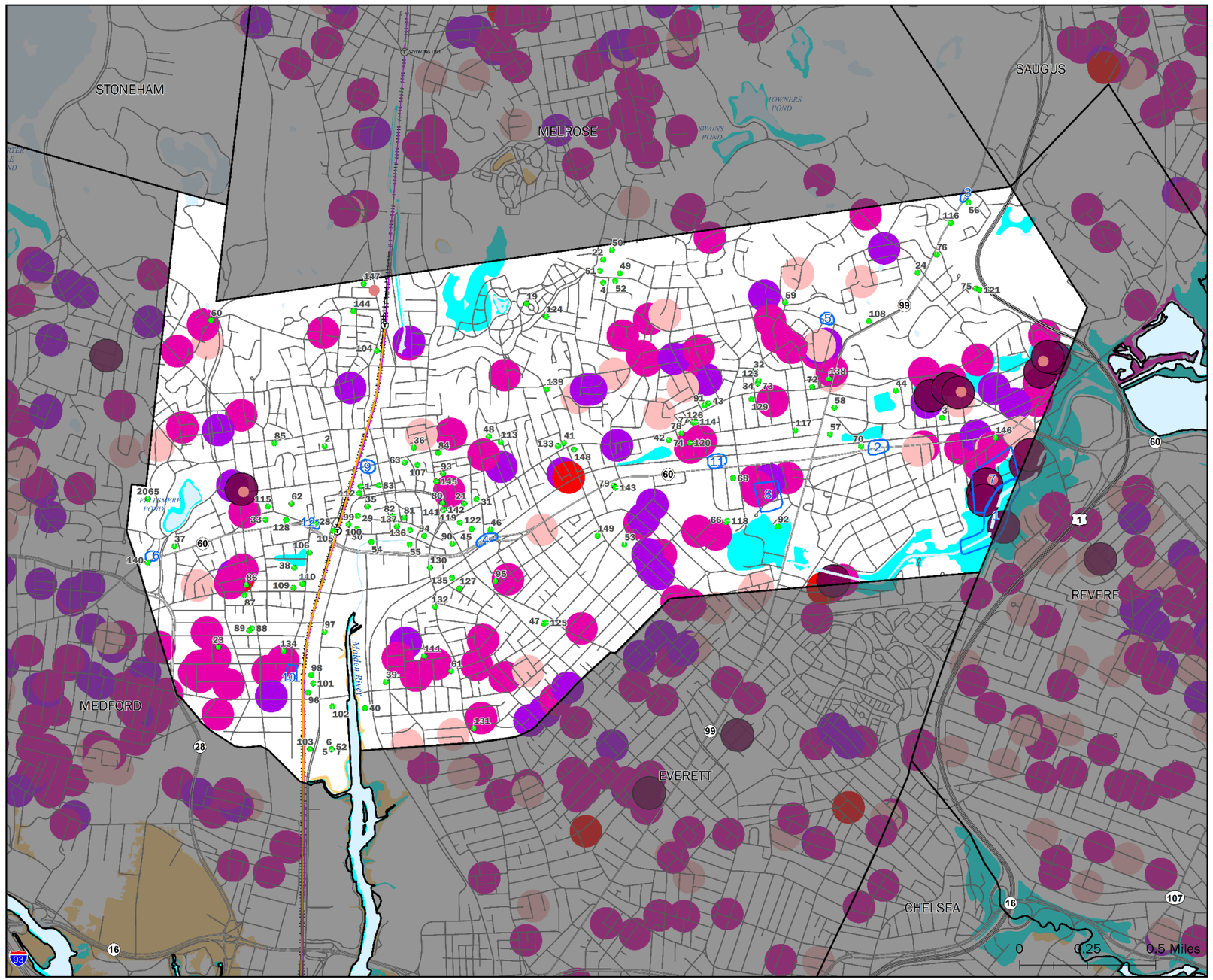
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google

0 0.5 1 Miles

MALDEN, MA

Date: 6/1/2022



Map 3: Flood Zones

MAPC dcr

FEMA Hazard Mitigation Planning Grant

MALDEN, MA

Sites

- Critical Infrastructure*
- Repetitive Loss Sites
- Locally Identified Flooding

* See details in separate table

- Water Bodies

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

All Roads

- Interstate
- U.S. Highway
- State Route
- Streets

Rail

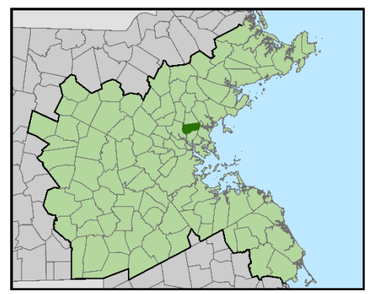
- Stations
- Commuter Rail
- Trains

March 2010 Flood Claims

- Flood Insurance

Disaster Assistance

- 0 to 1 inch
- 2 to 6 inches
- 6 inches to 2 feet
- 2 feet plus



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60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)

Flood Zones datalayer updated by MassGIS October 2013 from finalized data provided by Federal Emergency Management Agency (FEMA)

MALDEN, MA
Date: 6/1/2022

Path: \\data-001\public\DataServices\Projects\Current_Projects\Environment\FHM\project_files\FHM

APPENDIX B: HAZARD MITIGATION TEAM MEETINGS

Malden Hazard Mitigation Plan
Local Team Meeting #1

Thursday, December 9, 2021
10:00 – 11:30 AM

Zoom Meeting
https://zoom.us/j/98328078353

Call-in Numbers
312 626 6799
646 876 9923
Meeting ID: 983 2807 8353

AGENDA

1. **Welcome and Introductions**

2. **Overview of the HMP Project**

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

3. **Getting Started: Local Data Updates from 2017 Plan**

   - *We will update the following local data from the 2017 plan (see attachments for each) and update maps using Google MyMaps*

     1) Local Flooding Areas of Concern
     2) Critical Facilities
     3) New Development sites

4. **Public Meetings and Outreach**

   - Two Public Meetings
   - Identify local stakeholders to invite

APPENDIX B: HAZARD MITIGATION TEAM MEETINGS

Malden Hazard Mitigation Plan
Local Team Meeting #2

Thursday, February 24, 2022
10:00 – 11:30 AM

Zoom Meeting
https://zoom.us/j/99485600180

Meeting ID: 994 8560 0180
One tap mobile
+13126266799,,99485600180# US (Chicago)
+16468769923,,99485600180# US (New York)

Dial by your location
+1 312 626 6799 US (Chicago)
+1 646 876 9923 US (New York)

AGENDA

1. **Welcome and Introductions**
2. **Review and Update of Mitigation Goals for the Plan**
   See Mitigation Goals from the 2016 plan attached
   - Revise, delete, or add new goals
3. **Review Status of Existing Mitigation Measures**
   See table of Existing Mitigation from the 2016 Plan attached
   - Update comments as needed on **Effectiveness and Improvements Needed**
   - Note any **Updates or Changes for 2022**
   - Add any **New Measures** adopted since 2016
4. **Prepare for First Public Meetings**
   - Date and hosting board/commission
   - *Meeting Invitation and outreach:*
     - ***Identify local stakeholders to invite*** (refer to MVP invitees?)

APPENDIX B: HAZARD MITIGATION TEAM MEETINGS

Malden Hazard Mitigation Plan
Local Team Meeting #3

Thursday, April 14, 2022
10:00 – 11:30 AM

Zoom Meeting
https://us06web.zoom.us/j/89815395800
Meeting ID: 898 1539 5800

One tap mobile
+13126266799,,89815395800# US (Chicago)
+16468769923,,89815395800# US (New York)

Dial by your location
+1 312 626 6799 US (Chicago)
+1 646 876 9923 US (New York)

AGENDA

1. Welcome and Introductions

2. Review and Update Status of Mitigation from the 2017 Plan
See table showing 2017 Mitigation Recommendations to be updated

- Confirm 2017 mitigation that has been completed or partially completed
- Review 2017 mitigation that has not been completed
  - Determine which of these measures should be retained in the 2022 plan
  - Determine if any 2017 mitigation should be revised for the 2022 plan
- Decide if any 2017 measures should be deleted for the 2022 plan

3. Prepare for the final Public Meeting

- MAPC to present an overview of the draft plan
- Need to 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 provider)*

APPENDIX B: HAZARD MITIGATION TEAM MEETINGS

Malden Hazard Mitigation Plan
Local Team Meeting #4

Thursday, May 26, 2022
10:00 – 11:30 AM

Zoom Meeting
https://us06web.zoom.us/j/87806520690
Meeting ID: 878 0652 0690

One tap mobile
+13017158592,,87806520690#
+13126266799,,87806520690#

Dial by your location
+1 301 715 8592
+1 312 626 6799

AGENDA

1. Welcome and Introductions

2. Recommended Mitigation Strategies for the 2022 Plan
See table showing recommended mitigation for 2022

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

3. Prepare for the final Public Meeting

- MAPC to present at Emergency Management Comm, June 15 at 4 PM
- MAPC will conduct outreach/invitations and media advisory
- ***Team: please identify local stakeholder contacts (refer to MVP invitees?)***
  - *Business groups, major employers, community organizations, etc.*

APPENDIX C: PUBLIC MEETINGS

Malden Hazard Mitigation Plan

Public Meeting

Hosted by the Conservation Commission

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

The City of Malden is preparing an updated Hazard Mitigation Plan to reduce its vulnerability to natural hazards such as flooding, hurricanes, and winter storms. Please join the City for a presentation about the Hazard Mitigation Plan at a public meeting hosted by the Conservation Commission. Questions and suggestions for the plan are welcome.

