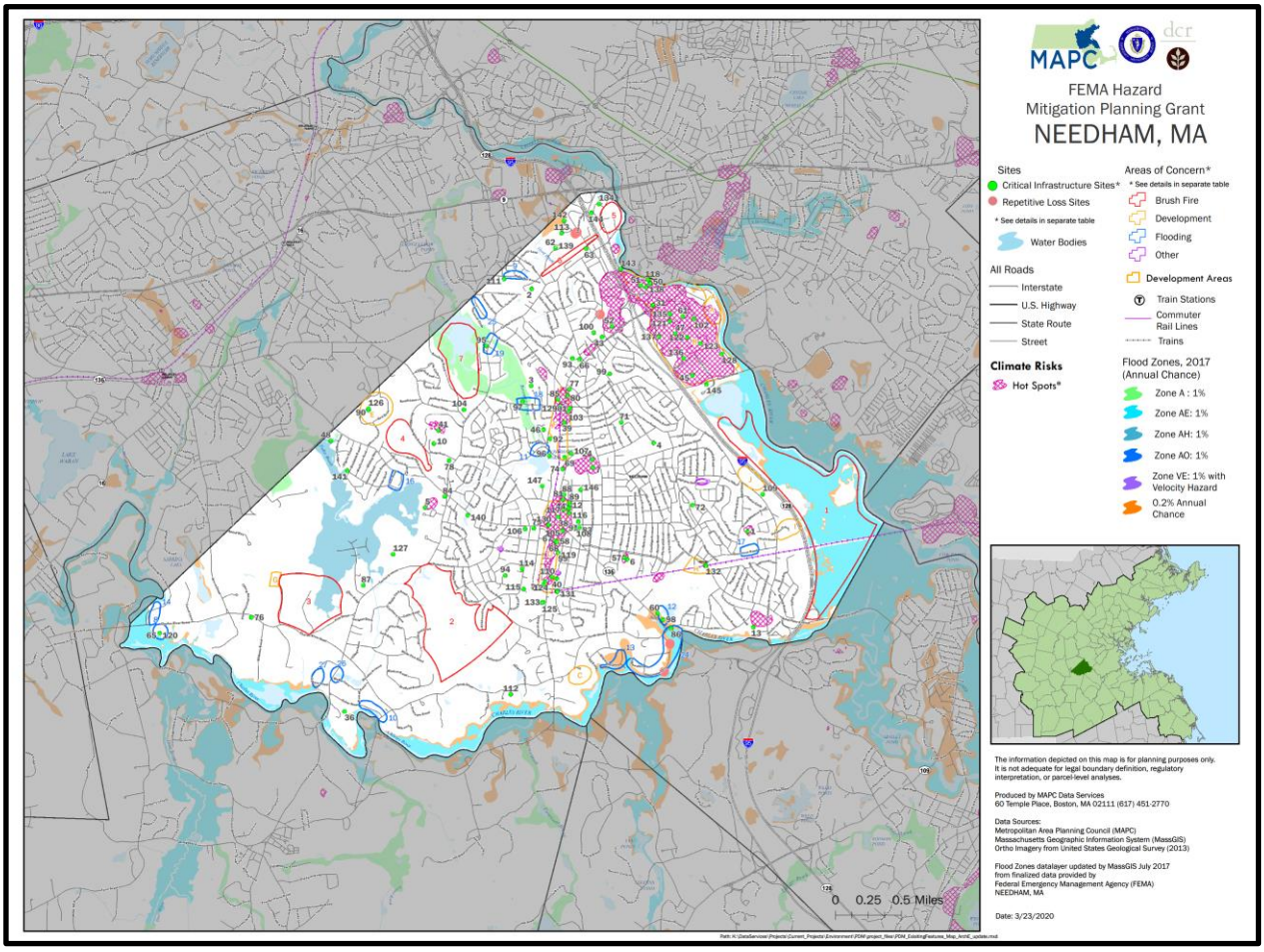
DRAFT

TOWN OF NEEDHAM

HAZARD MITIGATION PLAN

2020 UPDATE



MAPC 50 YEARS
METROPOLITAN AREA PLANNING COUNCIL
SMART GROWTH AND REGIONAL COLLABORATION

Draft Plan Update
June 2, 2020

ACKNOWLEDGEMENTS & CREDITS

This plan was prepared for the Town of Needham 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 Massachusetts Municipal Vulnerability Preparedness Program.

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

PLANNING PROCESS

Planning for the Hazard Mitigation Plan update was led by the Needham Local Hazard Mitigation Planning Team, composed of staff from a number of different town departments. The team also led a parallel planning process as part of the Massachusetts Municipal Vulnerability Preparedness (MVP) program focused on identifying climate risks and resilience strategies. In the joint effort, the team met on November 13, 2019, December 11, 2019, and May 21, 2010 and discussed where the impacts of natural hazards most affect the town, goals for addressing these impacts, updates to the Town's existing mitigation measures, and new or revised hazard mitigation measures that would benefit the town.

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 Town takes to mitigate them. The Town's Local Hazard Mitigation Planning Team hosted two public meetings. Due to the restrictions on public gatherings associated with the corona virus pandemic public outreach had to handled creatively. The first meeting took place in the form of a website posted on May 4, 2020 that provided a video presentation and survey for participants to fill out. The video was viewed more than 70 times and 20 people filled out surveys. The second meeting on June 9, 2010 was held via Zoom and the draft plan update was posted on the Town's website for public review. Key town stakeholders and neighboring communities were notified and invited to review the draft plan and submit comments. As part of the MVP program, the town hosted an all-day workshop on January 10, 2020 where 39 participants identified climate resilience vulnerabilities and mitigation strategies. These strategies were also reviewed in the May website posting. See Public Comments for feedback. The top priorities are shown in Appendix E.

RISK ASSESSMENT

The Needham Hazard Mitigation Plan assesses the potential impacts to the town from flooding, high winds, winter storms, brush fire, geologic hazards, extreme temperatures, drought and, invasive species. For each risk, the assessment identifies the projected impacts of a warming climate. These are shown in the map series in Appendix B. The Needham Local Hazard Mitigation Planning Team identified 113 Critical Facilities. These are also shown on the map series and listed in Table 28, 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 Needham estimates property damages from Hurricanes of category 2 and 4 ($36 million to $138 million), earthquakes of magnitudes 5 and 7 ($725 million to $6.3 billion), and the 1% and .2% chance of flooding ($27 to $36 million).

HAZARD MITIGATION GOALS

The Needham Local Multiple Hazard Community Planning Team endorsed the following eleven hazard mitigation goals at the January 16, 2020 team meeting. The team added an eleventh goal focused on incorporating future climate change projections.

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

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

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

4. Prevent and reduce the damage to public infrastructure resulting from all hazards.

5. Encourage the business community, major institutions and non-profits to work with the Town to develop, review and implement the hazard mitigation plan.

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

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

8. Take maximum advantage of resources from FEMA and MEMA to educate Town staff and the public about hazard mitigation.

9. Consider the potential impacts of future climate change. Incorporate climate sustainability and resiliency in hazard mitigation planning.

HAZARD MITIGATION STRATEGY

The Needham Local Hazard Mitigation Planning Team identified a number of mitigation measures that would serve to reduce the Town's vulnerability to natural hazard events. Overall, the hazard mitigation strategy recognizes that mitigating hazards for Needham will be an ongoing process as our understanding of natural hazards and the steps that can be taken to mitigate their damages changes over time. Global climate change and a variety of other factors impact the Town's vulnerability in the future, and local officials will need to work together across municipal

lines and with state and federal agencies in order to understand and address these changes. The Hazard Mitigation Strategy will be incorporated into the Town's other related plans and policies.

PLAN REVIEW & UPDATE PROCESS

The process for developing Needham's Hazard Mitigation Plan 2020 Update is summarized in Table 1.

Table 1: Plan Review and Update Process

Section	Reviews and Updates
Section 3: Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan, discussing strategies to enhance participation opportunities at the first local committee meeting. During plan development, the plan was discussed at two public meetings hosted by the Hazard Mitigation Team and the Select Board. The plan was also available on the Town's website for public comment. See Public Comments for feedback.
Section 4: Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with town staff to identify changes in local hazard areas and development trends. Town staff reviewed critical infrastructure with MAPC staff in order to create an up-to-date list. The Risk Assessment integrates projected climate impacts. 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 and endorsed by the Needham Local Hazard Mitigation Planning Team.
Section 6: Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the town.
Sections 7 and 8: Hazard Mitigation Strategy	Mitigation measures from the 2009 plan were reviewed and assessed as to whether they were completed, in progress, or deferred. The Local Hazard Mitigation Planning Team determined whether to carry forward measures into the 2020 Plan Update or modify or delete them. The Plan Update's hazard mitigation strategy reflects both new measures and measures carried forward from the 2009 plan. The Local Hazard Mitigation Team prioritized all of these 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 Town in incorporating hazard mitigation issues into other Town planning and regulatory review processes and better prepare the Town for the next comprehensive plan update.

As indicated in Table 33, Needham made good progress implementing mitigation measures identified in the 2009 Hazard Mitigation Plan. Considerable work has been done reduce infiltration into the sewer system. The Town is now moving its focus to inflow. Bypass protocols are in place to prevent sewer back-ups. The Town purchased portable generators for multiple locations. The control structure and weir at Walker Pond were completed. The Hazardous Materials Response plan was revised and updated. The Town continues to make open space purchases and regularly sets aside $1.5 million for purchase of priority properties that may become available. The Town adopted a strong stormwater bylaw and completed a comprehensive stormwater management plan in compliance with MS4 requirements.

Some projects were partially completed, and/or will be continued to the next plan for on-going maintenance. A permanent generator is needed for the Senior Center and for sewer pump stations as they are upgraded. While many bridges have been updated, the Central Avenue bridge to Dover needs attention. Stormwater management and open space purchases are all ongoing priorities.

Moving forward into the next five-year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town's decision-making processes. As in the past, the Town 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 Needham Hazard Mitigation Implementation Team, as described in Section 9 Plan Adoption and Maintenance.

SECTION 2: INTRODUCTION

PLANNING REQUIREMENTS UNDER THE FEDERAL DISASTER MITIGATION ACT

The Federal Disaster Mitigation Act, passed in 2000, requires that 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).

The Town of Needham contracted with the Metropolitan Area Planning Council (MAPC), to assist the Town in updating its local Hazard Mitigation Plan to assist the Town in updating its local Hazard Mitigation Plan, which was first adopted in 2009 as a multijurisdictional plan.

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 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, there have been 24 natural hazard events that triggered federal or state disaster declarations that included Norfolk County. These are listed in Table 2 below. The majority of these events involved flooding, while others were due to hurricanes or nor'easters, and severe winter weather.

Table 2: Presidentially Declared Disasters, 1991-2018

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	March 2001	Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, Worcester
Snowstorm	February 2003	Statewide
Snowstorm	December 2003	Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, Worcester
Flooding	April 2004	Essex, Middlesex, Norfolk, Suffolk, Worcester
Snow	January 2005	Statewide
Hurricane Katrina	August 2005	Statewide
Severe Storms, Flooding	October 2005	Statewide
Severe Storms, Flooding	May 2006	Statewide
Severe Storm, Inland, Coastal Flooding	April 2007	Statewide
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
Tropical Storm Irene	August 2011	Barnstable, Berkshire, Bristol, Dukes, Franklin, Hampden, Hampshire, Norfolk, Plymouth
Severe Winter Storm, Snowstorm and Flooding	February, 2013	Statewide
Severe winter storm, snowstorm and flooding	April 2015	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe winter storm and flooding	March 2018	Barnstable, Bristol, Essex, Nantucket, Norfolk, Plymouth

Disaster Name	Date of Event	Declared Areas
Severe winter storm and Snowstorm	March 2018	Essex, Middlesex, Norfolk, Suffolk, Worcester

Source: MA Hazard Mitigation and Climate Adaptation Plan, 2018

FEMA FUNDED MITIGATION PROJECTS

Needham has not previously received FEMA funded mitigation projects.

COMMUNITY PROFILE

Needham covers nearly 13 square miles and is located 10 miles southwest of downtown Boston. The Charles River surrounds Needham on three sides. The Town of Needham was established in 1711. Through the mid-1800's Needham was primarily an agricultural community. With the development of rail access, Needham became home to seasonal estates and to the knitting industry. The construction of Route 128 in the mid-20th century brought new commercial ventures. Needham today is residential suburban community with significant business presence along Route 128.

Needham is a relatively affluent community with high median annual income and a low poverty rate. Needham has just over 30,000 residents. Roughly 87% of residents are White. There is a growing Asian population. Approximately half of the 8% of the population that identifies as Asian is of Chinese descent. Notably, 25% of Needham's population lives alone, and 50% of those living alone are over 65 years old.

The town maintains a website at http://www.needhamma.gov/

Table 3: Needham Characteristics

Population = 30,429 people

- 5.7% are under age 5
- 26.9% are under age 18
- 18.2% are over age 65
- 4.4% of households are limited English-speaking
- 1.7% of households have no vehicle available
- 87% of the population is White

Number of Housing Units = 3,799

- 17.4% are renter-occupied housing units
- 23.8% of housing units were built before 1940

Source: 2017 American Community Survey

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

- Needham has been proactive in addressing the impact of climate on natural hazards; the community is in the process of becoming certified by the state as a Municipal Vulnerability Preparedness community.
- Needham is lies within the Charles River watershed and is encircled by the river on three sides.
- Water quantity and quality are important concerns for maintaining drinking water supply and the for the health of the many brooks, river and wetlands within the town.
- Records from flooding in 2010 highlight that the more densely developed northeast half of the town is where flood damage occurred.
- A portion of Route 128 lies within Needham's boundaries. Residents noted concerns about potential impacts from the transport of hazardous materials, and for extreme traffic tie-ups in the event of emergency evacuations.

SECTION 3: PLANNING PROCESS & PUBLIC PARTICIPATION

MAPC employs a six-step planning process based on FEMA's hazard mitigation planning guidance focusing on local needs and priorities but maintaining a regional perspective matched to the scale and nature of natural hazard events. Public participation is a central component of this process, providing critical information about the local occurrence of hazards while also serving as a means to build a base of support for hazard mitigation activities. MAPC supports participation by the general public and other plan stakeholders through two public meetings, posting of the plan to the Town's website, and invitations sent to neighboring communities, town boards and commissions, and other local or regional entities to review the plan and provide comment.

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. In 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.

Figure 1: Six-Step Planning Process

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. These maps can be found in Appendix B.

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

    - Town of Needham General By-Laws
    - Zoning By-Law of the Town of Needham
    - Town of Needham Community Resilience Building Workshop Summary of Findings 2020
    - Town of Needham Draft Open Space and Recreation Plan 2017
    - Blue Hill Observatory
    - FEMA, Flood Insurance Rate Maps for Norfolk County, MA, 2012
    - FEMA, Hazards U.S. Multi-Hazard
    - FEMA, Local Mitigation Plan Review Guide, October 2011
    - Fourth National Climate Assessment, 2018
    - Massachusetts Flood Hazard Management Program
    - Massachusetts Office of Coastal Zone Management Shoreline Change Data
    - 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
    - Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data
    - National Weather Service
    - Nevada Seismological Library
    - New England Seismic Network, Boston College Weston Observatory, http://aki.bc.edu/index.htm
    - NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/
    - Northeast Climate Adaptation Science Center
    - Northeast States Emergency Consortium, http://www.nesec.org/
    - Tornado History Project
    - US Census, 2010 and American Community Survey 2017 5-Year Estimates
    - USGS, National Water Information System, http://nwis.waterdata.usgs.gov/usa/nwis

3. **Review Existing Mitigation** – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as most have adopted flood plain zoning districts, wetlands protection programs, and other measures as well as enforcing the State building code, which has strong provisions related to hazard resistant building requirements. All current municipal mitigation measures must be 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 Section 7.

5. **Plan Approval & Adoption** – Once a final draft of the plan is complete it is sent to MEMA for the state level review and, following that, to FEMA for approval. Typically, once FEMA has approved the plan the agency issues a conditional approval (Approval Pending Adoption), with the condition being adoption of the plan by the municipality. More information on plan adoption can be found in Section 9 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.

2009 PLAN IMPLEMENTATION & MAINTENANCE

The 2009 Town of Needham Hazard Mitigation Plan contained a risk assessment of identified hazards for the town and mitigation measures to address the risk and vulnerability from these hazards. Since approval of the plan by FEMA progress has been made on implementation of the measures. The Town has advanced a number of projects for implementation, addressing sewer infiltration, adoption of a Stormwater Bylaw and, land preservation.

THE LOCAL MULTIPLE HAZARD COMMUNITY PLANNING TEAM

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

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

Rebecca Ping	Emergency Management Administrator, Project Coordinator
Kimberly Donovan	Compliance Coordinator
Sean Harrington	Superintendent Water and Sewer
Nicholas Ceurvels	Lieutenant Firefighter
Tony Del Gaizo	Town Engineer
Richard Merson	Public Works Director
Carys Lustig	Director of Finance and Administration for Public Services
Eleanor Rosellini	Green Needham Collaborative
Jessica Moss	Assistant Director of Counselling and Volunteers – Council on Aging

Dave Roche	Building Commissioner
Steve Cusick	Water Treatment Plant Manager
Debbie Anderson	Conservation Administrator
Tiffany Zike	Public Health Nurse
John McGrath	Police Lieutenant
Barry Dulong	Director of Building Maintenance
Rhain Hayland	Superintendent Highway Division
Lee Newman	Director of Planning and Community Development

The Needham Planning Board and Conservation Commission are the primary entities responsible for regulating development in town. Feedback was assured through the participation of the Conservation Administrator and Director of Planning and Community Development. A member of the Planning Board and the Select Board and representatives of most town departments and many boards and commissions participated in an all-day workshop on natural hazards and climate impacts. In addition, MAPC, the State-designated regional planning authority for Needham, works with all agencies that that regulate development in the region, including the listed municipal entities and state agencies, such as the Department of Transportation and the Department of Conservation and Recreation.

The Local Hazard Mitigation Planning Team met on the following dates: November 13, 2019, December 11, and May 21, 2020. The purpose of the meetings was to introduce the Hazard Mitigation planning program, review and update hazard mitigation goals, and to gather information on local hazard mitigation issues and sites or areas related to these. The team also coordinated the Municipal Vulnerability Preparedness Workshop in early November. Later meetings focused on verifying information gathered by MAPC staff and discussion of existing mitigation practices, the status of mitigation measures identified in the 2009 hazard mitigation plan, and potential new or revised mitigation measures. The agendas for these meetings are included in Appendix A.

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 and climate impacts, 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 Town hosted two public meetings, one during the planning process and one after a complete draft plan was available for review.

In addition to the two public meetings, Needham held an all-day workshop attended by thirty-nine Needham town staff, board and committee members, and representatives of local

organizations. The workshop focused on climate impacts to natural hazards. The public had an opportunity to provide input to the Needham hazard mitigation planning process during via a website that provided a video and survey feedback option during the first two weeks in May. The draft plan update was presented at a Select Board meeting on June 9, 2020 held virtually via Zoom. The Select Board meeting was also broadcast on local cable television and the Town website. Both meetings were publicized in accordance with the Massachusetts Public Meeting Law. The attendance list for each meeting can be found in Table 4. See public meeting notices in Appendix C.

Table 4: Needham Public Meetings

Meeting #1 May 4 to May 18 (virtual)	
Total Attendance: 20+	
20 filled out surveys	
71 viewed the video	
Meeting #2 June 9, 2020	
Total Attendance:	
Name	**Representing**

LOCAL STAKEHOLDER INVOLVEMENT

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

- Charles River Watershed Association
- Newton Needham Chamber of Commerce
- Green Needham
- League of Women Voters
- Babson College
- Needham Heights Neighborhood Assoc.
- Beth Israel Deaconess – Needham
- MWRA
- Olin College
- Town of Wellesley
- Town of Dover
- Town of Westwood
- Town of Dedham
- City of Boston
- City of Newton
- Needham Clergy Association

See Appendix C for public meeting notices. The draft Needham Hazard Mitigation Plan 2020 Update was posted on the Town's website for the second public meeting. Members of the public could access the draft document and submit comments or questions to the Town.

PUBLIC COMMENT

Comments from the first public comment period indicated strong support for four priorities including protecting drinking water infrastructure, addressing stormwater flooding, strategies to both protect trees and protect the public from tree damage, and assuring robust and redundant utility and communications infrastructure. Comments from the second meeting here.

CONTINUING PUBLIC PARTICIPATION

Following the adoption of the plan update, the planning 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 Implementation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Implementation Team will be publicly noticed in accordance with town and state open meeting laws.

PLANNING TIMELINE

November 13, 2019	Meeting of the Needham Local Hazard Mitigation and MVP Planning Team
December 11, 2019	Meeting of the Needham Local Hazard Mitigation and MVP Planning Team
January 10, 2020	All day MVP Workshop
May 4-18, 2020	First Public Meeting held virtually
May 21 2020	Meeting of the Needham Local Hazard Mitigation and MVP Planning Team
June 9, 2010	Second Public Meeting with the Needham Select Board
	Draft Plan Update submitted to MEMA
	Draft Plan Update submitted to FEMA
	Notice of Approvable Pending Adoption sent by FEMA
	Plan Adopted by the Needham Select Board

	FEMA final approval of the plan for 5 years, until xxxxxxxx

SECTION 4: RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town of Needham 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 Needham's risk assessment, MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. MAPC also used FEMA's damage estimation software, HAZUS.

