TOWN OF DOVER
DRAFT HAZARD MITIGATION PLAN
2022 UPDATE

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Draft Plan
January 14, 2022

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TOWN OF DOVER HAZARD MITIGATION PLAN DRAFT 2022 UPDATE

ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the Town of Dover 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).

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Cover photo: Charles River flooding at Mill Street, March 2010

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SECTION 1: EXECUTIVE SUMMARY

Hazard Mitigation planning is a proactive effort to identify actions that can be taken to reduce the dangers to life and property from natural hazard events. In the communities of the Boston region of Massachusetts, hazard mitigation planning tends to focus most on flooding, the most likely natural hazard to impact these communities. Other common concerns are the impacts of extreme heat, drought, and nor'easters. This plan also considers how our changing climate will affect natural hazards. Warming temperatures will fuel changing precipitation patterns, and an increasing frequency and intensity of severe storms and drought. The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to be eligible to receive FEMA hazard mitigation grants to adopt a local multi-hazard mitigation plan and update the plan in five-year intervals.

PLANNING PROCESS

Planning for the Hazard Mitigation Plan update was led by the Dover Local Hazard Mitigation Planning Team, composed of staff from a number of different Town Departments. The Dover Team met on July 29, 2021, October 9, 2021, and November 29, 2021. The team 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 the planning process is important for improving awareness of the impacts of natural hazards and to build support for the actions the Town takes to mitigate them. The Local Team hosted two public meetings hosted by the Planning Board via Zoom, the first on September 27, 2021, and the second on July 24, 2022. The draft plan update was posted on the Town's website for public review and comment. Key Town stakeholders and neighboring communities were notified and invited to participate.

RISK ASSESSMENT

The Dover Hazard Mitigation Plan assesses the potential impacts to the Town from flooding, high winds, winter storms, drought, brush fire, extreme temperatures, and geologic hazards. While flooding, is a significant risk as it is in other towns in the region, Dover is also particularly susceptible to drought due to its reliance on local groundwater sources for public and private water supply. Areas of the town susceptible to multiple natural hazards are shown on the hazard map series (Appendix A).

The Dover Local Hazard Mitigation Planning Team identified 37 Critical Facilities. These are also shown on the map series and listed in Table 37, identifying which facilities are located within the mapped hazard zones.

Hazards US–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. A HAZUS-MH analysis provided estimates of damages in Dover from Hurricanes of category 2 and 4 ($6.0 million to $19.5 million), earthquakes of magnitudes 5 and 7 ($76.8

million to $702million), and flooding from a 100-year and 500-year storm ($41 million to $208 million.)

HAZARD MITIGATION GOALS

Hazard Mitigation Goals

The Dover Hazard Mitigation Planning Team identified the following hazard mitigation goals for the Town. Compared to the 2016 plan, the team added a twelfth goal focused on incorporating climate change hazards.

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

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

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

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

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

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

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

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

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

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

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

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

HAZARD MITIGATION STRATEGY

The Dover Local Hazard Mitigation Planning Team identified a number of mitigation measures that would serve to reduce the Town's vulnerability to natural hazards.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Dover 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 will impact the Town's vulnerability in the future, and local officials will need to work together across departments and municipal lines and collaborate 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 Dover's Hazard Mitigation Plan 2022 Update is summarized in Table 1.

Table 1 - Plan Review and Update Process

Section	Reviews and Updates
3 – Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan, discussing strategies to enhance participation opportunities at the local team meeting. During plan development, the plan was discussed at two public meetings hosted by the Planning Board. The plan was available on the Town's website for public comment.
4 – Risk Assessment	MAPC gathered the most recently available hazard, climate, 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. MAPC also used the most recently available version of HAZUS-MH to assess the impacts of flooding, hurricanes, and earthquakes.
5 - Goals	The Hazard Mitigation Goals were reviewed and endorsed by the Dover Local Hazard Mitigation Planning Team.
6 – Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the Town.
7 & 8 – Hazard Mitigation Strategy	Mitigation measures from the 2016 plan were reviewed and assessed as to whether they were completed, partially completed, or not completed. The Dover Hazard Mitigation Planning Team determined whether to carry forward mitigation measures into the 2022 Plan, revise them, or delete them from the 2022 Plan Update. The hazard mitigation strategy reflects both new measures and measures carried forward from the 2016 plan. The Dover

	Hazard Mitigation Team prioritized all of these measures based on current conditions.
9 – Plan Adoption & Maintenance	This section of the plan was updated with an 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 on Table 27, Dover made some progress on implementing mitigation measures identified in the 2016 Hazard Mitigation Plan. Overall, three of the mitigation measures from the 2016 plan will be carried over to this 2022 plan and four others will be carried over with revisions. Four of the 2016 mitigation recommendations will not be carried over, but will be replaced by different measures to address each respective hazard. Finally, four new mitigation recommendations that were not in the previous plan were identified and will be added to this 2022 plan update.

All but one of the 2016 recommendations being carried over to the 2022 plan will retain the same priority, only one will change from medium to low. Two of the four new mitigation measures are ranked high priority and two others are ranked medium. Of the 15 total recommendations included in this 2022 plan update, six are high priority, six are medium priority, and three are low priority.

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

SECTION 2: INTRODUCTION

PLANNING REQUIREMENTS UNDER THE FEDERAL DISASTER MITIGATION ACT

The Federal Disaster Mitigation Act, passed in 2000, requires that 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 Dover contracted with the Metropolitan Area Planning Council (MAPC), to assist the Town in updating its third local Hazard Mitigation Plan, which was first adopted in 2009 and was updated in 2016.

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 1: Federal Declared Disasters 1991-2021

Disaster Name	Date of Event	Declared Areas
Hurricane Bob	August 1991	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
Severe Coastal Storm No Name Storm	October 1991	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
Blizzard	March 1993	Statewide
Blizzard	January 1996	Statewide

Disaster Name	Date of Event	Declared Areas
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
Snowstorm	January 2005	Statewide
Hurricane Katrina	August 2005	Statewide
Severe Storms, Flooding	October 2005	Statewide
Severe Storms, Flooding	May 2006	Statewide
Severe Storm, Inland, Coastal Flooding	April 2007	Statewide
Severe Winter Storm	December 2008	Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, Worcester
Severe Storms, Flooding	December 2008	Statewide
Severe Storms, Flooding	March/April 2010	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
Severe Winter Storm, Snowstorm	January 2011	Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, Suffolk
Severe Storm, Snowstorm	October 2011	Berkshire, Franklin, Hampden, Hampshire, Middlesex, Worcester
Severe Winter Storm, Snowstorm, Flooding	February, 2013	Statewide
Severe winter storm, snowstorm, flooding	April 2015	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe winter storm and Snowstorm	March 2018	Essex, Middlesex, Norfolk, Suffolk, Worcester

Source: MA Hazard Mitigation and Climate Adaptation Plan, 2018

FEMA FUNDED MITIGATION PROJECTS

Over the last 20 years the Town of Dover has not received funding from FEMA for any mitigation projects under the Hazard Mitigation Grant Program.

COMMUNITY PROFILE

The Town of Dover is a suburban community set between the western and southwestern axis of metropolitan Boston expansion. The town is bordered by Medfield and Walpole on the south, Sherborn on the west, Natick on the northwest, Wellesley and Needham on the north and Westwood on the east. Dover is 16 miles southwest of Boston.

Prior to its incorporation as a Town, the area was named Springfield because it was predominantly a farming community with open fields centered around the "bubbling springs" of Trout Brook. It was incorporated as a Town in 1836. The town has an open town meeting form of government with a three -member Board of Selectmen and a town administrator.

Dover relied on agriculture and grazing as the basis for its colonial economy although the ruggedness of its terrain plus the relative lack of waterpower limited its early growth. The Town's proximity to Boston led to the development of lumbering for the shipbuilding industry. The damming of the Charles River in the late 18th century provided some power and allowed for the development of mills which made nails and rolled iron, but the future of the community would not be industrial. Little remains of Dover's industrial heritage. However, the remains of the Dover Union Iron Mill in Noanet Woodlands were reconstructed and serve as a monument to the ingenuity of the Town's forebears in using waterpower to drive the machinery to create iron bars.

Dover's farming heritage is evident in the present-day rural quality of the Town. Scenery common to farming communities in New England (such as open pastureland; stands of white pine, birch, oak, and maple; old stone walls dividing properties; and farmhouses and barns) is still very much in evidence today. This heritage and country atmosphere is highly valued by the citizens of Dover.

By the late 19th century, Dover was a firmly suburban community, some of whose residents had assembled large country estates. Wealthy Bostonians created at least 18 estates between 1901 and 1914 alone, some of them as large as 300-400 acres.

Modern Dover is a residential community that still retains a semi-rural character although there has been some development and subdividing of estate lands. The 2020 population was 5,923 and there were 2,031 housing units as of 2019 (see Table 4 for demographic and housing characteristics).

Dover has a small Town Center in which the Town House, Police Station, the Caryl Community Center, the Charles River School, a market, a post office, a sandwich shop, a gas station, and several other small commercial, legal and medical establishments are located. The majority of Dover's commercial, professional, and medical needs are provided for outside its borders.

A major cultural resource is a branch of the Massachusetts Horticultural Society, located on 36 acres of the 188-acre Elm Bank Estate, now owned and managed by the Commonwealth's Department of Conservation and Recreation.

Table 3: Dover Community Characteristics

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Population = 5,923

- 2.2% are under age 5
- 23.1% are under age 15
- 16.4% are over age 65
- 11.4% are householders living alone
- 8.6% are householder over 65 living alone
- 18.8% speak a language other than English at home
- 2.4% speak English less than very well
- 6.7% have a disability
- 1.6 % have no vehicle

Number of Housing Units = 2,031

- 5.2% are renter-occupied housing units
- 27.6% of housing units were built prior to 1940

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

Transportation

The town has good access to Boston, though only one numbered state highway, Route 109. passes through the town itself, bordering the southernmost part of Dover. The major town roads, which generally radiate out from the Town Center, include Dedham, Walpole, Pine, Center, Farm, and Main Streets, as well as Springdale Avenue. In addition, Route 128 and Route 9 are readily accessible from Dover in the neighboring towns of Westwood, Needham, Wellesley, and Natick. No commuter rail service exists within Dover, but service is available in the abutting Towns of Natick, Wellesley, Needham, and Walpole.

Water Supply

Dover residents rely primarily on local wells for their water supply. The private Colonial Water Company (formerly Dover Water Company) serves some parts of Town. Some residents near the Town line receive water service from Natick and Medfield. For both private and public water supplies, the Town is 100% reliant on groundwater as a potable water source. The Town faces significant challenges with respect to both the quality and quantity of its water supply sources.

Wastewater

Dover has no Town sewer system. This has been a factor in limiting growth as well as resulting in low-density development. There are no plans to provide sewer service in Town. The three comprehensive permit projects (County Court off County Street, The Meadows off Springdale Avenue and Dover Farms off Centre Street) all have utilized small wastewater treatment plants in order to make those developments possible. The Dover-Sherborn Regional High School also has a small wastewater treatment plant. All other residences and businesses in Dover use on-site septic systems regulated under Title 5 of the state sanitary code and enforced by the Board of Health.

The Town maintains a website at http://www.doverma.org.

Narrative based on information provided by the Town of Dover

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 Local Hazard Mitigation Planning Teams, two public meetings hosted by the local Hazard Mitigation Team, posting of the plan to the MAPC website, and invitations sent to community stakeholders, Town boards and commissions, neighboring communities, and other local or regional entities.

PLANNING PROCESS SUMMARY

The six-step planning process summarized in Figure 1 below is based on the guidance provided by FEMA in the 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. By working on municipal hazard mitigation plans in groups of neighboring cities and towns, MAPC is able to identify regional opportunities for collaboration and facilitate communication between communities. 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

- **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 Ab.

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

    - Blue Hill Observatory
    - Charles River Watershed Association, *Charles River Watershed Model*, 2020
    - City of Somerville, *The Wellbeing of Somerville* (2017)
    - FEMA, Flood Insurance Rate Maps for Norfolk County, MA, 2012
    - FEMA, Hazards U.S. Multi-Hazard (HAZUS-MH), 2021
    - FEMA, *Local Mitigation Plan Review Guide;* October 1, 2011
    - Mass. Audubon Society, *Encouraging Low Impact Development in Dover*
    - Massachusetts Office of Dam Safety, Inventory of Massachusetts Dams 2018
    - Mass. Emergency Management Agency, *State Hazard Mitigation Plan,* 2013
    - Mass. Emergency Management Agency, *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
    - NOAA, National Centers for Environmental Information
    - Northeast Climate Adaptation Science Center
    - Northeast States Emergency Consortium
    - Tornado History Project
    - Town of Dover Comprehensive Emergency Management Plan
    - Town of Dover Master Plan (2012)
    - Town of Dover Open Space and Recreation Plan (2011)
    - Town of Dover Stormwater Management Plan (2021)
    - Town of Dover Subdivision Regulations
    - Town of Dover Town Bylaws
    - USDA Forest Service, Wildfire Risk to Communities
    - U.S. Geological Survey, National Water Information System
    - U.S. Census, 2020 and American Community Survey, 2019
    - U.S. Global Change Research Program, *Fourth National Climate Assessment*, 2018

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

- **Develop Mitigation Strategies** – MAPC works with the local municipal staff to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessments, and the community's existing mitigation efforts to determine where additional work is necessary to reduce the potential damages from hazard events. Additional information on the development of hazard mitigation strategies can be found in Section 7.

- **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 by the Town can be found in Appendix D.

- **Implement & Update the Plan** – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a five year basis making preparation for the next plan update an important on-going activity. Section 9 includes more detailed information on plan implementation.

2016 PLAN IMPLEMENTATION & MAINTENANCE

The 2016 Town of Dover Hazard Mitigation Plan contained a risk assessment of identified hazards for the Town and mitigation measures to address the risks and vulnerability from these hazards. Since approval of the plan by FEMA the Town has advanced several measures, and In addition, the Town completed a Municipal Vulnerability Preparedness planning process in 2019 and has been designated an MVP Community by the Executive Office of Energy and Environmental Affairs.

THE LOCAL HAZARD COMMUNITY PLANNING TEAM

MAPC worked with the local community representatives to organize a Local Hazard Mitigation Planning Team for Dover. 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 can be found in Table 4 below.

The Local Hazard Mitigation Planning Team met on July 29, 2021, October 9, 2021, and November 29, 2021. The purpose of the first meeting 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 second meeting focused on verifying information gathered by MAPC staff and discussion of existing mitigation practices, and the third meeting focused on the status of mitigation measures identified in the Town's 2016 Hazard Mitigation Plan and identifying new or revised mitigation measures for this plan update. The agendas for these meetings are included in Appendix B.

Table 4 - Dover Hazard Mitigation Planning Team

Name	Representing
Lori Hagerty	Administrative Assistant, Conservation
Courtney Sparrow	Land Use Director; Hazard Mitigation Team Coordinator
Dave Sullivan	Municipal Project Manager
John Tosi	Superintendent of Streets
Karl Warnick	Superintendent of Buildings

The Dover Planning Board and Conservation Commission are the primary entities responsible for regulating development in the Town. Feedback was assured through the participation of the Land Use Director and a representative of the Conservation Commission on the Dover Hazard Mitigation Team throughout the process. The Land Use Director served as the local team coordinator, and the Planning Board hosted both public meetings. In addition, MAPC, the State-designated regional planning authority for the Boston metropolitan region, works with all agencies that that regulate development in the region, including the listed municipal entities and state agencies such as the Mass. Department of Transportation and Department of Conservation and Recreation (DCR).

PUBLIC MEETINGS

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

The public had an opportunity to provide input to the Dover hazard mitigation planning process during a meeting of the Planning Board, on September 27, 2021 held remotely via Zoom. The draft plan update was presented to the public at a Planning Board meeting held on January 24, 2022, also remotely via Zoom. Both meetings were publicized as part of regular meetings of the Planning Board according to the Massachusetts Public Meeting Law. See meeting notices, press advisories, and notification of neighboring communities in Appendix C.

LOCAL STAKEHOLDER INVOLVEMENT

The local Hazard Mitigation Planning Team was encouraged to reach out to local stakeholders that might have an interest in the Hazard Mitigation Plan including neighboring communities, agencies, businesses, nonprofits, and other interested parties. Notice was sent to the following organizations and neighboring municipalities inviting them to participate in the public meetings. In addition, the local press was advised of the meetings, and notice was posted on the Town's website and social media platform.

Town of Medfield
Town of Natick
Town of Needham
Town of Sherborn
Town of Walpole
Town of Wellesley
Town of Westwood
Hale Reservation
The Trustees
Dover Sherborn Cable Television
Dover Mothers' Association
Friends of the Dover Council on Aging
The Dover Historical Society
Dover Land Conservation Trust
Dover-Sherborn Regional High School
Charles River School
Chickering El. School PTO
Dover Council on Aging

The draft Dover Hazard Mitigation Plan 2022 Update was posted online for the second public meeting. Members of the public could access the draft document and submit comments or questions on the plan.