Tuesday, May 3, 2022, 7:00 pm

The meeting will be held remotely by video conference.
Please join the meeting from your computer, tablet or smartphone.
Join Zoom Meeting
https://cityofmalden.zoom.us/j/91491527651?pwd=dVdZUll5WUV0ZFF5a05MTGh2T052Zz09
Meeting ID: 914 9152 7651
Passcode: 964707
One tap mobile
+19294362866,,91491527651# US (New York)
+16465189805,,91491527651# US (New York)
Dial by your location
+1 929 436 2866 US (New York)
+1 646 518 9805 US (New York)
Meeting ID: 914 9152 7651
Find your local number: https://cityofmalden.zoom.us/u/adI2TnxHrl

APPENDIX C: PUBLIC MEETINGS

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

CALENDAR LISTING / MEDIA ADVISORY

MALDEN'S HAZARD MITIGATION PLAN TO BE DISCUSSED AT MAY 3 PUBLIC MEETING

Who: Malden 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 Tuesday, May 3 at 7:00 PM, a presentation on the Malden Hazard Mitigation Plan, 2022 Update will be hosted by the Malden Conservation Commission. The presentation will be given by the Metropolitan Area Planning Council, which is assisting the City in the preparation of the plan. There will be an opportunity for questions and discussion following the presentation.

The City of Malden is preparing the updated 2022 Hazard Mitigation Plan to document natural hazards that affect the City, such as floods, hurricanes, and severe winter storms, and to recommend actions that the City can take to reduce its vulnerability to these hazards.

Once completed and approved by the Federal Emergency Management Agency (FEMA), the City will be eligible for grants from FEMA that support significant mitigation projects such as stormwater infrastructure and drainage improvements.

When: **Tuesday, May 3, 2022, 7:00 PM**

Where: **Virtual meeting online:** The meeting will be held remotely by video conference.

Join Zoom Meeting
https://cityofmalden.zoom.us/j/91491527651?pwd=dVdZUll5WUV0ZFF5a05MTGh2T052Zz09
Meeting ID: 914 9152 7651
Passcode: 964707
One tap mobile
+19294362866,,91491527651# US (New York)
+16465189805,,91491527651# US (New York)
Dial by your location
+1 929 436 2866 US (New York)
+1 646 518 9805 US (New York)

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.

##

APPENDIX C: PUBLIC MEETINGS

APPENDIX C: PUBLIC MEETINGS

Malden Hazard Mitigation Plan

Public Meeting hosted by the Emergency Management Team

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

The City of Malden is preparing an updated Hazard Mitigation Plan to reduce its vulnerability to natural hazards such as flooding, hurricanes, and winter storms. Please join the City for a presentation on the draft Hazard Mitigation Plan at a public meeting hosted by the Emergency Management Team. Questions and comments on the plan are welcome. *The meeting will be held in-person at City Hall and will also be available online as a Zoom webinar.*

Wednesday, June 15, 2022, 4:00 pm
Malden Emergency Management Team
Malden City Hall, Room 105
215 Pleasant St. Malden, MA

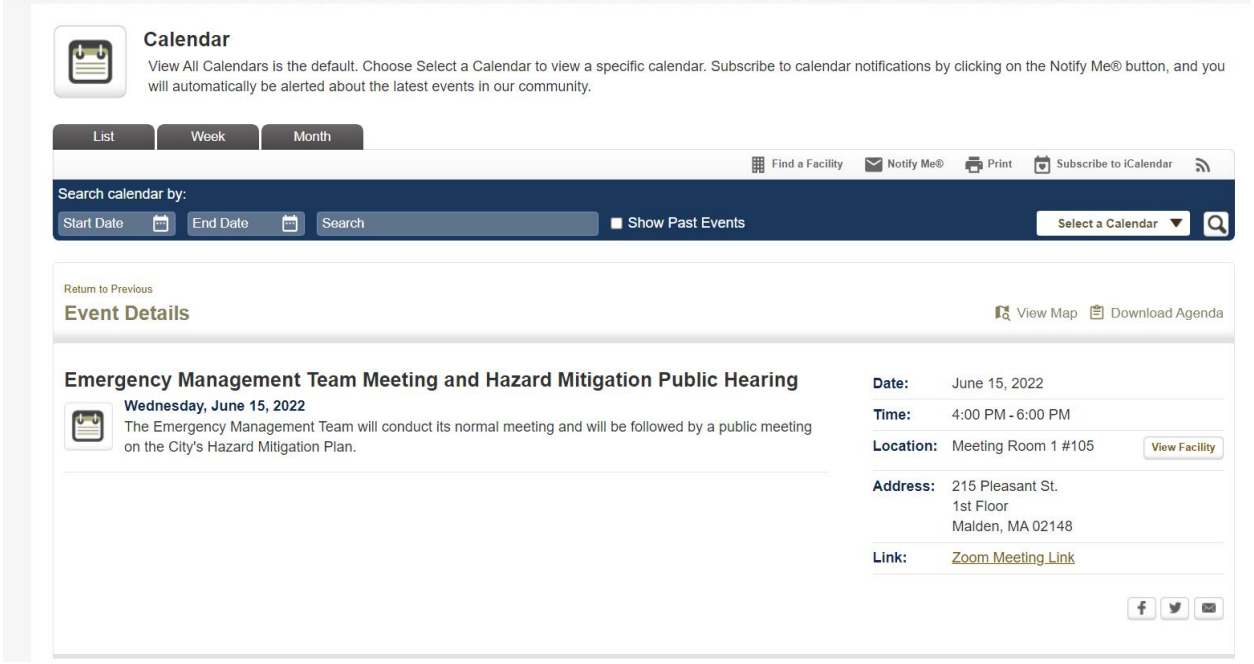
Also available online as a Zoom Webinar
Please click the link below to join the webinar:
https://cityofmalden.zoom.us/j/99874024889?pwd=S3Z2eE8zK0tNYSiQ0RTM5eE1vZW9udz09
Passcode: 187538

Or One tap mobile :
US: +19294362866,,99874024889# or +16465189805,,99874024889#

Or Telephone:
Dial(for higher quality, dial a number based on your current location):
US: +1 929 436 2866 or +1 646 518 9805
Webinar ID: 998 7402 4889

APPENDIX C: PUBLIC MEETINGS

Hazard Mitigation Plan Public Meeting, June 15, 2022
Malden Public Meeting Calendar
www.malden.org



APPENDIX C: PUBLIC MEETINGS

CALENDAR LISTING / MEDIA ADVISORY

MALDEN'S HAZARD MITIGATION PLAN TO BE PRESENTEDED AT JUNE 15 PUBLIC MEETING

What: On Wednesday, June 15, 2022, at 4:00 PM the Malden Emergency Management Team will host a public meeting to present the City's draft Hazard Mitigation Plan, which has recently been completed.

The City of Malden has prepared an updated draft Hazard Mitigation Plan to reduce the city's vulnerability to natural hazards such as flooding, droughts, hurricanes, and blizzards, and increase the city's resilience to the impacts of climate change. Malden's previous plan was prepared in 2017 and is due to be updated ever five years. By completing this plan, the City will remain eligible for grants from the Federal Emergency Management Agency for mitigation projects such as drainage improvements.

Please join the City on June 15 at 4:00 PM for a public presentation about the draft Hazard Mitigation Plan at City Hall, Room 105. The meeting will also be available online via Zoom webinar at the link below. Questions, comments, and suggestions for the draft plan are welcome.

Who: Malden residents, business owners, civic organizations and institutions are invited to participate in the public meeting and provide their questions and comments as part of this on-going effort to plan for a resilient future for the City of Malden.

When: **Wednesday, June 15, 2022, 4:00 PM**

Where: The Meeting will be held in-person in Malden City Hall, and will also be available online as a Zoom webinar.

Malden City Hall, Room 105
215 Pleasant Street, Malden, MA

Online webinar via Zoom:

Please click the link below to join the webinar:
https://cityofmalden.zoom.us/j/99874024889?pwd=S3Z2eE8zK0NYSiQ0RTM5eE1vZW9udz09
Passcode: 187538

Or One tap mobile :
US: +19294362866,,99874024889# or +16465189805,,99874024889#

Or Telephone:
Dial(for higher quality, dial a number based on your current location):
US: +1 929 436 2866 or +1 646 518 9805
Webinar ID: 998 7402 4889

International numbers available:
https://cityofmalden.zoom.us/u/admCjsQSM0

APPENDIX C: PUBLIC MEETINGS

NOTICE OF PUBLIC MEETING
TO MALDEN'S NEIGHBORING COMMUNITIES

TO: City and Town Clerks in Everett, Medford, Melrose, Revere, and Saugus

RE: Notification of Public Meeting on the Malden Hazard Mitigation Plan

The City of Malden has prepared a draft 2022 update of the *Malden Hazard Mitigation Plan*, which is intended to reduce the City's vulnerability to natural hazard events such as flooding, drought, hurricanes, and winter storms. The plan identifies a range of recommended local hazard mitigation measures, including infrastructure improvements, regulatory measures, and educational and outreach efforts related to natural hazards

As part of the planning process, Malden's neighboring communities are being notified of a public meeting on the draft plan. The meeting will be held as follows:

The Meeting will be held in-person with the Malden Emergency Management Team in Malden City Hall, and will also be available online as a Zoom webinar.