With the adoption of the Hazard Mitigation and Climate Adaptation Plan 2018 (SHMCAP), Massachusetts became the first state to integrate climate projections in 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. 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 AND PROJECTIONS

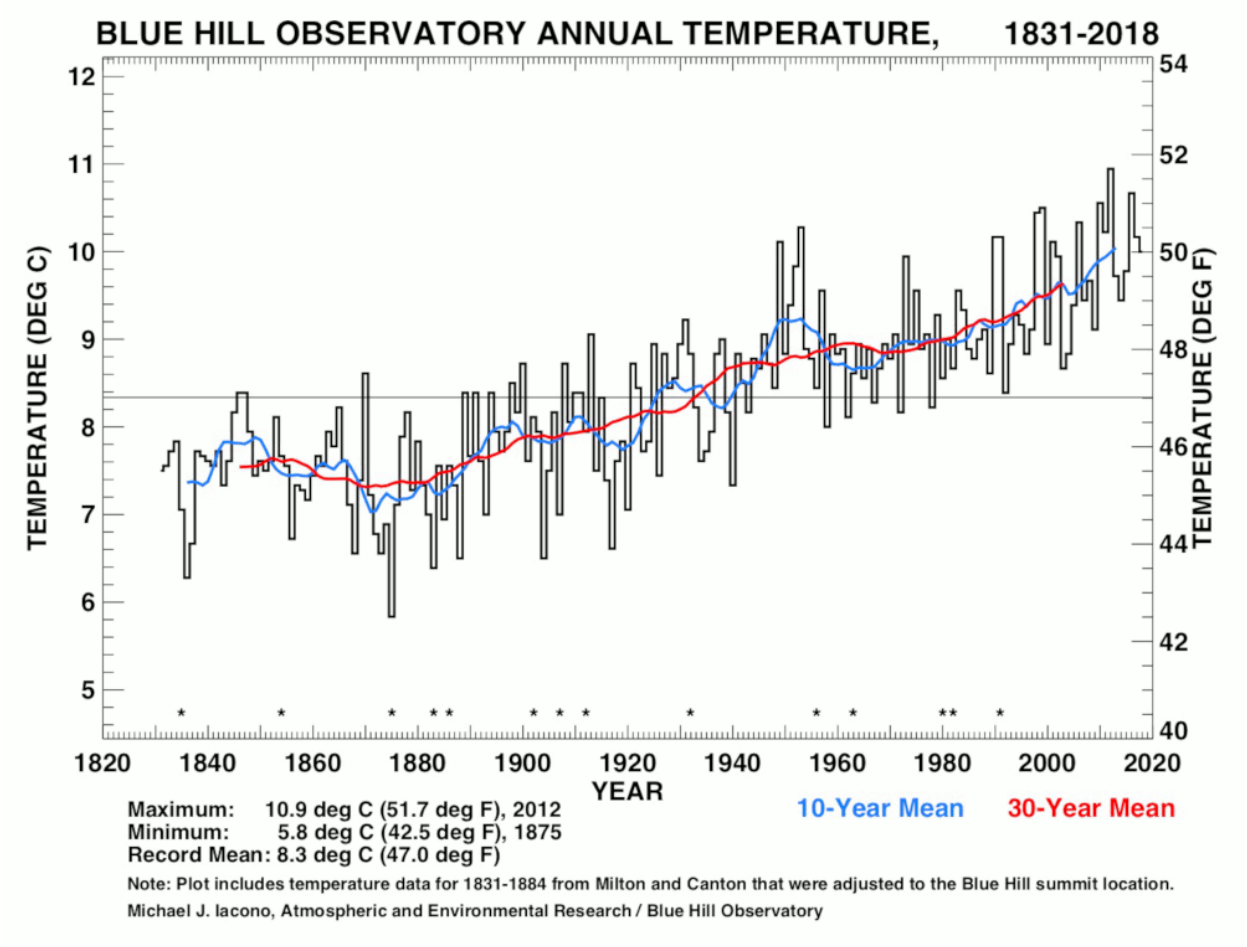
Climate change observations come from a variety of data sources that have measured and recorded changes in recent decades and centuries. Climate change projections, however, predict future climate impacts and, by their nature, cannot be observed or measured. As a result of the inherent uncertainty in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

Temperature

Our climate has always been regulated by gases, including carbon dioxide, methane, and nitrous oxide, that 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.

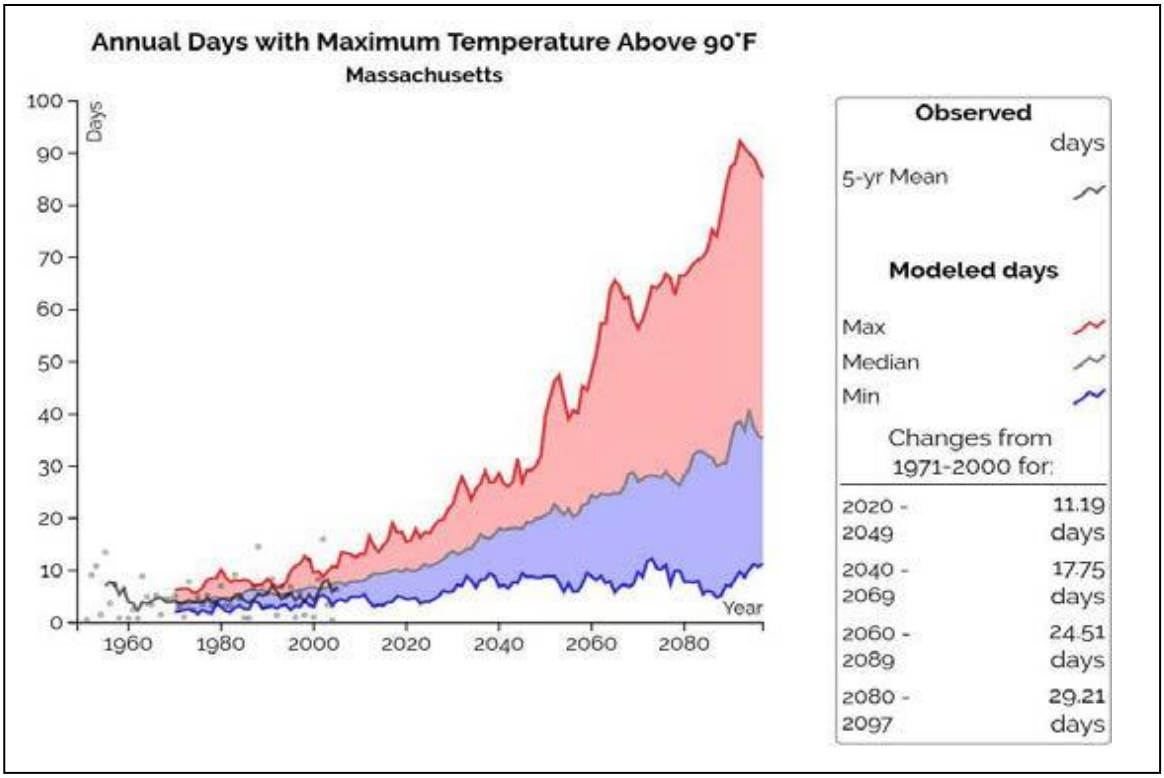
Records from the Blue Hill Observatory in Milton, MA show that average temperatures (30-year mean) have risen approximately 3 degrees (F) in the almost 200 years since record keeping began in 1831.

Figure 2: Observed Increase in Temperature



Climate projections include an increase in average temperature and in the number of extreme heat days. Extreme cold day 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. Table 3 shows the NECASC range of projections for increases in the number of days over 90 degrees annually.

Figure 3: Projected Increase in Annual Days Over 90 Degrees F



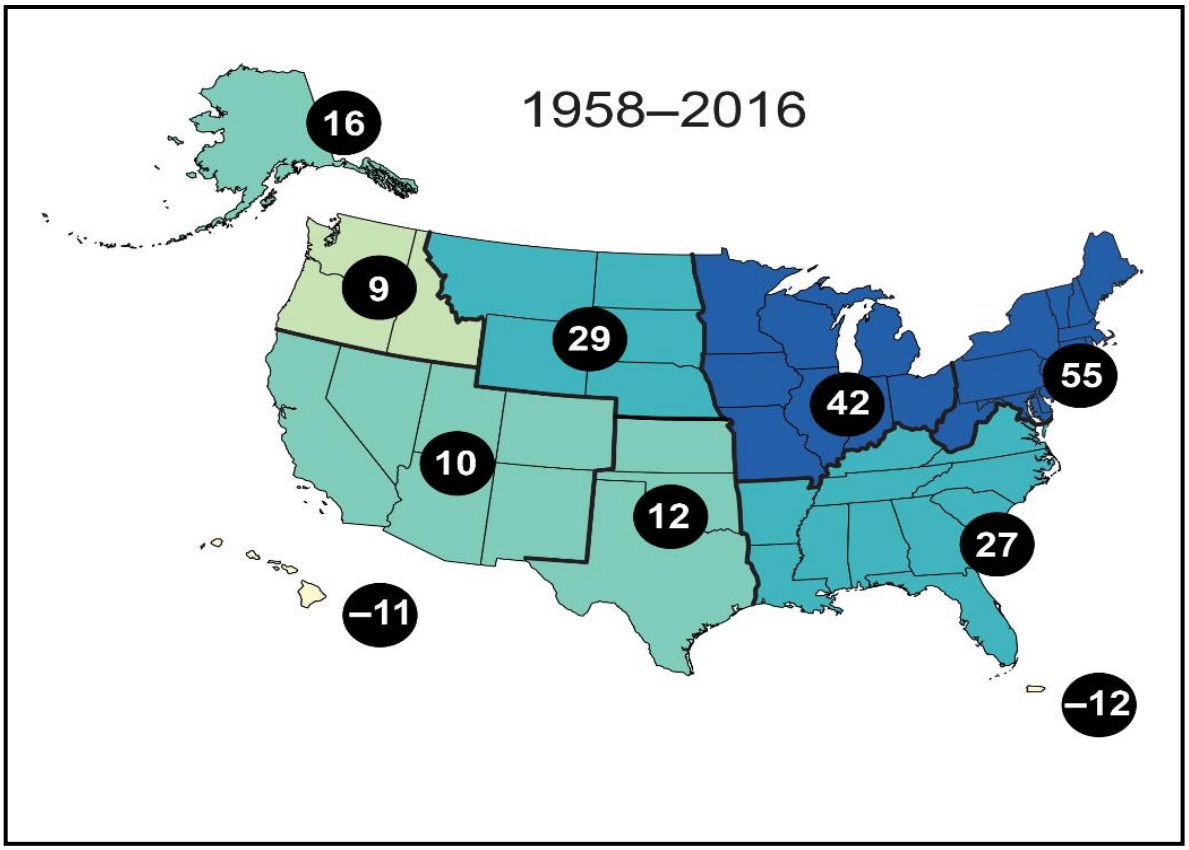
Source: Northeast Climate Adaptation Science Center

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 4). 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 5).

Figure 4: Observed Change in Total Annual Precipitation Falling in the Heaviest 1% of Events

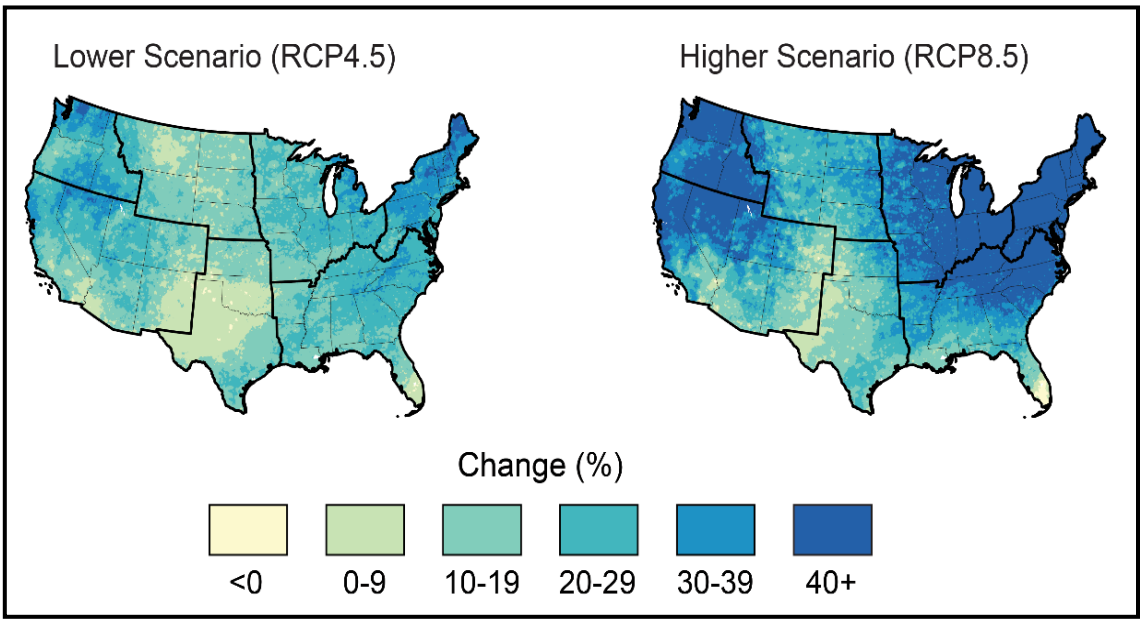


Source: Fourth National Climate Assessment, 2018

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

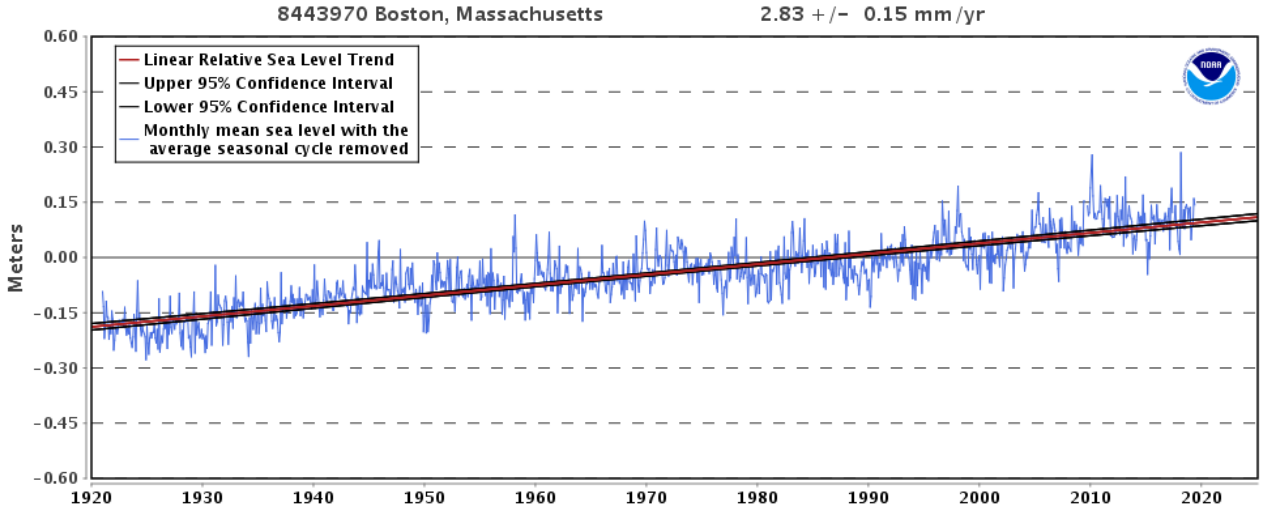


Source: Fourth National Climate Assessment, 2018

Sea Level Rise

Records from the Boston Tide Station show nearly one foot of sea level rise in the past century (Figure 6). Warming temperatures contribute to sea level rise in two 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.

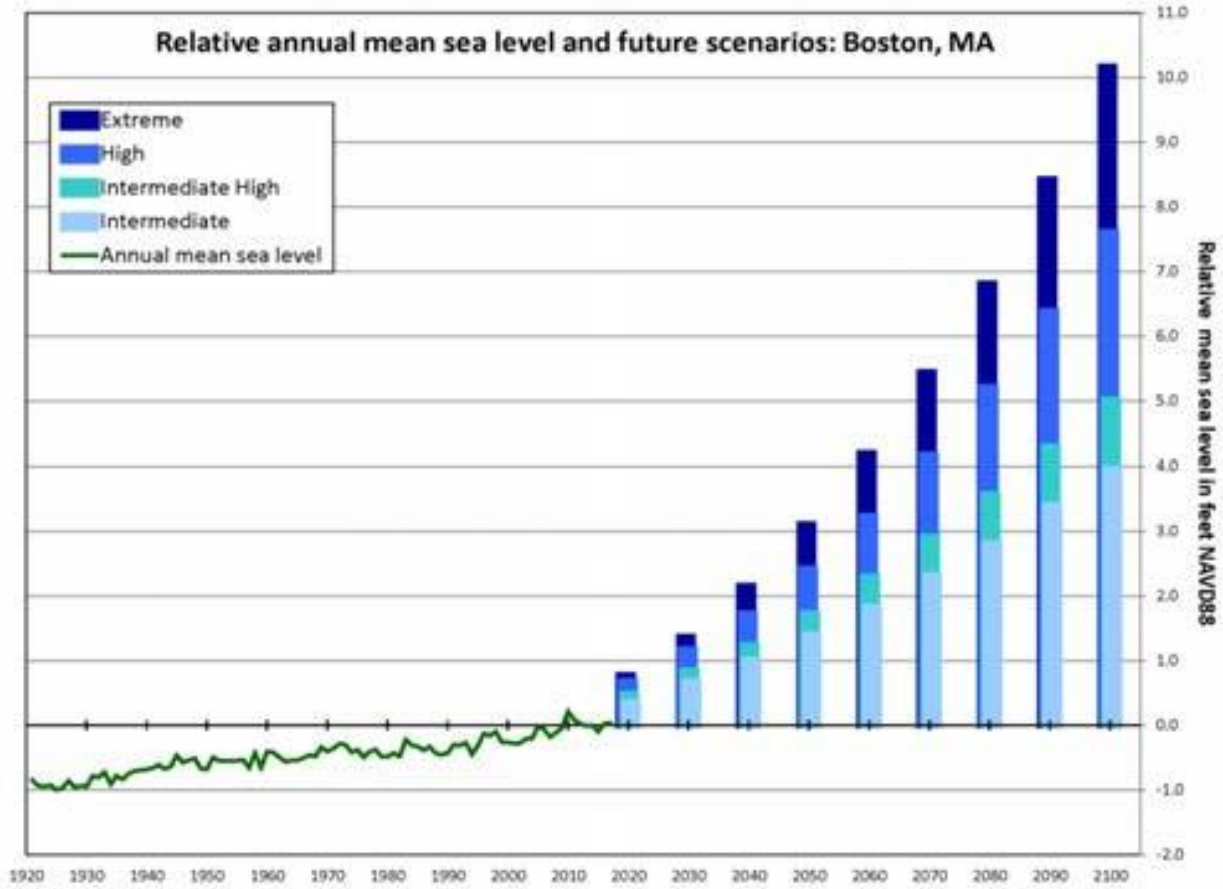
Figure 6: Observed Increase in Sea Level Rise



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 7 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.

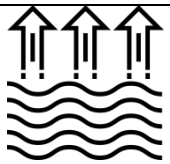
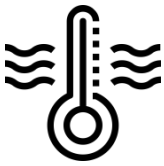
Figure 7: Recent and Projected Increase in Sea Level Rise



Source: SHMCAP

Following the general outline of the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 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. It should be noted that a few of the hazards listed in the 2018 Massachusetts State Hazard Mitigation plan are not applicable to the Town of Needham. Ice Jams are an unlikely natural hazard; with only two occurrences in Norfolk County in 1970 and 1971. There was no damage reported as a result of these ice jams and Needham has chosen not to profile ice jams since they are a secondary hazard. Finally, since Needham is an inland community, Needham is not vulnerable to Tsunamis, Coastal Flooding, and Coastal Erosion; hazards related to coastal areas were not addressed.

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, 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 and subsidence of wetlands
	Coastal Erosion	Changes in Precipitation, 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, ecosystem stress, energy brownouts from higher energy demands, more intense heat waves, public health impacts from high heat exposure and poor outdoor air quality, 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	Rising Temperatures, Changes in Precipitation	
	Tornadoes	Rising Temperatures, Changes in Precipitation	
	Other Severe Weather (Including Strong Wind and Extreme Precipitation)	Rising Temperatures, Changes in Precipitation	
Non-Climate-Influenced Hazards	Earthquake	Not Applicable	There is no established correlation between climate change and this hazard

OVERVIEW OF HAZARDS AND IMPACTS

Table 7 summarizes the frequency and severity of hazard risks for Massachusetts and Needham. The Massachusetts frequency assessment is based on data in the SHMCAP. The Needham frequency assessment reflects data from the National Climatic Data Center (NOAA) for Norfolk County*, from the SHMCAP** and, from the local Hazard Mitigation Team***.

Table 6: Hazards Risk Summary

Hazard	Frequency		Severity	
	Massachusetts	Needham	Massachusetts	Needham
Inland Flooding	Substantial every 3rd year	3.2 per year*	Serious	Serious
Drought	1% any given month	1% any given month***	Minor	Minor
Landslides	Every other year	None recorded**	Minor	Minor
Coastal Flooding	6 events per year	NA	Serious	NA
Coastal Erosion	Frequency can't be measured	NA	Serious	NA
Tsunami	1in every 39 years	NA	Extensive	NA
Extreme Temperatures	2 heat events and 1 cold event event/year	4 heat events in 10 years/2 cold events in 10 years*	Minor	Minor
Brush Fires	One notable event per year	Notable events are rare	Minor	Minor
Hurricane/Tropical Storm	One every two years	1 recorded event	Serious	Serious
Severe Winter Storms/Nor'easters	One notable event per year	1.8 per year*	Extensive	Serious
Tornadoes	1.7 per year	None recorded	Serious	Serious
Other Severe Weather (Thunderstorms/High Winds)	20-30 thunderstorms annually; 43.5 high wind events annually	3 per year*	Minor	Minor
Earthquake	10 - 15% chance of Mag 5 in 10-year period	10 - 15% chance of Mag 5 in 10-year period***	Extensive	Extensive

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

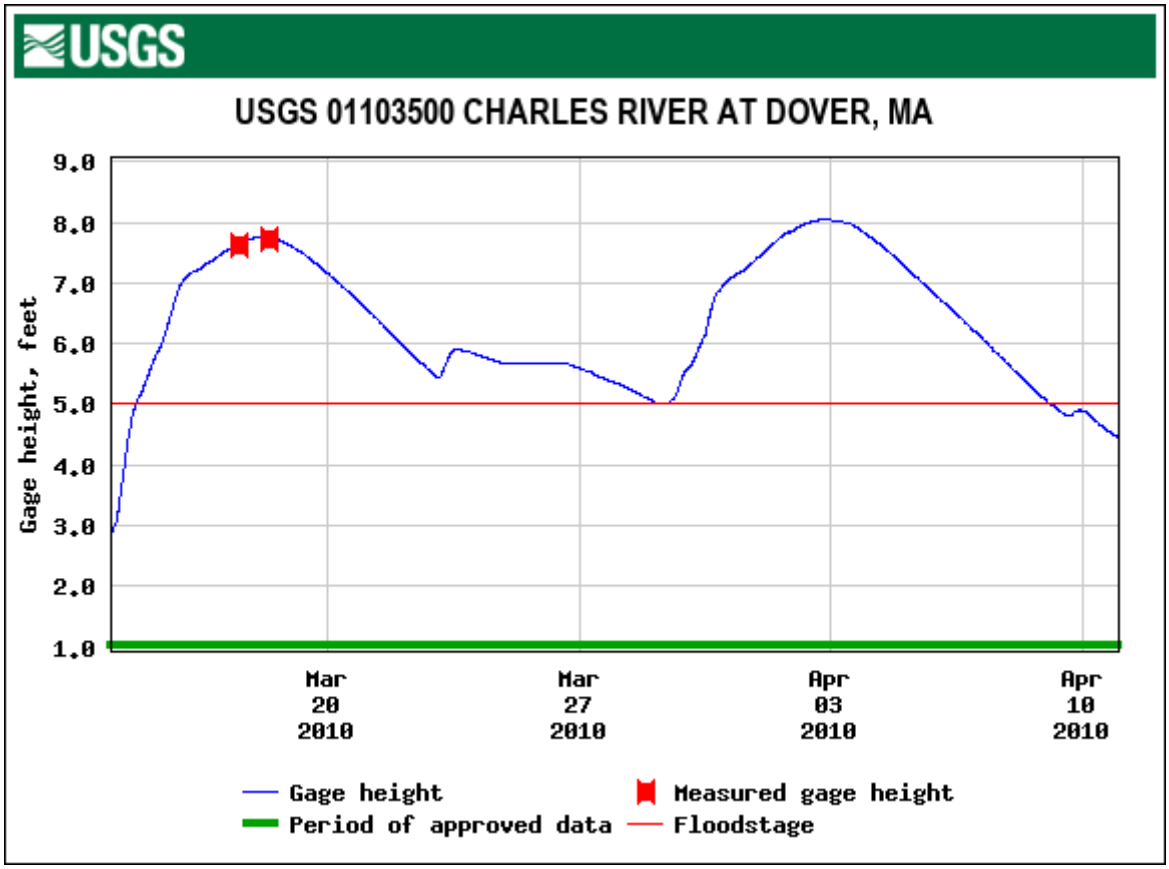
INLAND FLOODING

Inland flooding can be associated with overflowing rivers and streams, stormwater flooding associated with impervious surfaces and stormwater infrastructure, and in more rare cases ice jams, ground failures (erosion), and in some communities beaver dams. Inland flooding is generally caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms. Climate change has the potential to exacerbate these issues over time due to increasing extreme rainfall events. Increase in average annual rainfall may also lead to more incidents of basement flooding caused by high seasonal groundwater levels.