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. The Dover Land Use Director acts as the coordinator for the local Hazard Mitigation Team. 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

July 29, 2021	1st Meeting of the Dover Hazard Mitigation Team
September 27, 2021	First Public Meeting held virtually by the Planning Board
October 9, 2021	2nd Meeting of the Dover Hazard Mitigation Team
November 29, 2021	3rd Meeting of the Dover Hazard Mitigation Team
January 24, 2022	Second Public Meeting held virtually by the Planning Board
TBD	Draft Plan Update submitted to MEMA
TBD	Draft Plan Update submitted to FEMA

TBD	Notice of Approvable Pending Adoption sent by FEMA
TBD	Plan Adopted by the Town of Dover
TBD	FEMA Formal Approval of the plan for 5 years

POST-PLAN APPROVAL: IMPLEMANTATION AND PLAN UPDATE TIMELINE

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

SECTION 4: RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town of Dover 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 Dover'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

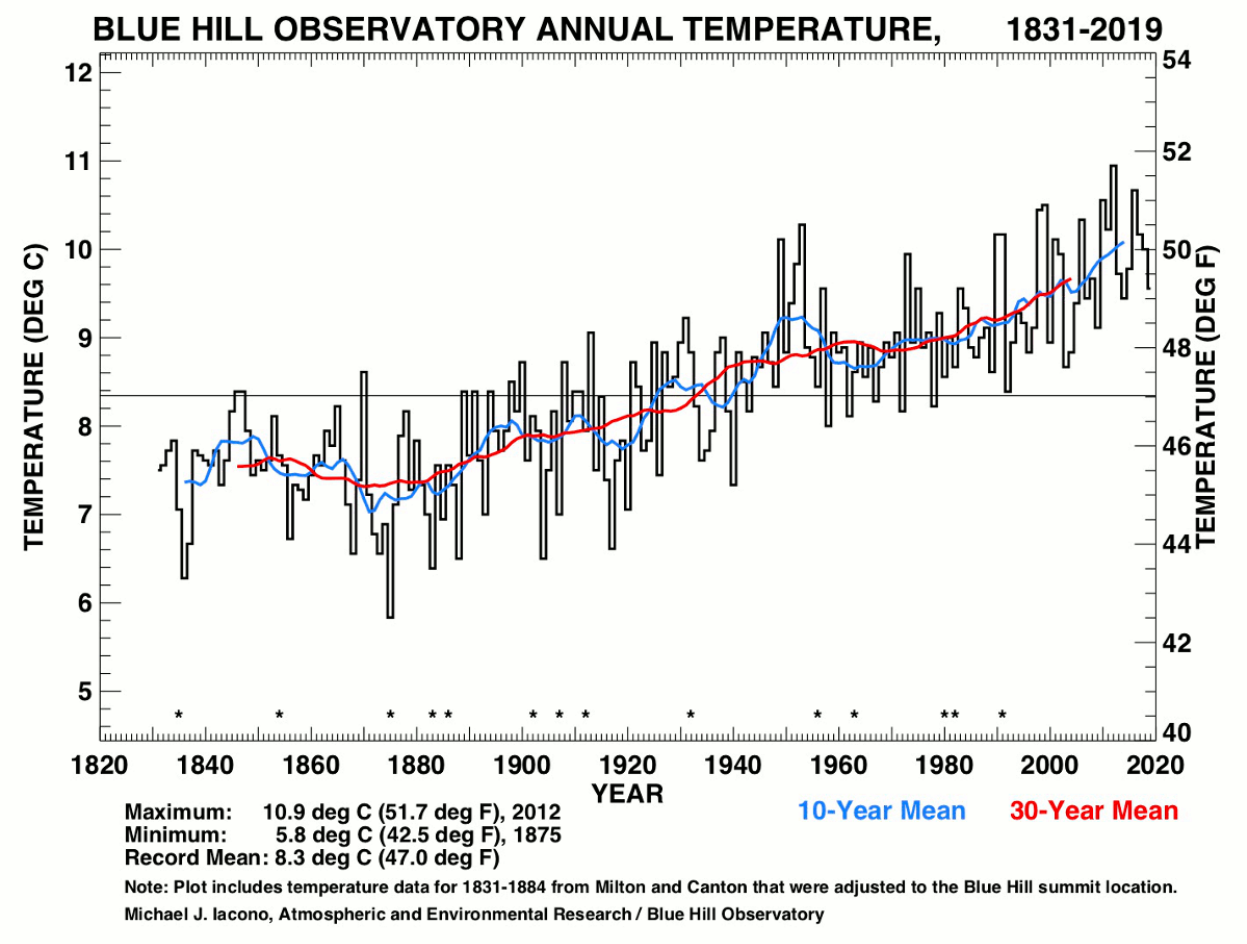
Climate change observations come from a variety of data sources that have measured and recorded changes in recent decades and centuries. Climate change projections, however, predict future climate impacts and, by their nature, cannot be observed or measured. As a result of the inherent uncertainty in 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, which blanket the earth. These gases trap heat that would otherwise be reflected out to space; without them our planet would be too cold to support life. We refer to these gases as "greenhouse gases" (GHGs) for their heat trapping capacity. The combustion of fossil fuels, our primary energy source in the age of industrialization, releases GHGs into the atmosphere. In the past century, human activity associated with industrialization has contributed to a growing concentration of GHGs in our atmosphere.

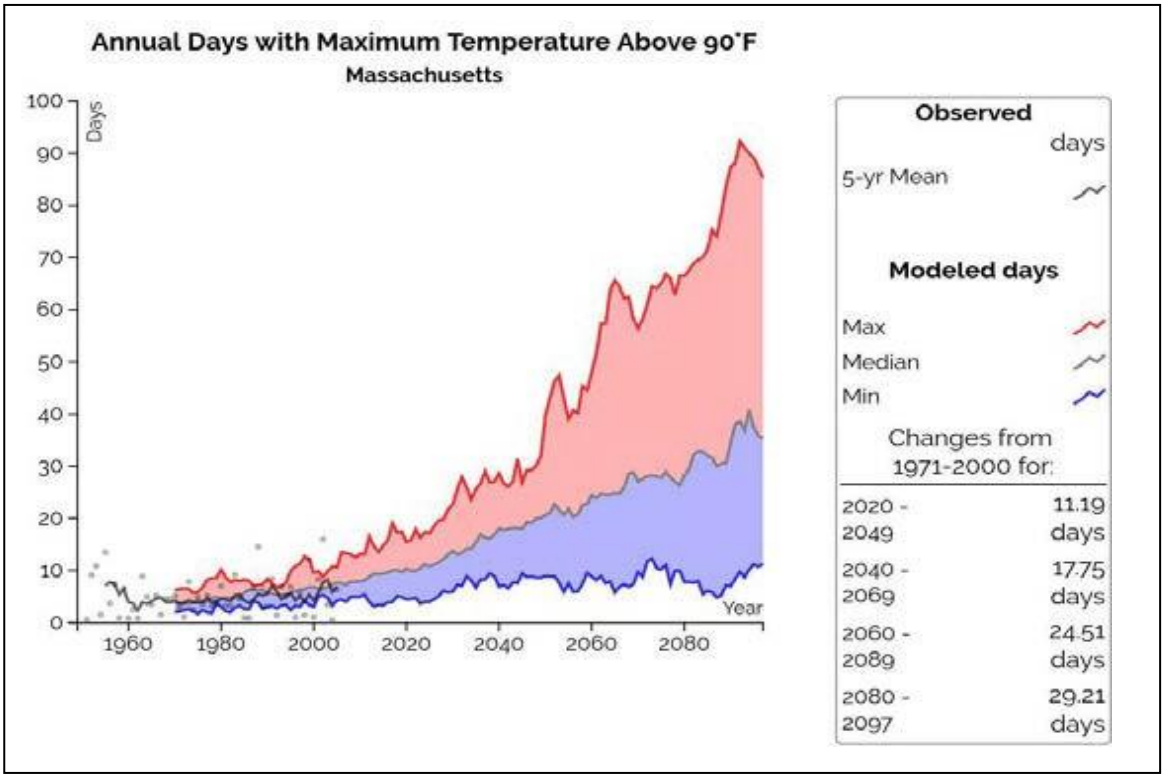
Records from the Blue Hill Observatory in Milton, MA show that average temperatures (30-year mean) have risen approximately 3 degrees (F) in the almost 200 years since record keeping began in 1831.

Figure 2: Observed Increase in Temperature



Climate projections include an increase in average temperature and in the number of extreme heat days. Extreme cold days are projected to decrease in number. The Northeast Climate Adaptation Science Center (NECASC) projects average temperatures in Massachusetts will increase by 5 degrees F by mid-century and nearly 7 degrees F by the end of the century. Figure 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



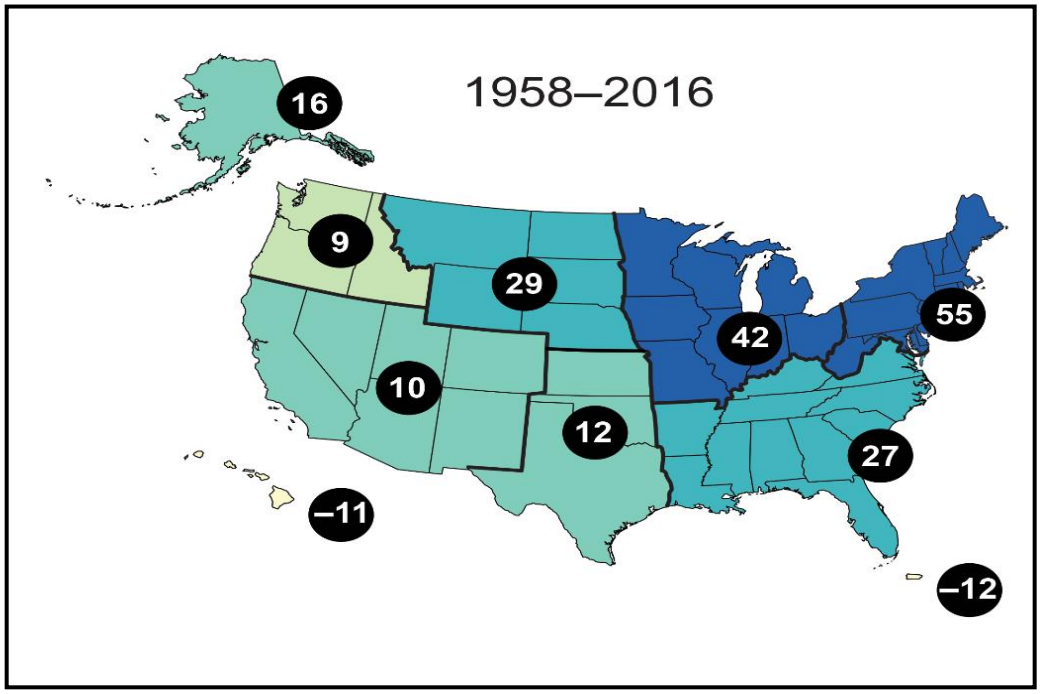
Source: Northeast Climate Adaptation Science Center

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).

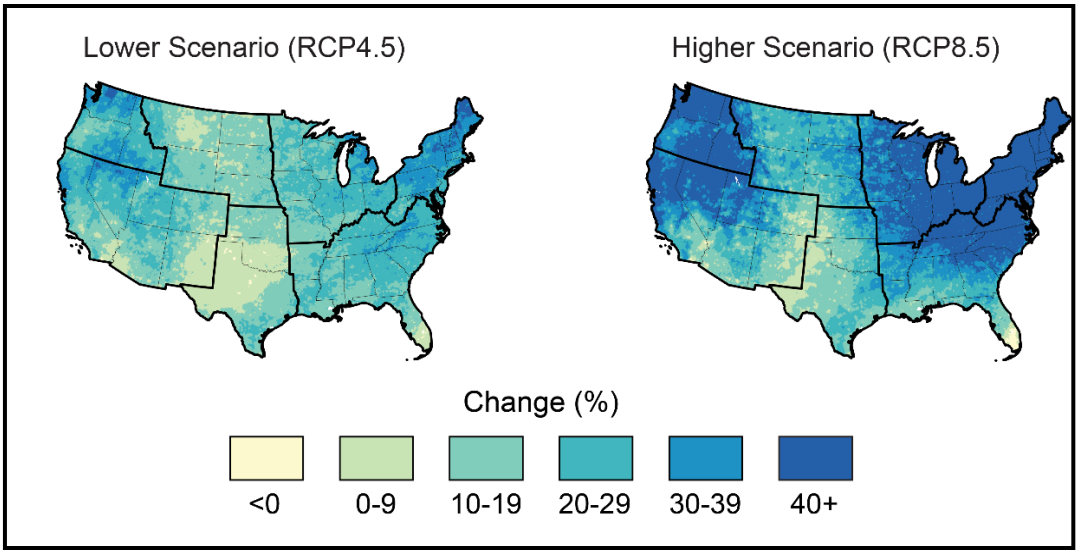
Figure 4 Observed Change in Total Annual Precipitation Falling in the Heaviest 1% of Events



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

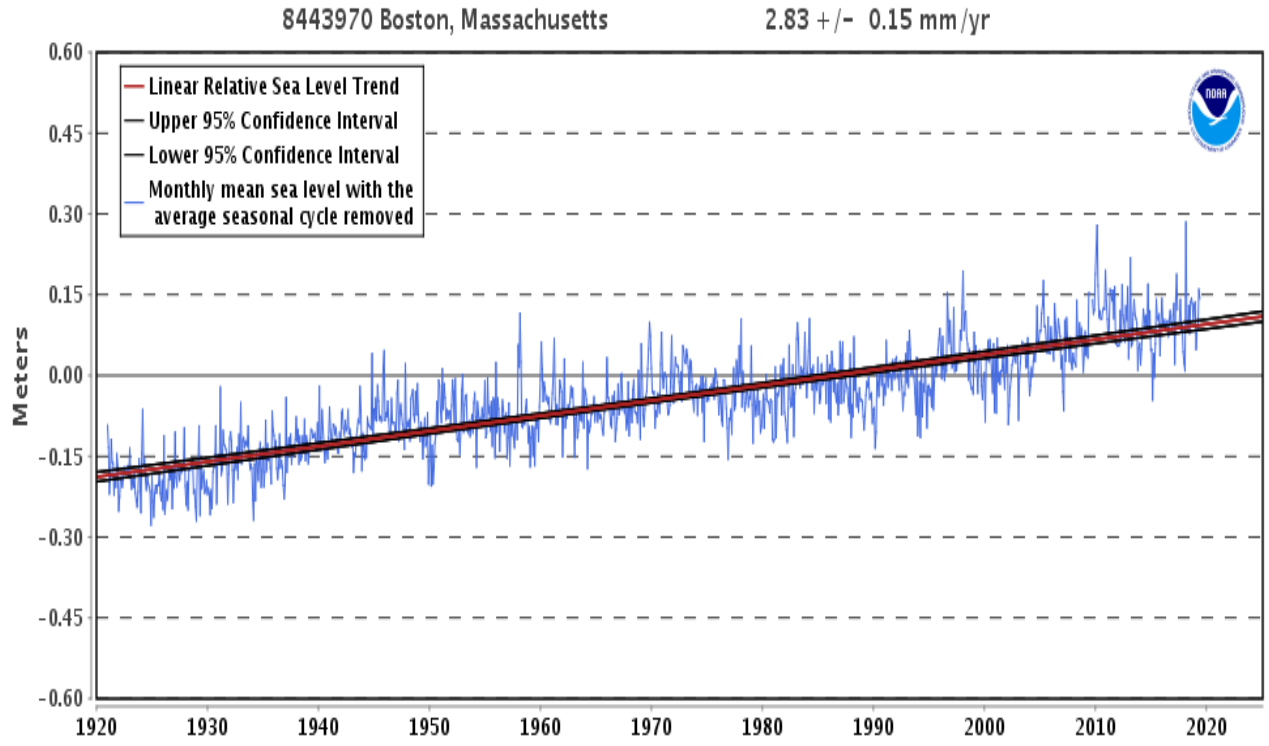


Source: Fourth National Climate Assessment, 2018

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 three ways. First, warm water expands to take up more space. Second, rising temperatures are melting land-based ice which enters the oceans as melt water. A third, quite minor, contributor to sea level rise in New England is not related to climate change. New England is still experiencing a small amount of land subsidence (drop in elevation) in response to the last glacial period.