Malden City Hall, Room 105
215 Pleasant Street, Malden, MA

Online webinar via Zoom:
Please click the link below to join the webinar:
https://cityofmalden.zoom.us/j/99874024889?pwd=S3Z2oE8zK0NYSiQ0RTM5oE1vZW9vdz09
Passcode: 187538

Or One tap mobile :
US: +19294362866,,99874024889# or +16465189805,,99874024889#

Or Telephone:
US: +1 929 436 2866 or +1 646 518 9805
Webinar ID: 998 7402 4889

A flyer announcing the meeting with the above information is also attached. Questions and comments on the draft plan may be submitted at the meeting or in writing after the meeting by email to resilientmalden@mapc.org by June27, 2022.

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

COMMENTS RECEIVED ON THE DRAFT HAZARD MITIGATIO PLAN-2022 UPDATE

From: Stephen Winslow <swinslow@CITYOFMALDEN.ORG>
Sent: Tuesday, June 14, 2022 2:14 PM
To: Emily Granoff <egranoff@CITYOFMALDEN.ORG>; Isaac Slavitt <slavitt@seas.harvard.edu>; Glenn Cronin <gcronin@maldenpd.com>
Cc: Yem Lip <ylip@CITYOFMALDEN.ORG>
Subject: Re: HMGP 4496 Notice of Funding Opportunity Revision-- FEDERAL GRANT MONEY FOR MITIGATION PROJECTS

Emily:

I am looping Captain Cronin into this conversation since there is a meeting on Malden's Hazard Mitigation Plan coming up.

I am also sharing a list of 30+ areas in the City that have been prone to flooding from storms. We are in the midst of investigation of those areas to better determine why they flood and hope to have some plans together by fall on what to do in the most flood prone areas. That would be the ultimate basis on what to apply for.

Steve

-----Original Message-----
From: Lisa <lisasulda@gmail.com>
Sent: Friday, June 17, 2022, 1:31 PM
To: Malden Hazard Mitigation Plan <resilientmalden@mapc.org>
Subject: Comment re: 2022 Hazard Mitigation Plan

Good Day~ Thank you for this opportunity to comment regarding the Draft 2022 Hazard Mitigation Plan.

I would like to bring to your attention the on Page 101, in the Wind Hazard Mitigation Measures section, #17 mentions a Street Tree Inventory from 1999. I know Councilor O'Malley was working on something just a couple of years ago and a more current Street Tree Inventory from 2020 or 21 is most likely available and should be used for all references and updates in the 2022 Hazard Mitigation Plan.

I would like to also suggest inclusion of the importance of using more permeable surfacing and reducing the amount of non-permeable surfaces throughout the city as measures to mitigating the effects of flooding, extreme temperature and drought.

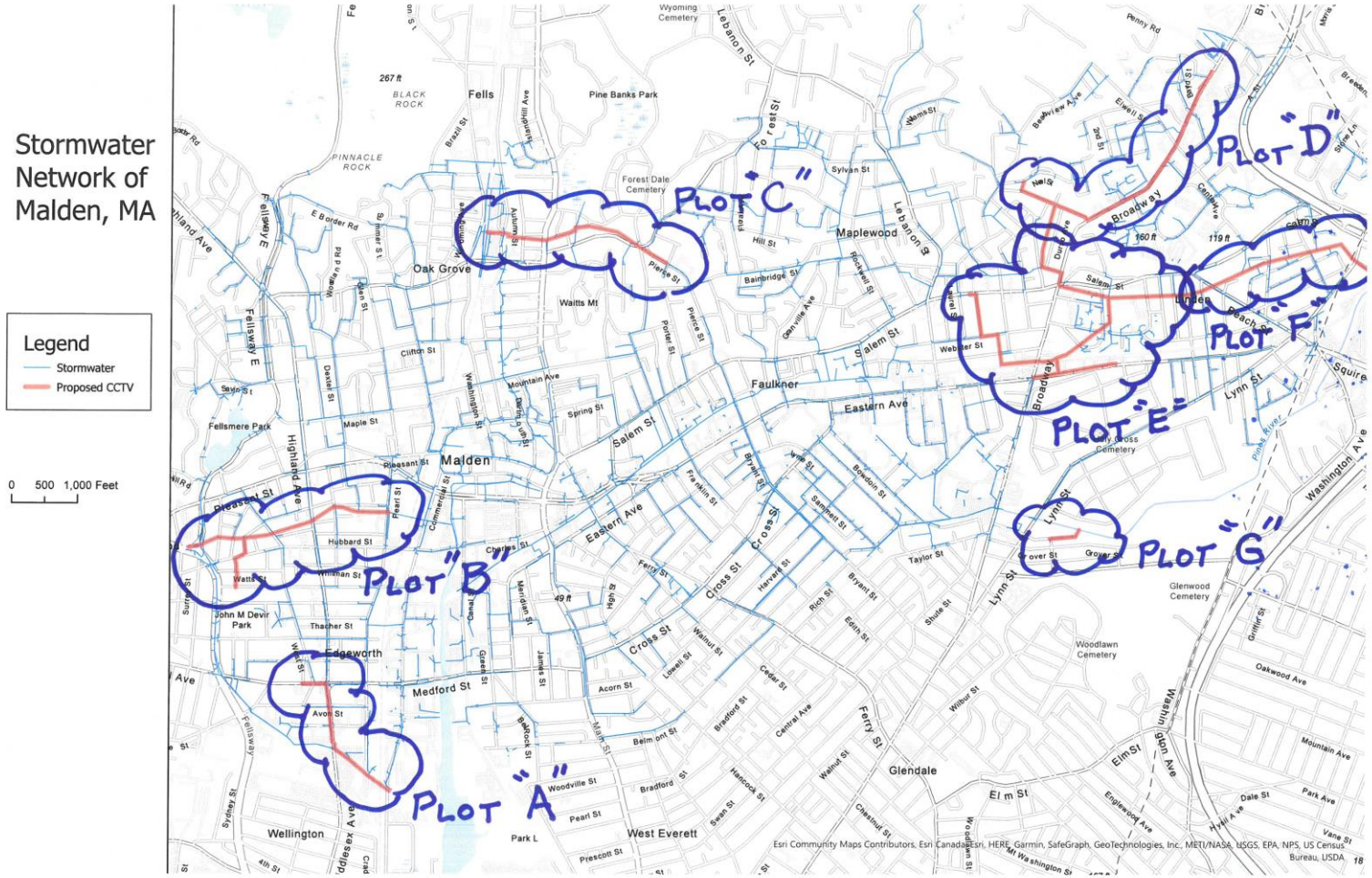
Thank you for coordinating the update of this very important document for our city!