Flooding was the most prevalent serious natural hazard identified by local officials in Needham. Flooding can be caused by major storms, known as northeasters and hurricanes. Northeasters 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 rain storms or snowfalls can also lead to inland flooding.

The 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 frozen ground, and while vegetation is still dormant. The Blue Hill Observatory in Milton recorded 17.7 inches of rain from three storms in the 19 days from March 13 to 31. As shown in the USGS gage approximately ¼ mile downstream of South Street on the Charles River, river levels surged well above flood stage twice and stayed there for nearly a month (Figure 8). The March 2010 storms were a federally declared disaster making federal assistance available to property owners who did not carry flood insurance. Based on the claims, Needham experienced extensive flood damage, with one flood insurance claim and 231 disaster claims, 99% of which were located *outside* of FEMA Special Flood Hazard Areas. The claims were most concentrated in the more densely developed northeast half of the town. See Map 3 in Appendix B for claim locations.

Figure 8: March 2010 USGS Charles River Gage



Local data for previous flooding occurrences are not collected by the Town of Needham. The best available local data is for Norfolk County through the National Climatic Data Center. Norfolk County, which includes the Town of Needham, experienced 32 flood events from 2010 through 2019. No deaths or injuries were reported and the total reported property damage in the county was $25 million dollars. Nearly all of the damage is attributed to the events in March 2010. This is an average of 3.2 flood events each year.

Table 7: Norfolk County Flood Events, 2010 through 2019

Date	Deaths	Injuries	Property Damage
03/14/2010	0	0	16.64M
03/29/2010	0	0	8.320M
04/01/2010	0	0	0.00K
07/24/2010	0	0	20.00K
08/05/2010	0	0	0.00K
08/25/2010	0	0	8.00K
08/28/2011	0	0	0.00K
08/15/2012	0	0	0.00K

Date	Deaths	Injuries	Property Damage
10/29/2012	0	0	0.00K
06/07/2013	0	0	0.00K
07/29/2013	0	0	0.00K
08/09/2013	0	0	15.00K
10/22/2014	0	0	0.00K
10/23/2014	0	0	0.00K
8/15/2015	0	0	0.00K
8/18/2015	0	0	0.00K
6/07/2016	0	0	5.00K
8/14/2016	0	0	5.00K
4/1/2017	0	0	5.00K
7/12/2017	0	0	0.00K
7/18/2017	0	0	1.00K
8/2/2017	0	0	0.00K
9/30/2017	0	0	10.00K
10/25/2017	0	0	0.00K
10/29/2017	0	0	0.00K
01/12/2018	0	0	0.00K
01/13/2018	0	0	0.00K
04/16/2018	0	0	0.00K
07/06/2018	0	0	10.00K
10/29/2018	0	0	0.00K
11/03/2018	0	0	0.00K
4/15/2019	0	0	0.00K
Total	**0**	**0**	**25 M**

Source: NOAA, National Climatic Data Center

ICE JAMS

Ice jams occur in cold weather when normally flowing water begins to freeze effectively damming the waterway and causing localized flooding in the area. Flooding may also occur when ice jams break up and ice may pile up at culverts or around bridges. There is no recent history of ice jams leading to flooding in Needham and Town staff did not identify this hazard as an issue for the town.

DAM FAILURE OR OVERTOPPING

Dams can fail because of structural problems or age, independent of any storm event. Dam failure can follow an earthquake by causing structural damage. Dams can also fail structurally because of flooding arising from a storm or they can overspill due to flooding. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the path of the dam's floodwaters.

A concern for dams in Massachusetts is that many were built in the 19th century without the benefits of modern engineering or construction oversight. In addition, some dams have not been properly maintained. The increasing intensity of precipitation is the primary climate concern related to dams, as they were most likely designed based on historic weather patterns. The SHMCAP indicates that changing precipitation patterns may increase the likelihood of overflow events. Dam failure is a highly infrequent occurrence, but a severe incident could result in loss of lives and significant property damage. According to the Association of State Dam Safety Officials, three dams have failed in Massachusetts since 1984, one of which resulted in a death.

Data in this chart from August 2018 were provided by the DCR Office of Dam Safety. The Cochrane Dam is identified as located in Dover, but it is on the Charles between Dover and Needham. Only Rosemary Lake Dam is considered a High Hazard dam.

Table 8: Status of Dams in Needham

Dam Name	River	Owner	Hazard Classification
Rosemary Lake Dam	Rosemary Brook	Town of Needham, Select Board	High
Needham Reservoir Dam	Tributary of Charles River	Town of Needham, Select Board	Low
Sabrina Lake Dam - South	No inlet	Not Available for unregulated small dams	N/A
Cochrane Dam	Charles River	Department of Conservation and Recreation	Low

Source: DCR Office of Dam Safety

DCR Dam Hazard Classification

High: Dams located where failure or mis-operation will likely cause loss of life and serious damage to homes(s), industrial or commercial facilities, important public utilities, main highways(s) or railroad(s).

Significant: Dams located where failure or mis-operation may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s)

Low: Dams located where failure or mis-operation may cause minimal property damage to others. Loss of life is not expected.

LOCALLY IDENTIFIED AREAS OF INLAND FLOODING

Information on potential flood hazard areas was taken from two sources. The first is the National Flood Insurance Rate Maps (FIRM). The FIRM flood zones are shown on Map 3 in Appendix B. The "Locally Identified Areas of Flooding" described below were identified by Town staff as areas where flooding is known to occur. These areas do not necessarily coincide with the flood zones on the FIRM maps. Flood sources include inadequate drainage systems, high groundwater, and other local conditions. The numbers correspond to the numbers on Map 8, "Local Hazard Areas."

Table 9: Locally Identified Areas of Flooding

Map ID	Name	Description
8	Water Treatment Plant at the Dover line	According to local officials, this site is a low flood hazard that also floods infrequently, since the road was raised when reconstructed. However, Public Works Superintendent Richard Merson did note that the flooding, in certain circumstances could be quite severe and could jeopardize the town's well field of three fresh water wells. There is no current mitigation system in place. When the need arises the town has, in the past, sand-bagged the area to protect the wells, which supply eighty percent of the town's annual water supply. Elevating the pumps is needed.
9	Wellesley Avenue	This moderate flooding hazard does not truly threaten homes, but does flood annually at this spot, because there is a low spot in the road that does not drain easily. There is an existing dry well and catch basins along the street also. Installation of an infiltration system has reduced but not eliminated flooding.
10	Red Wing Bay	Flooding at this site relates to the Cochrane Dam and can be quite serious, impacting three to four homes near the intersection of Fisher and South streets. The area is part of an old mill site, and thus sits against the river. The site floods approximately every ten years or so and there is no existing mitigation in place. A suggested course of action would be to

		construct a bypass structure off the side of the dam, allowing flood waters to get around the dam, instead of over it and avoiding the neighborhood in question. However, town staff noted that such a project would likely be cost-prohibitive for the benefit it would provide, and the priority is considered low.
11	Rosemary Street at Rosemary Lake outfall	Although DCR classifies this location as a high hazard dam, the town is working on having the location declassified as a dam. The flooding associated with overtopping this dam is considered to be low severity and low frequency, having occurred twice in the past twenty years. No buildings were flooding as a result of those events. The town has a protocol to lower the lake to prevent flooding. There is a control weir at the top of the dam and maintenance of the exiting dam and roadway are considered to be the best mitigation to keeping the dam from becoming a hazard. There is a low priority on other mitigation for the site.
12	Dedham Avenue at the DPW complex	Flooding here is associated with a manmade retention pond or reservoir that sits on the town owned DPW land. Flooding also occurs when Charles River flooding backs up Alder Brook. Flooding does not affect any homes but can flood Dedham Avenue and affect vehicles in the DPW lots and the building itself, which sits below the reservoir.
13	Wildwood Drive at the Charles River	Contained completely within the floodplain, this neighborhood is simply located in a poor location on the banks of the Charles. Flooding at this site can be moderate to severe and flooding can occur about every ten years. Flooding does not typically impact the homes themselves, but it does impact residential backyards along the northern bank of the Charles. There is no existing mitigation to deter the water, but a coffer dam or sand bag wall could provide relief for the residents. However, since the flooding takes place within the flood plain on private property it is considered a low priority by the town and real mitigation is thought to be cost prohibitive.
14	Winding River Road	This is a moderate severity flood hazard that floods on average once every ten years. According to town officials, drainage from this street flows into the Charles River, but when water levels are elevated, the water from the street cannot release into the river and it backs up into the neighborhood. Town officials would endorse a plan to mitigate the problem, but due to lack of funding Winding River Road has not been proposed because there are higher priorities around town. However, if flooding there were to increase in severity of frequency, it is possible the town could look at a measure to allow the water to be pumped over the river bank, above the water level, in order to alleviate flooding on the street. However, such a measure would likely be too costly at this point, given the benefit it would impart.

16	Carol Road at Great Plain Avenue	Issues at this site are related to the wetlands area surrounding the intersection. When the wetlands surcharge, water backs up into an underground brook on Carol Road. Several homes along Great Plain Avenue can be impacted by backyard flooding. The flooding is considered a low severity flooding and low frequency hazard, as it occurs once every ten years or less. There is a natural drain to the wetlands, which serves as the area's only mitigation and the wetlands area is a designated and legally designed flood storage mechanism.
17	Grosvenor Road	This moderate flood hazard floods every ten years. Flooding occurred here in March 2010. Water does backup to the rear side of residential properties along the north side of the site and it can also flood an area ball field. There is an existing catch basin and a culvert under the commuter railroad tracks. The culvert needs to be enlarged. Recent development of a subdivision has improved drainage.
18	West Street at Rosemary Brook	Flooding here is moderate, with the frequency very low at every 25 years or so. There are no homes downstream of this flooding site, but there is a sewer pump station that could be in jeopardy if left unchecked in a big storm. There is a culvert under West Street that does a good job of handling the needs here in most circumstances. Potential future mitigation could include a larger culvert, if the downstream capacity indicated that such a move was acceptable. However, town officials have said they would need to study downstream capacity first and that this is a low priority.
19	Central Avenue at Rosemary Brook	Issues here are similar to those at West Street. The flooding here can be of a moderate severity, but the frequency is low, occurring only every 25 years or so. Again, officials would want to study the downstream capacity of the brook before expanding any culverts or drainage mechanisms. However, the site would likely remain a low priority to address, since the issues there are not serious or frequent.
24	Edgewater and Dedham Avenue	As with Wildwood Drive, the flooding here is contained mostly within the flood plain and the homes built along the river's edge are in the flood plain and poorly sited. However, the bank here is fairly high, and flooding is said to be moderate and not very frequent, every ten years or so. There is no real mitigation here, and flood waters can reach into backyards. In a truly high rain water event, it would be possible for flooding to reach the homes and cause damage, but since the homes are in the flood plain on the edge of a river, it is not clear what can be done. Some options could include moving utilities out of the basements, or at least off basement floors, and construction of a coffer dam or retention dam to keep flood level waters in the river and off the Priority to undertake mitigation here is considered to be low.

25	Hunnewell Street	Moderate flooding in this neighborhood in the northern section of town is also fairly infrequent, with an occurrence of about every ten years. There are existing catch basins and a culvert, but it appears the capacity of these devices is not large enough. The town designed a larger drainage pipe for the area, with an estimated cost of between $75,000 and $120,000 and identified this project as a high priority. However, the town was not able to obtain the easements needed for the project.
26	Walker	Flooding at this site can be severe, impacting about four homes in the area, every five years. According to town officials, the outfall from Walker Pond needs maintenance and could also use a control structure, such as a small dam with a control weir atop. Such a project is estimated to cost upwards of $250,000 and s considered a moderate priority, because of the repetitive damage to impacted homes.
27	Oxbow Road	This moderate severity flooding hazard is a product of drain water to the Charles River backing up in the surrounding neighborhood. There is an existing drainage pipe, but it is believed to be inadequate. Suggested future mitigation for this site could include expanding the size of the drain pipe, but as with flooding at Winding River (14), elevated water levels in the Charles can also create problems with the drainage flow. Thus, it is not clear how effective an expanded drainage pipe would be when the river waters are high. The area needs more study, and there is no estimated cost or timeline developed for any future mitigation here at this point. It is considered a low priority.

REPETITIVE LOSS STRUCTURES

As defined by FEMA, a repetitive loss property is a NFIP-insured structure that has had two or more paid flood losses of $1,000 or more in any given 10-year period since 1978. There are 5 repetitive loss properties, all single-family homes, in Needham. The properties are shown on the maps in Appendix A. These repetitive loss properties had a total of 15 losses from 1978 to 2018, totaling $57,258 in paid claims. For more information on repetitive losses see https://www.fema.gov/txt/rebuild/repetitive_loss_faqs.txt and https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet.

Table 8 summarizes the number and location of repetitive loss structures located within Needham and the number of losses and total claims associated with them.

Table 10: Summary of Repetitive Losses and Claims

	A, AE, AO, AH Zones	VE Zone	X Zones	Total
Number of Properties	0	0	5	5
Number of Losses	0	0	15	15

Total Claims	0	0	$57,258	$57,258

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

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.

Droughts are projected to increase in frequency and intensity in the summer and fall as weather patterns change. 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.

Five levels of drought have been developed to characterize drought severity: Normal, Advisory, Watch, Warning, and Emergency. These drought levels are based on the conditions of natural resources and are intended to provide information on the current status of water resources. The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions.

Needham does not collect data relative to drought events. Because drought tends to be a regional natural hazard, this plan references state data as the best available data for drought. 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 9).

Table 11: 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

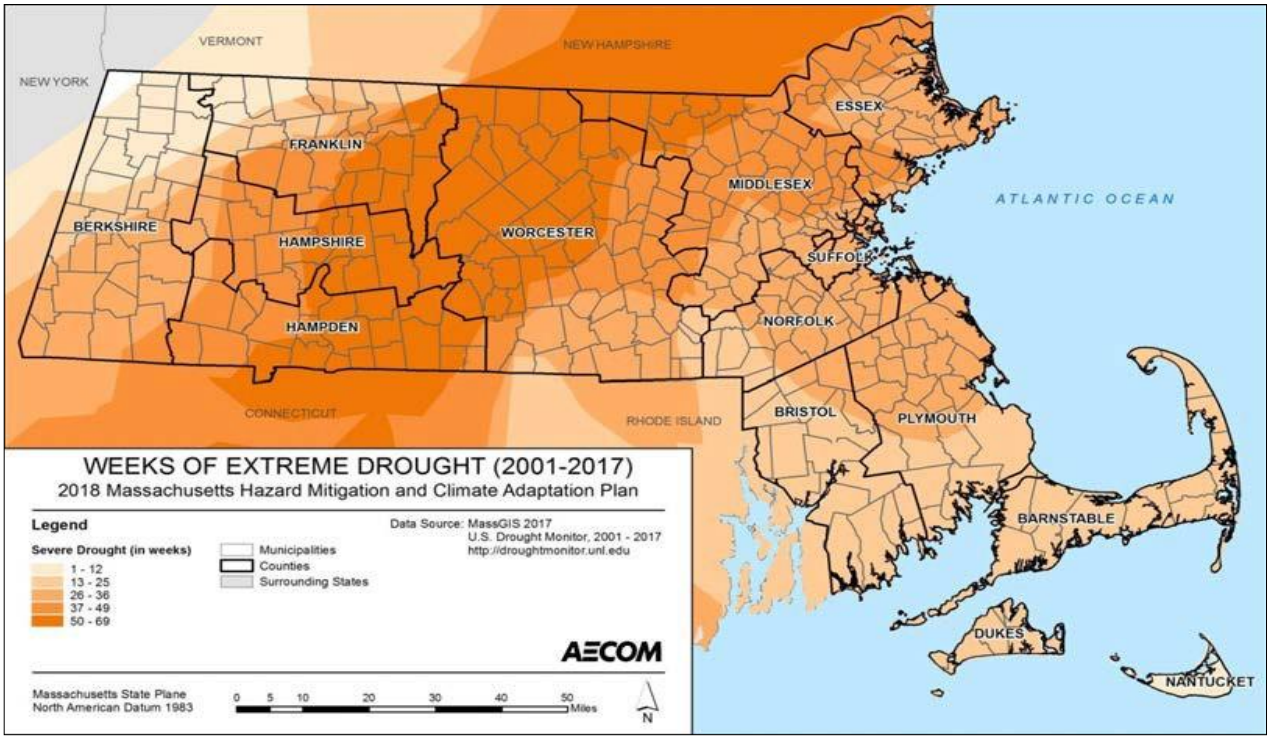
Source: SHMCAP

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. 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 the potential for forest fires.

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 9 below, Needham experienced between 26 and 36 weeks of severe drought between 2001 and 2017. Drought affects Needham's drinking water supply. In the most recent drought town officials note that excessive lawn watering caused the town to exceed permitted well water pumping levels.

Figure 9: Weeks of Severe Drought (2001-2017)



Source: SHMCAP

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. More frequent extreme rain events may increase the chance of landslides as saturated soils are conducive to landslides. Drought may also increase the likelihood of landslides if loss of vegetation decreases soil stability.

The SHMCAP, utilizing 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. 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.

Needham is classified as having low susceptibility and a low incidence of landslides (see Map 4, Appendix B). Should a landslide occur in the future, the type and degree of impacts would be highly localized. The town's vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Needham. There are no recorded instances of landslides having occurred in the Town of Needham.

RISING TEMPERATURES

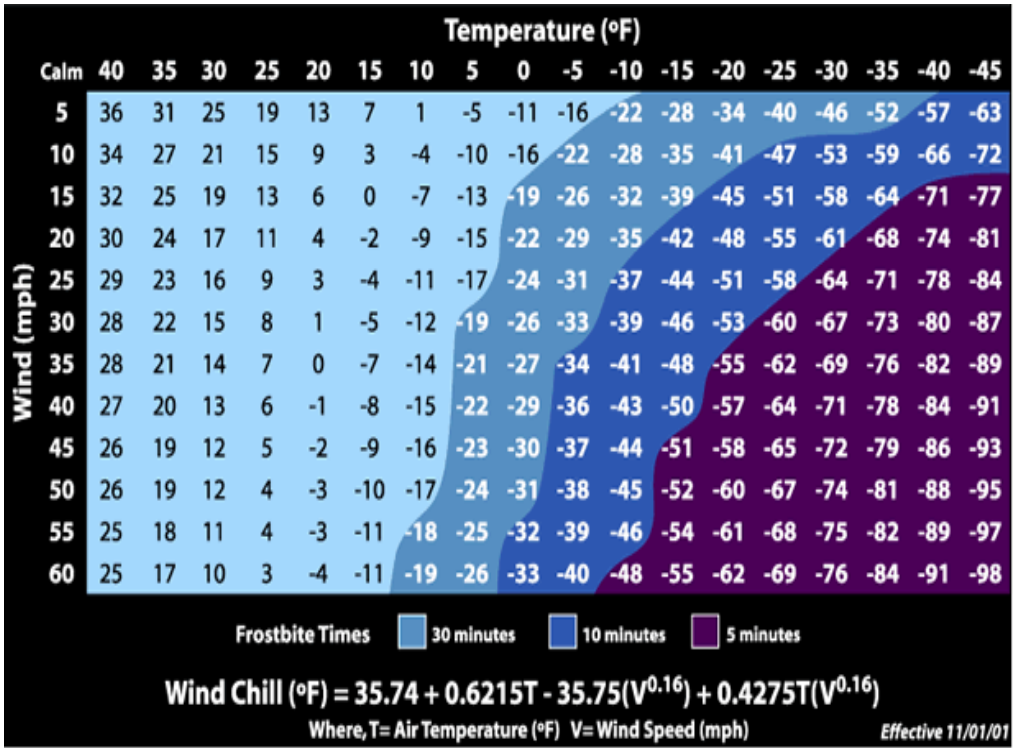
AVERAGE AND EXTREME TEMPERATURES

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 long periods of time where there is a long stretch of excessively hot or cold weather. Needham 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

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 11 below. 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.

Figure 10 Wind Chill Temperature Index and Frostbite Risk



Source: National Weather Service

The Town of Needham does not collect data for previous occurrences of extreme cold. The best available local data are for Norfolk County, through the National Climatic Data Center (NCDC). There have been two extreme cold events in the past ten years, which caused no deaths, no injuries, or property damage. This is an average of one event every 5 years.

Table 12: Norfolk County Extreme Cold and Wind Chill Occurrences 2010-2019

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

Source: NOAA, National Climatic Data Center

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 12) 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 11: 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.

The Town of Needham does not collect data on excessive heat occurrences. The best available local data are for Norfolk County, through the National Climatic Data Center. In the past ten years there has been one excessive heat day and no deaths, injuries, or property damage (see Table 11). This is an average of one extreme heat occurrence every 2.5 years.

Table 13: Norfolk County Extreme Heat Occurrences 2010-2019

Date	Deaths	Injuries	Damage
7/22/2011	0	0	0
7/1/2018	0	0	0
7/3/2018	0	0	0
8/28/2018	0	0	0

Source: NOAA, National Climatic Data Center

Extreme cold events are predicted to decrease in the future, while extreme heat days, as well as average temperatures are projected to increase. The projected increase in extreme heat and heat waves is the source of one of the key health concerns related to climate change. Prolonged exposure to high temperatures can cause heat-related illnesses, such as heat cramps, heat exhaustion, heat stroke, and death. Heat exhaustion is the most common heat-related illness and if untreated, it may progress to heat stroke. People who perform manual labor, particularly those who work outdoors, are at increased risk for heat-related illnesses. Prolonged heat exposure and the poor air quality and high humidity that often accompany heat waves can also exacerbate pre-existing conditions, including respiratory illnesses, cardiovascular disease, and mental illnesses.