Figure 6: Observed Increase in Sea Level Rise



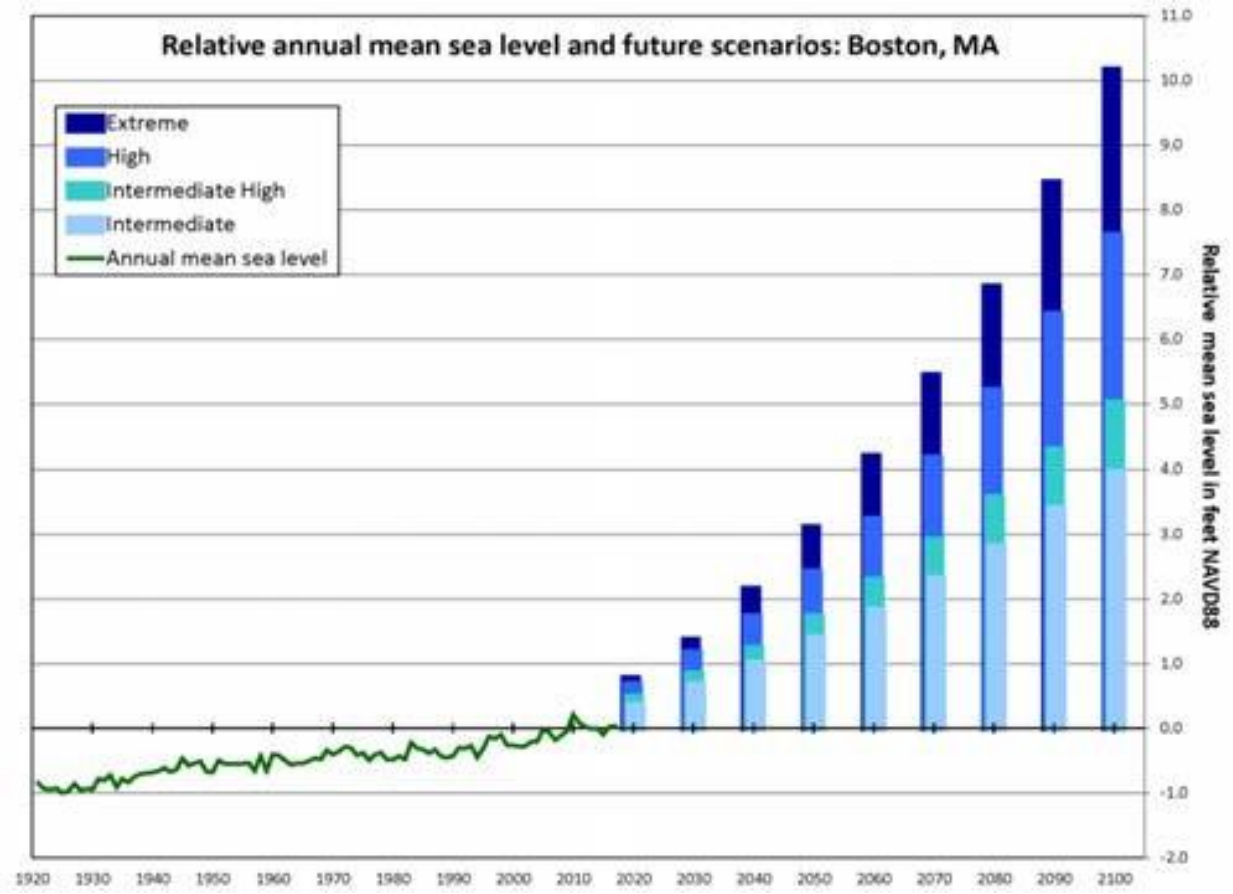
Source: NOAA

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.

Following the outline of the Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), this local hazard mitigation plan organizes consideration of natural hazards based on their relationship to projected climate changes. Table 5 below, from the SHMCAP, summarizes the natural hazards reviewed in this plan, climate interactions, and expected impacts.

Figure 7: Recent and Projected Increase in Sea Level Rise

1



Source: SHMCAP

Table 5: Natural Hazards and Climate Change

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

OVERVIEW OF HAZARDS AND IMPACTS

In order to update Dover'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. The risk assessment analyzes the potential natural hazards that could occur within the Town of Dover 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 using FEMA's damage estimation software, HAZUS-MH, which estimates the potential damages that could result from certain large scale natural hazard events.

Table 6 summarizes the frequency and severity of hazard risks for Massachusetts and Dover. The Massachusetts assessment is based on the State Hazard Mitigation Plan. The statewide assessment was modified to reflect local conditions in Dover using the definitions for hazard frequency and severity listed below. This evaluation takes into account the frequency of the hazard, historical records, and variations in land use. This analysis is based on the vulnerability assessment in the Massachusetts State Hazard Mitigation Plan. The statewide assessment was modified to reflect local conditions in Dover using the definitions for hazard frequency and severity listed below. Based on this, the Town set an overall priority for each hazard.

Table 6: Hazard Risks Summary

Hazard	Frequency		Severity	
	Massachusetts	Dover	Massachusetts	Dover
Flooding	High	Medium	Serious	Serious
Drought	Low	Medium	Minor	Serious
Hurricane/Trop Storm	Medium	Medium	Serious	Serious
Tornadoes	Medium	Very Low	Serious	Serious
Earthquakes	Very Low	Very Low	Serious	Serious
Thunderstorms	High	High	Minor	Minor
Nor'easter	High	High	Minor	Minor
Winter-Blizzard/Snow	High	High	Minor	Minor
Winter-Ice Storms	Medium	Low	Minor	Minor
Brush fires	Medium	Medium	Minor	Minor
Extreme Temperatures	Medium	Medium	Minor	Minor
Landslides	Low	Very Low	Minor	Minor
Dam failures	Very Low	Very Low	Extensive	Minor
Coastal Hazards	High	N/A	Serious	N/A

Source: Massachusetts State Hazard Mitigation Plan, modified for Dover

Definitions used in the Massachusetts State Hazard Mitigation Plan

Frequency

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

Severity

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

CHANGING PRECIPITATION PATTERNS: FLOODING

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

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

Dover is divided into two major watersheds. Except for its southeastern corner, most of Dover is in the Charles River watershed. The southeastern part drains into the Neponset River and has been declared a sole source aquifer. The tributary sub-basins in Dover that are within the Charles River basin include Trout Brook, Noanet Brook, Powisett Brook, and Mill Brook. Trout Brook is the largest drainage area in Town, and Noanet Brook is the second largest. Except for Mill Brook, which flows south and west into North Brook in Medfield and then into the Charles River, these brooks flow generally northward directly into the Charles River. The Dover portion of the Neponset watershed includes parts of the Bubbling Brook sub-basin and the Mill Brook (different from the Mill Brook in the Charles River basin),-and Tubwreck Brook.

Regionally Significant Floods

There have been a number of major floods that have affected the Metro Boston region over the last fifty years. Significant historic flood events have included:

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991
- October 1996 –
- June 1998 –
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- December 2010

The best available local data on previous occurrences of flooding is available for Norfolk County through the National Centers for Environmental Information (see Table 7). Norfolk County, which includes the Town of Dover, experienced 41 flood events from 2010 –2020. No deaths or injuries were reported and the total reported property damage in the county was $25.1 million dollars. Of that total, $24.9 million is attributed to the two major events of March 2010.

Table 7: Norfolk County Flood Events, 2010-2020

Date	Deaths	Injuries	Property Damage
03/14/2010	0	0	16.64M
03/29/2010	0	0	8.32M
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
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

Date	Deaths	Injuries	Property Damage
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
7/6/2019	0	0	0.00K
7/16/2019	0	0	0.00K
6/21/2020	0	0	0.00K
6/28/2020	0	0	14.70K
8/23/2020	0	0	2.00K
12/25/2020	0	0	0.00K
7/7/2021	0	0	0.00K
7/18/2021	0	0	0.00K
Total	**0**	**0**	**25.056 M**

Source: NOAA, National Centers for Environmental Information

The flooding vulnerability analysis estimates a range of damages from flooding of $456,138 to $2,280,692 (see Table 42).

The Storms of March 2010

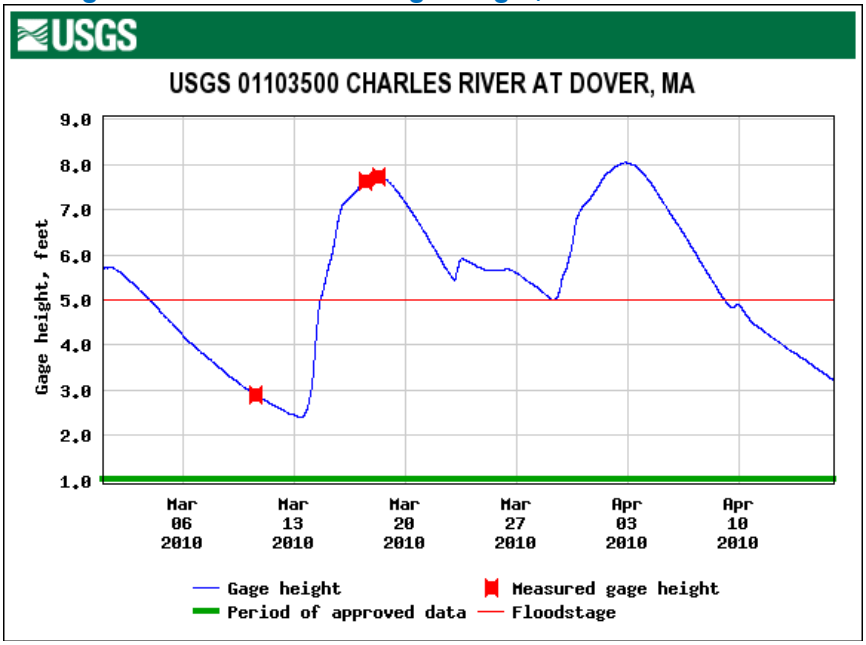
The most severe recent flooding occurred during the major storms of March 2010. The Blue Hill Observatory recorded 17.7 inches of rain from three storms in the 19 days from March 13 to 31. The weather pattern that caused these floods consisted of early springtime prevailing westerly winds that moved three successive storms, combined with tropical moisture from the Gulf of Mexico, across New England. Torrential rainfall caused March 2010 to be the wettest month on record.

One indication of the extent of flooding is the level of flow in the Charles River during this record flood. The river at the USGS gage in Dover exceeded flood stage of 5 feet on March 15, 2010 and rose to a peak of 7.9 feet on March 18 (Figure 8). The river peaked again on April 3 at 8.0 feet and the cumulative impact of multiple storms kept river levels above flood stage until April 10. All told, the river was above flood stage for 26 days.

The historic March 2010 rainstorms fit the profile of a type of event expected to increase in frequency as the climate warms. That is, significant precipitation, falling in late winter as rain rather than snow, on ground saturated with snow melt, and while vegetation is still dormant.

The March 2010 storms were a federally declared disaster making federal assistance available to residents who did not carry flood insurance. There were 42 claims in Dover, 38 of which were disaster claims and 4 of which were standard flood insurance claims. All but one of these claims were located *outside* of FEMA Special Flood Hazard Areas. See Map 3 in Appendix B for a general overview of claim locations.

Figure 8: Charles River Gage Height, March 2010 Floods



Source: USGS, National Water Information System

Figure 9: Charles River Flooding at Mill Street, March 2010

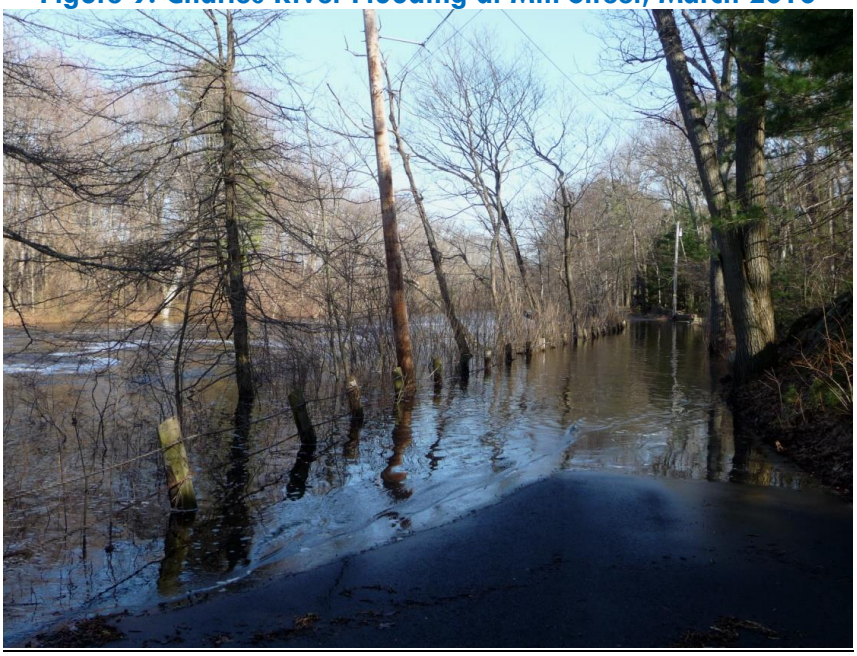


Photo: M. Pillsbury

Overview of Town-Wide Flooding Impacts and Vulnerability

Dover is primarily impacted by the Charles River, which creates a natural border for the town on its Western edge with Sherborn and then along its northern boundary with Wellesley and Needham. Dover's waterways also consist of tributary brooks, such as Trout Brook, Powissett Brook, and Mill Brook, as well as low-lying wetland areas, and naturally formed ponds. Flooding occurs in Dover on a routine basis, ranging from minor nuisance roadway flooding, to basement flooding, to roadway closures, and to bridge scouring. The causes can be due to proximity to floodplain, improperly functioning drainage systems, and beaver activity. More detail on specific flooding areas within the town is provided in the site-specific flooding section below. In the event of a large storm event, the greatest concerns are property damage, blockages of roadways or bridges vital for emergency response.

Potential Flood Hazard Areas

Information on potential flood hazard areas was taken from two sources. The first was the National Flood Insurance Rate Maps (FIRM). The FIRM flood zones are shown on Map 3 in Appendix B and their definitions are listed below. The FIRM maps currently in effect for Dover were adopted in 2021. The Flood Insurance Study (FIS) and FIRM maps are occasionally updated by FEMA, and it should be noted that an updated Preliminary Flood Insurance Study (FIS) and Preliminary FIRM's were issued by FEMA on June 19, 2020 and the FIS was revised on July , 2021. The preliminary FIRM maps have been posted to the FEMA website but have not yet been officially adopted. When the final FIRM maps are issued by FEMA, the Town will need to make a corresponding update to its local floodplain bylaw.

Flood Insurance Rate Map Zone Definitions

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

Zones X (.2% annual chance) **-** Zone X is the flood insurance rate zone that correspond to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone

As shown on Map 3 in Appendix A, Zone A areas in Dover include the wetlands along Noanet, Powissett and Trout Brooks, along a small brook that offshoots from Trout Brook near Springdale Avenue, wetlands around Lyman's Pond, a small patch at the southern end of Trout Brook, and a small pool o water north of Oak Hill and West of Center Street. Zone AE areas in Dover include

land all along the Charles River, and some wetlands along Trout Brook. Zone X zones in Dover include areas surrounding the AE zones along the Charles River and Trout Brooks. Additionally, X zones include a small patch of water just Northeast o Powissett Brook, wetlands at the Northern end of North Brook, a small patch of wetlands north o Oak Hill and east of Center Street, wetlands along the Westwood border near Powissett Peak, along Mill Brook and Snow Hill Lane.

The Norfolk County Flood Insurance study describes the flood issues of the Charles River:

> Charles River has caused flooding issues over the years as a result of hurricanes, snow melt combined with spring rains, and summer thunderstorms. The notable flood events along Charles River were the March 1936 snow melt and rainfall event, July 1938 rainfall event, August 1955 – two successive hurricanes in a one-week span, March 1968 snow melt and rainfall event, and spring 2010 which involved three large rainfall events over a five week period. Some bridges were overtopped and numerous roads in low-lying areas along the river were flooded. The July 1938, August 1955, and March 1968 flood events were about at a 2-percent annual chance flood, and the spring 2010 event was about a 4-percent annual chance flood, based on peak-flow data at the USGS Charles River at Dover stream gage (01103500). At the USGS Charles River at Waltham stream gage (01104500) further downstream, the spring 2010 event was about a 1-percent annual chance flood, and the 1938, 1955, and 1968 were between a 20- and 10-percent annual chance.
>
> Table 8 summarizes the historic flood elevations recorded for Dover in the FEMA Flood Insurance Study. Note that the

Table 8. Dover Historic Peak Flood Elevations

Flooding Source	Location	Peak (Feet NAVD88)	Event Date	Source of Data
Charles River	USGS stream gage Mill St., Dover	95.8	March 2010	USGS
Charles River	USGS stream gage Mill St., Dover	97.2	March 2010	USGS
Charles River	Chestnut St., Dover	93.6	March 2010	USGS
Charles River	Chestnut St., Dover	94.6	March 2010	USGS
Charles River	Central Street in Town of Dover	105.48	March 1968	USACE 1972
Charles River	USGS stream gage Mill St., Dover	98.0	March 1936	USACE 1972
Charles River	USGS stream gage Mill St., Dover	98.2	August 1955	USACE 1972
Charles River	USGS stream gage Mill St., Dover	97.7	March 1968	USACE 1972
Charles River	USGS stream gage Mill St., Dover	97.3	January 1979	USACE 1972

Source: FEMA, Norfolk County, MA Flood Insurance Study, July 2021

Locally Identified Areas of Flooding

In addition to the FEMA Flood Insurance Study and FIRM maps, information on areas of Dover subject to flooding was provided by the Local Hazard Mitigation Team. The Locally Identified Areas of Flooding described below were identified by Town staff as areas where flooding is known to occur. All of these areas do not necessarily coincide with the flood zones from the FIRM maps. Some may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone.