-Lisa Sulda
Ashland St
Malden

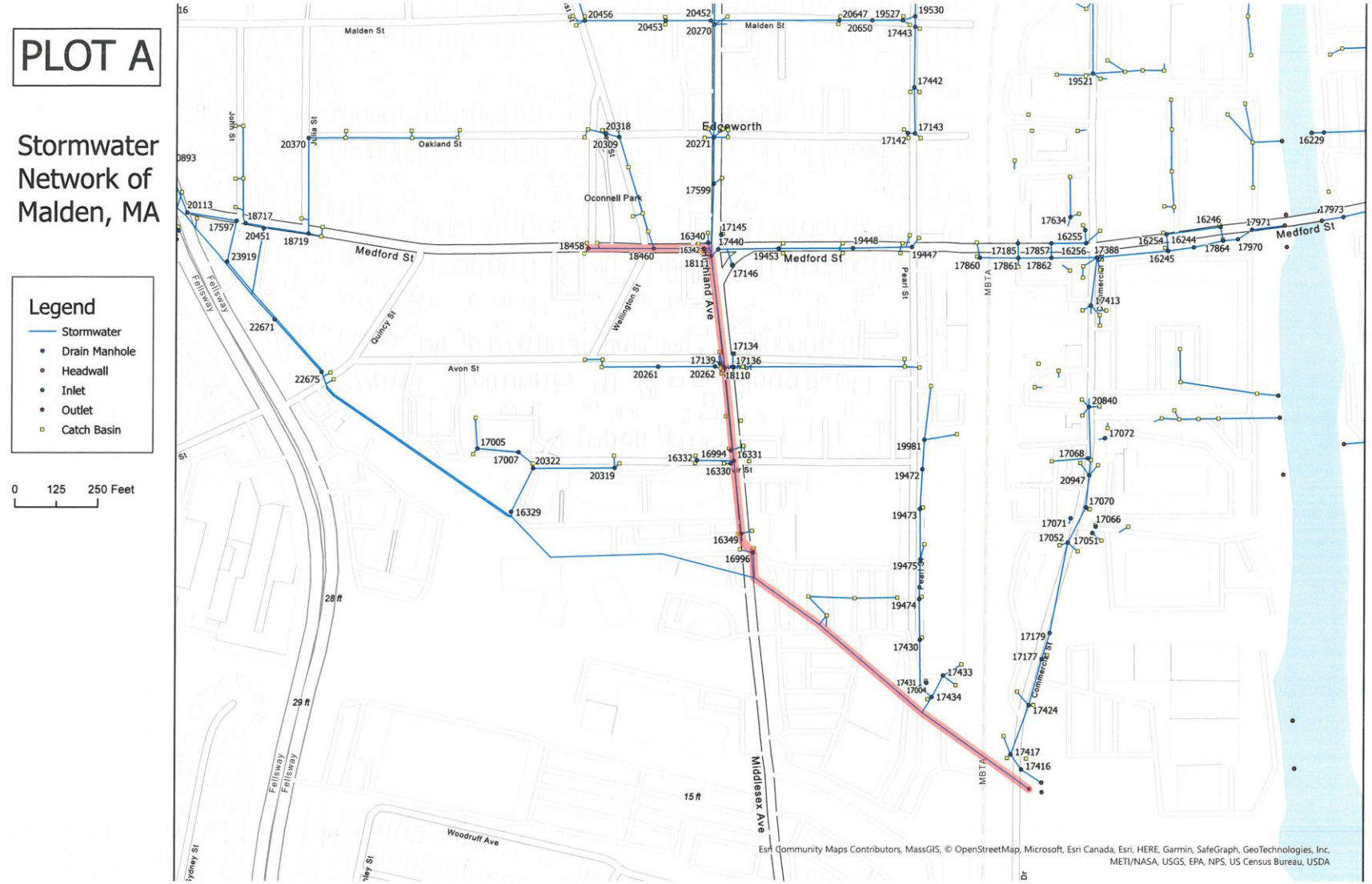
MAPS OF ADDITIONAL DRAINAGE AND FLOODING AREAS OF CONCERN SUBMITTED BY COUNCILOR WINSLOW

The following maps showing additional areas of local drainage and flooding concern were submitted by City Councilor Steve Winslow. These areas were added to the plan's Hazard Maps (Appendix A). Map 1 is an overview, followed by maps detailing each area.