Older adults are often at elevated risk due to a high prevalence of pre-existing and chronic conditions. People who live in older housing stock and in housing without air conditioning have increased vulnerability to heat-related illnesses. Power failures are more likely to occur during heat waves, affecting the ability of residents to remain cool during extreme heat. Individuals with pre-existing conditions and those who require electric medical equipment may be at increased risk during a power outage.

Due to what is termed the "heat island effect", 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 B displays areas that are among the hottest 5% of land in the MAPC region based on land surface temperature derived from satellite imagery on July 13, 2016, when the high temperature at Logan Airport was 92°F. The southwest half of Needham has Needham has extensive tree cover and no "hot spots". The business and commercial areas along Route 128 that have extensive pavement, and buildings form a large hot spot. The areas surrounding the Needham Heights and Needham Center commuter rail stations are also hot spots. Many of the schools including Broadmeadow, Newman, Pollard, Walker, St. Sebastian, and the high school are in hot spots, again due to the prevalence of pavement and buildings. It is worth noting however, that heat impacts are more likely to be felt by residents without air conditioning, by those who work outdoors, and those with underlying health conditions.

WILDFIRE

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

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

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 most vegetation is void of any appreciable moisture, making them highly flammable. Once "green-up" takes place in late May to early June, the fire danger usually is reduced somewhat. As the climate warms, drought and warmer temperatures may increase the risk of wildfire as vegetation dries out and becomes more flammable.

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 the wild fire destroys the ground cover, then erosion becomes one of several potential problems.

POTENTIAL BRUSHFIRE HAZARD AREAS

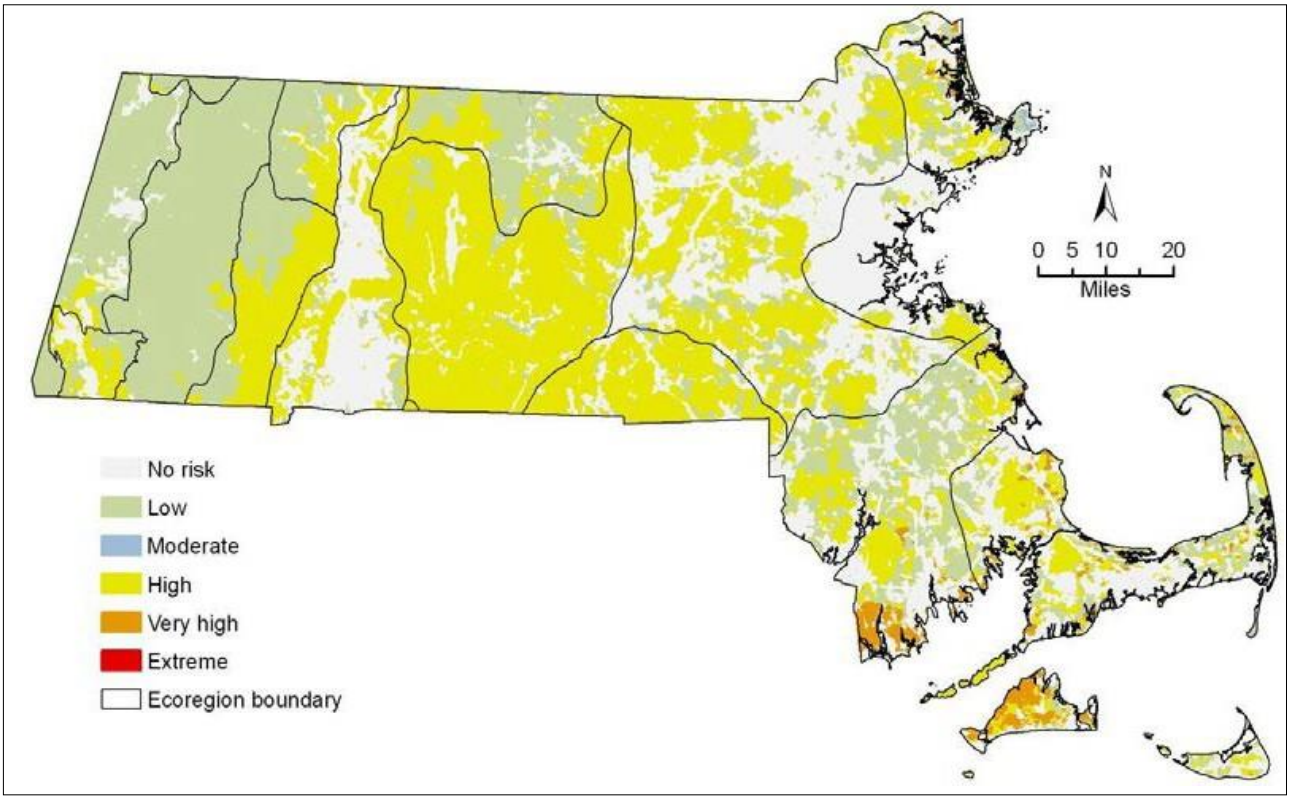
The SCHMCAP includes a graphic that depicts statewide fire risk incorporating three risk components: fuel, wildland-urban interface, and topography (Figure 12). The wildland-urban interface reflects communities where housing and vegetation intermingle, and fire can spread from structures to vegetated areas. The most susceptible fuels are pitch pine, scrub oak and oak forests. Topography can affect the behavior of fires, as fire spreads more easily uphill. Needham is shown in the moderate and high-risk zones. Fire was not identified as a common occurrence, but for some locations concern was expressed that access to forested areas and to adequate water supply could be a challenge. The most common cause of wildfires is the careless disposal of smoking materials and untended campfires.

The following areas of town were identified as having the highest potential for brush fires. The numbers correspond to the numbers on Map 8, "Hazard Areas":

Table 14: Locally Identified Areas of Brushfire Risk

Map ID	Name	Description
1	Cutler Park	There have been both brush and bog fires here in recent years. Both water supply and physical access are problematic. The town has to shuttle in water and use out of town sources for supply.
2	Town Forest	There have been brushfires here. Water supply is a problem. Access is also an issue as the access roads need maintenance.
3	Ridge Hill Reservation	There was a meadow fire here in recent years.
4	Olin College	There have been no recent fires here.
5	New Pond (Hemlock Gorge)	This is DCR property. There is good access.
6	Echo Bridge (aqueduct)	This is DCR property. There is good access.
7	Brookside Road	This is an area of fire concern, both water supply and access are issues.

Figure 12: Wildfire Risk Areas



Source: SHMCAP

While there a substantial areas of fire risk, town officials indicate that significant brush fires are not a common occurrence.

INVASIVE SPECIES

The 2018 SHMCAP includes invasive species as a natural hazard for the first time. They are defined as "non-native species that cause or are likely to cause harm to ecosystems, economies, and/or public health". Town officials indicated that invasives have had a negative effect on the health of forested water supply lands.

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 below 74 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. Since 1900, 39 tropical storms have impacted New England (NESEC).

Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane.

Although uncommon, the Town of Needham's entire area is vulnerable to hurricanes, which occur between June and November. As shown on Map 5 in Appendix B, a tropical storm tracked through Needham in 1944. A hurricane or storm track is the line that delineates the path of the eye of a hurricane or tropical storm. The town also experiences the impacts of the wind and rain from hurricanes and tropical storms regardless of whether the storm track passed through the town. The hazard mapping indicates that the 100-year wind speed in Needham is 110 miles per hour.

Table 15: Hurricane Records for Massachusetts, 1938 to 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

*Category 3
Source: National Oceanic and Atmospheric Administration

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

Table 16: Saffir/Simpson Scale

Scale No. (Category)	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

Hurricanes typically have regional impacts beyond their immediate tracks. Falling trees and branches are a significant problem because they can result in power outages when they fall on power lines or block traffic and emergency routes. Hurricanes are a town-wide hazard in Needham. Potential hurricane damages to Needham have been estimated using HAZUS-MH. Total damages are estimated at $36 million for a Category 2 hurricane and $138 million for a Category 4 hurricane. Hurricanes and tropical storms are an infrequent event having passed directly through Needham only once.

SEVERE WINTER STORM/NOR'EASTER

A northeast storm, known as a nor'easter, is typically a large counterclockwise wind circulation around a low-pressure center. Featuring strong northeasterly winds blowing in from the ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 10 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rain or snow, depending on temperatures. 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.

Needham 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. Nor'easters are also a cause of coastal flooding.

A blizzard is a winter snow storm 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 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.

The National Weather Service defines "heavy snow fall" as an event generating at least four inches of snowfall within a 12-hour period. The Northeast Snowfall Impact Scale (NESIS), developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004), characterizes and ranks high impact northeast snowstorms.

These storms have large areas of 10-inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The NESIS categories are summarized below:

Table 17: NESIS Categories

Category	NESIS	Value Description
1	1 – 2.499	Notable
2	2.5 – 3.99	Significant
3	4 – 5.99	Major
4	6 – 9.99	Crippling
5	10+	Extreme

Source: Massachusetts State Hazard Mitigation Plan, 2013

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. In Needham, blizzards and severe winter storms have occurred in the following years:

Table 18: Severe Weather Major Disaster Declarations in Eastern MA

Storm Event	Date
Severe Winter Storm and Snowstorm	March 2018
Severe Winter Storm, Snowstorm, and Flooding	January 2015
Severe Winter Storm, Snowstorm, and Flooding	February 2013
Hurricane Sandy	October/November 2012
Severe Storm and Snowstorm	October 2011
Tropical Storm Irene	August 2011
Severe Winter Storm and Snowstorm	January 2011
Severe Winter Storm and Flooding	December 2008
Severe Storms and Inland and Coastal Flooding	April 2007
Severe Storm and Flooding	October 2005
Severe Storms & Flooding	March 2001
Blizzard	January 1966
Winter Coastal Storm	December 1992
Severe Coastal Storm	October 1991
Hurricane Bob	August 1991
Hurricane Gloria	September 1985

Coastal Storm, Flood, Ice, Snow	February 1978
Hurricane, floods	August 1955
Hurricanes	September 1954

Source: FEMA

As with hurricanes, warmer ocean water and air will provide more fuel for storms. According to the SHMCAP it appears that Atlantic coast nor'easters are increasing in frequency and intensity.

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

Winter storms are a potential town-wide hazard in Needham. Map 6 in Appendix A indicates that the average annual average snowfall in most of Needham is between 48 and 72 inches. A number of public safety issues can arise during snow storms. 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.

The Town of Needham does not keep local records of winter storms. Data for Norfolk County is the best available data to help understand previous occurrences and impacts of heavy snow events. According to National Climate Data Center (NCDC) records, from 2010 through 2019, western Norfolk County experienced 18 heavy snowfall events, resulting in no injuries, deaths, or property damage (Table 18).

Table 19: Heavy Snow Events and Impacts in Norfolk County, 2010 through 2019

Date	Deaths	Injuries	Property Damage ($)
1/12/2011	0	0	0
1/26/2011	0	0	0
12/29/2012	0	0	5K
2/8/2013	0	0	0
3/7/2013	0	0	0
3/18/2013	0	0	0
12/14/2013	0	0	0

Date	Deaths	Injuries	Property Damage ($)
1/2/2014	0	0	0
1/21/2014	0	0	0
2/5/2014	0	0	0
1/26/2015	0	0	0
2/2/2015	0	0	0
2/8/2015	0	0	0
2/14/2015	0	0	0
1/23/16	0	0	0
2/5/2016	0	0	100K
3/14/2017	0	0	0
11/15/2018	0	0	0
Total	**0**	**0**	**105K**

Source: NOAA, National Climatic Data Center

Heavy snow is considered to be high frequency events based on past occurrences, as there have been 18 events in the past ten years, for an average of almost 2 events each winter. As with nor'easters, warmer ocean water and air will provide more fuel for storms. According to the SHMCAP changing atmospheric patterns favor the development of winter storms.

TORNADO

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 Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. 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 below:

Table 20: Enhanced Fujita Scale

Fujita Scale			Derived		Operational EF Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gust (mph)	EF Number	3-second gust (mph)
0	40 – 72	45 – 78	0	65 – 85	0	65 – 85
1	73 – 112	79 – 117	1	86 – 109	1	86 – 110
2	113 – 157	118 – 161	2	110 – 137	2	111 – 135
3	158 – 207	162 – 209	3	138 – 167	3	136 – 165
4	208 – 260	210 – 261	4	168 – 199	4	166 – 200
5	261– 318	262 – 317	5	200 – 234	5	Over 200

Source: Massachusetts State Hazard Mitigation Plan, 2013

The frequency of tornadoes in eastern Massachusetts is low; on average, there are six tornadoes that touchdown somewhere in the Northeast region every year. The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC). Recent tornado events in Massachusetts were in Springfield in 2011 and in Revere in 2014. The Springfield tornado caused significant damage and resulted in four deaths in June of 2011. The Revere tornado touched down in Chelsea just south of Route 16, moved north into Revere's business district along Broadway, and ended near the intersection of Routes 1 and 60. The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour. Approximately 65 homes had substantial damages and 13 homes and businesses were rendered uninhabitable.

Since 1950, there have been eleven tornadoes in Norfolk County recorded by the Tornado History Project. On August 9, 1972 a tornado crossed through Needham from Great Plain Avenue and Webster Street and northeast into Newton resulting in one fatality and six injuries. There have been one F3 and one F2, and three FI tornados. These eleven tornadoes resulted in a total of one fatality and 23 injuries and $4.1 million in damages, as summarized in Table 22. This an average of one tornado every 6 years.

Table 21: Tornado Records for Norfolk County

Date	Fujita	Fatalities	Injuries	Width	Length	Damage
June 1953	3	0	17	667	28	$500K – 5M
11/21/1956	2	0	0	17	0.1	$500-$5000
8/9/1972	1	1	6	30	4.9	$5K-$50K
9/6/1973	1	0	0	10	1.1	$5K-$50K
7/10/1989	0	0	0	23	0.1	$500-$5000
5/18/1990	0	0	0	10	0.2	$500-$5000
5/18/1990	0	0	0	10	0.2	$500-$5000
6/30/2001	0	0	0	80	0.1	-
8/21/2004	1	0	0	40	6	$1,500,000
5/9/2013	0	0	0	50	0.38	$20,000
06/23/2015	0	0	0	200	0.48	-

Source: The Tornado History Project

Buildings constructed prior to current building codes may be more vulnerable to damages caused by tornadoes. Evacuation of impacted areas may be required on short notice. Sheltering and mass feeding efforts may be required along with debris clearance, search and rescue, and emergency fire and medical services. Key routes may be blocked by downed trees and other debris, and widespread power outages are also typically associated with tornadoes.

Although tornadoes are a potential town-wide hazard in Needham, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Needham would greatly depend on the track of the tornado. Based on the record of previous occurrences since 1956, Tornado events in Needham are a low frequency event as there is only one instance of tornado activity in Needham. According to the SHMCAP, it is possible that severe thunderstorms which can include tornadoes may increase in frequency and intensity. However, scientists have less confidence in the models that seek to project future changes in tornado activity.

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 best available data on previous occurrences of thunderstorms in Needham is for is for Norfolk County through the National Climatic Data Center (NCDC). For the years 2010 through 2019, NCDC records show 30 thunderstorm events in Norfolk County (Table 21). These storms resulted in a total of $307,500 in property damage. There were no injuries or deaths reported. This is an average of 3 events per year.

Table 22: Norfolk County Thunderstorm Events, 2010 to 2019

DATE	MAGNITUDE	DEATHS	INJURIES_DIRECT	PROPERTY DAMAGE
6/6/2010	53	0	0	0
6/20/2010	50	0	0	5,000
6/24/2010	50	0	0	0
8/19/2011	50	0	0	1,000
6/23/2012	50	0	0	25,000
8/10/2012	50	0	0	5,000
8/15/2012	40	0	0	500
6/17/2013	50	0	0	3,000
7/29/2013	50	0	0	20,000
7/3/2014	50	0	0	20,000

7/28/2014	60	0	0	50,000
6/23/2015	50	0	0	5,000
8/4/2015	50	0	0	10,000
8/15/2015	50	0	0	10,000
2/25/2016	50	0	0	15,000
6/7/2016	50	0	0	10,000
7/18/2016	50	0	0	50,000
7/22/2016	50	0	0	50,000
7/23/2016	40	0	0	5,000
8/14/2016	50	0	0	5,000
6/9/2017	45	0	0	1,000
6/13/2017	48	0	0	1,000
6/23/2017	50	0	0	1,000
8/2/2017	50	0	0	2,500
9/6/2017	50	0	0	1,000
7/17/2018	45	0	0	3,000
9/6/2018	50	0	0	1,000
11/3/2018	50	0	0	500
7/17/2019	50	0	0	2,000
7/31/2019	50	0	0	5,000
TOTAL		**0**	**0**	**307,500**

Source: NOAA, National Climatic Data Center

Severe thunderstorms are a town-wide hazard for Needham. The town'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. According to the National Climatic Data Center database several of the thunderstorms had impacts in Needham. On July 29, 2014 a microburst downed trees and powerlines on Country Way and Moseley Avenue. On July 18, 2016 trees and wires were downed on Hoover Street. On July 31, 2019 a tree went down on a house on Greendale Avenue and a tree was downed on a utility pole on Oakcrest Road.

Based on the record of previous occurrences, severe thunderstorms in Needham are high frequency events as this hazard has occurred an average of three times per year in the past ten years. 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.

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. 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:

Table 23: 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
Tea cup	3.00
Grapefruit	4.00
Softball	4.50

While ice pellets and sleet are examples of these, 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 damaging electric lines.

Town-specific data for previous ice storm occurrences are not collected by the Town of Needham. The best available local data is for Norfolk County through the National Climatic Data Center. Norfolk County experienced twelve events from 2010 through 2019, for an average of 1.2 events per year. There is some indication that as winters warm, temperatures may be more likely to produce icing conditions. Indeed, town officials report that road icing conditions have been a problem in recent winters.

Table 24: Norfolk County Hail Events, 2010 through 2019

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE
6/5/2010	1.5	0	0	0
6/20/2010	1	0	0	0
6/1/2011	0.75	0	0	0
6/23/2012	0.88	0	0	0
7/18/2012	0.75	0	0	0
5/21/2013	0.75	0	0	0
9/1/2013	0.75	0	0	0

8/7/2014	0.75	0	0	0
5/12/2015	0.75	0	0	0
6/23/2015	1	0	0	0
8/4/2015	1	0	0	0
6/30/2019	0.75	0	0	0
TOTAL		**0**	**0**	**0**

*Magnitude refers to diameter of hail stones in inches
Source: NOAA, National Climatic Data Center

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 below:

Table 25: Richter Scale and Effects

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

Source: Nevada Seismological Library (NSL), 2005

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2007, 355 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 24.

Table 26: Historical Earthquakes in Massachusetts or Surrounding Area

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

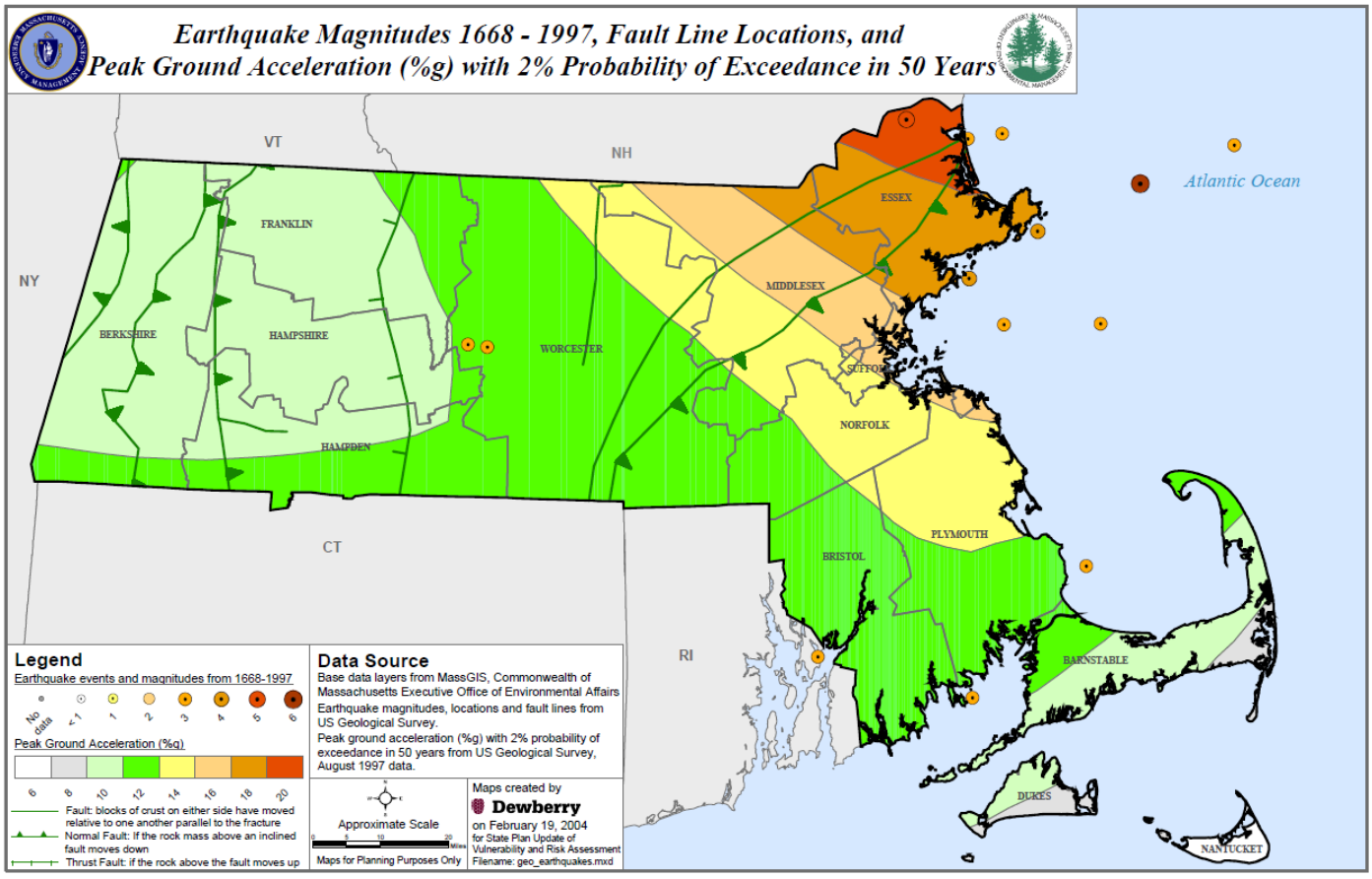
Source: Boston HIRA

One measure of earthquake risk is ground motion, which is measured as maximum peak horizontal acceleration, expressed as a percentage of gravity (%g). The range of peak ground acceleration in Massachusetts is from 10 %g to 20 %g, with a 2% probability of exceedance in 50 years. Needham is in the middle part of the range for Massachusetts, at 14 %g to 16 %g, making it a relatively moderate area of earthquake risk within the state, although the state 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 Needham.