The following areas were identified by Town staff as areas that have experienced more significant flooding in the past. The numbers in parentheses refer to the Areas of Concern on Map 8 in Appendix B.

(1) Dedham Street at Needham town line – According to Hughes, this area is a low severity flood area with a frequency of once every ten years or so. There is an existing culvert that needs to be cleaned and maintained. The culvert had formerly been owned by the state, but is now under the care of the town. Hughes noted that this is a low priority flood area and noted that future maintenance of the culvert is the only further mitigation that is recommended at this time.

(2) **Turtle Lane near intersection of Dover Road** – Flooding severity here can be quite high as it has flooded homes and the road way in the past. Hughes estimated that flooding at Turtle Lane occurs every other year or so and indicated that there is no existing flood mitigation here, because the road is a private way. Hughes also said that he believes residents of Turtle Lane would object to the town taking any action there on their behalf, but said that the impacted area could use some study and that it might be possible to convince residents of the need to elevate utilities to avoid flooding damage. Priority to take corrective action here would be high, but again Hughes said that residents of the neighborhood accept it and rarely complain of or even report the flooding. The road is built right along the banks of the Charles River and several homes there are close to the water's edge.

(3) **Clay Brook Road, near Cullen Road** – Hughes rated this area as a moderate severity flooding hazard with flooding occurring approximately every seven years. There is an existing culvert that Hughes said is probably too small to handle large rain events, especially when coupled with spring runoff. Hughes and Homer suggested that enlarging/replacing the existing culvert would be the best way to address the problems here, but said that the priority to do something here was only moderate.

(4) **Clay Brook Road at Trout Brook** – This area is a severe flood threat, with flooding occurring every other year, and it is close to where Trout Brook merges with the Charles River. According to Hughes, there is an existing culvert under the road at this spot, but the culvert is not large enough to handle flow during heavy rain events, particularly during the spring, when snow melt is also impacting the brook. Enlarging the culvert is one option, but no plan for such a project has been put forward to this point. Still, Hughes indicated that this would be a high priority project for his department.

(5) **Wilsondale Street at Powissett Brook** – This is described as a low severity flooding threat, with rare or infrequent flooding, which is related to a small private dam in the area, which is manually controlled with the placement of boards or planks. There is an existing culvert beneath Wilsondale Street, that could be enlarged to alleviate the rare flooding and Hughes indicated that this would be a moderate priority for the town.

(6) **USGS gauging station at Mill Street on the Charles River** – This is a rare flooding threat with low severity. Homer estimated that the area floods every 10 years or less. There is no existing mitigation and Hughes indicated no need to develop mitigation for the site.

(7) **544 Yorkshire Road** – This hazard is considered a moderate flooding hazard, with a frequency of every five to seven years, but the flooding doesn't typically impact the home itself. There is no existing mitigation for the site and Hughes indicated that raising the utilities or septic system might be a possible mitigation measure, but indicated that the river would have to rise eight- to ten-feet in order to impact the home that severely. This would be a moderate priority.

(13) **USGS gauging station at Haven Street on Trout Brook** – This is considered a moderate flooding threat, occurring every ten years. There is an existing culvert and Hughes indicated that expansion of that culvert would likely reduce the frequency and severity of flooding here.

(14) **Claybrook Road** – Charles River flooding and bank erosion opposite 140 Claybrook Road.

(15) **Willow Street** – Charles River/Noanet Brook flooding and bank erosion.

Repetitive Loss Structures

As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. For more information on repetitive losses see http://www.fema.gov/business/nfip/replps.shtm.

There are no repetitive loss structures in the Town of Dover.

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

Climate Change and Future Flooding

As the climate continues to warm, more intense precipitation has been observed since the mid-20th century (see Figure 4) and is expected to accelerate in future decades (see Figure 5). How much this trend increases in the future will depend on the degree to which Greenhouse Gases (GHG) are controlled in this century, thus the two scenarios shown in Figure 5, for lower and higher GHG emissions projected to 2070-2099.

To assess how these global trends may affect the Charles River Watershed, which includes the Town of Dover, the Charles River Watershed Association (CRWA)and15 communities in the watershed worked together to develop the Charles River Flood Model to identify areas vulnerable to flooding under future climate conditions. The following description of the project comes from the Charles River Watershed Model final report prepared by Weston and Sampson for the Charles River Watershed Association under a Municipal Vulnerability Preparedness grant.

The project resulted in an interactive display of model results showing areas in the upper and middle Charles River watershed at risk from projected flooding events. The model was developed for the watershed area draining to the Watertown Dam and comprises of over 270 square miles. This represents the upper/middle Charles River watershed, which includes Dover. The Charles River Flood Model represents the impacts of flooding across the watershed from various types and sizes of rainstorms under both present and future climate scenarios and can also be used to test the efficacy of various flood mitigation measures. This model will help the region take steps to protect the people, property and nature in the watershed.

Future rain events can impact between 1,200 and 1,900 additional acres of watershed that are not flooded under current conditions, depending on the type of the storm. Additionally, many areas that currently experience modest or nuisance flooding are likely to experience more severe flooding as a result of larger and more frequent storms . This increased flooding could also impact additional critical facilities and infrastructure and climate vulnerable residents.

The model's future scenarios are based on projections of precipitation patterns for 2030-2050 and 2070-2090. The model assesses ten different 24-hour duration rainstorms:

- **Present day:** 2-, 10-, and 100-year events
- **2030:** 2-, 10-, and 100-year events
- **2070:** 2-, 10-, and 100-year events
- **Mystic River 2070:** 100-year event (an extreme rainfall event of 11.7 inches)

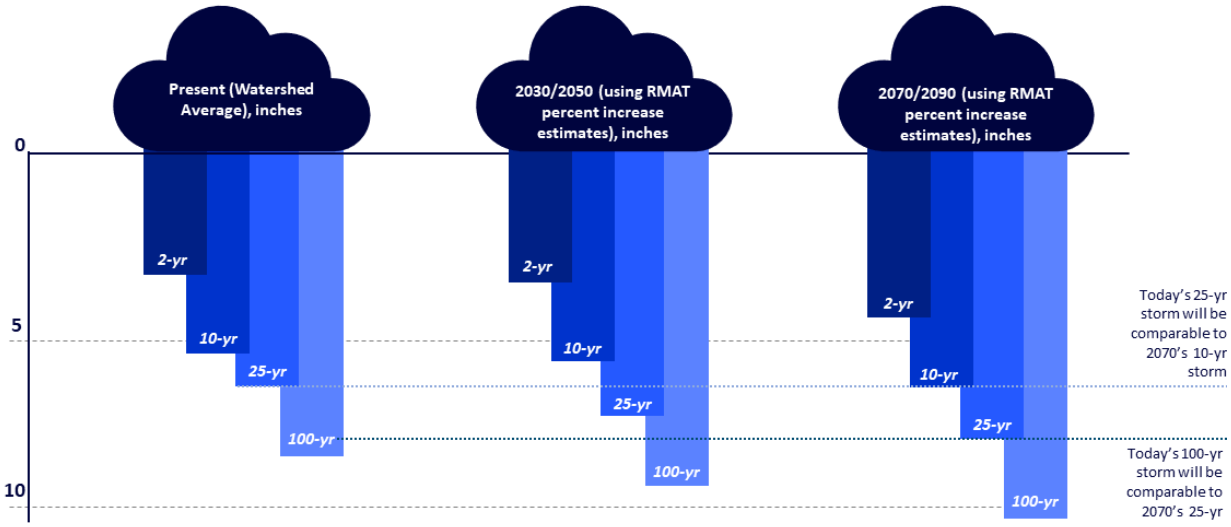
The present-day baseline precipitation is based on NOAA Atlas 14, a widely used standard by government agencies, engineers, and developers. Future increases in precipitation above the Atlas 14 baseline were applied using projections from the Massachusetts RMAT tool, which projects an increase of 8% to15% for 2030/2050 and from 20% to 36% for 2070/2090. Based on these increases, the future scenarios for storms from 2-year to 500-year are shown in Table 9 and are illustrated in Figure 10.

Table 9: Proposed Design Rainfall Depths for Future Storms in the Charles River Watershed

Recurrence Interval	Present (Watershed Average), inches	2030/2050 (using RMAT percent increase estimates), inches	2070/2090 (using RMAT percent increase estimates), inches
2-yr	3.34	3.60	4.00
10-yr	5.20	5.62	6.25
25-yr	6.37	6.88	7.64
100-yr	8.17	9.07	10.37
500-yr	11.12	12.79	15.12

Source: Charles River Watershed Association

Figure 10: Projected future increase in precipitation scenarios in the Charles River Watershed Model



Source: Charles River Watershed Association

The Charles River stormwater flood model is capable of estimating peak and total runoff from more than 700 sub-catchments within the watershed; peak and total runoff in nearly 200 miles of the Charles River and its tributaries; of estimating peak water levels and flood depths at more than 450 dams and bridge crossings; and of estimating flood levels, depths, and extents throughout nearly 19,000 acres of floodplain.

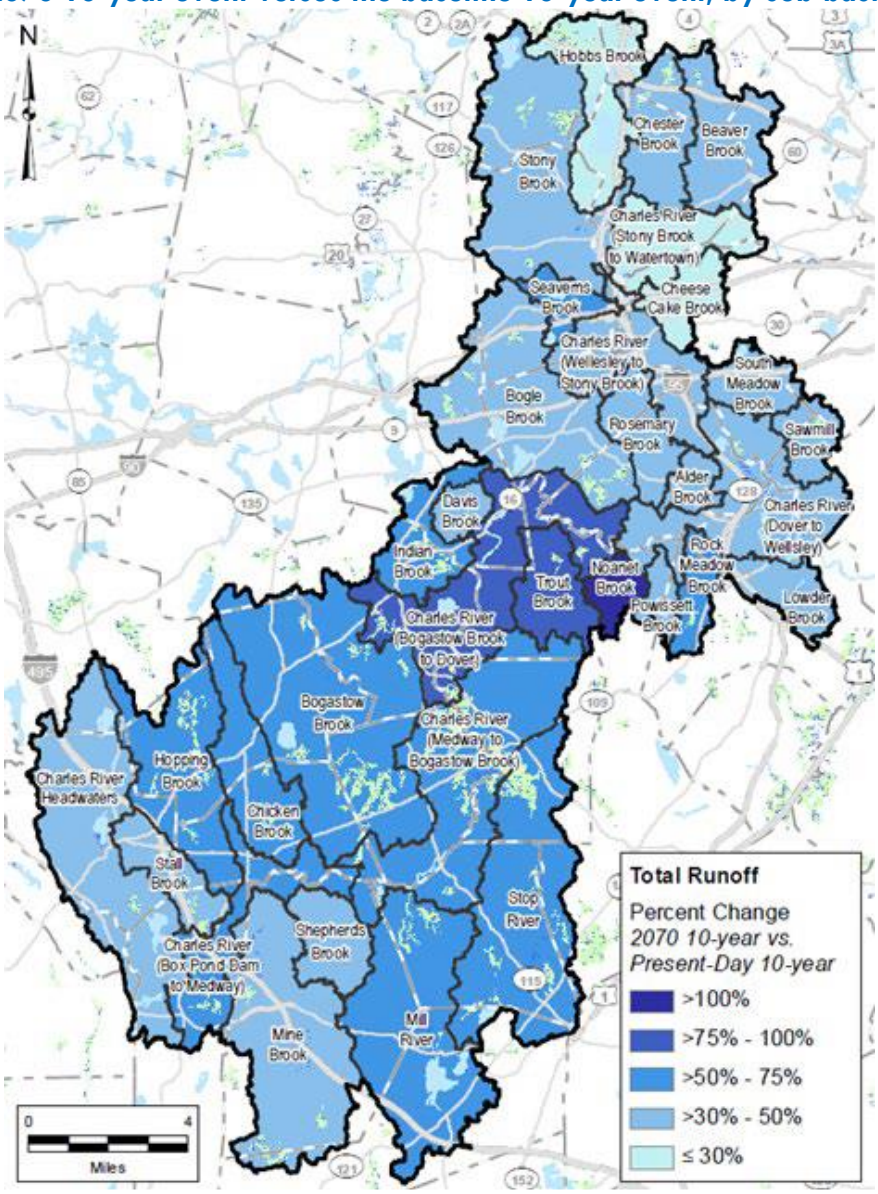
On average watershed-wide, flood prone areas in the Charles River watershed are projected to increase by 1,685 acres for the 10-year storm by 2070, a 23% increase. For the 100-year storm the projected increase is 1.433 acres, a 13% increase in flood prone areas (Table 10). However, there is considerable variability in different sub-basins throughout the watershed in the anticipated increase in flood-prone area. Several sub-basins, including Powissett Brook in Dover, are all expected to experience minimal increases in flooding extents. In contrast, Trout Brook, also in Dover, is expected to experience a more than 100% increase in flood-prone areas for the 10-year storm by 2070 (see Figure 11 and Table 11).

Table 10: Change in flooding Between Present and 2070, Charles River Watershed

		Acres of flooding (ac)	Runoff Volume (MG)
2-yr Storm	Present	3,490	3,053
	2070	4,719	4,264
	Increase from Present	*+1,229 (+35%)*	*+1,211 (+40%)*
10-yr Storm	Present	7,243	7,368
	2070	8,928	10,651
	Increase from Present	*+1,685 (+23%)*	*+3,283 (+45%)*
100-yr Storm	Present	11,067	17,321
	2070	12,500	25,568
	Increase from Present	*+1,433 (+13%)*	*+8,247 (+48%)*
Mystic 100-yr Storm	2070	13,001	30,794
	Increase from Present	*+1,934 (+18%)*	*+16,473 (+95%)*
March 2010 Storm (8.99 inches)		10,446	20,831

Source: Charles River Watershed Association

Figure 11: Percent increase in total runoff volume during the 2070 10-year event versus the baseline 10-year event, by sub-basin



Source: Charles River Watershed Association

Table 11: Summary of Inundation for Baseline and 2070 10-year Events for Sub-basins in Dover

Sub-Basin	Inundated Area (acres)		
	Baseline	2070	% Change
Noanet Brook	0	0	0%
Powissett Brook	40	40	0%
Trout Brook	46	92	100%
Total	**86**	**132**	**35%**

Source: Adapted from Charles River Watershed Association

The project also considered the benefits of six mitigation strategies, summarized in Table 12.

Table 12: Change in Flooding Between Present and 2070, Charles River Watershed

Category	Scenario Number	Strategy
Green Stormwater Infrastructure	1	Green stormwater infrastructure (GSI) stores 2" storm runoff from up to 50% of all impervious cover town-wide
	2	20% of feasible/priority land area is GSI
	3	Storage on large (>5 acres) public properties (GSI, underground storage, "blue roofs")
Reduce Impervious Cover	4	Reduce effective impervious cover watershed wide by 10% (for subbasins over 10%)
Land Conservation	5	Allow 50% of remaining undeveloped/unprotected land to become impervious
Increase Tree Canopy	6	25% public ROWS become green streets: tree box filters/bioswales connected to leaching catch basins

Source: Charles River Watershed Association

The watershed model estimated the change in inundated area and critical facilities impacted by each of the six mitigation strategies. An example of mitigation strategy #2 is shown in Table 13.

Table 13: Change in flooding between present and 2070, Charles River Watershed

Mitigation 2 Scenario Results for the Present and 2070 10-year Storm	Critical Facilities Impacted	Inundated Area (acres)	Total Runoff (MG)
Present 10-yr storm – No Action	53	7,243	7,368
Present 10-yr storm + Green Infrastructure Scenario 2	45	6,694	6,493
Change from No Action	**-8 (-15%)**	**-549 (-8%)**	**-875(-12%)**
2070 10-yr storm – No Action	56	8,928	10,651
2070 10-yr storm + GI Sc 2	55	8,501	9,817
Change from No Action	**-1 (-2%)**	**-427 (-5%)**	**-834 (-8%)**

Source: Charles River Watershed Association

Dams and Dam Failure

Dam failure can occur as a result of structural failure, independent of a hazard event, or as the result of the impacts of a hazard event such as flooding associated with storms or an earthquake. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters.
Dam failure is a highly infrequent occurrence, but a severe incident in certain locations could result significant property damage. Since 1984, three dams have failed in Massachusetts, one of which resulted in a death. There have been no recorded dam breaches in Dover.