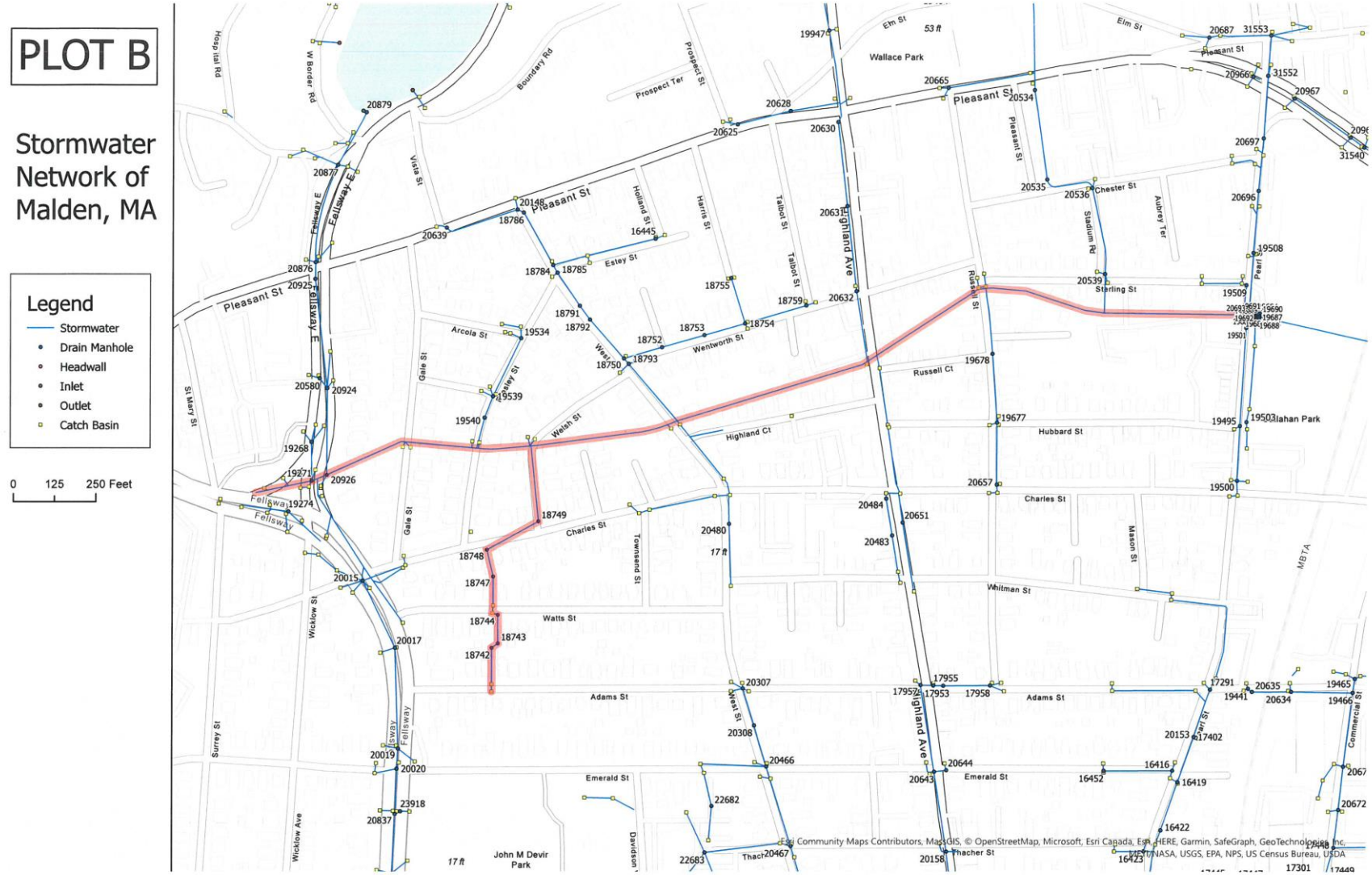
MAP 1 – OVERVIEW OF ALL AREAS OF CONCERN FOR DRAINAGE/FLOODING



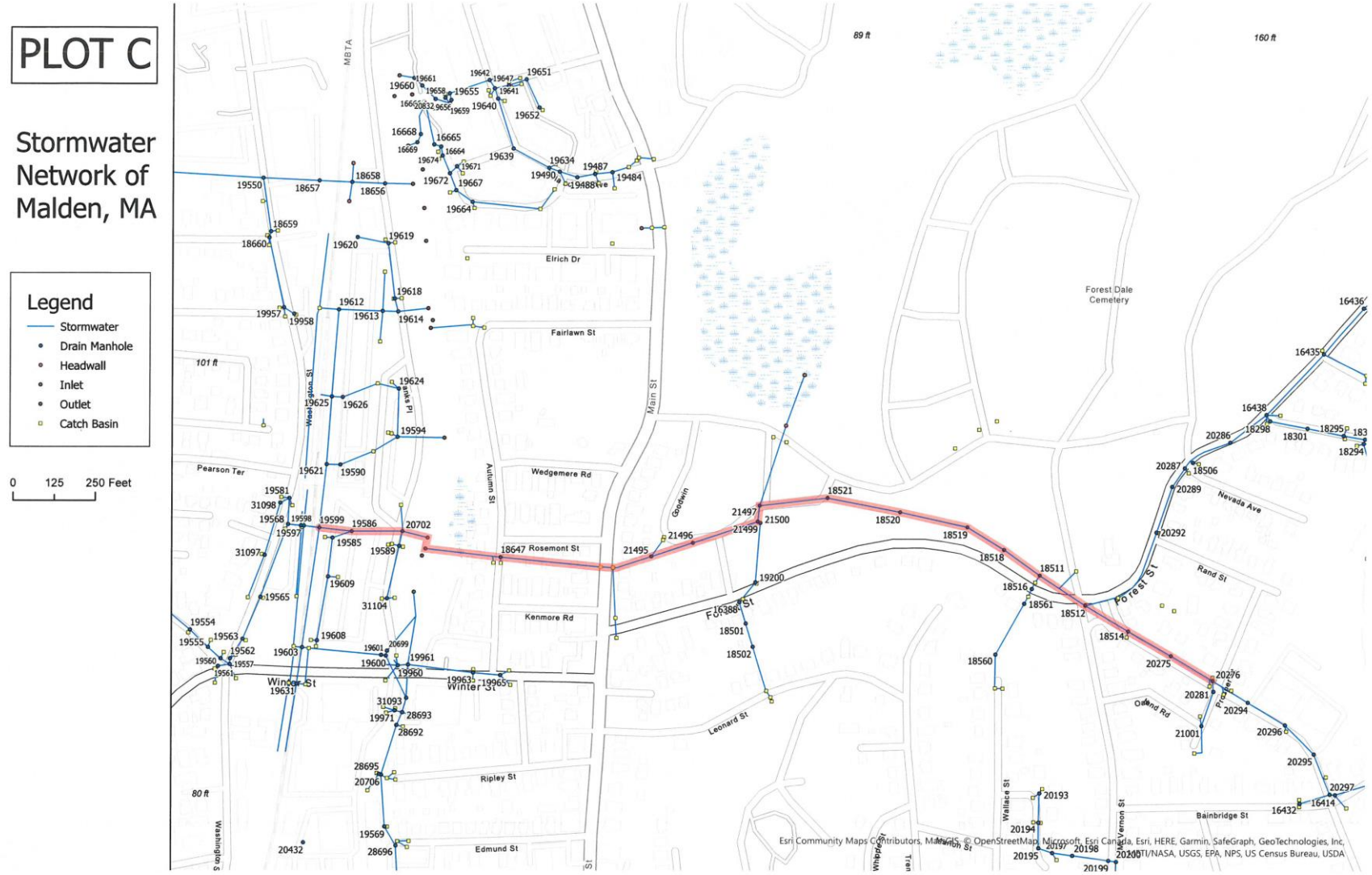
MAP 2 – ADDITIONAL DRAINAGE AND FLOODING AREAS OF CONCERN



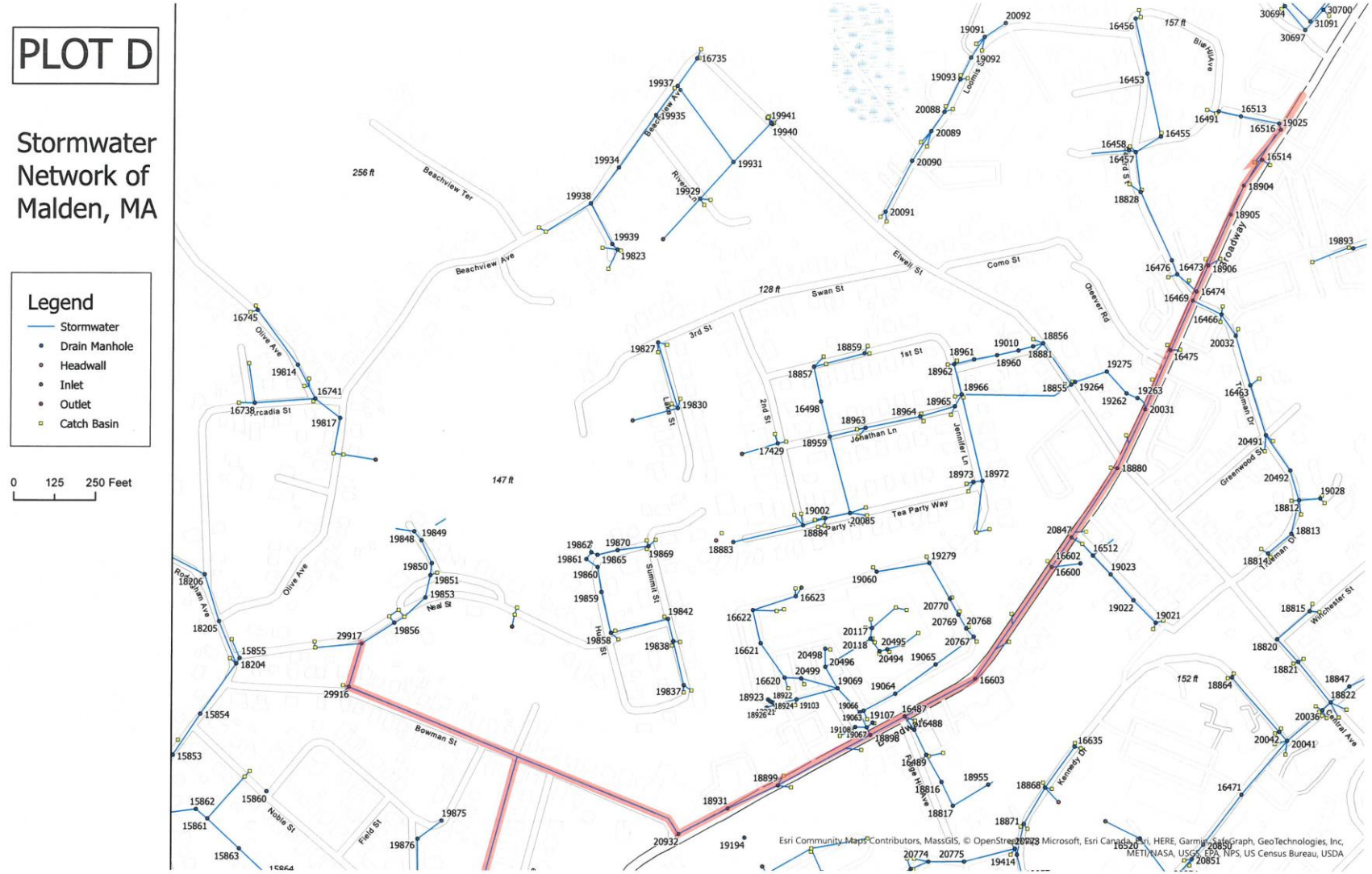
MAP 3 – ADDITIONAL DRAINAGE AND FLOODING AREAS OF CONCERN



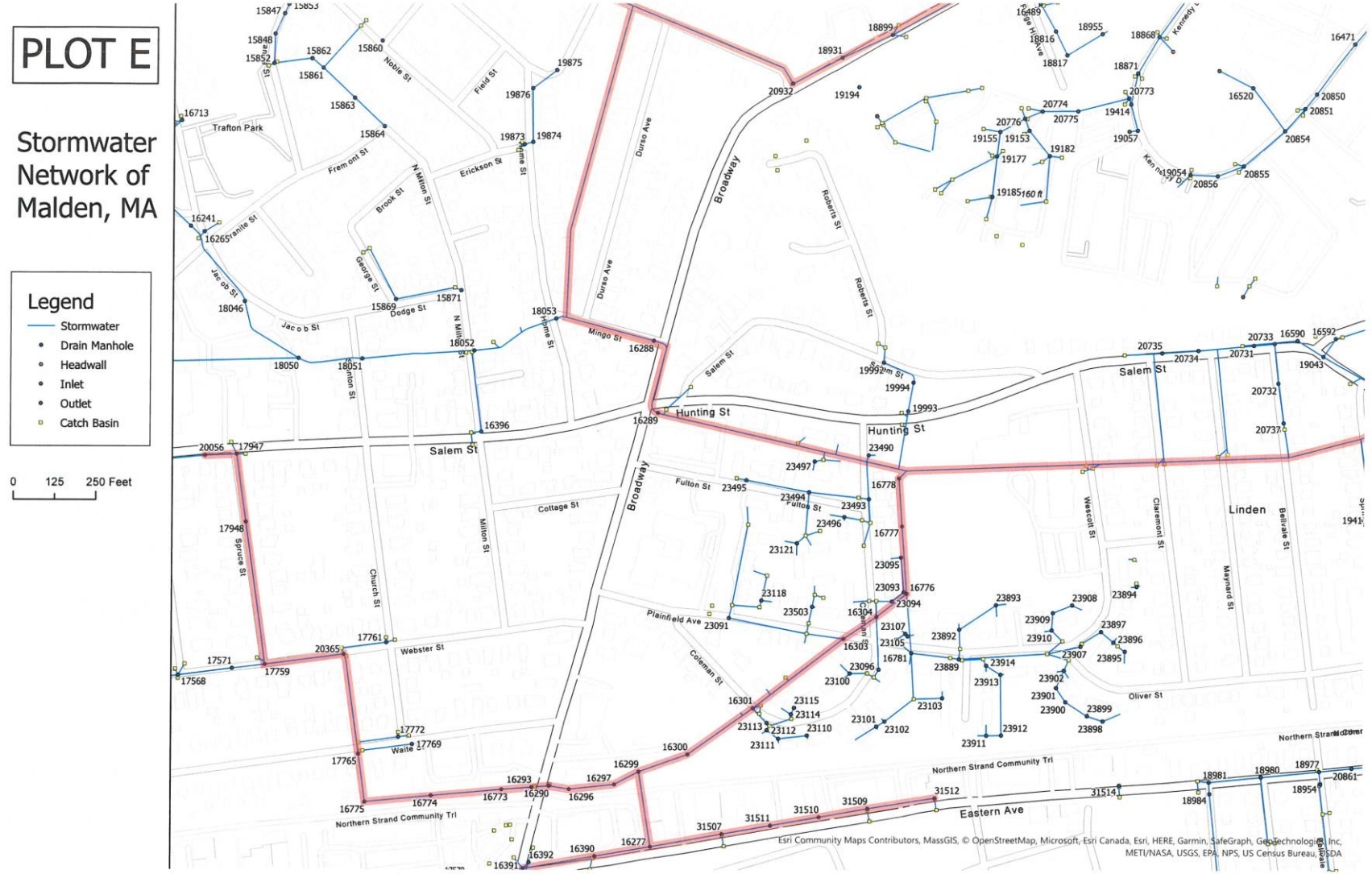
MAP 4 – ADDITIONAL DRAINAGE AND FLOODING AREAS OF CONCERN



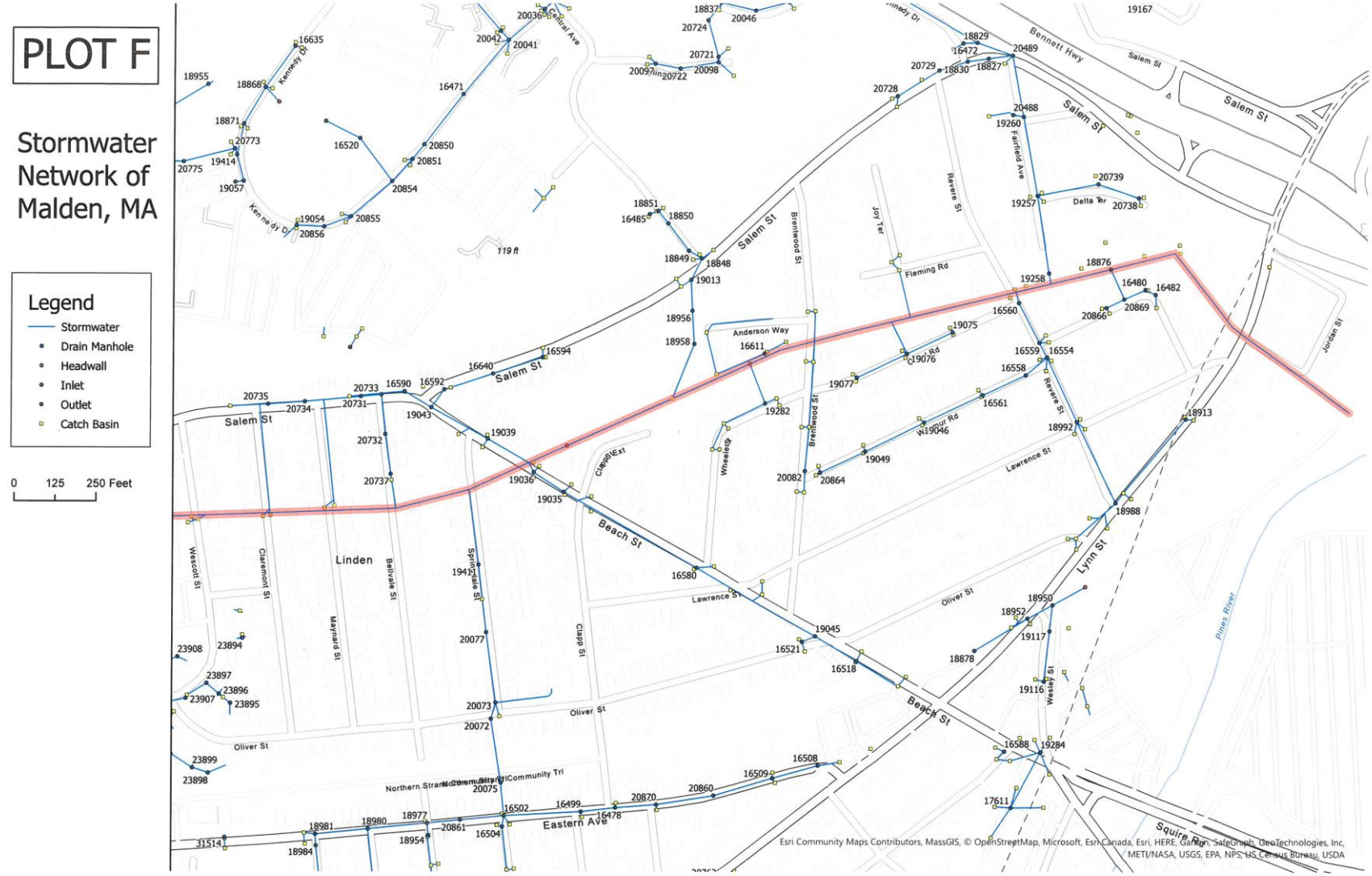
MAP 5 – ADDITIONAL DRAINAGE AND FLOODING AREAS OF CONCERN



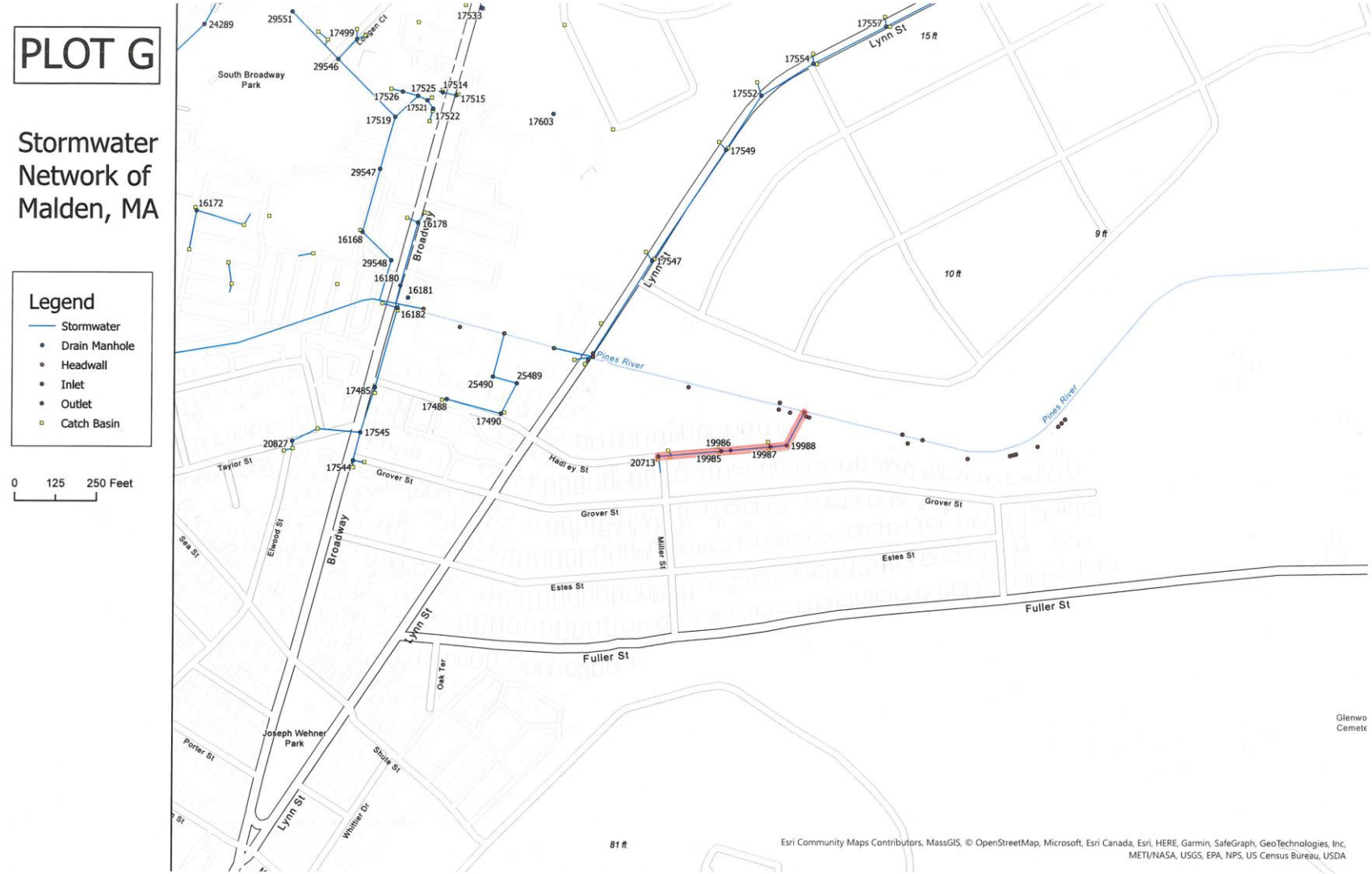
MAP 6 – ADDITIONAL DRAINAGE AND FLOODING AREAS OF CONCERN



MAP 7 – ADDITIONAL DRAINAGE AND FLOODING AREAS OF CONCERN



MAP 8 – ADDITIONAL DRAINAGE AND FLOODING AREAS OF CONCERN



APPENDIX D: RECORDS OF BRUSHFIRES 2013-2022

Malden Fire Department Response Report (2013 – Present)

National Fire Incident Reporting System (NFIRS) codes 140, 141, 142 & 143

Code 140 NATURAL VEGETATION FIRE, OTHER

2003621-0	05/09/2022 13:53:56	NATURAL VEGETATION FIRE, OTHER	500 BROADWAY
20006533-0	10/06/2020 15:03:52	NATURAL VEGETATION FIRE, OTHER	74-78 UPHAM ST
20006196-0	09/21/2020 13:38:39	NATURAL VEGETATION FIRE, OTHER	5 DUKE ST
20003792-0	06/12/2020 10:13:03	NATURAL VEGETATION FIRE, OTHER	17 PLEASANT ST
15003111-0	05/04/2015 15:07:52	NATURAL VEGETATION FIRE, OTHER	215 BEACH ST
14004181-0	07/03/2014 15:03:57	NATURAL VEGETATION FIRE, OTHER	195 CANAL ST
14004125-0	07/01/2014 13:47:27	NATURAL VEGETATION FIRE, OTHER	WASHINGTON ST