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.

Figure 13: State of Massachusetts Earthquake Probability Map



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.

According the SHMCAP there is a 10-15% chance of a magnitude 5 earthquake in a given ten-year period. Earthquakes are a potential town-wide hazard in Needham. Although new construction under the most recent building codes generally will be built to seismic standards, much of the development in the town pre-dates the most recent building code. Potential earthquake damages to Needham have been estimated using HAZUS-MH. Total building damages are

estimated at $725.5 million for a 5.0 magnitude earthquake and $6.3 billion for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 30.

LAND USE AND DEVELOPMENT TRENDS

Existing Land Use

The most recent land use statistics available from the state are from aerial imagery completed in 2016. Table 28 shows the acreage and percentage of land in 13 categories. If the primary residential categories are aggregated, residential uses make up 47.5% of the area of the town. Commercial and industrial uses combined make up 5.8% of the town. Agriculture, Open Land, and Recreation total 17.7% of the land. The tax-exempt category represents 16.5% of Needham's land. Most of this land is additional open space.

Table 27: Town of Needham, MA 2005 Land Use

Land Use Type	Acres	Percentage
Residential - single family	3496	42.9
Residential - multi-family	207	2.5
Mixed use, primarily residential	174	2.1
Mixed use, primarily commercial	0	0
Commercial	263	3.2
Mixed use, other	5	0.1
Industrial	214	2.6
Agriculture	35	0.4
Open land	1374	16.9
Recreation	30	0.4
Unknown	65	0.8
Right-of-way	937	11.5
Tax exempt	1342	16.5
Total	**8142**	**100.0**

For more information on how the land use statistics were developed and the definitions of the categories, please go to https://docs.digital.mass.gov/dataset/massgis-data-land-use-2005.

Economic Elements

Needham is primarily a suburban residential community. Many residents commute to Boston, which is easily accessible by public transportation. Needham does have several areas of concentrated economic activity. These include commercial and industrial areas located adjacent to Route 128. More development along Route 128 is anticipated in the next five years. Smaller scale commercial businesses are located along Highland Avenue and in close proximity to commuter rail. Not surprisingly, all of these locations are associated with the high heat areas mapped for Needham. Due to traffic congestion along Route 128, residents expressed concern about the need for monitoring evacuation plans and plan for handling hazardous waste.

NATURAL, CULTURAL, AND HISTORICAL RESOURCE AREAS

Needham has two historic districts, the McIntosh Corner and Town Hall Historic District. In addition, there are 18 buildings on the Massachusetts Register of Historic Places. Scenic roads in Needham include Charles River Street, South Street, and Central Avenue between Nehoidan Street and Marked Tree Road. Natural resources include Ridge Hill Reservation and Needham Town Forest. Cutler Park and Hemlock Gorge are DCR properties. The Charles River encircles Needham on three sides and Needham has many ponds, streams, and wetlands areas.

DEVELOPMENT TRENDS

Development trends throughout the metropolitan region are tracked by MassBuilds, MAPC's Development Database, which provides an inventory of new development over the last decade. The database tracks both completed developments and those currently under construction. The database includes seven completed projects in the Town of Needham since 2105

The database also includes several attributes of the new development, including housing units, and commercial space. The seven developments in Needham include a total of 656 housing units and over 700,000 square feet of commercial space.

Table 28: Summary of Needham Developments, 2015-2020

Name	Status	Year	Housing Units	Commercial Square Feet	Project Type
Needham Bank expansion	Complete	2015	0	12,363	Commercial
Wingate	Complete	2016	0	52 rooms	Commercial
Rockwood Estates	Complete	2017	9	0	Residential
Needham Mews	Complete	2018	266	0	Residential
Homewood Suites	Complete	2018	0	31,148	Commercial
Second Avenue Residences	Complete	2019	390	0	Residential
Center 128	Complete	2020	0	740,000	Commercial

POTENTIAL FUTURE DEVELOPMENT

MAPC consulted with the Local Hazard Mitigation Planning Team to determine areas that may be developed in the future, based on the Town's comprehensive planning efforts and current trends and projects. These areas are listed below with their flood and heat risk outlined in Table 27. In order to characterize any change in the town's vulnerability associated with new developments, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map and the hottest 5% of land surface in the MAPC region. Potential future development projects:

A) Boston Children's Hospital: Proposed expansion in Founder's Park. Three additional buildings totaling 450,000 square feet.

B) Hotel: 156 B Street, 180 units and 96,010 square feet
C) 390 Grove Street: two lot subdivision
D) Heather Lane: proposed new subdivision for 6 house lots and5 residential compound lots.
E) 1180 Great Plain Avenue: 40-B proposal for 16 rental units

FUTURE DEVELOPMENT IN HAZARD AREAS

Table 27 shows the relationship between potential future development areas and the applicable mapped hazard areas (flood zones and heat). This information is provided so that planners can ensure that development proposals comply with floodplain zoning and that careful attention is paid to drainage, heat, and other issues.

Table 29: Relationship of Potential Development to Hazard Areas

Map ID	Potential Future Project	Flood Zones	High Heat
A	Boston Children's Hospital		75%
B	Hotel		100%
C	Grove Street Subdivision		
D	Heather Lane Subdivision	32% AE 16% X	
E	Great Plain Ave. 40B		

CRITICAL FACILITIES & INFRASTRUCTURE IN HAZARD AREAS

Critical facilities and infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, communications, and electricity) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). There are 113 facilities identified in Needham. These are listed in Table 28 and are shown on the maps in Appendix B.

Explanation of Columns in Table 28

- ***Column 1: ID #:*** The first column in Table 28 is an ID number which appears on the maps that are part of this plan. See Appendix B.
- ***Column 2: Name****:* The second column is the name of the site.
- ***Column 3: Type*:** The third column indicates what type of site it is.
- ***Column 4: FEMA Flood Zone*:** The fourth column addresses the risk of flooding. A "No" entry in this column means that the site is not within any of the mapped risk zones on the Flood Insurance Rate Maps (FIRM maps). If there is an entry in this column, it indicates the type of flood zone. as follows: **Zone AE** Zones AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by detailed methods. Mandatory flood insurance purchase requirements apply.
- **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** 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. Mandatory flood insurance purchase requirements and floodplain management 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 Area of Flooding*:** The fifth column indicates the risk of flooding in local hazard areas. A "No" entry in this column means that the site is not within any of the mapped flood hazard zones. If there is an entry in this column, it indicates the local hazard area.
- ***Column 6:*** Hot spots indicates areas that are within the 5% of hottest areas in the MAPC region based on satellite data from 2016.
-

Table 30: Critical Facilities and Relationship to Hazard Areas

ID	NAME	TYPE	FEMA FLOOD ZONE	LOCAL ID FLOOD ZONE	HOT SPOT
1	Broadmeadow Elementary School	School	No	No	Yes
2	Eliot School	School	No	No	No
3	Hillside Elementary School	School	No	No	No
4	William Mitchell Elementary School	School	No	No	No

ID	NAME	TYPE	FEMA FLOOD ZONE	LOCAL ID FLOOD ZONE	HOT SPOT
5	Newman Elementary School	School	No	No	No
6	Pollard Middle School	School	No	No	Yes
7	Needham High School	School	No	No	Yes
10	Charles River Assn. for Retarded Citizen	Special Needs	No	No	No
12	St. Joseph Elementary/Middle School	School	No	No	Yes
13	St. Sebastian's High School	School	No	No	No
24	Needham High School Shelter	Shelter	No	No	Yes
31	Riverside Community Care	School	No	No	Yes
36	Walker Home School	School	No	No	No
38	Town Hall	Municipal	No	No	Yes
39	Avery Manor Nursing Home	Nursing Home	No	No	Yes
40	Briarwood Nursing Home	Nursing Home	No	No	No
41	North Hill Retirement Community	Nursing Home	No	No	Yes
43	Wingate Nursing Home	Nursing Home	No	No	No
44	Verizon Telephone Switch Bldg	Communication Tower	No	No	Yes
45	Coca-Cola Bottling Company	Hazardous Material Site	No	No	Yes
46	Verizon	Communication Tower	No	No	No
47	Level III	Hazardous Material Site	No	No	Yes
48	Algonquin Gas Meter Station	Gas Distribution	AH	No	No
50	Kerivan-Lane Petroleum	Hazardous Material Site	X	No	Yes
51	Comcast of Needham Inc.	Hazardous Material Site	No	No	Yes
52	Muzi Motors Inc.	Hazardous Material Site	No	No	Yes
57	Pollard Middle School-Shelter	Shelter	No	No	Yes
58	Emergency Management/Operations Center	Emergency Operations Center	No	No	Yes
59	Beth Israel Deaconess Hospital	Hospital	No	No	No
60	Needham Department of Public Works	Municipal	X	No	No
61	Media Transmission Towers	Communication Tower	No	No	Yes
62	Media Transmission Towers	Communication Tower	No	No	No
63	St. Mary Pump Station	Water Pump Station	No	No	No
65	Water Treatment Plant	Waste Water Treatment	No	Water Treatment Plant	No
66	Needham Fire Department Station#2	Fire Station	No	No	No
67	Needham Fire Dept.	Fire Station	No	No	Yes
68	Needham Police Dept.	Police Station	No	No	Yes
69	Needham Public Library	Municipal	No	No	No
70	Roche Brothers Supermarket	Grocery Store	No	No	No
71	Water Storage Tank Storage #2	Water Storage Tank	No	No	No
72	Water Storage Tank Storage #1	Water Storage Tank	No	No	No
74	Sudbury Farms Supermarket	Grocery Store	No	No	Yes

ID	NAME	TYPE	FEMA FLOOD ZONE	LOCAL ID FLOOD ZONE	HOT SPOT
76	Duke Energy NG Transmission Line PC	Gas Distribution	No	No	No
77	Carter Methodist Church	Church	No	No	No
78	Charles River Industry	Special Needs	No	No	No
79	U.S. Post Office	Post Office	No	No	No
80	U.S. Post Office	Post Office	No	No	Yes
81	St Joseph's Church	Church	No	No	Yes
83	First Baptist Church	Church	No	No	No
84	Presbyterian Church	Church	No	No	No
85	Council on Aging	Senior Services	No	No	Yes
86	Public Services Administration Building	Municipal	X	Edgewater Drive	No
87	Recycling and Transfer Station	Municipal	No	No	No
88	School Administration Building	School	No	No	Yes
89	Monsignor Haddad Middle School	School	No	No	Yes
90	Olin College of Engineering	School	No	No	No
91	YMCA Afterschool	School	No	No	No
92	Needham Community Council/Food Pantry	Social Service	No	No	No
93	Daley Building	Municipal	No	No	No
94	High Rock School	School	No	No	No
95	Sunita Williams School	School	No	Central Avenue at Rosemary Brook	No
96	Rosemary Recreation Complex	Back-up EOC	No	No	No
97	West Street Sewer Pump Station	Sewer Pump	A	West Street at Rosemary Brook	No
98	Dedham Avenue Water Pump Station	Water Station	X	Dedham Ave at DPW complex)	No
99	Avita Memory Care	Nursing Home	No	No	No
100	Wingate of Needham	Nursing Home	No	No	No
101	CareWell Urgent Care	Medical Facility	No	No	Yes
102	Otrada Adult Day Care	Senior Services	No	No	Yes
103	Trader Joe's	Grocery Store	No	No	Yes
104	Volante Farms	Grocery Store	No	No	No
105	First Parish in Needham	Church	No	No	Yes
106	Congregational Church	Church	No	No	No
107	Christ Episcopal Church	Church	No	No	No
108	First Church of Christ Scientist	Church	No	No	No
109	Greendale Ave Worship Center	Church	No	No	No

ID	NAME	TYPE	FEMA FLOOD ZONE	LOCAL ID FLOOD ZONE	HOT SPOT
110	Chestnut Street Animal Hospital	Animal Hospital	No	No	Yes
111	Highland Avenue Animal Hospital	Animal Hospital	No	No	No
112	Stanley Tippett House	Long Term Care	No	No	No
113	Needham Public Housing	Senior Housing	No	No	No
114	Needham Public Housing	Senior Housing	No	No	No
115	Needham Public Housing	Senior Housing	No	No	No
116	Verizon Telephone Switch Building	Hazardous Material Site	No	No	Yes
117	Microwave Development Labs Inc	Hazardous Material Site	No	No	Yes
118	AT&T - MA3438	Hazardous Material Site	AE	No	No
119	Beth Israel Deaconess Hospital	Hazardous Material Site	No	No	No
120	Charles River Water Treatment Facility	Hazardous Material Site	No	Water Treatment Plant (	No
121	Digital 105 Cabot, LLC	Hazardous Material Site	No	No	Yes
122	General Dynamics C4 Systems	Hazardous Material Site	No	No	Yes
123	Needham Nine Owners LLC	Hazardous Material Site	No	No	Yes
124	Needham Oil & Air	Hazardous Material Site	No	No	Yes
125	NSTAR Station 148 & 381	Hazardous Material Site	No	No	No
126	Olin College of Engineering	Hazardous Material Site	No	No	No
127	Recycle and Transfer Station	Hazardous Material Site	No	No	No
128	Celldex	Hazardous Material Site	No	No	Yes
129	Needham Heights	Train Stations	No	No	Yes
130	Needham Center	Train Stations	No	No	Yes
131	Needham Junction	Train Stations	No	No	No
132	Hersey	Train Stations	No	No	No
133	Eversource Electric Substation	Utility	No	No	No
134	Water Pump Station 3	Water Pump Station	No	No	No
135	Sheraton Needham Hotel	Hotel	No	No	Yes
136	Residence Inn by Marriott Boston Needham	Hotel	No	No	Yes
137	Hilton Homewood Suites	Hotel	No	No	Yes
139	Needham CO - LTPF9 (AT&T Services Inc)	Hazardous Material Site	No	No	Yes
139	WBZ Transmitter Site (American Tower)	Hazardous Material Site	No	No	No
140	Great Plain Pump Station	Sewer Pump Station	No	No	No
141	Alden Road Pump Station	Sewer Pump Station	No	No	No
142	Cook's Bridge	Sewer Pump Station	X	No	No
143	Reservoir B	Sewer Pump Station	AE	No	No
144	Reservoir A	Sewer Pump Station	No	No	No
145	Kendrick Street Pump Station	Sewer Pump Station	No	No	No
146	Warren Pump Station	Sewer Pump Station	No	No	No
147	Lake Drive Pump Station	Sewer Pump Station	No	No	No

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.

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 Town of Needham, it does not capture all relevant information. In fact, the HAZUS training manual notes that the default data is "subject to a great deal of uncertainty."

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

ESTIMATED DAMAGES FROM HURRICANES

The HAZUS software was used to model potential damages to the community from a 100-year and 500-year hurricane event; storms that are 1% and 0.2% likely to happen in a given year, and roughly equivalent to a Category 2 and Category 4 hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the 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 31: Estimated Damages from Hurricanes

	Category 2	Category 4
Building Characteristics		
Estimated total number of buildings	10,974	
Estimated total building replacement value (2014 $)	$6,181,000,000	
Building Damages		
# of buildings sustaining minor damage	406	2,000
# of buildings sustaining moderate damage	29	350
# of buildings sustaining severe damage	1	21
# of buildings destroyed	0	11
Population Needs		
# of households displaced	0	9
# of people seeking public shelter	0	5
Debris		
Building debris generated (tons)	1,381	6,898
Tree debris generated (tons)	3,943	9,892
# of truckloads to clear building debris	55	276
Value of Damages		
Total property damage (buildings and content)	$34,835,950	$129,607,190
Total losses due to business interruption	$1,063,630	$8,700,670

ESTIMATED DAMAGES FROM EARTHQUAKES

The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic

center of the study area. For the purposes of this plan, two earthquakes were selected: magnitude 5.0 and a magnitude 7.0. Historically, major earthquakes are rare in New England, though a magnitude 5 event occurred in 1963.

Table 32: Estimated Damages from Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	10,974	
Estimated total building replacement value (2014 $)	$6,181,000,000	
Building Damages		
# of buildings sustaining slight damage	3,211	295
# of buildings sustaining moderate damage	1,741	2,117
# of buildings sustaining extensive damage	485	3,099
# of buildings completely damaged	126	5,433
Population Needs		
# of households displaced	281	5,440
# of people seeking public shelter	151	2,893
Debris		
Building debris generated (tons)	130,000	1,040,000
# of truckloads to clear debris (@ 25 tons/truck)	5,520	41,640
Value of Damages		
Total property damage	$725,541,900	5,526,238,600
Total losses due to business interruption	$151,616,900	$806,267,800

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 33: Estimated Damages from Flooding

	100-Year Flood	500-Year Flood
Building Characteristics		
Estimated total number of buildings	10,974	
Estimated total building replacement value (2014 $)	$6,181,000,000	
Building Damages		
# of buildings sustaining limited damage	50	39

# of buildings sustaining moderate damage	23	51
# of buildings sustaining extensive damage	3	1
# of buildings substantially damaged	4	5
Population Needs		
# of households displaced	349	398
# of people seeking public shelter	115	18
Value of Damages		
Total property damage	$26,730,000	$36,220,000
Total losses due to business interruption	$14,390,000	$53,690,000

SECTION 5: HAZARD MITIGATION GOALS

The Needham Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2009 Hazard Mitigation Plan for the Town of Needham. All of the goals are considered critical for the Town and they are not listed in order of importance. Prior to the Hazard Mitigation Plan update process, the Town of Needham developed a Climate Change Vulnerability Analysis and Action Plan. The local team chose to incorporate climate considerations as noted in Goal 11.

GOAL 1: Ensure that critical infrastructure sites are protected from natural hazards.

GOAL 2: Protect existing residential and business areas from flooding

GOAL 3: Maintain existing mitigation infrastructure in good condition.

GOAL 4: Continue to enforce existing zoning and building regulations.

GOAL 5: Educate the public about zoning and building regulations.

GOAL 6: Work with surrounding communities to ensure regional cooperation and solutions for hazards affecting multiple communities.

GOAL 7: Encourage future development and redevelopment in areas that are not prone to natural hazards.

GOAL 8: Educate the public about natural hazards and mitigation measures.

GOAL 9: Make efficient use of public funds for hazard mitigation.

GOAL 10: Pursue land acquisition strategies.

GOAL 11: Consider the potential impacts of future climate change. Incorporate climate sustainability and resiliency in hazard mitigation planning.

SECTION 6: EXISTING MITIGATION MEASURES

The existing protections in the Town of Needham 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. 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. Needham's adoption of a stormwater utility will contribute significantly to efforts to address stormwater flooding.

The Town's existing mitigation measures, which were in place prior to the original 2005 Plan, are listed by hazard type here and are summarized in Table 32 below. Many upgrades to existing measures are noted in the following sections.

EXISTING MULTI-HAZARD MITIGATION MEASURES

Multi-Department Review of Developments – Multiple departments, such as Planning, Zoning, Health, Public Works, Fire, Police, and Conservation review all subdivisions and site plans prior to approval.

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. The CEMP is available online through secure access for town personnel.

Enforcement of the State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads.

Local Emergency Management Planning Committee (LEPC) – The LEPC consists of representatives from Public Works, Fire, Police, Health, School, Town Manager, Transportation, Board of Selectmen, Emergency Management, and local businesses.

Emergency Preparedness public education is available on the town's website.

The town has a reverse 911 system and names can be added to the database via the town's website.

The Needham High School is the designated community shelter site.

The town has a Citizen Emergency Response Team (CERT) that provides training, supplies, and public education to neighborhoods.

The town also has a volunteer Medical Reserve Corps, that could be activated in times of emergency to provide medical care/vaccinations to large numbers of people.

The town works with the Council on Aging to help provide shelter to the elderly during extreme heat.

EXISTING TOWN-WIDE MITIGATION FOR FLOOD-RELATED HAZARDS

Needham employs a number of practices to help minimize potential flooding and impacts from flooding, and to maintain existing drainage infrastructure. Existing town-wide mitigation measures include the following:

Participation in the National Flood Insurance Program (NFIP) – Needham participates in the NFIP with 240 policies in force as of the August 30, 2019. FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at https://www.fema.gov/policy-claim-statistics-flood-insurance.

The following information is provided for the Town of Needham:

Flood insurance policies in force (September 30, 2018)	149
Coverage amount of flood insurance policies	$44,782,100
Premiums paid	$296,268
Closed losses (losses that have been paid)	102
Substantial Damage Claims since 1978	7
Total payments (total amount paid on losses)	$1,363,146

The Town complies with the NFIP by enforcing floodplain regulations, maintaining up-to-date floodplain maps, and providing information to property owners and builders regarding floodplains and building requirements.

Engineering staff developing a Drainage System Inventory and integrating the data into the Town's Geographical Information System (GIS).

Catch basins on public roads and property are cleaned annually. Street sweeping also occurs on an annual basis.

The Public Works Department provides maintenance to culverts, drainage pipes, and other drainage infrastructure on an as-needed basis. Drainage maintenance activities are coordinated with the state Department of Environmental Protection and Massachusetts Water Resources Authority.

The Town mitigates for beavers on a case-by-case basis. The town will use a trapper as necessary if there is an immediate threat and is a public health issue. A permit to do so is required by state law through the local Board of Health. In some instances, pond levels will be lowered in anticipation of potential flooding.

Needham's Zoning has a Flood Plain Protection District that restricts certain activities and requires a special permit for activities located within a flood zone.

Needham's Zoning has a Wetlands Protection Regulation, intended to protect wetland resource areas, and minimize flooding.

The Massachusetts Stormwater Policy is applied to developments within the jurisdiction of the Conservation Commission.

The Town's subdivision regulations have general language about avoiding impacts to flood plains and minimizing drainage issues. Peak flows and runoff from the property cannot be greater than pre-development rates. Drainage requirements for Site Plans are also general and require post-development rates to meet pre-development runoff rates.

Open Space Residential Developments are allowed under Needham's Zoning.

The Town's Zoning also has an Aquifer Protection District to protect its drinking water supplies.

Needham has substantial protected open space and proactive land acquisition and preservation programs, including:

- The town's draft Open Space Plan and Community Preservation Plan are comprehensive and identify key parcels for purchase or protection.
- Low-lying wetland areas provide significant flood storage for the town's rivers.
- Flood plain has been preserved and is effective at minimizing flooding.

The town continues to implement its NPDES Phase II stormwater program which includes public education programs.