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 event.

According to data provided by the Massachusetts Department of Conservation and Recreation (DCR) and the Town, there are three dams located in Dover, all classified as Low Hazard dams. Cochrane Dam on the Charles River is owned by DCR and was rebuilt by the state about 18 years ago. The Willow Street Spillway is also a CR owned facility. The Worthington Pond Dam is privately owned by the Hale Reservation. The dams are summarized in Table 14.

Table 14: DCR Inventory of Dams

Dam Name	River/Pond	Owner	Hazard Classification
Cochran Dam	Charles River	DCR Flood Control	Low
Willow Street Bypass Dam	Charles River	DCR Flood Control	Low
Worthington Pond Dam	Worthington Pond	Hale Reservation	Low

Source: Mass. DCR Inventory of Dams

DCR defines dam hazard classifications as follows:

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

Based on the record of no previous occurrences dam failure in Dover this is a Very Low frequency event as defined by the Massachusetts State Hazard Mitigation Plan. This hazard may occur less frequently than once in 100 years (less than 1% chance per year).

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 known history of ice jams leading to flooding in Dover and the local team did not identify this hazard as an issue for the Town.

CHANGING PRECIPITATION PATTERNS: DROUGHT

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

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

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

Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. The DCR precipitation index divides the state into seven regions: Western, Central, Connecticut River Valley, Northeast, Southeast, Cape Cod, and Islands. Dover is located in the Northeast Region. In Dover drought is a potential town-wide hazard.

The Massachusetts Drought Management Plan was revised in 2019 to change the state's classification of droughts by establishing four levels to characterize drought severity: Mild Drought, Significant Drought, Critical Drought, and Emergency. These levels are based on conditions of natural resources and provide information on the current status of water resources. The levels provide a framework from which to take actions to assess, communicate, and respond to drought conditions. The Massachusetts drought levels are shown in comparison to the U.S. Drought Monitor levels in Table 15. The two sets of drought indices are similar, but Massachusetts combines the USDM's level D2 and D3 into one category, Critical Droughts.

Drought levels are used to coordinate both state agency and local response to drought situations. Water restrictions might be appropriate at the significant drought stage, depending on the

capacity of each individual water supply system. A critical drought level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which mandatory water restrictions or use of emergency supplies is necessary.

Table 15: US Drought Monitor Compared to MA Statewide Drought Levels

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

Source: Massachusetts Drought Management Plan, 2019

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

1. Standardized Precipitation Index (SPI) reflects soil moisture and precipitation.
2. Crop Moisture Index: (CMI) reflects soil moisture conditions for agriculture.
3. Keetch Byram Drought Index (KBDI) is designed for fire potential assessment.
4. Precipitation Index is a comparison of measured precipitation amounts to historic normal precipitation.
5. The Groundwater Level Index is based on the number of consecutive month's groundwater levels are below normal (lowest 25% of period of record).
6. The Stream flow Index is based on the number of consecutive months that stream flow levels are below normal (lowest 25% of period of record).
7. The Reservoir Index is based on the water levels of small, medium and large index reservoirs across the state, relative to normal conditions for each month.

Table 16 shows the range of values for each of the indices associated with the drought levels. Because drought tends to be a regional natural hazard, this plan references state data as the best available data for previous drought occurrences.

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

Table 16: Indices Values Corresponding to Drought Index Severity Levels

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

Source: Massachusetts Drought Management Plan, 2019

Previous Occurrences

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

Drought Emergency

Drought emergencies have been reached infrequently, with five events occurring in the period since 1879: in 1883, 1911, 1941, 1957, and 1965-1966. The 1965-1966 drought period is viewed as the most severe drought to have occurred in modern times in Massachusetts because of its long duration.

Drought Warning

Drought Warning levels not associated with drought Emergencies have occurred five times since 1879, in 1894, 1915, 1930, 1985, 2016 and 2019.

Drought Watch

Drought Watches not associated with higher levels of drought generally have occurred in three to four years per decade between 1850 and 1950. In the 1980s, there was a lengthy drought Watch level of precipitation between 1980 and 1981, followed by a drought Warning in 1985. A frequency of drought Watches at a rate of three years per decade resumed in the 1990s (1995, 1998, 1999). In the 2000s, Drought Watches occurred in 2001-2003, 2007-2008, 2010, 2014, and 2021.

A summary of Massachusetts historic drought events since 1879 is shown in Table 17. It should be noted that this table was prepared for the 2019 Drought Management Plan, so it does not include the droughts of 2020 (Level 3) and 2021(Level 2).

Table 17 - Chronology of major droughts in Massachusetts

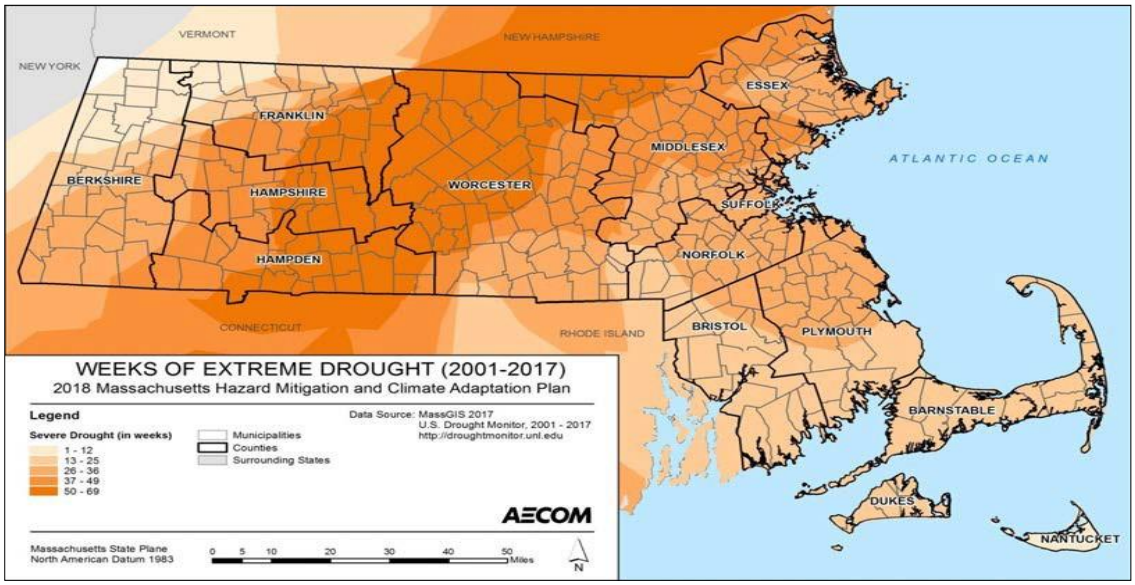
Date	Area affected	Recurrence interval (years)	Remarks	Reference
1879-83	–	–	Kinnison 1931 referenced these periods as two of three worst droughts on record in 1931, the third being the then current drought of 1929-1932.	Kinnison 1931
1908-12	–	–		
1929-32	Statewide	10 to >50	Water-supply sources altered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

Source: Massachusetts Drought Management Plan, 2019

As shown in Table 15, another measure of drought is the U.S. Drought Monitor, which characterizes droughts as abnormally dry, moderate, severe, extreme, and exceptional. Extreme drought is characterized by likely crop and pasture losses, water shortages, and water

restrictions. As shown in Figure 12, Dover experienced between 26 and 36 weeks of severe drought between 2001 and 2017.

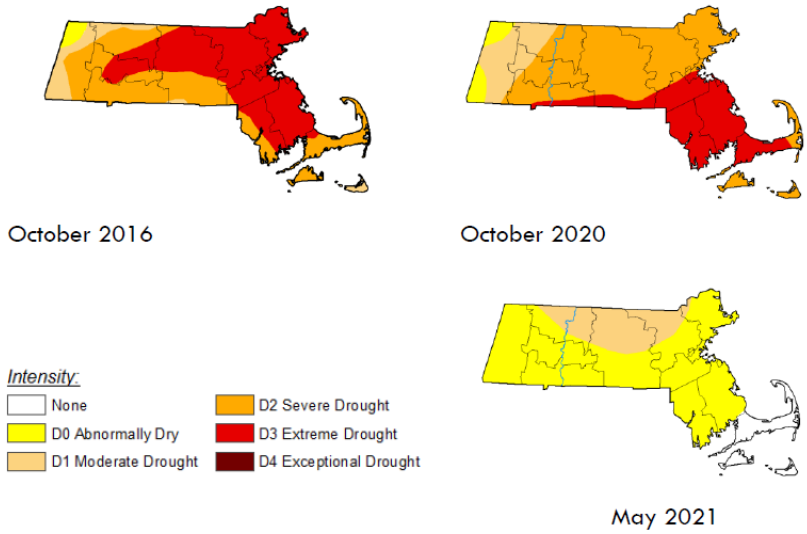
Figure 12: Weeks of Extreme Drought (2001-2017)



Source: SHMCAP

In just the last five years there have been three droughts in Massachusetts. The drought of 2016 was the worst one since 1985, with more than half of the state reaching the Extreme Drought stage for several months (Figure 13). This was followed by another drought four years later in 2020, which was most severe in Southeastern Massachusetts, including Norfolk County. Finally, in the early spring of 2021 a third, milder, drought was declared. By the summer of 2021 conditions in the northeast region improved.

Figure 13: Recent Massachusetts Drought Events (2016-2021)



Source: U.S. Drought Monitor

Potential Drought Vulnerability

The town's vulnerability to drought could include impacts on public and private water supplies, agriculture, aquatic ecology, wildlife, and fire hazard. The Town of Dover depends on wells for its public and private water supplies, and prolonged drought could lower water tables and reduce the amount of water available from pumping wells. Lowering the water table could also result in reductions in water quality. A severe drought could also increase the risk of wildfire on forested lands and other vegetated areas, which are a dominant feature of Dover.

The Town is particularly vulnerable to drought because of its near total reliance on limited local groundwater resources that are already showing concerning signs of stress on both water quantity and water quality. According the 2020 hydrology report prepared for the Town by Kleinfelder:

> Two-thirds of the Town of Dover's residents obtain their domestic water supply from private wells. A small percentage of residents are served by the Natick and Walpole municipal systems. The remainder of residents are primarily served by privately owned public water suppliers operating supply wells installed in the sand and gravel aquifers within the Town of Dover. These gravel aquifers, depicted on Plate 1, are typically shallow and limited in area and capacity. The Dover Board of Health (BOH) is the local regulatory authority for new private wells in Dover. Over the past several years, the Board has seen an increase in reported problems with private wells. MassDEP records indicate that between 2007 and 2017 in Dover, 134 wells have either been decommissioned, drilled deeper, or hydrofractured to increase yield. In addition, concerns about streams and wetlands drying out were raised, with reports of some perennial streams becoming intermittent.

The seven public water systems supplied by groundwater wells in Dover are shown in Table 18. By far the largest of these is the Colonial Water company, which operates seven gravel pack wells and provides water to 1,674 residents, about 25% of the town's population.

Table 18: Public Water Systems Supplied by Wells in Dover

System Name	PWS ID#	Dover Population Served[1]	System Type	Notes	Average Daily Pumping [2] (gal/d)
Colonial Water	3078006	1,674	Community	7 active gravel wells	146,284
Springdale Farms Trust (Colonial Water purchased 2018)	3078008	150	Community	2 gravel wells	18,987
Town of Dover Water Dept	3078000	500	Non-Transient-Non-Community (school)	Caryl Park Well (gravel)	1,795
Old Farm Rd. Water Trust	3078001	40	Community	Bedrock Well	3,410
Glen Ridge Trust	3078002	122	Community	Purchases water from Natick	12,042
Meadowbrook Water Trust	3078005	57	Community	Purchased water from Natick	5,031
Precious Beginnings	3078010	44	Transient Non-Community (day care)	Day care center	80

(1)Service population is from MassDEP ASR
(2) Average Daily Pumping from MassDEP ASR 2009 - 2017

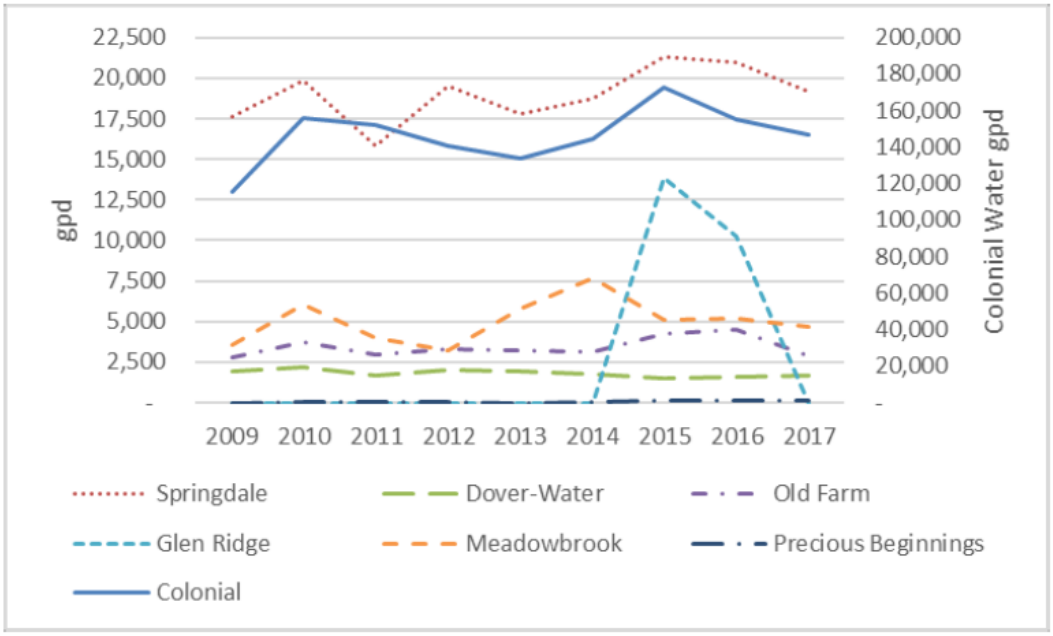
Source: Kleinfelder, Town of Dover Hydrology Report, 2020

The Kleinfelder hydrology report also notes that:

> Concurrently, the Board of Health had also noted instances of public water suppliers (PWS) reporting usage exceeding state conservation standards and permitted withdrawal limits. Evaluation of the local public water systems (PWS) records provided evidence of highest usage in the warmer months with peaks in July through September, during the time of year that groundwater levels are often lowest. This indicates excessive household seasonal non-essential outdoor water use.
>
> • Colonial Water has the highest Average Daily Demand (ADD) and serves the largest population. The ADD ranges between 115,000 to 172,000 gallons per day (gpd);
>
> • Colonial Water exceeded its Water Management Act Permit allocation in 7 of the last 9 years. During 2015 this exceedance was 33% higher than its Permit limit.
>
> • The Springdale Farms PWS (a part of Colonial Water Company since 2018) has the second highest ADD and a small population (150). Springdale Farm's ADD ranges between 15,000 to 21,000 gallons per day.
>
> • The Dover Water Department has the second highest population and the second lowest ADD, which reflects the fact that it serves a school instead of residences. The ADD ranges between 1,500 to 2100 gpd.

Recent trends in water demand among the seven public water supplies is shown in Figure 14.

Figure 14: Average Daily Demand for PWSs, 2009-2017 (gallons per day



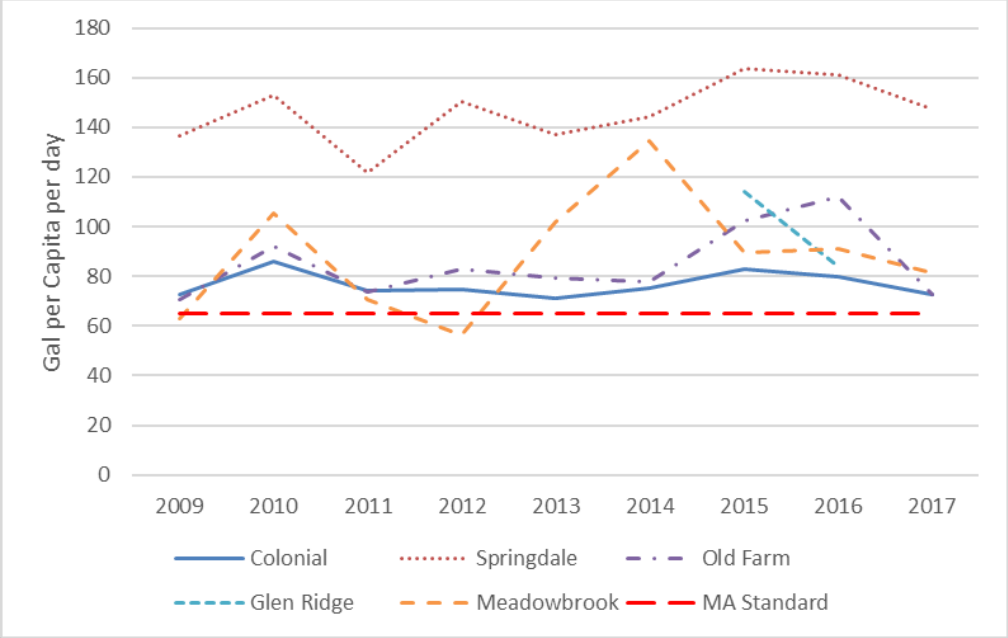
Source: Kleinfelder, Town of Dover Hydrology Report, 2020

Figure 15 translates the Average Daily Demand into residential gallons per capita day (RGPCD) for the five community water systems. The RGPCD is the estimated domestic

water usage per person. Higher rates can be indicative of more frequent summer lawn watering and/or other outdoor uses, or of plumbing fixtures not meeting state plumbing code efficiency standards. The Massachusetts RGPCD Standard is 65 gal/capita/day and is depicted in the figure as the red dashed line. Colonial Water, Springdale Farms, Old Farm, Glen Ridge, and Meadowbrook all have RGPCD over the Massachusetts standard, with Springdale Farms over twice the standard.