Code 141 FOREST, WOODS OR WILDLAND FIRE

21003956-0	06/06/2021 07:58:12	FOREST, WOODS OR WILDLAND FIRE	**150 FOREST ST**
21003118-0	05/03/2021 16:19:19	FOREST, WOODS OR WILDLAND FIRE	**150 FOREST ST**
20006678-0	10/11/2020 21:11:10	FOREST, WOODS OR WILDLAND FIRE	**E BORDER RD**
16005194-0	07/21/2016 19:31:02	FOREST, WOODS OR WILDLAND FIRE	**E BORDER RD**
14002857-0	05/06/2014 16:22:16	FOREST, WOODS OR WILDLAND FIRE	1032 EASTERN AV

Code 142 BRUSH, OR BRUSH AND GRASS MIXTURE FIRE

22003635-0	05/09/2022 17:50:09	BRUSH, OR BRUSH AND GRASS MIXTURE F	180 EASTERN AV
22003396-0	05/01/2022 13:16:55	BRUSH, OR BRUSH AND GRASS MIXTURE F	15 QUARRY LN
22003090-0	04/20/2022 14:23:26	BRUSH, OR BRUSH AND GRASS MIXTURE F	195 CANAL ST
22001779-0	03/04/2022 21:31:03	BRUSH, OR BRUSH AND GRASS MIXTURE F	27 BLOMERTH ST
21008223-0	11/08/2021 13:22:03	BRUSH, OR BRUSH AND GRASS MIXTURE F	79 GRANITE ST
21007712-0	10/21/2021 20:45:41	BRUSH, OR BRUSH AND GRASS MIXTURE F	195 PLEASANT ST
21007512-0	10/16/2021 07:34:00	BRUSH, OR BRUSH AND GRASS MIXTURE F	800 EASTERN AV
21006504-0	09/08/2021 17:52:39	BRUSH, OR BRUSH AND GRASS MIXTURE F	195 PLEASANT ST
21006458-0	09/07/2021 10:07:47	BRUSH, OR BRUSH AND GRASS MIXTURE F	BROADWAY
21005739-0	08/12/2021 20:29:29	BRUSH, OR BRUSH AND GRASS MIXTURE F	99 CHARLES ST
21004342-0	06/19/2021 14:44:55	BRUSH, OR BRUSH AND GRASS MIXTURE F	7 JACKSON ST
21004027-0	06/08/2021 19:22:20	BRUSH, OR BRUSH AND GRASS MIXTURE F	30 FRANKLIN ST
21003951-0	06/05/2021 22:29:55	BRUSH, OR BRUSH AND GRASS MIXTURE F	**150 FOREST ST**
21003703-0	05/26/2021 18:44:27	BRUSH, OR BRUSH AND GRASS MIXTURE F	99 CHARLES ST

APPENDIX D: FIRE DEPT RECORDS OF BRUSHFIRES

21002909-0	04/26/2021 15:38:23	BRUSH, OR BRUSH AND GRASS MIXTURE F	11 CONCORD ST
21002617-0	04/14/2021 16:56:42	BRUSH, OR BRUSH AND GRASS MIXTURE F	323 COMMERCIAL ST
21001805-0	03/12/2021 12:41:11	BRUSH, OR BRUSH AND GRASS MIXTURE F	300 COMMERCIAL ST
21000622-0	01/24/2021 23:24:53	BRUSH, OR BRUSH AND GRASS MIXTURE F	22 LAKE CIR
20007017-0	10/27/2020 20:50:10	BRUSH, OR BRUSH AND GRASS MIXTURE F	**150 FOREST ST**
20006682-0	10/11/2020 21:35:03	BRUSH, OR BRUSH AND GRASS MIXTURE F	**W BORDER RD**
20006636-0	10/10/2020 15:43:30	BRUSH, OR BRUSH AND GRASS MIXTURE F	500 BROADWAY
20006635-0	10/10/2020 14:53:04	BRUSH, OR BRUSH AND GRASS MIXTURE F	29 WESCOTT ST
20006627-0	10/10/2020 11:43:56	BRUSH, OR BRUSH AND GRASS MIXTURE F	29 WESCOTT ST
20005631-0	08/27/2020 10:24:21	BRUSH, OR BRUSH AND GRASS MIXTURE F	795 EASTERN AV
20005334-0	08/15/2020 05:01:34	BRUSH, OR BRUSH AND GRASS MIXTURE F	29 PLEASANT ST
20004507-0	07/11/2020 20:56:09	BRUSH, OR BRUSH AND GRASS MIXTURE F	MUTUAL AID - REVERE
20003370-0	05/24/2020 15:14:27	BRUSH, OR BRUSH AND GRASS MIXTURE F	42 LOOMIS ST
20002941-0	05/04/2020 22:44:32	BRUSH, OR BRUSH AND GRASS MIXTURE F	167 KENNEDY DR
19007399-0	10/21/2019 14:00:51	BRUSH, OR BRUSH AND GRASS MIXTURE F	30 BENT AV
19007187-0	10/15/2019 10:20:25	BRUSH, OR BRUSH AND GRASS MIXTURE F	102 BOWDOIN ST
19006526-0	09/16/2019 20:23:55	BRUSH, OR BRUSH AND GRASS MIXTURE F	12 ROBERTS ST
19005826-0	08/19/2019 19:14:13	BRUSH, OR BRUSH AND GRASS MIXTURE F	25 COMMERCIAL ST
19005106-0	07/21/2019 17:25:58	BRUSH, OR BRUSH AND GRASS MIXTURE F	150 TREMONT ST
19003555-0	05/22/2019 15:47:22	BRUSH, OR BRUSH AND GRASS MIXTURE F	CENTRE ST
19002627-0	04/14/2019 18:22:38	BRUSH, OR BRUSH AND GRASS MIXTURE F	53 ASHLAND ST
18004709-0	07/06/2018 08:27:58	BRUSH, OR BRUSH AND GRASS MIXTURE F	188 COMMERCIAL ST
18004636-0	07/03/2018 20:01:25	BRUSH, OR BRUSH AND GRASS MIXTURE F	**E BORDER RD**
18004217-0	06/16/2018 10:39:09	BRUSH, OR BRUSH AND GRASS MIXTURE F	142 KENNEDY DR
18004141-0	06/12/2018 22:44:16	BRUSH, OR BRUSH AND GRASS MIXTURE F	95 MIDDLESEX ST
18004135-0	06/12/2018 19:42:25	BRUSH, OR BRUSH AND GRASS MIXTURE F	114 BROADWAY
18004130-0	06/12/2018 17:42:39	BRUSH, OR BRUSH AND GRASS MIXTURE F	185 CENTRE ST

APPENDIX D: FIRE DEPT RECORDS OF BRUSHFIRES

18004124-0	06/12/2018 16:15:45	BRUSH, OR BRUSH AND GRASS MIXTURE F	300 COMMERCIAL ST
18004122-0	06/12/2018 14:48:58	BRUSH, OR BRUSH AND GRASS MIXTURE F	229 CENTRE ST
18003816-0	05/30/2018 13:31:01	BRUSH, OR BRUSH AND GRASS MIXTURE F	CENTRE ST
18003227-0	05/05/2018 13:28:33	BRUSH, OR BRUSH AND GRASS MIXTURE F	55 DARTMOUTH ST
18003223-0	05/05/2018 11:12:05	BRUSH, OR BRUSH AND GRASS MIXTURE F	175 BROADWAY
18002960-0	04/24/2018 17:17:20	BRUSH, OR BRUSH AND GRASS MIXTURE F	EASTERN AV
18002952-0	04/24/2018 15:23:24	BRUSH, OR BRUSH AND GRASS MIXTURE F	195 PLEASANT ST
18002718-0	04/14/2018 13:31:00	BRUSH, OR BRUSH AND GRASS MIXTURE F	356 COMMERCIAL ST
17007623-0	11/03/2017 12:08:11	BRUSH, OR BRUSH AND GRASS MIXTURE F	EASTERN AV
17006133-0	09/02/2017 16:04:47	BRUSH, OR BRUSH AND GRASS MIXTURE F	CENTRE ST
17005823-0	08/20/2017 17:59:57	BRUSH, OR BRUSH AND GRASS MIXTURE F	11 OVERLOOK RIDGE DR
17004628-0	07/05/2017 19:40:04	BRUSH, OR BRUSH AND GRASS MIXTURE F	120 MOUNTAIN AV
17004424-0	06/27/2017 13:34:47	BRUSH, OR BRUSH AND GRASS MIXTURE F	10 COMO ST
17003405-0	05/18/2017 13:57:09	BRUSH, OR BRUSH AND GRASS MIXTURE F	CENTRE ST
17002619-0	04/16/2017 18:29:43	BRUSH, OR BRUSH AND GRASS MIXTURE F	45 FRANKLIN ST
17002606-0	04/16/2017 11:17:00	BRUSH, OR BRUSH AND GRASS MIXTURE F	72 ASHLAND ST
16008751-0	12/16/2016 09:50:16	BRUSH, OR BRUSH AND GRASS MIXTURE F	200 MOUNTAIN AV
16005936-0	08/19/2016 12:42:17	BRUSH, OR BRUSH AND GRASS MIXTURE F	173 WASHINGTON ST
16005665-0	08/09/2016 10:33:39	BRUSH, OR BRUSH AND GRASS MIXTURE F	20 HILLSIDE AV
16005558-0	08/04/2016 18:23:38	BRUSH, OR BRUSH AND GRASS MIXTURE F	576 EASTERN AV
16005179-0	07/21/2016 13:17:33	BRUSH, OR BRUSH AND GRASS MIXTURE F	151 CENTRE ST
16004481-0	06/24/2016 22:37:27	BRUSH, OR BRUSH AND GRASS MIXTURE F	**E BORDER RD**
16003516-0	05/18/2016 17:36:08	BRUSH, OR BRUSH AND GRASS MIXTURE F	10 SUMMER ST
16003509-0	05/18/2016 12:59:45	BRUSH, OR BRUSH AND GRASS MIXTURE F	1290 SALEM ST
16003060-0	04/29/2016 22:06:22	BRUSH, OR BRUSH AND GRASS MIXTURE F	**E BORDER RD**
16003051-0	04/29/2016 17:58:52	BRUSH, OR BRUSH AND GRASS MIXTURE F	350 MAIN ST
16002989-0	04/27/2016 15:50:21	BRUSH, OR BRUSH AND GRASS MIXTURE F	65 LEONARD ST