EXISTING DAM FAILURE MITIGATION MEASURES

DCR dam safety regulations – All dams are subject to the Division of Conservation and Recreation's dam safety regulations. The dams must be inspected regularly, and reports filed with the DCR Office of Dam Safety.

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

EXISTING TOWN-WIDE MITIGATION FOR WIND-RELATED HAZARDS

The Public Works Department has an effective tree trimming in public areas and along Rights-of-Ways. They have a multi-year plan trimming program (approximately a 3-year cycle) to go over their whole system.

New developments must install buried utilities.

EXISTING TOWN-WIDE MITIGATION FOR WINTER-RELATED HAZARDS

The Public Works Department provides standard snow plowing operations, including salting and sanding, but with a restricted salt policy.

Overnight parking bans are in effect year-round.

Public Education - Winter Maintenance information is available on the town website

The town has a Snow and Ice Disposal bylaw that states no person shall put any snow or ice in any public place or upon any part of a public street or sidewalk.

The Town provides public education to residents regarding roof collapses due to snow when conditions are dangerous. In addition, new codes are more stringent to better guard against roof collapses.

The town has sufficient snow storage .

EXISTING TOWN-WIDE MITIGATION FOR FIRE-RELATED HAZARDS

Town bylaws allow controlled open burning in accordance with state regulations, but a permit is required from the Fire Chief for each day of intended burning.

The Fire department reviews all subdivision and site plans for compliance with site access, water supply needs, and all other applicable regulations.

The Fire Department is trained and has experience in protecting the open lands in town, as well as wooded areas associated with Olin College or other private institutions.

The town provides public education and notices during "drought watches."

EXISTING TOWN-WIDE MITIGATION FOR EARTHQUAKE HAZARDS

The town has shelters and backup facilities.

The Needham Water Department is proactive in being able to isolate portions of the water system and identify alternative firefighting water supply sources.

The town does have an evacuation plan as specified in its Comprehensive Emergency Management Plan (CEMP).

EXISTING TOWN-WIDE MITIGATION FOR LANDSLIDE HAZARDS

The subdivision regulations do have maximum slope requirements for new roads.

The town has an earth removal bylaw.

COMPILATION OF EXISTING MITIGATION

Table 32 summarizes the many existing natural hazard mitigation measures already in place in Needham when the first Hazard Mitigation Plan was developed in 2009. Because of the number of entities, public and private, involved in natural hazard mitigation, it is likely that this list is a starting point for a more comprehensive inventory of all measures.

Table 34: Existing Natural Hazard Mitigation Measures in Needham

Type of Existing Mitigation Measures	Effectiveness	Improvements/ Changes Needed
MULTIPLE HAZARDS		
Multi-department review of developments	Yes	
Comprehensive Emergency Management Plan (CEMP)	Yes	
Enforcement of State Building Code	Yes	
Local Emergency Planning Committee (LEPC)	Yes	
Emergency Preparedness public education on the town website	Yes	Expanded to social media
Reverse 911	Yes	
Needham High is community shelter	Yes	Back-up sites as well
Citizen Emergency Response Team	Yes	CERT and MRC are combined
Medical Reserve Corps	Yes	
Sheltering for elderly during extreme heat	Yes	Shelter available to all

FLOOD HAZARDS		
Participation in the National Flood Insurance Program	Yes	
Stormwater system mapped in GIS	Yes	
Annual catch basin cleaning and annual street sweeping	Yes	
Drainage system maintenance is performed as needed, and under a general maintenance permit issued by the Conservation Commission	Yes	
Long-term stormwater plan and funding, and ongoing system improvements	Yes	
Beaver mitigation	Yes	
Flood Plain Conservancy District	Yes	
Wetlands Protection Bylaw and Regulations	Yes	
Massachusetts Stormwater Policy	Yes	
Stormwater Requirements in Subdivision Regulations and Site Plan Review	Yes	
Open Space Residential Developments allowed	Yes	
Aquifer Protection Overlay District	Yes	
Protected open space and proactive land preservation programs	Yes	
Public Education on stormwater through the NPDES Phase II program	Yes	
WIND HAZARDS		
DPW tree maintenance program	Yes	
Requirement for new developments to install underground utilities	Yes	
WINTER HAZARDS		
Overnight parking ban year-round.	Yes	
Standard snow operations, restricted salt	Yes	
Public Education on snow operations and winter maintenance is planned for town website	Yes	
Snow and Ice Removal Bylaw	Yes	
Sufficient space for municipal snow storage	Yes	
GEOLOGIC HAZARDS (EARTHQUAKE AND LANDSLIDE)		
Evacuation plan in CEMP	Yes	
Shelters and backup facilities available	Yes	
Water Department able to isolate portion of the water system and identify alternate firefighting supply sources	Yes	
Maximum slopes for subdivision roads	Yes	
Earth Removal Bylaw in the Aquifer Protection District	Yes	
FIRE HAZARDS		
Open Burn Permits Required	Yes	

Fire Department Development Review	Yes	
Fire Department provides public education on its website	Yes	Expanded to social media
Fire Department is trained for protecting open space	Yes	
Town provides public education on drought watches	Not currently	
DAMS		
DCR Dam Safety Regulations	Yes	
Construction permits required	Yes	

MITIGATION CAPABILITIES AND LOCAL CAPACITY FOR IMPLEMENTATION

Under the Massachusetts system of "Home Rule," the Town of Needham is authorized to adopt and from time to time amend local bylaws and regulations that support the town's capabilities to mitigate natural hazards. These include Zoning Bylaws, Subdivision and Site Plan Review Regulations, Wetlands Bylaws, Health Regulations, Public Works regulations, and local enforcement of the State Building Code. Local Bylaws may be amended by the Select Board to improve the town's capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission.

The Town of Needham has recognized several existing mitigation measures that require implementation or improvements and has the capacity within its local boards and departments to address these.

SECTION 7: MITIGATION MEASURES FROM PREVIOUS PLAN

IMPLEMENTATION PROGRESS ON THE PREVIOUS PLAN

At a meeting of the Needham Hazard Mitigation Planning Committee, Town staff reviewed the mitigation measures identified in the 2009 Needham Hazard Mitigation Plan and determined whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into this Hazard Mitigation Plan 2020 Update. The decision on whether to delete or retain a particular measure was based on the committee'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 Town to take action on the measure. Table 33 summarizes the status of mitigation measures from the 2009 plan.

Table 35: Mitigation Measures from the 2009 Plan

Mitigation Action	Priority in 2012 plan	Current Status	Include in 2020 plan?
Upgrade existing sewer/storm water drainage systems in affected areas	High	Considerable work has done to reduce infiltration. The town is now moving focus to inflow. In the interim, bypass protocols are in place.	Yes
Establish ability to have a portable generator for the town	High	2 large portable generators were purchased, the new Police and Fire building will have generators installed. Several sewer pumps have generators (as well as capacity to bypass in case of malfunction). Still need a permanent generator for the Senior Center, and sewer pump stations as they are upgraded.	Yes
Upgrades to culvert and drainage on Hunnewell Street	High	The town was not able to proceed with the project because it was unable to get needed easements from residents.	Yes
Build a Control Structure and Weir at Walker Pond	Medium	This project is complete although ongoing maintenance is needed.	No
Maintenance and Monitoring of Main Bridges	Medium	Maintenance and monitoring is a required and ongoing activity. Many of the bridges have been rebuilt or upgraded. The Central Avenue bridge to Dover is in need of evaluation and work.	Yes
Update Hazardous	Medium	The plan has been revised and updated.	No

Mitigation Action	Priority in 2012 plan	Current Status	Include in 2020 plan?
Materials Response Plan			
Assessment of Historic Structure Natural Hazard Vulnerability	Medium	This was not completed. It is not currently a town priority.	No
Identify Potential back-up sites for Emergency Operations	Medium	This task is complete.	No
Continuation of Open Space Protection and Land Acquisition	Not rated	This is an ongoing priority. The town makes $1.5 million available each year as a placeholder should priority property become available for purchase.	Yes
Regulatory Revisions for Stormwater Management	Not rated	The town has a residential stormwater bylaw and follows federal NPDES requirements. The next step is to develop regulations for the bylaw. Town bylaw requires dry wells to capture roof and driveway runoff. The Planning Board supports Low Impact Development.	Yes
Maintenance of Existing Infrastructure	Not rated	This is complete. The town has a comprehensive stormwater maintenance plan. This is a federal requirement under NPDES.	No
Assessment of Municipal Structures for Susceptibly to Snow Loads	Low	This is not complete. The town shovels building with flat roofs as needed. This is not a current concern.	No

As indicated in Table 33, Needham made good progress implementing mitigation measures identified in the 2009 Hazard Mitigation Plan. Considerable work has been done to address sewer infiltration. The Town developed a comprehensive stormwater maintenance plan and adopted a new stormwater bylaw. Also completed was a hazardous materials management plan. Back up emergency operation are in place; open space purchases have been completed. Generators were purchase and the weir and control structure at Walker Pond were completed.

Several projects that were not completed will be continued into this plan update. While much work was done on area bridges, the Central Avenue bridge needs to be assessed and additional generators are needed in a few key locations. There are a number of measures for which the

Town does regular or periodic work, but they remain ongoing priorities. These include open space purchases and managing sewer infiltration and inflow.

Overall, six mitigation measures from the 2009 plan will be continued in the plan update. Most retain the same priority in this 2020 Update. Moving forward into the next five year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town's decision-making processes. The challenges the Town faces in implementing these measures are primarily due to limited funding and available staff time. This plan should help the Town prioritize the best use of its limited resources for enhanced mitigation of natural hazards.

SECTION 8: HAZARD MITIGATION STRATEGY

WHAT IS HAZARD MITIGATION?

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects and other activities. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Pre-Disaster Mitigation program (PDM), 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/pre-disaster-mitigation-grant-program
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)

REGIONAL AND INTER-COMMUNITY CONSIDERATIONS

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

REGIONAL PARTNERS

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

Following, is a brief overview of regional facilities found in Needham and a discussion of inter-municipal issues.

OVERVIEW OF REGIONAL FACILITIES WITHIN NEEDHAM

Major facilities owned, operated and maintained by state or regional entities include:

- State Routes 128 and 135 (MassDOT)
- MBTA Needham Commuter Rail Line (MBTA)
- Cutler Park and Hemlock Gorge (Mass DCR)
- Charles River Natural Valley Storage Area – includes land in Needham owned by the Army Corps of Engineers for flood control purposes

INTER-COMMUNITY CONSIDERATIONS

Mitigation measures for the following regional issues should be taken into account as Needham develops its own local plan:

A) <u>Coordinate and Review Developments on a Regional Basis</u>
As Needham and the surrounding communities are undergoing development, it is vital that these communities communicate and provide input during the review processes. When addressing housing, transportation, and economic development projects, the impacts to neighbors must be addressed.

B) Charles River Watershed

Needham and the cities and towns within the Charles River watershed participate in an extensive, on-going effort to improve water quality in the Charles River.

NEW DEVELOPMENT AND INFRASTRUCTURE

As part of the process of developing recommendations for new mitigation measures for this plan update, the Town considered the issues related to new development, redevelopment, and infrastructure needs in order limit future risks. Taking into consideration the Wetlands Act and bylaw enforced by the Conservation Commission and the recent adoption of a Stormwater Bylaw, the town determined that existing regulatory measures are taking good advantage of local Home Rule land use regulatory authority to minimize natural hazard impacts of development. Priorities for the future include adoption of stormwater regulations.

PROCESS FOR SETTING PRIORITIES FOR MITIGATION MEASURES

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

Priority setting was based on local knowledge of the hazard areas, including impacts of hazard events, the extent of the area impacted, and the relation of a given mitigation measure to the Town's goals. In addition, the local Hazard Mitigation Planning Team 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 any environmental constraints existed, and whether the Town would be able to justify the costs relative to the anticipated benefits.

Table 34 below demonstrates the prioritization of the Town's potential hazard mitigation measures. For each mitigation measure, the geographic extent of the potential benefiting area is identified as is an estimate of the overall benefit and cost of the measures. The benefits, costs, and overall priority were evaluated in terms of:

Estimated Benefits	
High	Action will result in a significant reduction of hazard risk to people and/or property from a hazard event
Medium	Action will likely result in a moderate reduction of hazard risk to people and/or property from a hazard event
Low	Action will result in a low reduction of hazard risk to people and/or property from a hazard event

Estimated Costs	
High	Estimated costs greater than $100,000
Medium	Estimated costs between $10,000 to $100,000
Low	Estimated costs less than $10,000 and/or 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

INTRODUCTION TO MITIGATION MEASURES TABLE

Description of the Mitigation Measure – The description of each mitigation measure is brief and cost information is given only if cost data were already available from the community. The cost data represent a point in time and would need to be adjusted for inflation and for any changes or refinements in the design of a particular mitigation measure.

Priority – As described above and summarized in Table 35, the designation of high, medium, or low priority was done considering potential benefits and estimated project costs, as well as other factors in the STAPLEE (Social, Technical, Administrative, Legal, Economic, and Environmental) analysis.

Implementation Responsibility – The designation of implementation responsibility was done 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.

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 team 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 https://www.mass.gov/hazard-mitigation-assistance-grant-programs describes the various Hazard Mitigation Assistance Program.

Table 36: Mitigation Measures Prioritization

Climate Change	ACTION	GEOGRAPHIC COVERAGE	LEAD	TIME FRAME	EST. BENEFIT	EST. COST	FUNDING SOURCE	PRIORITY
Changes in Precipitation 	Inland Flooding							
	Address sewer inflow	Site-specific	Public Works	On-going	High	High	Dept	High
	Upgrade culvert and drainage at Hunnewell Street	Site-specific	Public Works	2025	High	High	TM	Medium
	Monitor the condition of the Central Avenue bridge to Dover	Site-specific	Public Works	2021	Medium	High	Dept	Low
	Develop regulations for the recently adopted Stormwater Bylaw	Town-wide	Public Works Conservation	2021	High	Low	Depts	Medium
	Continue Open Space Protection and Land Acquisition	Site-specific	Conservation	On-going	Medium	High	CPA, TM	Medium
	Analyze flood risks of a 500-year storm to the Charles River well heads.	Site-specific	Public Works	2023	High	High	TM	High
	Drought							
	Promote drought tolerant landscaping/site design	Town wide	Planning Conservation	2021	High	Low	Dept	Medium
	Implement drought tolerant landscaping on town properties	Site-specific	PPBC Public Works	On-going	High	Low	Dept	Medium
	Advance permaculture to improve water quality and quantity	Site-specific	Public Works Conservation	On-going	High	Medium	Depts	Medium
	Landslide							
	Identify areas of potential landslide risk	Town-wide	Public Works	2025	Low	Low	Dept	Low
Rising Temperatures 	Extreme Heat and Heat Waves							
	Purchase a generator for the library	Site-specific	Bldg. Maint.	2024	Low	High	Grant, Capital	Medium
	Investigate the feasibility of solar canopies at town sites.	Site-specific	Bldg. Const.	2021	High	Low	Dept	High
	Develop a tree removal mitigation program	Town-wide	Planning	2022	Medium	Low	Dept	Medium

	ACTION	GEOGRAPHIC COVERAGE	LEAD	TIME FRAME	EST. BENEFIT	EST. COST	FUNDING SOURCE	PRIORITY
	Wildfires							
	Provide public education on fire risk	Town-wide	Fire	On-going	High	Low	Dept	High
	Map forest access roads. Maintain adequate access.	Site-specific	Public Works	On-going	High	Medium	Dept	Medium
	Invasive species							
	Develop forestry management plan for treatment plant property	Site-specific	Public Works	2024	Medium High	High	Capital	Medium
Extreme Weather	Hurricanes and Tropical storms (see Multihazards)							
	Severe Winter Storm/Nor'easter							
	Develop brining capacity	Town-wide	Public Works	2022	High	Medium	Capital	Medium
	Tornadoes (see Multihazards)							
	Other Severe weather (wind, thunderstorms) (see Multihazards)							
Multihazards	Multihazards							
	Address generator needs	Site-specific	Public Works	2024	High	High	Capital	Medium
Non-Climate Hazard	Earthquake							
	Assess retrofit or replacement costs of older town buildings	Site-specific	Public Works	2025	Low	Low	Dept	Low

DESCRIPTION OF MITIGATION MEASURES

Changes in Precipitation

Inland Flooding

Address sewer inflow: Considerable work has done to reduce infiltration. While that work continues, the Town is now moving focus to inflow. In the interim, bypass protocols are in place. Locations of focus include Warren and Grant Streets, and the Oak Street area.

Upgrade to Culvert and Drainage at Hunnewell Street: The Town completed plans for the project but was not able to proceed with the project because it was unable to obtain needed easements from residents. Moving forward with this project will most likely require revisiting the issue of easements.

Monitor the condition of the Central Avenue bridge to Dover: This would need to be a joint project with the Town of Dover. The approach to the bridge, the narrow passage, and the wooden railings are all safety concerns. The Town has secured funding to monitor shifting of stones in the bridge to assess the urgency of action.

Develop regulations for the recently adopted Stormwater Bylaw: The Town developed draft regulations. The next step will be to make revisions in response to the feedback received.

Continue Open Space Protection and Land Acquisition: This is an ongoing priority. The Town makes $1.5 million available each year as a placeholder should priority property become available for purchase

Analyze flood risks of a 500-year storm to the Charles River well heads: Flooding in 1987 was problematic. Sand bagging has been required in the past. The wellheads and the roadways to access the pumps are both subject to flooding.

Drought

Promote drought-tolerant landscaping/site design: Drought conditions have strained water supply in recent years. A particular issue has been summer usage to maintain lawns.

Implement drought-tolerant landscaping on town properties: Implement landscaping projects and highlight the efforts, in order to promote adoption of practices by residents.

Advance permaculture to improve water quality and groundwater levels: The Town is working on a project in the Walker Pond watershed to improve soil quality for water retention and infiltration. Residents will be encouraged to adopt highlighted practices. The Town will seek to expand the project to other sub watersheds upon completion of the Walker Pond demonstration project.

Landslide

Identify areas of potential landslide risk: The town has no recorded history of landslides but will evaluate where the potential for landslide may exist.

Rising Temperatures

Extreme Heat and Heatwaves

Purchase a generator for the library: A generator for the library is a priority as the library serves as a cooling center.

Investigate the feasibility of solar canopies at town sites: The canopies generate clean energy, and with battery storage, could provide for energy resilience in the event of power outages. The Town is currently investigating several locations for a project.

Develop a tree removal mitigation program: Develop a bylaw to ensure replacement of trees that are removed.

Wildfires

Provide public education on fire risk: Address illegal burning and fire risks.

Map forest access roads. Maintain adequate access: Utilize GIS to map the forest access roads. Develop and implement plan to assure maintenance of adequate access.

Invasive species

Develop forestry management plan for treatment plant property: The 70-acre property has significant dead wood. Invasives have contributed to the poor condition of the forest. Develop a plan to determine the best strategies to address the dead wood and improve and maintain the health of the forested land.

Extreme Weather

Hurricanes/Tropical storms: see Multihazards

Severe Winter Storm/Nor'easter

Develop brining capacity: The Town has experienced more frequent icing conditions. The use of brine melts ice more quickly and can reduce the need for salt application. The Town will investigate purchase of equipment for brining or fabrication of a system.

Tornadoes: see Multihazards

Other Severe Weather: see Multihazards

Multihazards

Address generator needs: Install a permanent generator at the Senior Center at the Heights. Install generators at the sewer pump stations as they are upgraded.

Non-Climate Hazard

Earthquake

Assess retrofit or replacement costs of older town buildings: Consider condition of older town buildings that predate Building Code seismic requirements.

SECTION 9: PLAN ADOPTION & MAINTENANCE

PLAN ADOPTION

The Needham Hazard Mitigation Plan 2020 Update was adopted by the Select Board on *[ADD DATE]*. See Appendix D for documentation. The plan was approved by FEMA on [*ADD DATE*] for a five-year period that will expire on [*ADD DATE*].

PLAN MAINTENANCE

MAPC worked with the Norwell 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. A member of the Town staff will be designated as the team coordinator. Additional members could be added to the local team from businesses, non-profits, and institutions. The Town 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 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.

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

Begin to Prepare for the next Plan Update – FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the Town's approved plan status and its eligibility for FEMA mitigation grants. Given the lead time needed to secure funding and conduct the planning process, the Hazard Mitigation Implementation Team will begin to prepare for an update of the plan in year three. This will help the Town avoid a lapse in its approved plan status and grant eligibility when the current plan expires.

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

Prepare and Adopt an Updated Local Hazard Mitigation Plan – Once the resources have been secured to update the plan, the Hazard Mitigation Team may decide to undertake the update themselves, contract with the Metropolitan Area Planning Council to update the plan or to hire another consultant. However, the Hazard Mitigation Implementation Team decides to update the

plan, the Town 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 Town will submit it to MEMA and FEMA for review and approval and adopt the plan update in order to obtain formal FEMA approval of the plan.

INTEGRATION OF THE PLANS WITH OTHER PLANNING INITIATIVES

Upon approval of the Needham Hazard Mitigation Plan 2020 Update by FEMA, 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. At a minimum, the plan will be reviewed and discussed with the following departments:

- Fire/Emergency Management
- Police
- Public Works
- Planning
- Council on Aging
- Building Department
- Conservation

Other groups that will be coordinated with include large institutions, Chambers of Commerce, land conservation organizations and watershed groups. The plan will also be posted on the Town's website with the caveat that a local team coordinator will review the plan for sensitive information that would be inappropriate for public posting. The posting of the plan on the website will include a mechanism for citizen feedback such as an e-mail address to send comments.

The Hazard Mitigation Plan will be integrated into other town plans and policies as they are updated and renewed, including the Open Space and Recreation Plan, Comprehensive Emergency Management Plan, Master Plan, and Capital Plan.