Given these exceedances, according to Water Management Act permit conditions, the PWSs exceeding the standard must file an RGPCD Compliance Plan with MassDEP. This Plan must include a description of actions taken each year to meet the standard, an analysis of cause of failure, and a description of proposed actions to meet the standard.

Figure 15: Residential Gallons per Capita per Day (2009-2017)



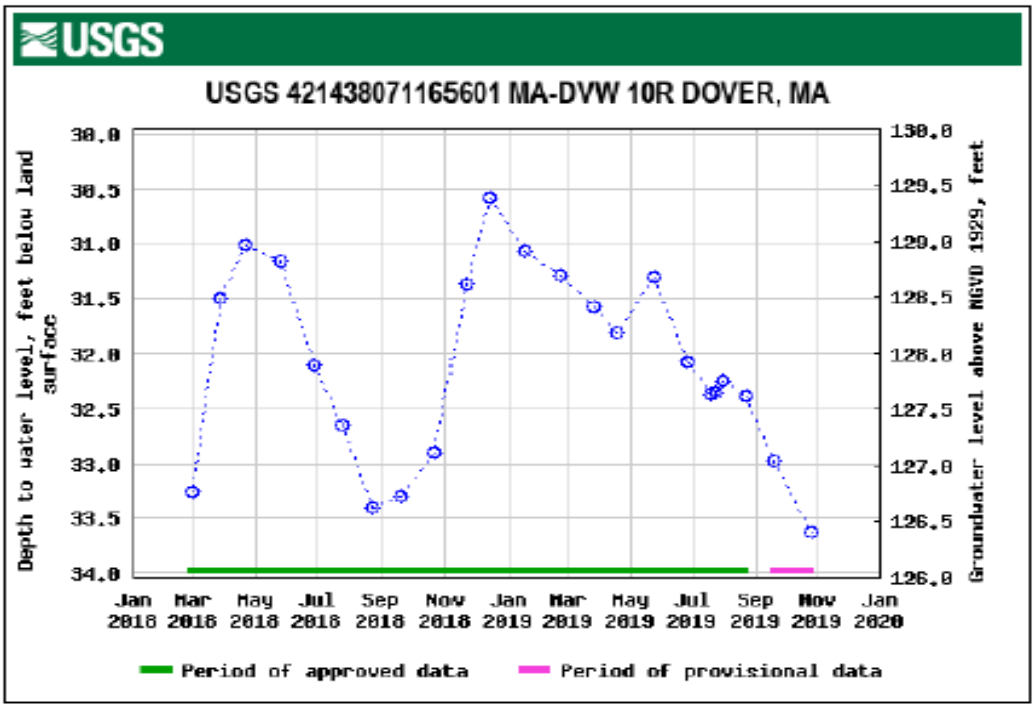
Source: Kleinfelder, Town of Dover Hydrology Report, 2020

Dover's groundwater resources are also vulnerable to degraded water quality due to droughts. Excessive withdrawals from the aquifer can have a negative impact on the quality of the groundwater, as the Kleinfelder hydrology report explains:

> Groundwater recharge areas for public water supply wells (designated by MassDEP as 'Zone II's), which are protected from certain incompatible land uses, are established based on approved pumping rates listed in PWS Water Management Act withdrawal permits. Pumping that significantly exceeds those permit limits has the potential to negatively impact water availability in Dover aquifers, and to mobilize contamination sources, **particularly during droughts such as the significant drought of 2016 (emphasis added)**. Excessive seasonal non-essential outdoor water use is of particular concern- both by PWS pumping from wells within in Dover, but also potentially by private residential or commercial well owners. The enforcement of non-essential outdoor water use restrictions is the best strategy for preventing excessive aquifer drawdown during summer when groundwater supplies, as well as streams and wetlands, are more vulnerable.

The combination of high groundwater withdrawals with drought results in excessive drawdown of the aquifer and presents the greatest vulnerability to the sustainability of the Town's water supplies. The US Geologic Survey maintains two groundwater monitoring wells in Dover. The records of groundwater levels from January 2018 to January 2020 is shown in Figure 16. The drawdown of the water table during the summer months is evident.

Figure 16: Average Daily Demand for PWSs (2009-2017), gallons per day



Source: USGS, National Water Information System

Droughts and Climate Change

Droughts are projected to increase in frequency and intensity in the summer and fall as weather patterns change. Factors contributing to this include increasing evaporation as a result of warmer weather, earlier snow melt, and more extreme weather patterns..

Probability of Future Occurrences

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 19).

Table 19: 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: Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018

LANDSLIDE HAZARDS

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

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

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

There is no universally accepted measure of landslide extent but it has been represented as a measure of the destructiveness. Table 20 summarizes the estimated intensity for a range of landslides. For a given landslide volume, fast moving rock falls have the highest intensity while slow moving landslides have the lowest intensity.

Table 20 Landslide Volume and Velocity

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

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

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

Dover is classified as having a low risk for landslides (MAP 4, Appendix A). Although potentially a town-wide hazard, there are no documented previous occurrences of landslides in Dover. Should a landslide occur in the future in Dover, the type and degree of impacts would be highly localized. he 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 Dover.

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

Climate Change and Landslides

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

EXTREME TEMPERATURES

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

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

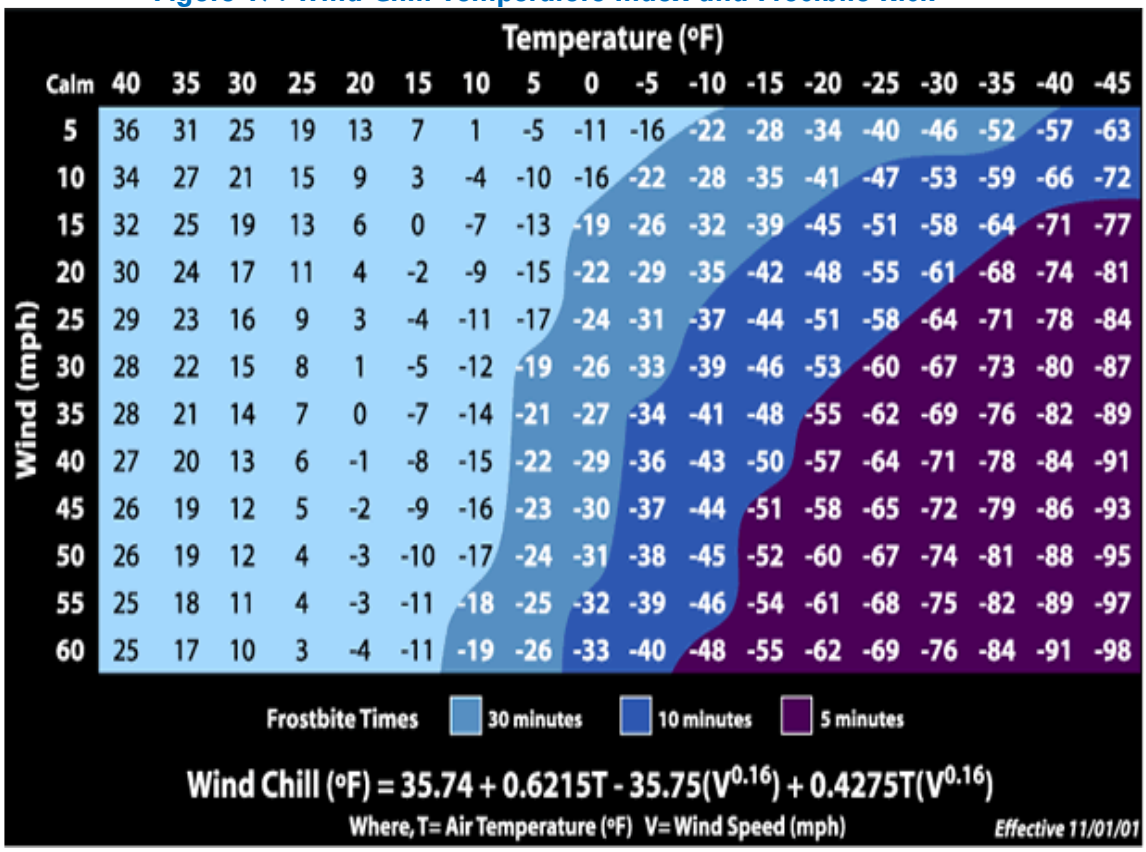
Extreme Cold

Extreme cold is relative to the normal climatic lows in a region. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The severity of extreme cold temperature is typically measured using 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 17 below. A Wind Chill warning is issued when the Wind Chill Index is forecast to fall below -25 degrees F for at least 3 hours.

Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat. The greatest vulnerability to the town would be a power outage during a winter storm, which could temporarily leave many residents without heat.

The best available local data on extreme cold are recorded for Norfolk County, where the Town of Dover is located, by the National Centers For Environmental Information (NCEI). There are five extreme cold event on record since 2007, which caused one death and no injuries or property damage (see Table 21). Extreme cold is a town-wide hazard for Dover.

Figure 17. Wind Chill Temperature Index and Frostbite Risk



Source: National Weather Service

Table 21– Norfolk County Extreme Cold Occurrences 2000-2021

Date	Deaths	Injuries	Damages
2/3/2007	1	0	0
2/16/15	0	0	0
2/13/16	0	0	0
2/14/16	0	0	0
1/6/18	0	0	0

Source: NOAA, Centers For Environmental Information

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 18) 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 18: Heat Index Chart

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

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

Source: National Weather Service

The best available local data on extreme temperatures in the Boston area are available from NOAA's NOWData (NOAA Online Weather Data). Historic records of the number of days per year with high temperatures 90F or more for the last 100 years were compiled and are displayed graphically in Figure 19. The table illustrates that the long-term trend has been for more extreme heat in recent years.

Heat Waves

While the number of 90F+ days per year is a broad indication of extreme temperatures, an indicator that relates more directly to public health impacts is the occurrence of multiple-day heat waves, defined at three or more consecutive days with high temperatures 90F or higher. The most recent summer of 2021 was an example of this, as shown in Figure 20.

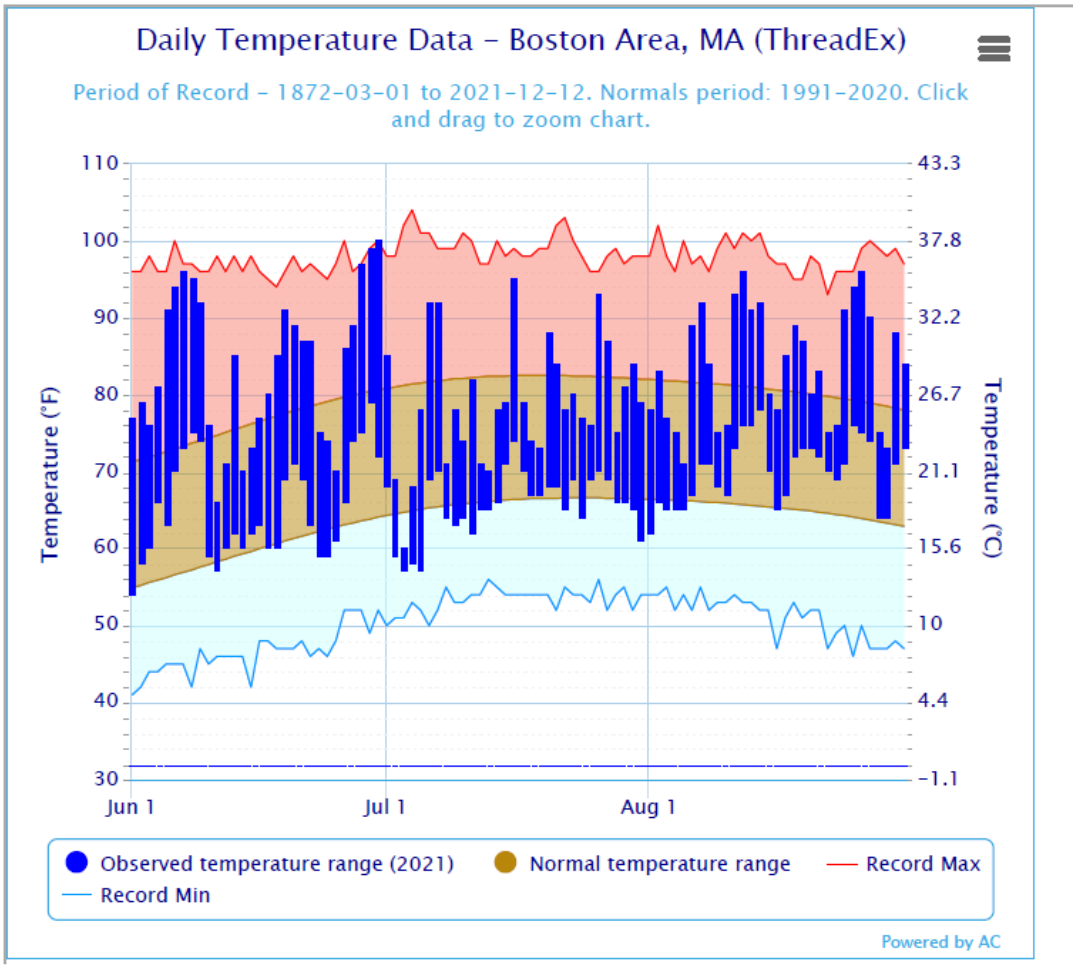
Figure 19: Annual Number OF Days >90F, 1920-2021

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

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

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

Figure 20: Summer 2021 Temperatures, Boston Area



Source: NOAA

The summer of 2021 was particularly hot, with four heat waves, two in June and two in August. Two of these lasted for five days, one lasted four days, and one lasted three days. Overall, there were 24 days 90F or more, 17 of which occurred during the four heat waves. Reviewing similar records for the last decade, the number and duration of heat waves from 2010 to 2021 are summarized in Table 22.

Heat waves and lower air quality can threaten the health of vulnerable populations, including the very young, the elderly, and people with certain medical conditions. In Dover, 23.1% of the residents are under the age of 15 and 16.4% are 65 years of age or older. However, even healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. People who work outdoors, such as construction, farming, and landscaping can be at higher risk of exposure to extreme heat combined with physical activity. 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.

Table 22: Heat Waves, Boston Area, 2010- 2021

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

Source: NOAA

Hot summer days can also worsen air pollution. With increased extreme heat, urban areas of the Northeast are likely to experience more days that fail to meet air quality standards. Prolonged heat exposure with 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. A study prepared for the City of Somerville, *The Wellbeing of Somerville* (2017) notes that extreme heat has disproportionate health impacts on both the young and the elderly:

> Young children are more vulnerable to extreme heat, poor air quality and insect-borne diseases. One reason for this is their limited ability to communicate when overheating or when left in dangerous situations; each year in the U.S., close to forty children die from heat exposure, typically in cars. In addition to greater physical frailty, children are less self-sufficient, more reliant on adults for transportation and other needs and less likely to cope emotionally during a disaster or climate event.
>
> Insect-borne diseases, such as Lyme disease and West Nile virus, are on the rise in Massachusetts. Research indicates that increases in temperature linked to climate change are projected to cause a correlating increase in the risk of insect-borne diseases. Lyme disease can reportedly also be transmitted to children in utero or through breastfeeding. Impacts to children's health can include a wide range of ongoing physical, behavioral and cognitive problems.
>
> Elderly residents often have greater physical limitations during a climate event. These limitations include higher overall health vulnerability, such as greater susceptibility to extreme heat and impacts from poor air quality and insect-borne diseases, among other illnesses. As a result of some of these vulnerabilities, older individuals – across all income brackets – have a greater reliance on support services, including senior centers and cooling centers during high heat events. Elderly residents that live alone may be more socially isolated and lack reliable access to transportation, which can make it more difficult for them to access support services or evacuate during emergency events.