APPENDIX D: FIRE DEPT RECORDS OF BRUSHFIRES

16002263-0	03/30/2016 07:38:51	BRUSH, OR BRUSH AND GRASS MIXTURE F	BENNETT HWY
16000783-0	02/02/2016 12:46:28	BRUSH, OR BRUSH AND GRASS MIXTURE F	1130 EASTERN AVE
15004341-0	06/20/2015 14:46:47	BRUSH, OR BRUSH AND GRASS MIXTURE F	195 CANAL ST
15004340-0	06/20/2015 14:43:31	BRUSH, OR BRUSH AND GRASS MIXTURE F	70 CLIFTON ST
15003306-0	05/11/2015 15:26:36	BRUSH, OR BRUSH AND GRASS MIXTURE F	26 SAINT MARY ST
15003305-0	05/11/2015 13:48:08	BRUSH, OR BRUSH AND GRASS MIXTURE F	171 CANAL ST
15003286-0	05/10/2015 19:57:04	BRUSH, OR BRUSH AND GRASS MIXTURE F	20 PEARL ST
15003177-0	05/06/2015 15:37:14	BRUSH, OR BRUSH AND GRASS MIXTURE F	**E BORDER RD**
15002953-0	04/27/2015 13:29:19	BRUSH, OR BRUSH AND GRASS MIXTURE F	300 COMMERCIAL ST
15002907-0	04/25/2015 11:13:12	BRUSH, OR BRUSH AND GRASS MIXTURE F	17 JULIA ST
15002863-0	04/23/2015 07:21:37	BRUSH, OR BRUSH AND GRASS MIXTURE F	8 QUARRY LN
15000570-0	01/23/2015 20:43:16	BRUSH, OR BRUSH AND GRASS MIXTURE F	11 MARVIN ST
14006403-0	10/01/2014 14:19:59	BRUSH, OR BRUSH AND GRASS MIXTURE F	158 HARVARD ST
14005618-0	08/31/2014 13:25:24	BRUSH, OR BRUSH AND GRASS MIXTURE F	29 WESCOTT ST
14005378-0	08/20/2014 22:56:28	BRUSH, OR BRUSH AND GRASS MIXTURE F	557 PLEASANT ST
14004465-0	07/13/2014 15:05:49	BRUSH, OR BRUSH AND GRASS MIXTURE F	175 BROADWAY ST
14004022-0	06/27/2014 17:18:01	BRUSH, OR BRUSH AND GRASS MIXTURE F	71 CEDAR ST
14002241-0	04/10/2014 15:25:09	BRUSH, OR BRUSH AND GRASS MIXTURE F	**E BORDER RD**
14001865-0	03/24/2014 21:05:01	BRUSH, OR BRUSH AND GRASS MIXTURE F	12 HORACE ST
14001693-0	03/16/2014 17:36:03	BRUSH, OR BRUSH AND GRASS MIXTURE F	77 KENNEDY DR
13007095-0	11/08/2013 11:31:11	BRUSH, OR BRUSH AND GRASS MIXTURE F	412 BRYANT ST
13006857-0	10/28/2013 15:53:30	BRUSH, OR BRUSH AND GRASS MIXTURE F	EXCHANGE ST
13006817-0	10/26/2013 17:46:05	BRUSH, OR BRUSH AND GRASS MIXTURE F	245 PLEASANT ST
13006674-0	10/20/2013 16:18:31	BRUSH, OR BRUSH AND GRASS MIXTURE F	45 LOOMIS ST
13006498-0	10/13/2013 15:55:22	BRUSH, OR BRUSH AND GRASS MIXTURE F	232 BROADWAY
13006179-0	09/29/2013 15:13:21	BRUSH, OR BRUSH AND GRASS MIXTURE F	SAVIN ST
13005971-0	09/19/2013 18:11:15	BRUSH, OR BRUSH AND GRASS MIXTURE F	6 BLAINE ST
13005801-0	09/12/2013 10:50:59	BRUSH, OR BRUSH AND GRASS MIXTURE F	EASTERN AT HILLSIDE

APPENDIX D: FIRE DEPT RECORDS OF BRUSHFIRES

Code 143 GRASS FIRE

22003626-0	05/09/2022 15:06:03	GRASS FIRE	21 QUARRY LN
22003366-0	04/30/2022 11:03:02	GRASS FIRE	43 FLORENCE ST
21002907-0	04/26/2021 14:43:26	GRASS FIRE	2 PEARL ST
21002863-0	04/24/2021 15:02:18	GRASS FIRE	COMMERCIAL ST
21002612-0	04/14/2021 12:24:36	GRASS FIRE	6 GROVE ST
21002605-0	04/14/2021 07:12:33	GRASS FIRE	7 HIGHLAND AV
20006067-0	09/16/2020 06:13:31	GRASS FIRE	39 FLORENCE ST
20005742-0	08/31/2020 15:40:07	GRASS FIRE	**431 FELLSWAY E**
20005653-0	08/28/2020 10:14:58	GRASS FIRE	185 CENTRE ST
20003979-0	06/20/2020 08:02:47	GRASS FIRE	10 SAINT MARY ST
20003316-0	05/22/2020 12:43:48	GRASS FIRE	1032 EASTERN AV
20003152-0	05/14/2020 21:28:03	GRASS FIRE	214 BROADWAY
19005651-0	08/12/2019 05:34:27	GRASS FIRE	25 COMMERCIAL ST
19004664-0	07/04/2019 21:25:07	GRASS FIRE	45 GLEN ROCK AV
19002138-0	03/26/2019 14:46:27	GRASS FIRE	49 STERLING ST
18004977-0	07/17/2018 12:06:19	GRASS FIRE	25 COMMERCIAL ST
18003190-0	05/04/2018 11:00:54	GRASS FIRE	EASTERN AV
17004023-0	06/11/2017 17:51:46	GRASS FIRE	10 LINWOOD ST
16006579-0	09/14/2016 17:16:40	GRASS FIRE	350 CHARLES ST
16005211-0	07/22/2016 15:25:23	GRASS FIRE	195 PLEASANT ST
15006495-0	09/19/2015 14:01:59	GRASS FIRE	14 SUMMER ST
15005745-0	08/19/2015 17:10:55	GRASS FIRE	25 COMMERCIAL ST
15003633-0	05/24/2015 15:49:06	GRASS FIRE	60 SUMMER ST
15003629-0	05/24/2015 13:42:42	GRASS FIRE	1 HIGHLAND AV
15003302-0	05/11/2015 12:07:05	GRASS FIRE	170 CENTRE ST
14005171-0	08/11/2014 16:51:39	GRASS FIRE	245 PLEASANT ST

APPENDIX E: PLAN ADOPTION BY THE CITY

<CITY LETTERHEAD>

CERTIFICATE OF ADOPTION
CITY COUNCIL

CITYOF MALDEN, MASSACHUSETTS

A RESOLUTION ADOPTING THE
CITY OF MALDEN HAZARD MITIGATION PLAN 2022 UPDATE

WHEREAS, the City of Malden, MA established a Committee to prepare the *City of Malden Hazard Mitigation Plan 2022 Update*; and

WHEREAS, the *City of Malden Hazard Mitigation Plan* 2022 *Update* contains several potential future projects to mitigate potential impacts from natural hazards in the City of Malden, and

WHEREAS, duly-noticed public meetings were held by the Malden Conservation Commission on May 6, 2022 and by the Malden Emergency Management Team on June 15, 2022;

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

NOW, THEREFORE BE IT RESOLVED that the Malden City Council adopts the *City of Malden Hazard Mitigation Plan 2022 Update,* in accordance with M.G.L. 40 §4 or the charter and ordinances of the City of Malden.

ADOPTED AND SIGNED this Date. _____

Name(s) / Title(s) Signature(s)

ATTEST