SECTION 10: LIST OF REFERENCES

Town of Needham General By-Laws

Zoning By-Law of the Town of Needham

Town of Needham Community Resilience Building Workshop Summary of Findings 2020

Town of Needham Draft Open Space and Recreation Plan 2017

Blue Hill Observatory

FEMA, Flood Insurance Rate Maps for Norfolk County, MA, 2012

FEMA, Hazards U.S. Multi-Hazard

FEMA, Local Mitigation Plan Review Guide, October 2011

Fourth National Climate Assessment, 2018

Massachusetts Flood Hazard Management Program

Massachusetts Office of Coastal Zone Management Shoreline Change Data

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

Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data

National Weather Service

Nevada Seismological Library

New England Seismic Network, Boston College Weston Observatory, http://aki.bc.edu/index.htm

NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/

Northeast Climate Adaptation Science Center

Northeast States Emergency Consortium, http://www.nesec.org/

Tornado History Project

US Census, 2010 and American Community Survey 2017 5-Year Estimates

USGS, National Water Information System, http://nwis.waterdata.usgs.gov/usa/nwis

APPENDIX A: MEETING AGENDAS

Needham Municipal Vulnerability Preparedness (MVP) Hazard Mitigation Plan (HMP) Team Meeting

November 13, 2019

Public Service Administration Building

1. Welcome and Introductions
2. Overview and Purpose MVP and HMP projects
3. The role of this committee
4. MVP: a little more detail on the workshop
5. Set Date and Location of MVP Workshop
6. Discussion of Workshop Invitees
7. HMP: Update hazard areas, critical infrastructure, new development sites
8. Next steps

Needham Municipal Vulnerability Preparedness/ Hazard Mitigation Plan

Team Meeting
December 10, 2019
10:00-12:00
Charles River Room

MVP: Workshop – Friday, January 10, 9:30 to 3:30

1. Check in on invitations, logistics
2. Review the workshop agenda
3. Review the workshop posters
4. Identify the top four hazards

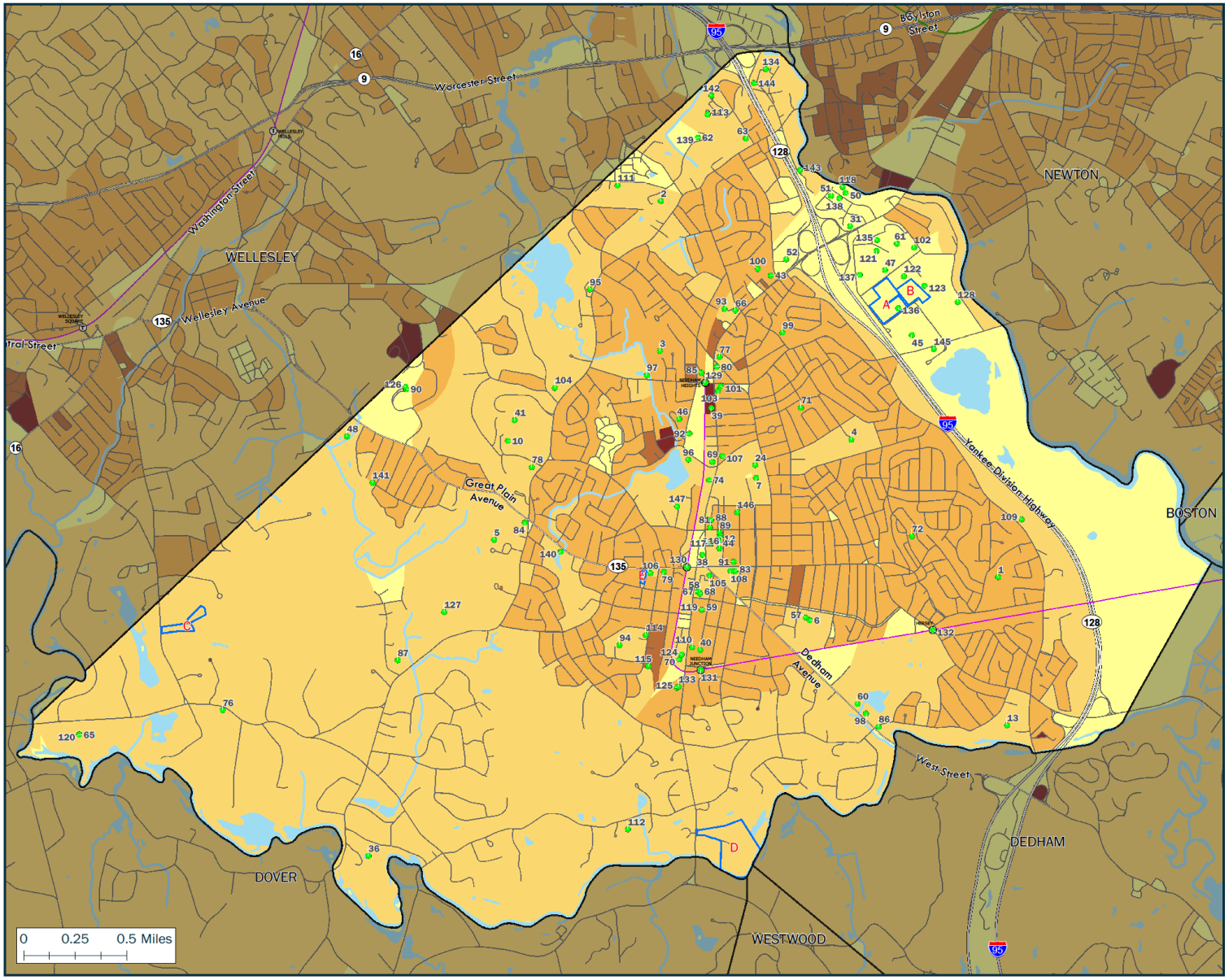
HMP

5. Review pre-existing mitigation measures from the 2008 plan
6. Review mitigation goals from the 2008 plan

Needham Municipal Vulnerability Preparedness/ Hazard Mitigation Plan Team Meeting May 21, 2020 1:30 – 3:30 via Zoom

1. Recap 1st public meeting and feedback
2. Review Hazard Mitigation goals
3. Develop mitigation measures for the plan update
4. Next steps – public meeting

APPENDIX B: HAZARD MAPPING



MAPC dcr

FEMA Hazard Mitigation Planning Grant
NEEDHAM, MA

Map 1: Population Density

Sites
- Critical Infrastructure*
- Development Areas

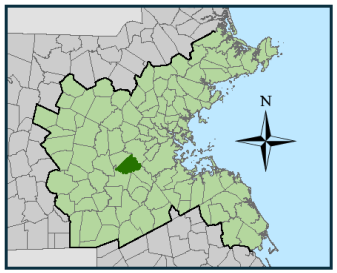
* See details in separate table

Water Bodies

Population Density
Census 2010 Blocks
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



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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)

NEEDHAM, MA

Date: 6/2/2020

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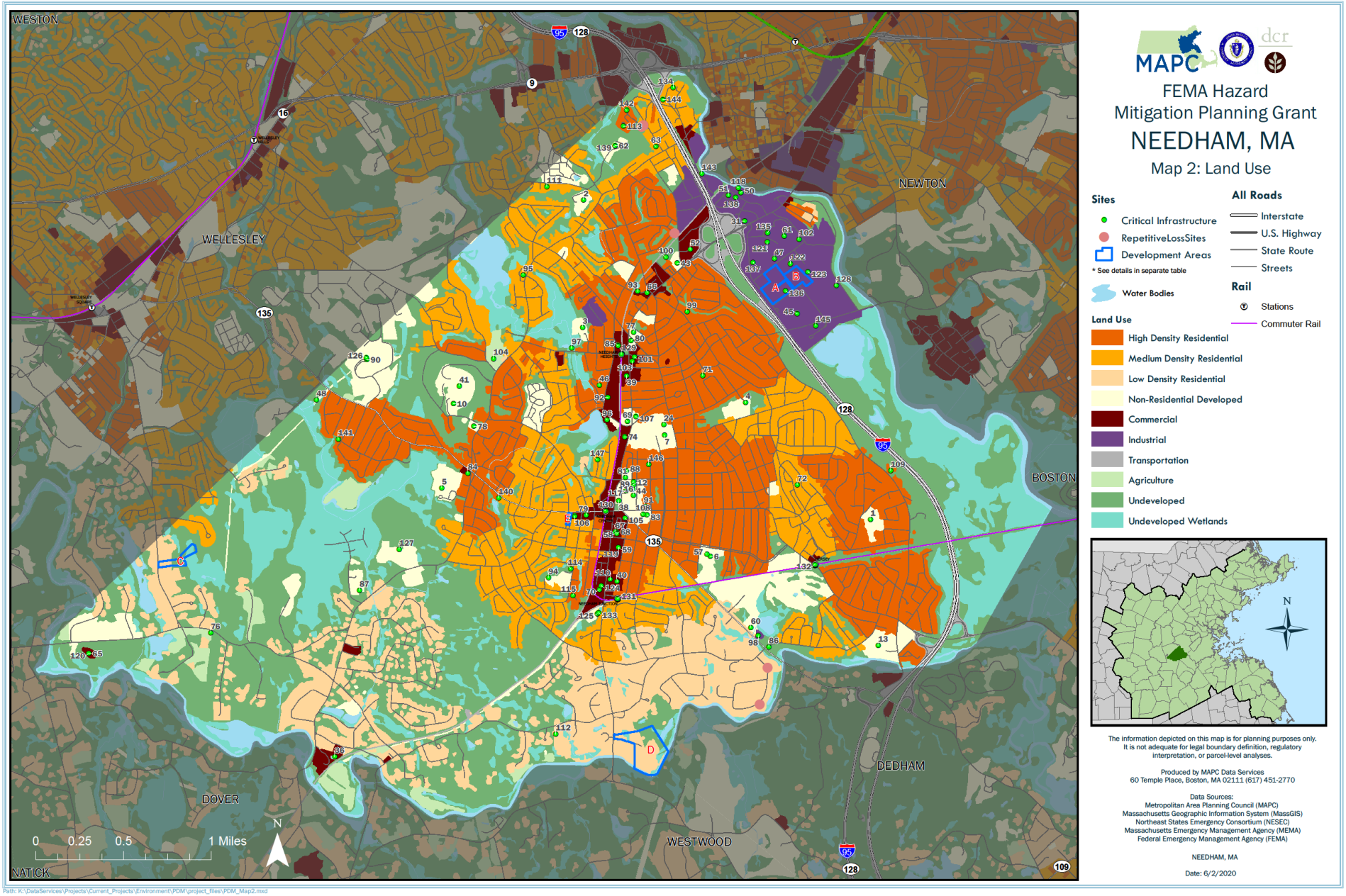

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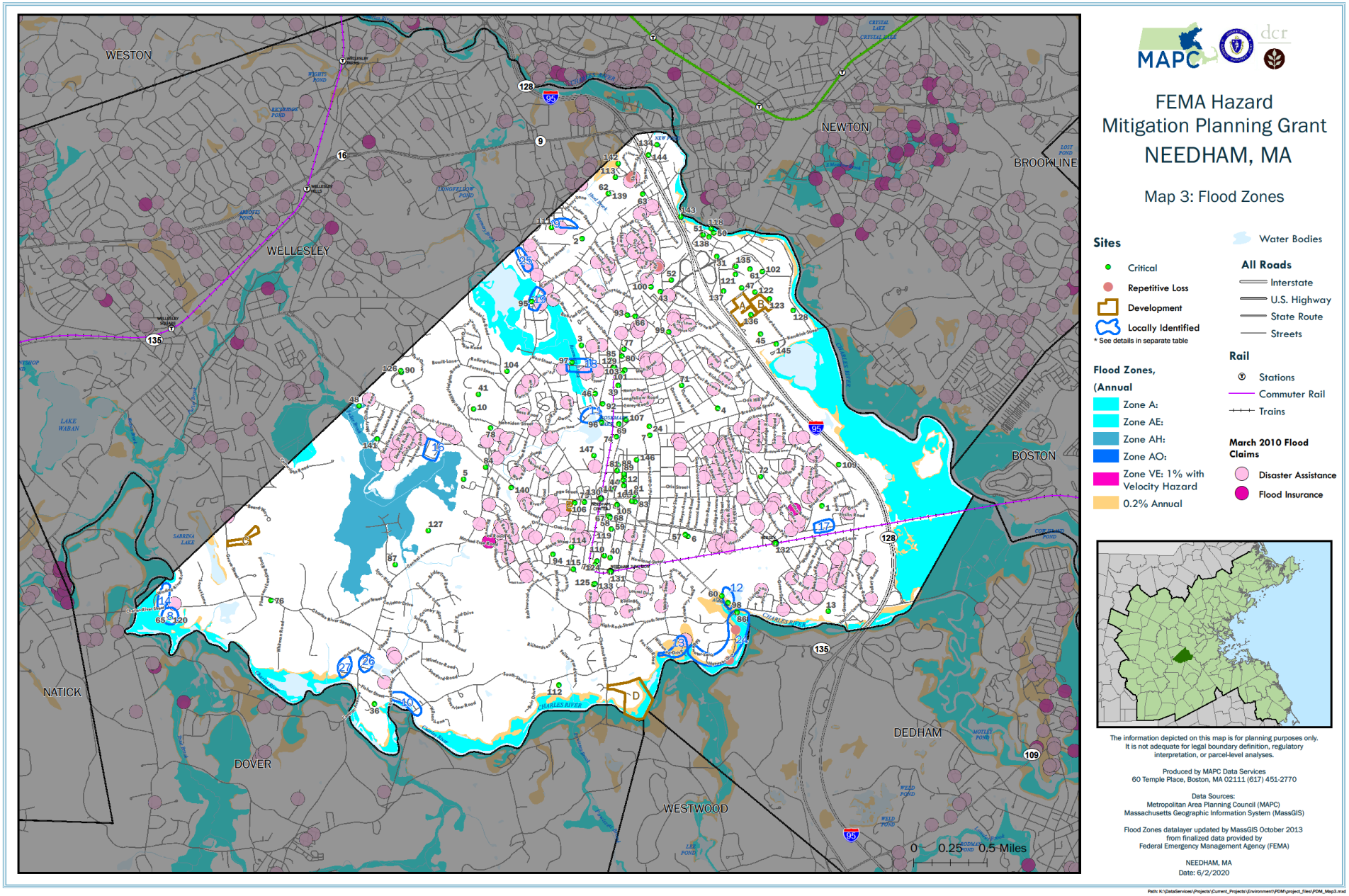
WESTON
WELLESLEY
NEWTON
BROOKLINE
BOSTON
NATICK
DOVER
DEDHAM
WESTWOOD
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
NEEDHAM, MA
Map 3: Flood Zones
Sites
Critical
Repetitive Loss
Development
Locally Identified
* See details in separate table
Flood Zones, (Annual
Zone A:
Zone AE:
Zone AH:
Zone AO:
Zone VE: 1% with Velocity Hazard
0.2% Annual
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Streets
Rail
Stations
Commuter Rail
Trains
March 2010 Flood Claims
Disaster Assistance
Flood Insurance
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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)
Flood Zones datalayer updated by MassGIS October 2013 from finalized data provided by Federal Emergency Management Agency (FEMA)
NEEDHAM, MA
Date: 6/2/2020
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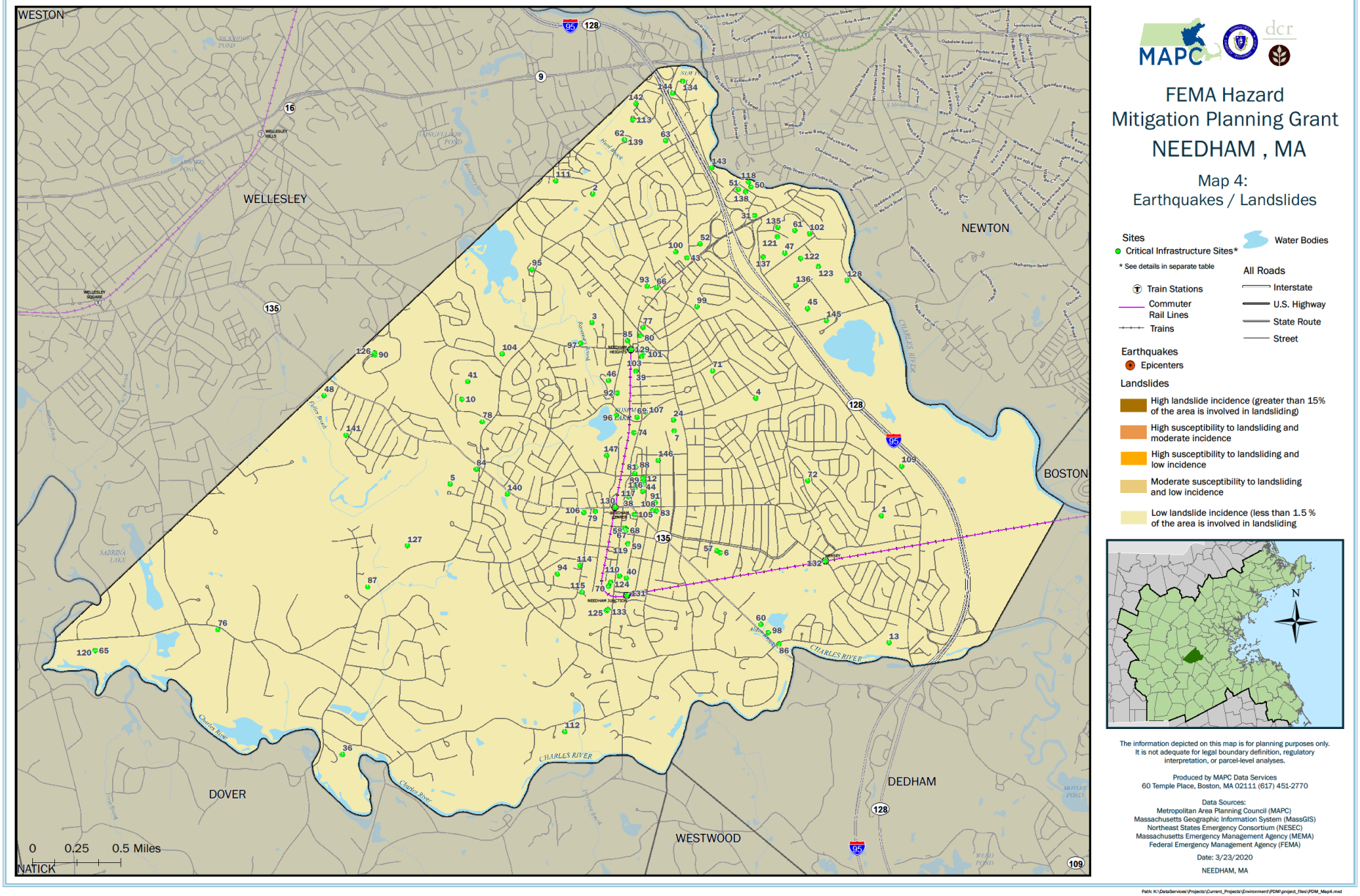
WESTON
WELLESLEY
NEWTON
BOSTON
DEDHAM
WESTWOOD
DOVER
NATICK
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
NEEDHAM , MA
Map 4: Earthquakes / Landslides
Sites
Critical Infrastructure Sites*
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
Water Bodies
All Roads
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
N
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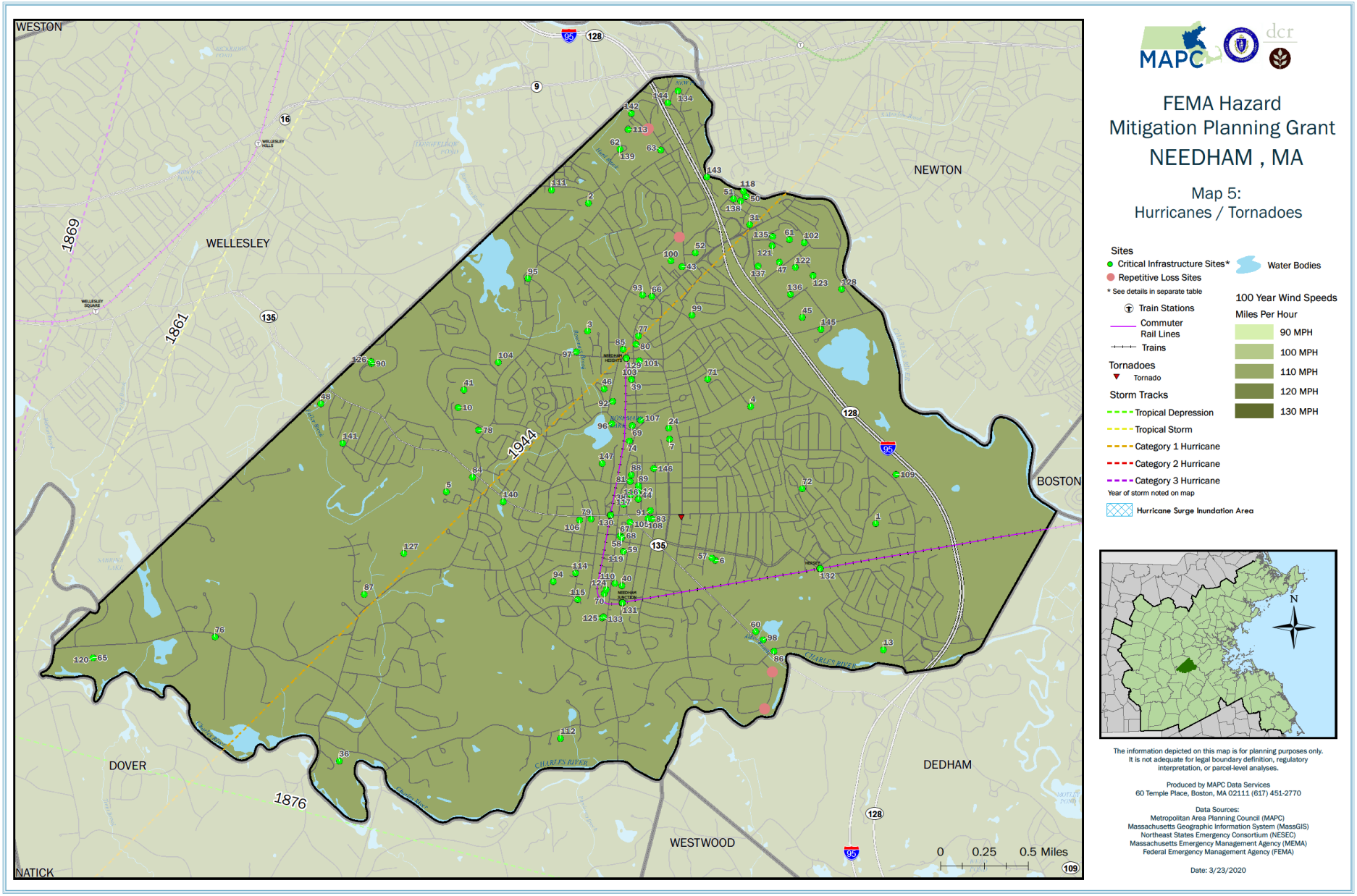
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Date: 3/23/2020
NEEDHAM, MA