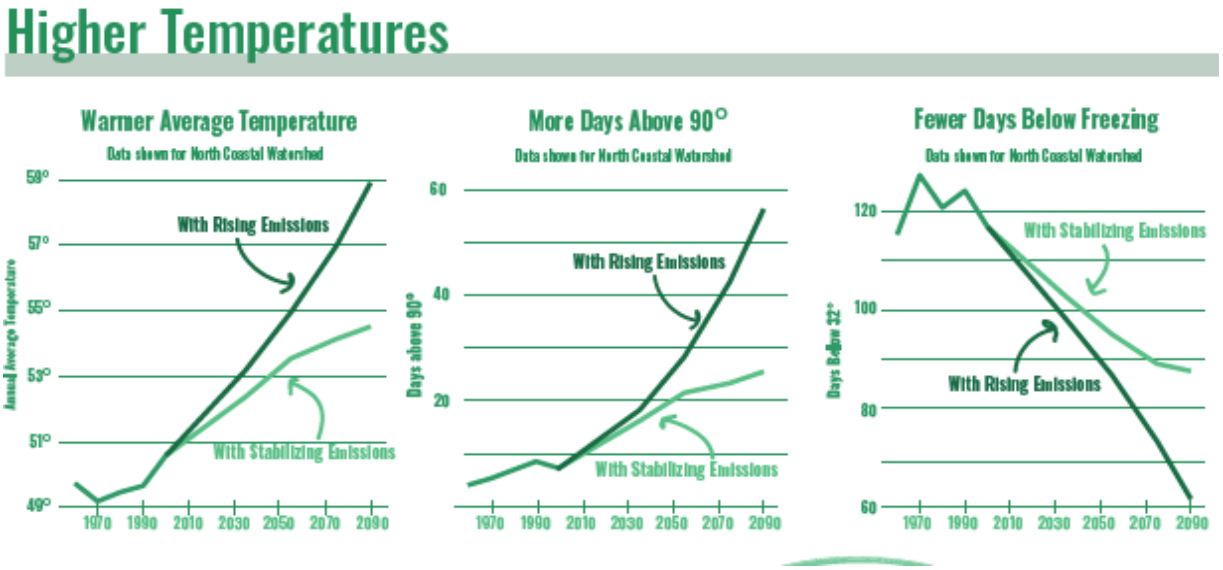
Exposure to poor air quality, which is impacted by heat, traffic pollution and rising pollen levels, can be linked to cardiac and lung problems, as well as cognitive and memory issues in seniors, altering quality of life, as well as longevity. Older adults, especially frail or immune compromised adults,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

Extreme temperature events are medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan. Both extreme cold and hot weather events occur between once in five years to once in 50 years, or a 2 percent to 20 percent chance of occurring each year. However the frequency of extreme temperature events is changing due to global warming, as described in the next section.

Climate Change and Extreme Temperatures

Extreme cold events are predicted to decrease in the future, while extreme heat days, as well as average temperatures are projected to increase (Figure 21). Average temperatures in Massachusetts are projected to increase by 3.8 to 10.8 degrees by the end of the century (SHMCAP). Over time our climate will become more similar to areas well south of New England, from Maryland to South Carolina, depending on future Greenhouse Gas (GHG) emissions.

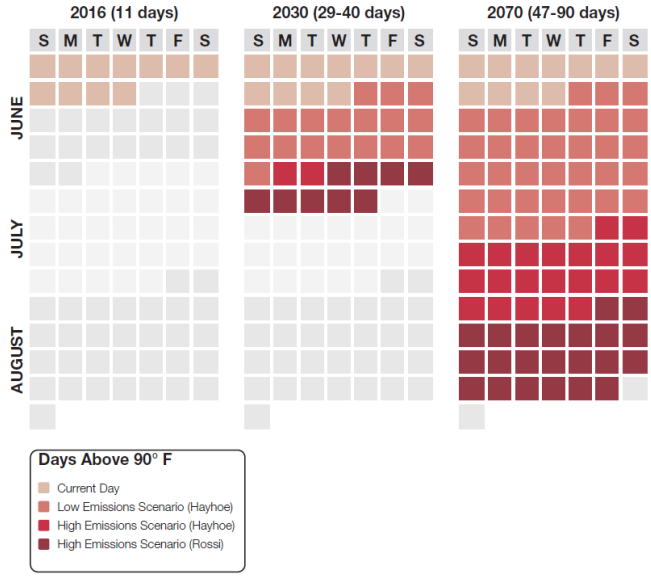
Figure 21: Massachusetts Projected Temperatures for Climate Scenarios to 2100



Source: ResilientMA.org

Based on future GHG scenarios, by 2030 it is anticipated that the Boston region could experience as many as 29-40 days over 90°F and, by 2070, that number could increase to 47-90 days over 90°F. By 2070, it is possible that the entire summer will be marked by temperatures above 90°F. (Figure 22). These vastly different future temperature scenarios underscore the critical importance of bringing GHG emissions under control.

Figure 22: Comparison of Days Above 90F for Low and High Emission Scenarios



Source: Somerville Climate Change Vulnerability Assessment

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

WILDFIRE HAZARDS

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 or even more rural areas of Massachusetts. A more likely occurrence is brush fires that typically burn no more than the underbrush of a forested area. 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. Most 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. The National Wildfire Coordinating Group classifies the severity of wildfires based on their acreage as follows:

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

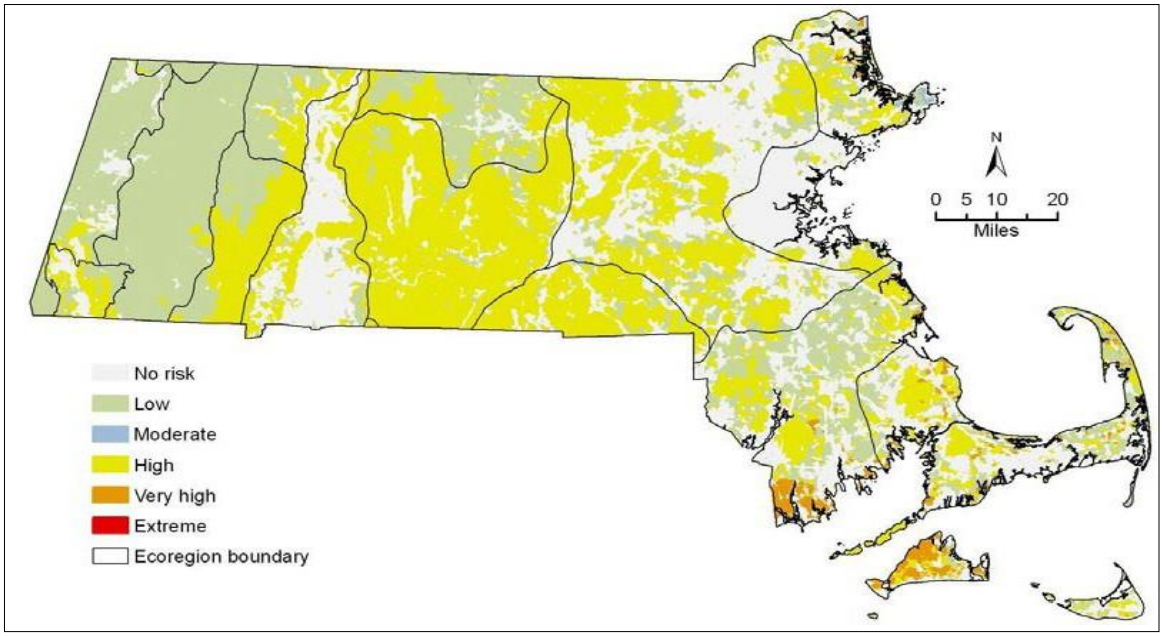
The most susceptible fuels are pitch pine, scrub oak and oak forests. Topography can affect the behavior of fires, as fire spreads more easily uphill. Fires can present a hazard where there is the potential to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire the spread into homes. Protecting structures from fire poses special problems and can stretch firefighting resources to the limit. If heavy rains follow a fire, other natural disasters can occur, including landslides, mudflows, and floods. If the wildfire destroys the ground cover, then erosion becomes one of several potential problems.

As the climate warms, drought and warmer temperatures may increase the risk of wildfire as vegetation dries out and becomes more flammable. Increasing damage to trees from pests, can also lead to greater fire risk. The most common cause of wildfires is the careless disposal of smoking materials and untended campfires.

Potential Wildfire Hazard Areas

The SCHMCAP includes a map that depicts statewide fire risk incorporating three risk components: fuel, wildland-urban interface, and topography (Figure 23). The wildland-urban interface reflects communities where housing and vegetation intermingle, and fire can spread from structures to vegetated areas.. Dover is shown partially in the high risk zone.

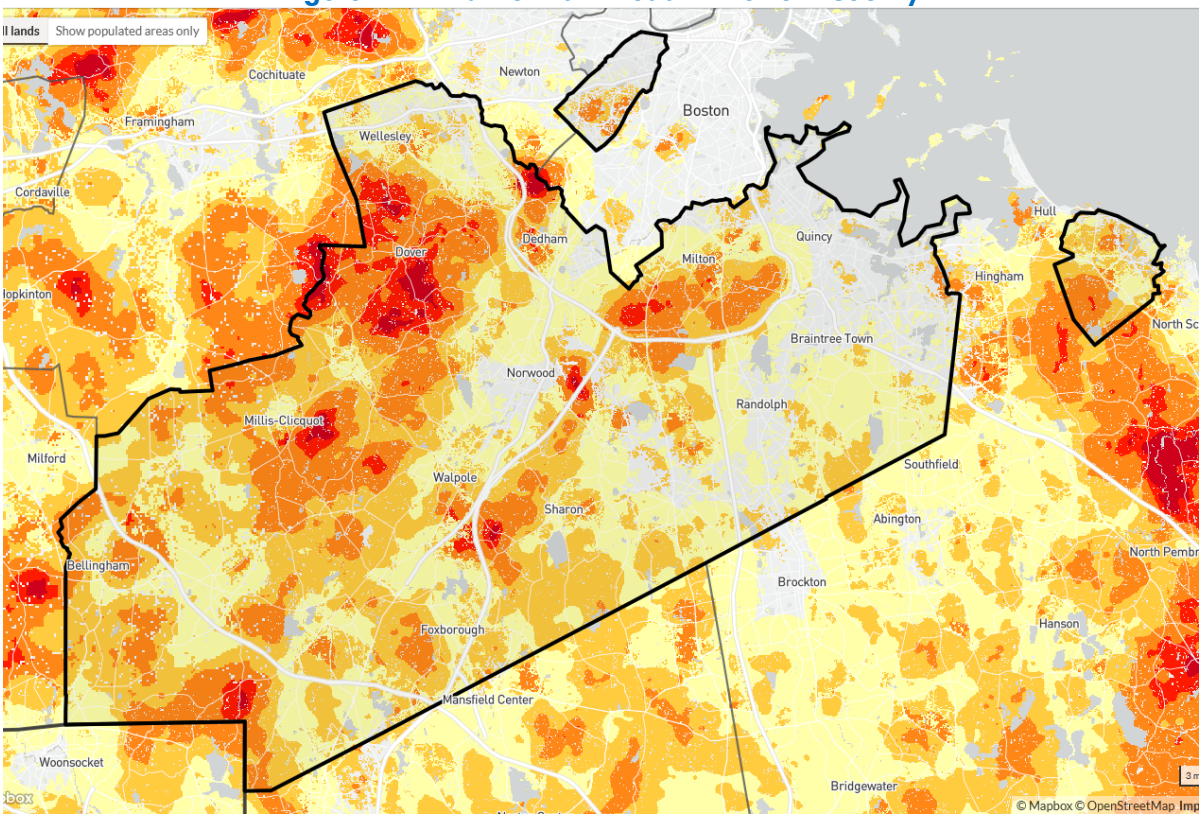
Figure 23: Wildfire Risk Areas in Massachusetts



Source: SHMCAP

A more detailed county-level map of "wildfire risk to homes" was prepared by the USDA Forest Service. The map for Norfolk County is shown in Figures 24. This map shows that Dover is in a higher risk zone than most surrounding communities in Norfolk County.

Figure 24: Wildfire Risk Areas in Norfolk County



Source: USDA Forest Service

Dover is not densely developed but it has some large open spaces that could be susceptible to wild fires. According to local officials, though, natural fires in Dover have not been a major issue. Locally identified areas susceptible to wildfires include the following:

(11) **Springdale Avenue to Hunt Road**

(12) **Pine Street/Center Street to Medfield town line**

(13) **Cedar Hill at High Rock Road**

The severity of fires in this area is considered higher because the wooded areas are close to residential neighborhoods and are harder to get into. This fire threat also shares a border with Medfield and is potentially a fire threat for that community as well. Existing mitigation measures here include trails maintained by the Trustees of the Reservation and police foot patrols aimed at keeping teen aged youth out of the area. Neighborhood fire watch and improved fire prevention education are considered appropriate measures here and Hughes indicated that such measures would likely be a high priority of the town.

(14) **Noannet Woods at Walpole Street and Bretton Road**
A moderate fire threat, occurring every other year. Existing measures include park rangers and trail grooming. Future mitigation measures should include improved and expanded fire prevention education for trail walkers.

(15) **Pegan Hill at Pegan Lane and Farm Street** – brush fires –
A moderate fire threat occurring every three to four years, according to Hughes. Only existing mitigation includes maintenance of trails and Hughes suggested a watch tower or watch program could help alleviate the threat, along with improved education program.

These are shown on Map 8 in Appendix A, with the numbers corresponding to the areas mapped.

Potential vulnerabilities to wildfires include damage to structures and other improvements and impacts on natural resources such as wildlife habitat. Should a wildfire occur in Dover or in other nearby communities, the resulting smoke could have negative impacts on air quality. This could have public health impacts, particularly for those with respiratory conditions such as asthma. However, given the low extent of wildfires in the town and the immediate response times to reported fires in Dover, the likelihood of injuries and casualties is minimal. There are none that have been recorded in the past.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan, wildfires are of Medium frequency, events that occur from once in 5 years to once in 50 years (2% to 20% probability per year).

EXTREME WEATHER

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

HURRICANES AND TROPICAL STORMS

A hurricane is a violent wind and rainstorm with wind speeds over 74 miles per hour. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits land. A tropical storm has similar characteristics, but wind speeds are between 34 and 73 miles per hour. Hurricanes are seasonal events that occur between June and November.

Hurricane intensity is measured according to the Saffir/Simpson scale, which categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. These are combined to estimate potential damage. Table 23 gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

Table 23: Saffir/Simpson Scale for Hurricanes

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

Previous Occurrences

Since 1900, 39 tropical storms have impacted New England (NESEC), and Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane. Hurricanes in Massachusetts since 1938 are shown in Table 18.

Table 24: Hurricane Records for Massachusetts 1938 - 2021

Hurricane Event	Date
Great New England Hurricane	September 21, 1938
Great Atlantic Hurricane	September 14-15, 1944
Hurricane Doug	September 11-12, 1950
Hurricane Carol	August 31, 1954
Hurricane Edna	September 11, 1954
Hurricane Diane	August 17-19, 1955
Hurricane Donna	September 12, 1960
Hurricane Gloria	September 27, 1985
Hurricane Bob	August 19, 1991
Hurricane Earl	September 4, 2010
Tropical Storm Irene	August 28, 2011
Hurricane Sandy	October 29-30, 2012

Source: National Oceanic and Atmospheric Administration

As shown on Map 5 in Appendix B, four storms have tracked through Dove: a tropical depression in 1861, a tropical storm in 1876, and two hurricanes in 1869 and 1944. A hurricane storm track is the line that delineates the path of the eye of a hurricane or tropical storm. However tropical storms and hurricanes have regional impacts, and Dover can also experience the impacts of the wind and rain from hurricanes and tropical storms regardless of whether a storm track passes directly through the town.

Falling trees and branches are a significant impact of the high winds of hurricanes, which often results in power outages or block traffic and emergency routes when they fall on roads. Rainfall

associated with hurricanes can cause flooding In the town's rivers and streams, as well as localized stormwater drainage flooding. Potential hurricane damages to Dover have been estimated using HAZUS-MH. Total damages are estimated at $6.0 million for a Category 2 hurricane and $19.5 million for a Category 4 hurricane. Other potential impacts are detailed in Table 40. Hurricanes are a town-wide hazard in Dover.

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

Hurricanes and Climate Change

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

SEVERE WINTER STORM/NOR'EASTER

Nor'easters

A northeast storm, known as a nor'easter, is typically a large counterclockwise wind circulation around a low-pressure center. Featuring strong northeasterly winds blowing in from the ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 20 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rain or snow, depending on temperatures.

Previous occurrences of nor'easters include the storm events shown on Table 25. Many of the historic flood events identified in the previous section were precipitated by nor'easters, including the "Perfect Storm" event in 1991. More recently, blizzards in February 2013, January 2015, and in March 2018 were large nor'easters that caused significant snowfall amounts.