WESTON
NEWTON
WELLESLEY
BOSTON
DOVER
DEDHAM
WESTWOOD
NATICK
1869
1861
1944
1876
0 0.25 0.5 Miles
FEMA Hazard Mitigation Planning Grant
NEEDHAM , 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
N
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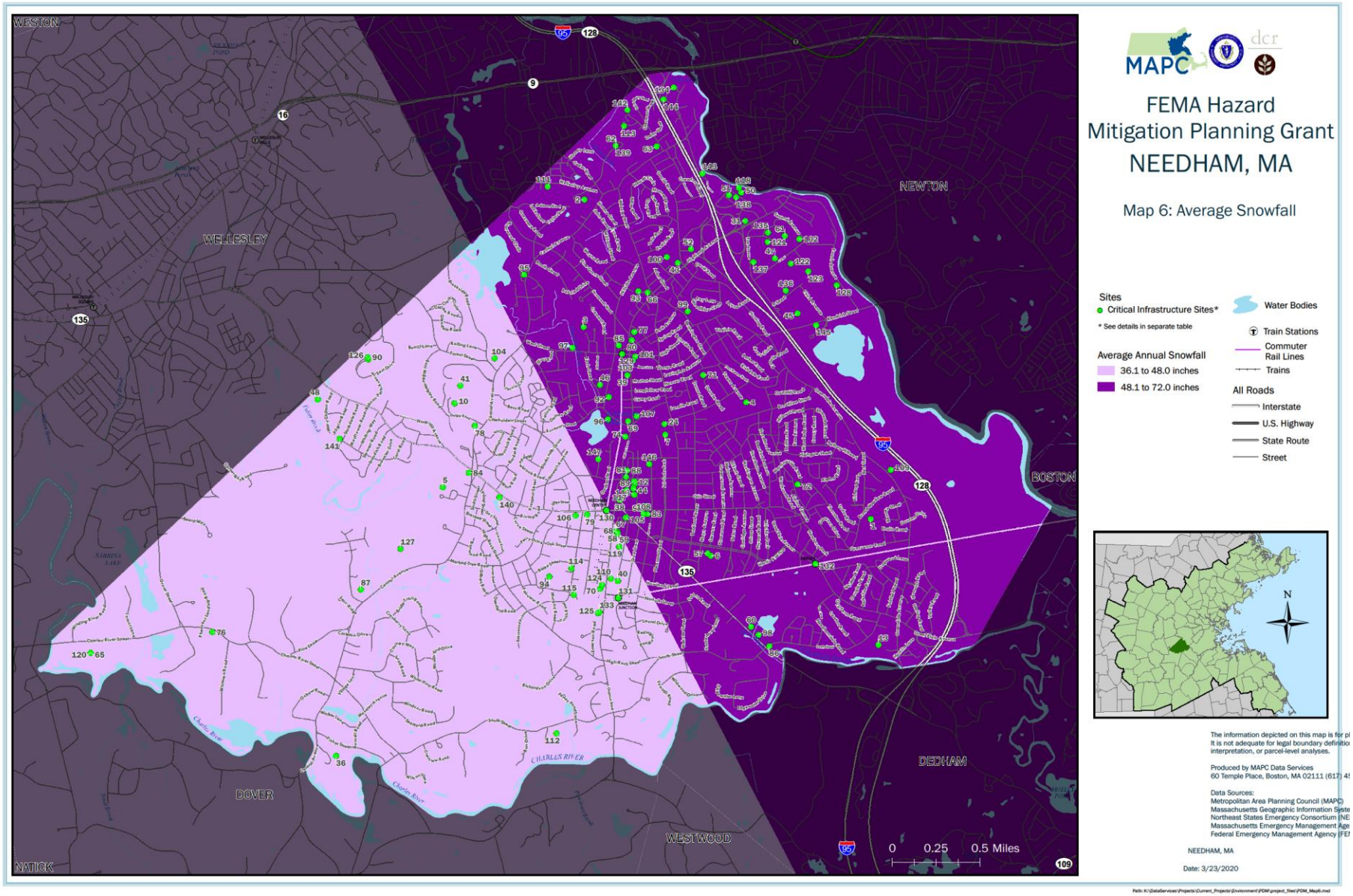
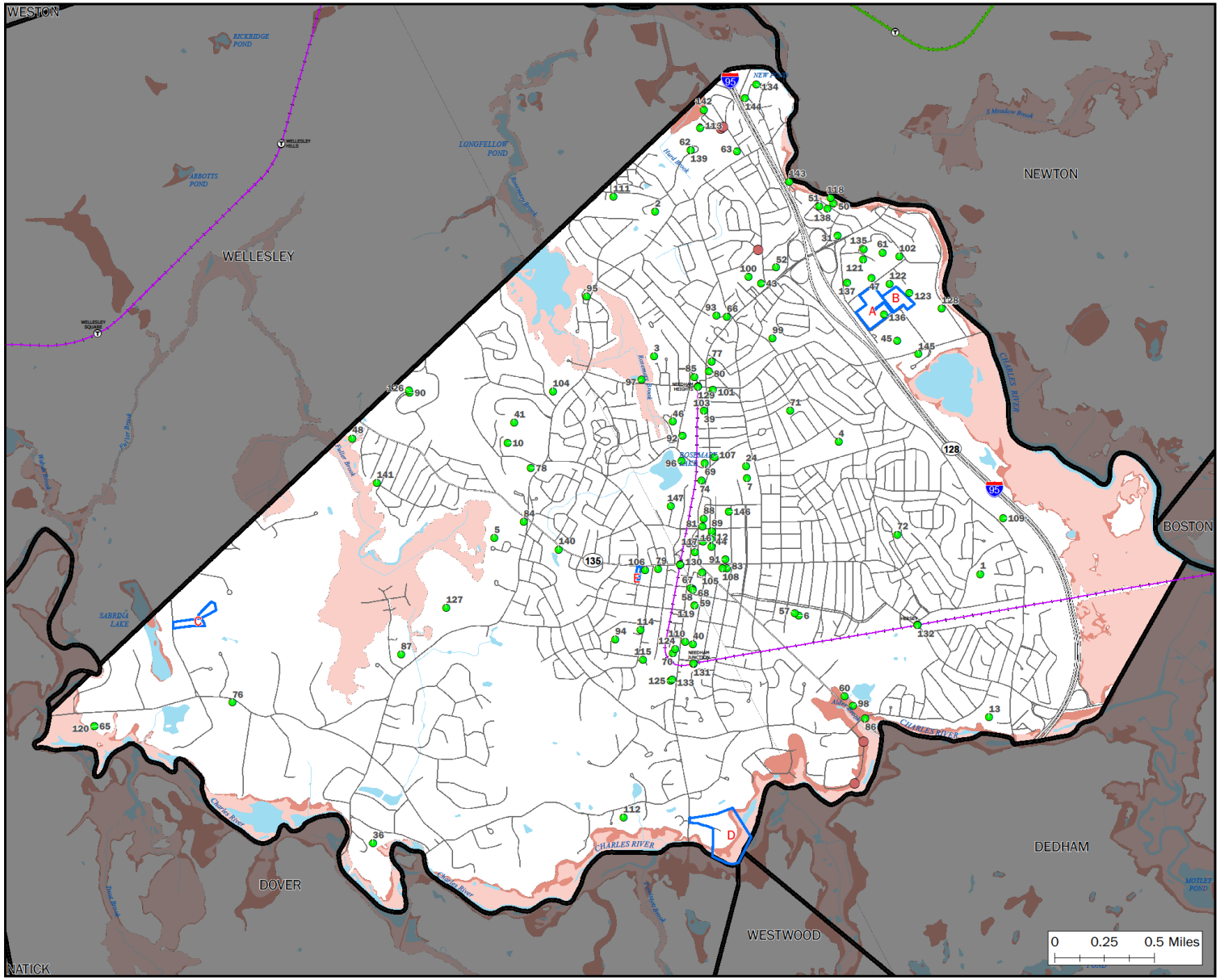
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Date: 3/23/2020


FEMA Hazard
Mitigation Planning Grant
NEEDHAM, MA
Map 6: Average Snowfall
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
WESTON
WELLESLEY
NEWTON
BOSTON
NEEDHAM
DOVER
WESTWOOD
NATICK
CHARLES RIVER
0 0.25 0.5 Miles
N
NEEDHAM, MA
Date: 3/23/2020



MAPC

FEMA Hazard Mitigation Planning Grant

NEEDHAM, MA

Map 7: Composite Natural Hazards

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

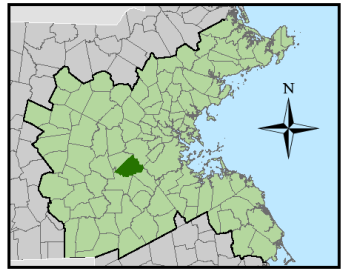
- Water Bodies

All Roads

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

Subway Lines

- Blue
- Green
- Orange
- Red
- Silver



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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) /

NEEDHAM, MA

Date: 6/2/2020

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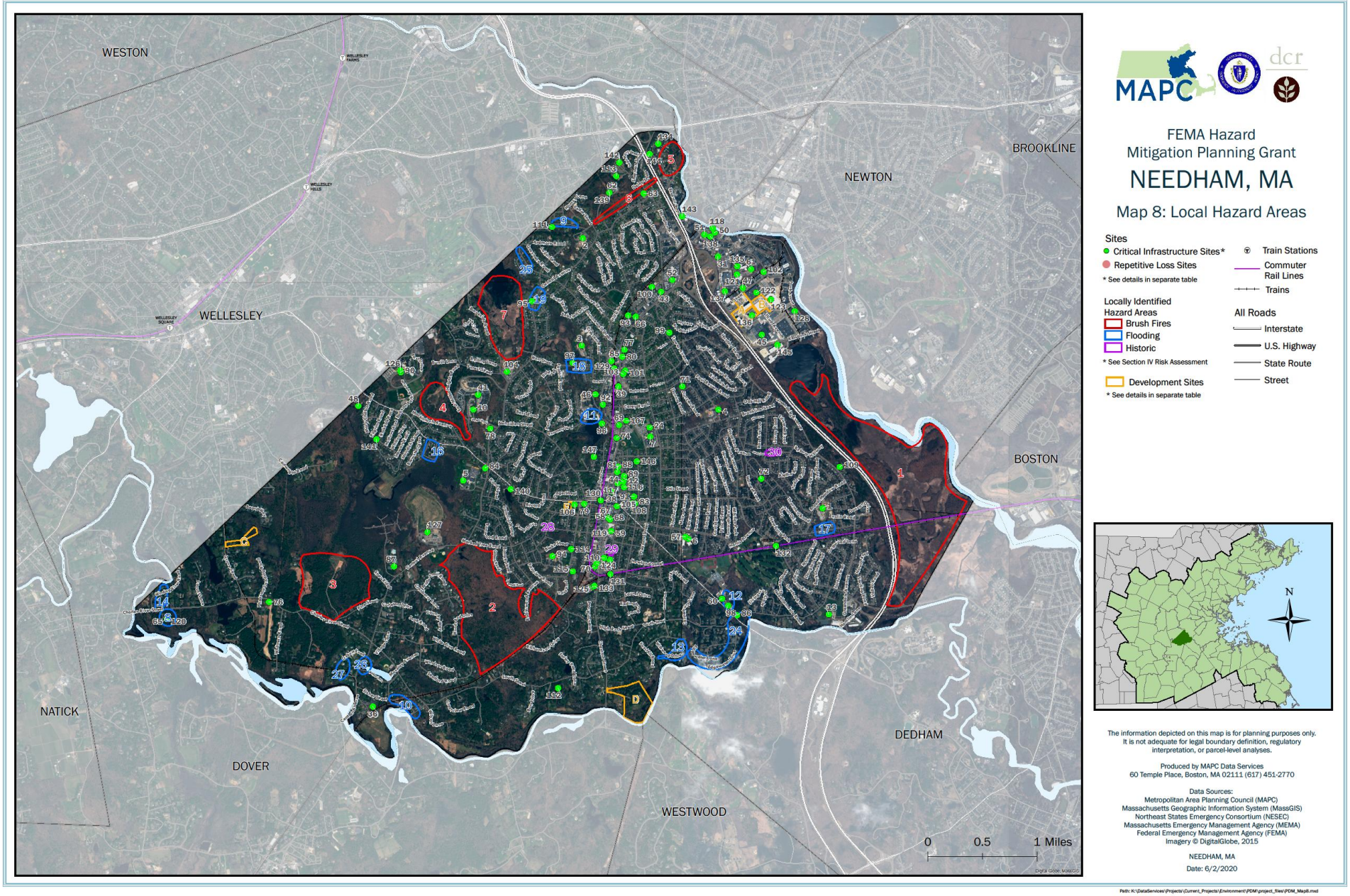
WESTON
WELLESLEY
NEWTON
BROOKLINE
BOSTON
NATICK
DOVER
WESTWOOD
DEDHAM
0
0.5
1 Miles
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
NEEDHAM, MA
Map 8: Local Hazard Areas
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Locally Identified
Hazard Areas
Brush Fires
Flooding
Historic
* 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
N
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Produced by MAPC Data Services
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Data Sources:
Metropolitan Area Planning Council (MAPC)
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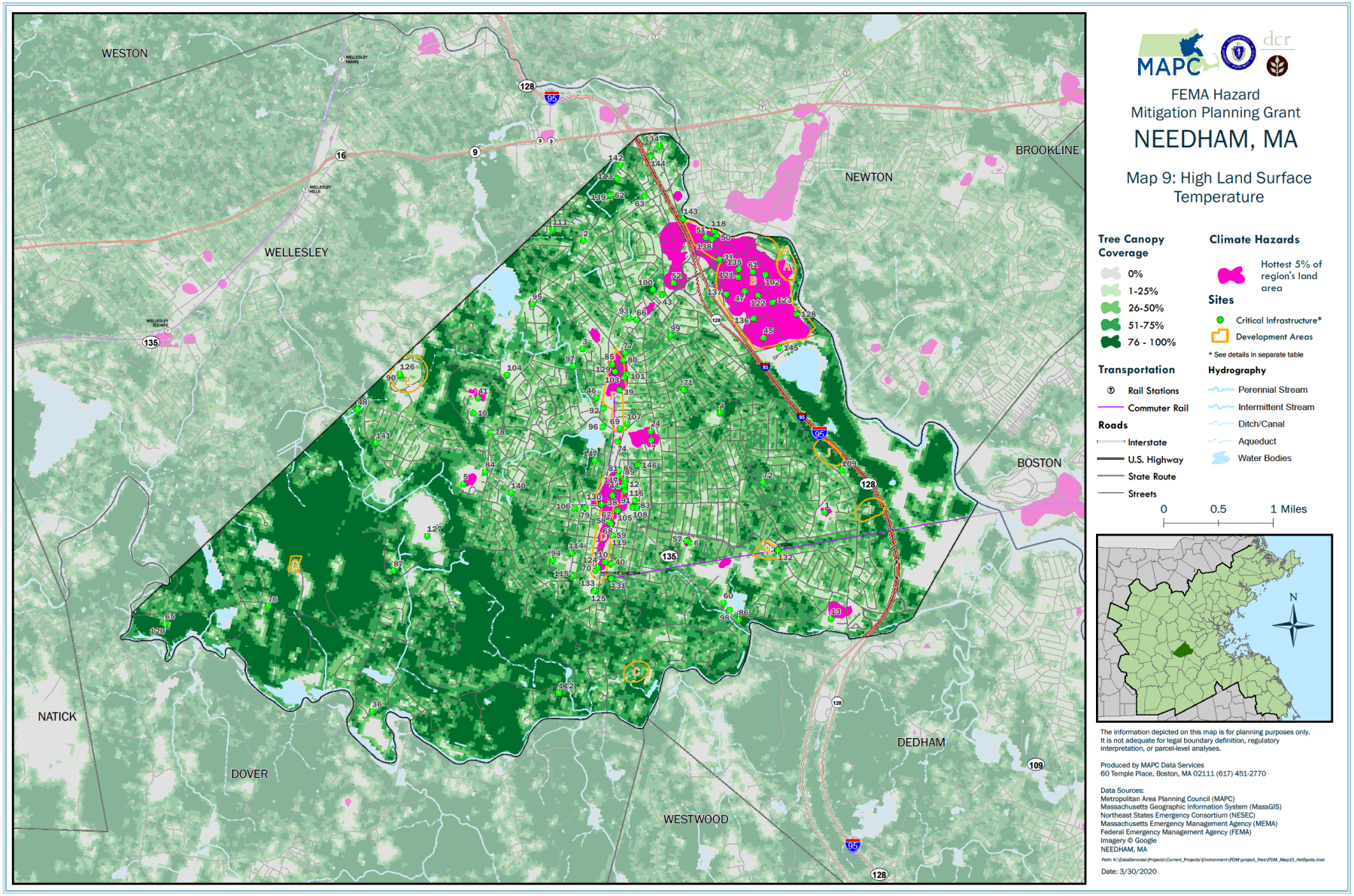
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © DigitalGlobe, 2015
NEEDHAM, MA
Date: 6/2/2020


WESTON
WELLESLEY
NEWTON
BROOKLINE
BOSTON
NATICK
DOVER
WESTWOOD
DEDHAM
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
NEEDHAM, MA
Map 9: High Land Surface Temperature
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
0
0.5
1 Miles
N
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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)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google
NEEDHAM, MA
Date: 3/30/2020

APPENDIX C: PUBLIC MEETINGS

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

CALENDAR LISTING / MEDIA ADVISORY

NEEDHAM DRAFT HAZARD MITIGATION AND CLIMATE PLANS TO BE PRESENTED VIRTUALLY MAY 4-18

Presentation of Needham's Hazard Mitigation and Climate Plans and solicit public comments

Who: Needham residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards and increasingly extreme weather.

What: A video presentation and feedback survey available on line.

The Hazard Mitigation plan identifies natural hazards affecting Needham such as floods, hurricanes, winter storms, and earthquakes. The climate plan focuses on hazards associated with our warming climate. The plans include actions that the Town can take to reduce future vulnerability to these hazards. The public is invited to offer feedback on priorities the town has identified to prepare for future extreme weather.

When: May 4- May 18

Where: **Website link:**

https://www.mapc.org/resource-library/needham-feedback/

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.

##

CLIMATE CHANGE AND NATURAL HAZARDS PREPAREDNESS


Our climate is changing and the Town of Needham is developing Climate and Hazard Mitigation plans to prepare for future extreme weather events. The plans will make the Town eligible to apply for funding of town priorities.

We are seeking your feedback on the priorities that should be included in the plans.

To learn about potential hazards facing Needham and provide your feedback please click the link to the website below. The site includes a short survey where you can offer your comments and suggestions about how Needham can best be prepared. Feedback received by May 18 will be included in the final report.

Website link:

https://www.mapc.org/resource-library/needham-feedback/

For more information, please contact Anne Herbst, Senior Environmental Planner at the Metropolitan Area Planning Council at (617) 933-0781 or email aherbst@mapc.org.

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

CALENDAR LISTING / MEDIA ADVISORY

NEEDHAM'S HAZARD MITIGATION PLAN TO BE DISCUSSED AT JUNE 9 PUBLIC MEETING

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

What: At a public meeting on Wednesday, June 9 at 6:00 PM, a presentation on the *Needham Draft Hazard Mitigation Plan, 2020 Update* will be hosted by the Select Board. The presentation will be made by the Metropolitan Area Planning Council (MAPC), which is assisting the Town with the preparation of the updated Hazard Mitigation Plan. There will be an opportunity for questions and discussion following the presentation.

The Town of Needham has prepared the draft Hazard Mitigation plan to document natural hazards that affect the Town, such as floods, hurricanes, and severe winter storms, and to recommend actions that the Town can take to reduce its vulnerability to these hazards. Once completed and approved by the Federal Emergency Management Agency (FEMA), the Town will be eligible for federal Hazard Mitigation Grants from FEMA.

When: Tuesday, June 9, 2020, 6:00 PM

Where: Virtual meeting via Zoom
Link to meeting available at: http://www.needhamma.gov/507/Agendas-Minutes

HAZARD MITIGATION PLAN PUBLIC MEETING

Natural hazards can have serious impacts on the Town of Needham and its residents

The Town of Needham has prepared a draft Hazard Mitigation Plan, as well as a Climate Plan, to help the town reduce its vulnerability to natural hazards such as flooding, hurricanes, and winter storms. Please join the Select Board for a public presentation of the Hazard Mitigation Plan. Your questions and suggestions for the draft plan are welcome, please join us!

Date: **Tuesday, June 9, 2020**
Time: **6:00 PM**
Location: **The meeting will be held virtually. Link available at: http://www.needhamma.gov/507/Agendas-Minutes**

For more information, please contact Anne Herbst at (617) 933-0781 or email aherbst@mapc.org.

Select Board agenda to go here

APPENDIX D: PLAN ADOPTION

<TOWN LETTERHEAD>

CERTIFICATE OF ADOPTION
SELECT BOARD

TOWN OF NEEDHAM, MASSACHUSETTS

A RESOLUTION ADOPTING THE
TOWN OF NEEDHAM HAZARD MITIGATION PLAN 2020 UPDATE

WHEREAS, the Town of Needham established a Committee to prepare the *Town of Needham Hazard Mitigation Plan 2020 Update*; and

WHEREAS, the *Town of Needham Hazard Mitigation Plan 2020 Update* contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Needham, and

WHEREAS, duly noticed public meetings were held by the LOCAL HAZARD MITIGATION PLANNING TEAM on May 4-18, 2020 and June 9, 2020 and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Needham Select Board adopts the *Town of Needham Hazard Mitigation Plan 2020 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Needham.

ADOPTED AND SIGNED this Date. _____

Name(s)

Title(s)

Signature(s)

APPENDIX E: MVP WORKSHOP RESULTS

Highest Priorities

Develop communication strategies: Several groups proposed targeted outreach to specific populations including seniors, low income residents, limited English language speakers, people with disabilities, people with cell phones, and people who work in Needham but live elsewhere. Creating a neighbor-to-neighbor outreach program was proposed.

Communicate and address health impacts: Provide outreach and education about extreme heat impacts and, mosquito and tick-borne illnesses. Develop heat exposure guidelines. Create a permanent shade structure at Rosemary Pond. Develop mosquito control plans, consider a regional plan, support environmentally friendly strategies.

Stormwater: While many groups highlighted Needham's new Stormwater Bylaw as a strength, stormwater management was identified as a top priority. Suggestions included providing needed funding and a long-term plan, addressing stormwater needs on large developments and ensuring new developments have increased capacity, incorporating nature-based solutions and, analyzing and planning for retrofits of undersized systems.

Water infrastructure: Monitoring and assessing vulnerabilities of the system was a general priority. Protecting the wells and water treatment plant, which are subject to flooding, was a key concern. In addition, assuring the protection and functioning of the St. Mary's Pump Station, town interconnections, and sewer pump stations was highlighted.

Tree and Forest Management: Develop a forest management plan to address invasive species, pests, and vulnerability to fire. Develop a tree bylaw. Identify locations to plant trees.

Ensure robust infrastructure: Consider cyber security, redundancy, and generator backup.

Upgrade the Central Avenue Bridge: Coordinate the work with the Town of Dover.

Focus on wetlands: Incorporate more climate concerns and resiliency in the local bylaw. Provide public education on the value and importance of wetlands.

Focus on seniors in public housing: Upgrade the building and infrastructure. Create additional green space. Develop a communications and coordination plan for emergencies.

Focus on residents with medical needs: Develop a list of medically fragile people for wellness visits during emergencies. Communicate the list with the hospital to ensure capacity for likely patients in the event of emergency.

Create a disaster response plan: The plan should include evacuation strategies.

Focus on hazardous materials: Map hazardous materials sites and communicate the information to the hospital.