Table 25: Nor'easter Events for Massachusetts, 1978 - 2021

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

January 2015	Blizzard of 2015
March 2015	March 2015 Nor'easters
January 2018	January 2018
March 2018	March 2018

Dover 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 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 flooding. 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 January 2015 January 2018 were large nor'easters that caused significant snowfall amounts.

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

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

Blizzards, Heavy Snow, and Ice Storms

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

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

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

The Regional Snowfall Index (RSI) characterizes and ranks the severity of northeast snowstorms. RSI has five categories: Extreme, Crippling, Major, Significant, and Notable. RSI scores are a function of the area affected by the storm, the amount of snow, and the number of people living in the path of the storm. The largest RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The RSI categories are shown in Table 26.

Table 26: Regional Snowfall Index

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

Source: SHMCAP, 2018

The most significant winter storm in recent history was the "Blizzard of 1978," which resulted in over three feet of snowfall and multiple day closures of roadways, businesses, and schools. Table 27 shows the blizzards and severe winter storms that were declared disasters since 1966:

Table 27: Severe Winter Storm Disaster Declarations in Eastern MA

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

Source: FEMA

The best available local data on past occurrences and impacts of winter storm events are reported for Middlesex County by the National Centers for Environmental Information (NCEI). From 2010 through 2020, Norfolk County experienced 22 heavy snowfall events, resulting in no injuries or deaths, and $105,000 in property damage, as shown in Table 28

Table 28: Heavy Snow Events in Norfolk County, 2010 - 2021

Date	Deaths	Injuries	Property Damage ($)
2/16/2010	0	0	0
12/20/2010	0	0	0
1/12/2011	0	0	0
1/26/2011	0	0	0
1/21/2012	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
1/2/2014	0	0	0
1/21/2014	0	0	0
2/5/2014	0	0	0
2/15/2014	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	2	0	100K
3/14/2017	0	0	0
11/15/2018	0	0	0
10/30/2020	0	0	0
12/16/2020	0	0	0
2/7/20221	0	0	0
Total	**0**	**0**	**105K**

Source: NOAA, National Centers for Environmental Information

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

Winter storms are a potential town-wide hazard in Dover. Map 6 in Appendix A indicates that the average annual snowfall in Dover is between 48 and 72 inches. A number of public safety issues can arise during snowstorms. Impassible streets are a challenge for emergency vehicles and affect residents and employers. Large piles of snow can also block sight lines for drivers, particularly at intersections. Refreezing of melting snow can cause dangerous roadway conditions. In addition, transit operations may be impacted, as they were in the 2015 blizzards which led to limited services on the commuter rail for several weeks.

Heavy snow and blizzards are considered to be high frequency events in Dover based on past occurrences. This hazard occurs more than once in five years, with a greater than 20 percent chance of occurring each year.

Climate Change and Nor'easters/Winter Storms

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

and intensity. Further, the SHMCAP notes that research suggests that warmer weather in the Artic is producing changes to atmospheric circulation patterns that favor the development of winter storms in the Eastern United States.

ICE STORMS

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

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

The best available local data on previous ice storm events are recorded at the county level through the National Centers for Environmental Information (NCEI).. However, there are no recorded ice storm events recorded for Norfolk County over the last 70 years. The same is true for the neighboring counties of Suffolk and Plymouth. In eastern Massachusetts, only Middlesex County registers any previous ice storms, and only three of these over the last 20 years (see Table 29). However, given the regional nature of ice storms, most of the damages occurred in the western portions of Middlesex county farther inland and at a higher elevation than Dover. The Town's location in the milder region closer to the coast and at lower elevations makes it less vulnerable to ice storms, as evidenced by the lack of any recorded events for Norfolk, Plymouth, and Suffolk Counties.

Table 29: Middlesex County Ice Storm Events, 2000 - 2020

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

Source: NOAA, National Centers for Environmental Information

The greatest hazard is created by freezing rain conditions, which is rain that freezes on contact with hard surfaces leading to a layer of ice on roads, walkways, trees, and other surfaces. The conditions created by freezing rain can make driving particularly dangerous and emergency

response more difficult. The weight of ice on tree branches can also lead to falling branches causing power outages and blocking roadways. The impacts of winter storms may also include roof collapses and property damage and injuries related to the weight of snow and ice.

Ice storms in Dover are considered low frequency events based on past occurrences. This hazard may occur once in 50 years to once in 100 years (1% to 2% per year;. There is some indication that as winters warm, temperatures may be more likely to produce icing conditions.

TORNADOES

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

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

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 01, 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale), which allows surveyors to create more precise assessments of tornado severity. The EF-scale is summarized in Figure 25.

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, in Revere in 2014, and in Concord in 2016. 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.

On August 22, 2016, an F1 tornado passed through part of the Town of Concord. It impacted an area 0.85 miles long by 400 yards wide. According to the report from the National Centers for Environmental Information:

> "This tornado touched down near the Cambridge Turnpike (Route 2) and headed northeast. Most of the damage was concentrated in an area beginning near the intersection of Lexington Road and Alcott Road and continuing up to the neighborhood of Alcott and Independence Roads. Numerous trees were uprooted or had the tops sheared off. These subsequently blocked roads, damaged homes, and downed power lines, cutting off power to the neighborhood. In addition, utility poles were downed either from the wind or from the downed power lines. Thirty-nine houses in this area were damaged. Only one house suffered significant structural damage. The historical home of Louisa May Alcott and her family was right next to the tornado path but was not damaged.

Figure 25: Enhanced Fujita Scale

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

Source: SHMCAP 2018

Although there have been no recorded tornados within the limits of the Town of Dover, since 1953 there have been 12 tornadoes in surrounding Norfolk County recorded by the Tornado History Project. One of these was an F3 tornado (1953), one was an F2 tornado (1956), and three were FI tornadoes (1972, 1973. And 2004). These 12 tornadoes resulted in a total of one fatality and 21 injuries and up to $4.106 million in damages, as summarized in Table 30.

Table 30 - Tornado Records for Norfolk County, 1950-2021

Date	Mag.	Fatalities	Injuries	Width	Length	Damage
6/9/1953	3	0	15	667	28	$2.50M
11/21/1956	2	0	0	17	0.1	$2.50K
8/9/1972	1	1	6	30	4.9	$25.0K
9/6/1973	1	0	0	10	1.1	$25.0K
7/10/1989	0	0	0	23	0.1	$2.50K
5/18/1990	0	0	0	10	0.2	$2.50K
5/18/1990	0	0	0	10	0.2	$2.50K
6/30/2001	0	0	0	80	0.1	$0.00K
8/21/2004	1	0	0	40	6	$1.50M
5/9/2013	EF0	0	0	50	0.38	$20.00K
6/23/2015	EF0	0	0	200	0.48	$20.00K
10/7/2020	EF0	0	0	--	--	$6.00K
Total		**1**	**21**			**44.106M**

Source: Tornado History Project; National Centers for Environmental Information

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 Dover, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Dover would greatly depend on the track of the tornado, as most the town is not densely developed. The town center area would be the most vulnerable to tornadoes.

Based on the record of previous occurrences since 1950, tornado events in Norfolk County are a medium frequency event as defined by the Massachusetts State Hazard Mitigation Plan. This hazard may occur in Norfolk County from once in 5 years to once in 50 years, or a 2% to 20% chance per year. However, for the Town of Dover, tornado events are a very low frequency event as there is no record of tornado activity in the Town. This hazard occurs in Dover less frequently than once in 100 years (less than 1% per year).

Tornadoes and Climate Change

According to the SHMCAP, it is possible that severe thunderstorms which can include tornadoes may increase in frequency and intensity. However, scientists have less confidence in the models that seek to project future changes in tornado activity.

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

The best available data on previous occurrences of thunderstorms in Dover is for is for Norfolk County through the National Centers for Environmental Informa (NCEI). For the years 2010 to 2021, records show 47 thunderstorm events in Norfolk County (Table 31). These storms resulted in a total of $815,200 in property damage. There were no injuries or deaths reported. This is an average of over 4 events per year.

Table 31: Norfolk County Thunderstorm Events, 2010 - 2021

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE
6/6/2010	53	0	0	10,000
6/20/2010	50	0	0	113,000
6/24/2010	50	0	0	1,000
8/19/2011	50	0	0	7,000
6/23/2012	50	0	0	41,000
8/10/2012	50	0	0	5,000
8/15/2012	40	0	0	500
6/17/2013	50	0	0	11,000
7/29/2013	50	0	0	20,500
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	30,000
8/15/2015	50	0	0	35,000

2/25/2016	50	0	0	94,000
6/7/2016	50	0	0	10,000
7/18/2016	50	0	0	90,000
7/22/2016	50	0	0	65,000
7/23/2016	40	0	0	35,000
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	6,000
11/3/2018	50	0	0	500
7/17/2019	50	0	0	5,000
7/31/2019	50	0	0	9,000
6/6/2020	50	0	0	10,000
6/28/2020	50	0	0	8,900
7/2/2020	50	0	0	31,000
7/5/2020	50	0	0	500
7/23/20	50	0	0	11,200
8/22/2020	50	0	0	2,000
8/23/2020	50	0	0	5,600
10/7/2020	55	0	0	35,800
11/15/20	50	0	0	500
6/8/2021	50	0	0	12,200
6/29/2021	50	0	0	1,100
6/30/21	55	0	0	1,500
7/7/2021	550	0	0	4,700
7/8/2021	50	0	0	1,000
7/16/2021	50	0	0	500
7/21/2021	50	0	0	600
7/27/2021	52	0	0	7,300
TOTAL		**0**	**0**	**$815,200**

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

Severe thunderstorms are a town-wide hazard for Dover. 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.

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

As noted previously, the intensity of rainfall events has increased significantly, and those trends are expected to continue. The SHMCAP does not specifically address whether climate will affect the intensity or frequency of thunderstorms.

HAIL

Hail events are frequently associated with thunderstorms and other severe storm events. Hail size typically refers to the diameter of the hailstones. Warnings may report hail size through comparisons with real-world objects that correspond to certain diameters as shown in Table 32.

The best available local data on previous hail events are recorded for Norfolk County through the National Centers for Environmental Information (NCEI). There were 13 hail events recorded from 2010 through 2021, as shown in Table 33. There was no property damages and no injuries or deaths reported for any of these hail events. Potential damages from larger-size hail could include damage to vehicles, windows, and other structures. These damages have not been reported in Dover.

Table 32: Hail Size Comparisons

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

Source: NOAA

Hail events are a potential town-wide hazard in Dover. Based on the record of previous occurrences, hail events in Dover are high frequency events as this hazard has occurred an average of two times per year in the past six years.

Table 33: Norfolk County Hail Events, 2010 - 2021

Date	Hail Size	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
6/28/2020	1.5	0	0	0
7/7/2021	1	0	0	0
TOTAL		**0**	**0**	**0**

Source: NOAA, National Centers for Environmental Information

*Magnitude refers to diameter of hail stones in inches

NON-CLIMATE INFLUENCED HAZARDS

EARTHQUAKES

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

Seismologists use a magnitude scale known as the Richter scale to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized in Table 34.

Table 34: Richter Scale and Effects

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

Source: Nevada Seismological Library (NSL), 2005

From 1668 to 2016, 408 earthquakes were recorded in Massachusetts (NESEC). Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault located off the coast of Rockport. The region has experienced larger earthquakes in the distant past, including a magnitude 5.0 earthquake in 1727 and a 6.0 earthquake that struck in 1755 off the coast of Cape Anne. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940. A 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historic records of some of the more significant earthquakes in the region are shown in Table 35.

Table 35: Historic Earthquakes in Massachusetts or Surrounding Area

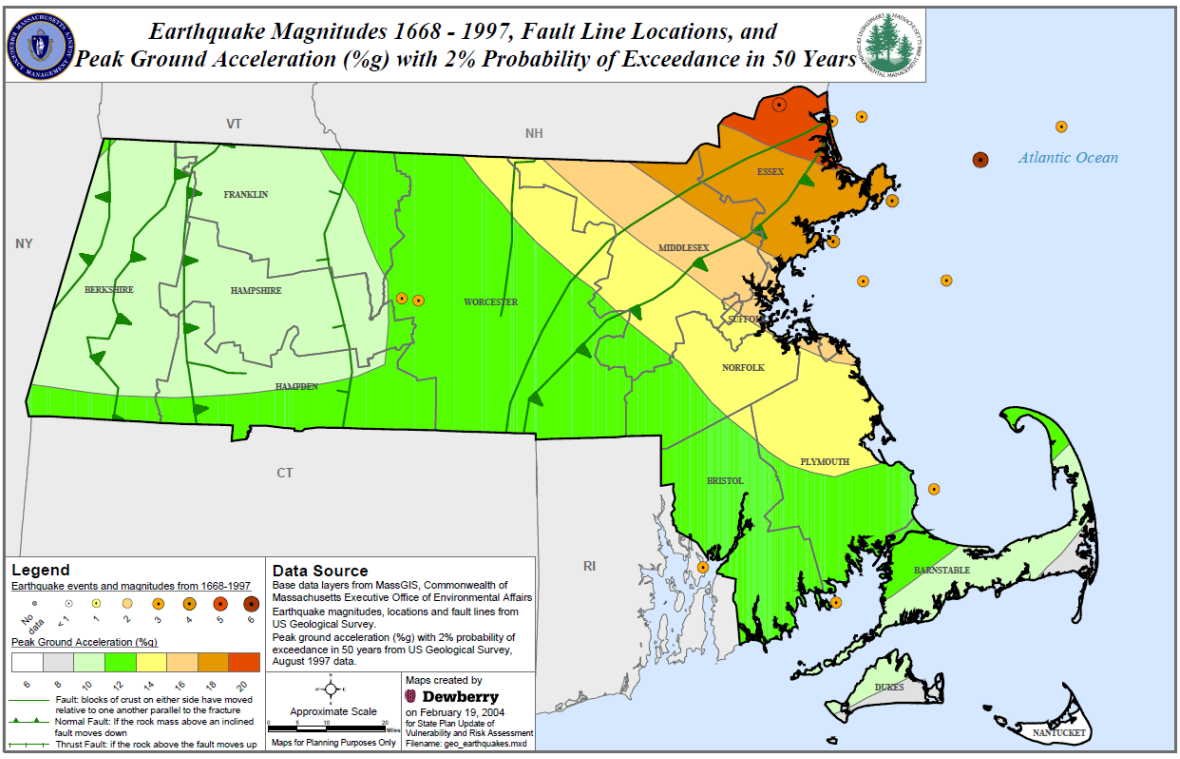
Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA – Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA – Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA - Off Cape Cod	11/23/1755	NA
MA – Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA – Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA – Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3

Location	Date	Magnitude
MA – Brewster	8/8/1847	4.2
MA – Boxford	5/12/1880	NA
MA – Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA
MA – Boston	12/27/74	2.3
MA - Nantucket	4/12/12	4.5
ME – Hollis	10/17/12	4.0

Source: Boston HIRA

One measure of earthquake risk is ground motion, which is measured as maximum peak horizontal acceleration, expressed as a percentage of gravity (%g). The range of peak ground acceleration in Massachusetts is from 10 %g to 20 %g, with a 2% probability of exceedance in 50 years, as shown in Figure 26. Dover is in the middle part of the range for Massachusetts, at 14g to 16g, making it a moderate area of earthquake risk relative to the state, although the Massachusetts as a whole is considered to have a low risk of earthquakes compared to the rest of the country. There have been no recorded earthquake epicenters within Dover.

Figure 26: Massachusetts Earthquake Probability Map



Source: MA Hazard Mitigation Plan

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

Earthquakes are a potential town-wide hazard in Dover. 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. The Town has many un-reinforced which could be vulnerable in the event of a severe earthquake. Potential earthquake damages to Dover have been estimated using HAZUS-MH. Total damages are estimated at $76.8 million for a 5.0 magnitude earthquake and $702 million for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 41.

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 to the Boston College Weston Observatory, in most parts of New England, there is a one in ten chance that a potentially damaging earthquake will occur in a 50-year time period. The Massachusetts State Hazard Mitigation Plan classifies earthquakes as "very low" frequency events that occur less frequently than once in 100 years, or a less than 1% per year.

LAND USE AND DEVELOPMENT

Existing Land Use

The most recent land use statistics available from MassGIS based on statewide aerial imagery completed in 2016. Table 36 shows the acreage and percentage of Dover's land in 14 categories. The largest single land use in Dover is open land, which makes up 26% of the town. But the land use classification also includes the category "tax exempt," the vast majority of which would also be open space holdings of land trusts and other nonprofit organizations. This includes an additional 15.7% of the town. About 1% is agricultural. Combing these three categories yields a total of 42.7% of the town. The next largest category by land area is residential. If the five residential categories are aggregated, residential uses make up 50% of the area of the town (4,934 acres). Commercial and industrial combined make up just under 1% of the town, or 84. The remaining land uses, including recreation, mixed use-other, right-of-way, and water combine to comprise a total of 6.3% of the town's total land area. Land use is also shown in Figure 27 and on Map 2 in Appendix A.

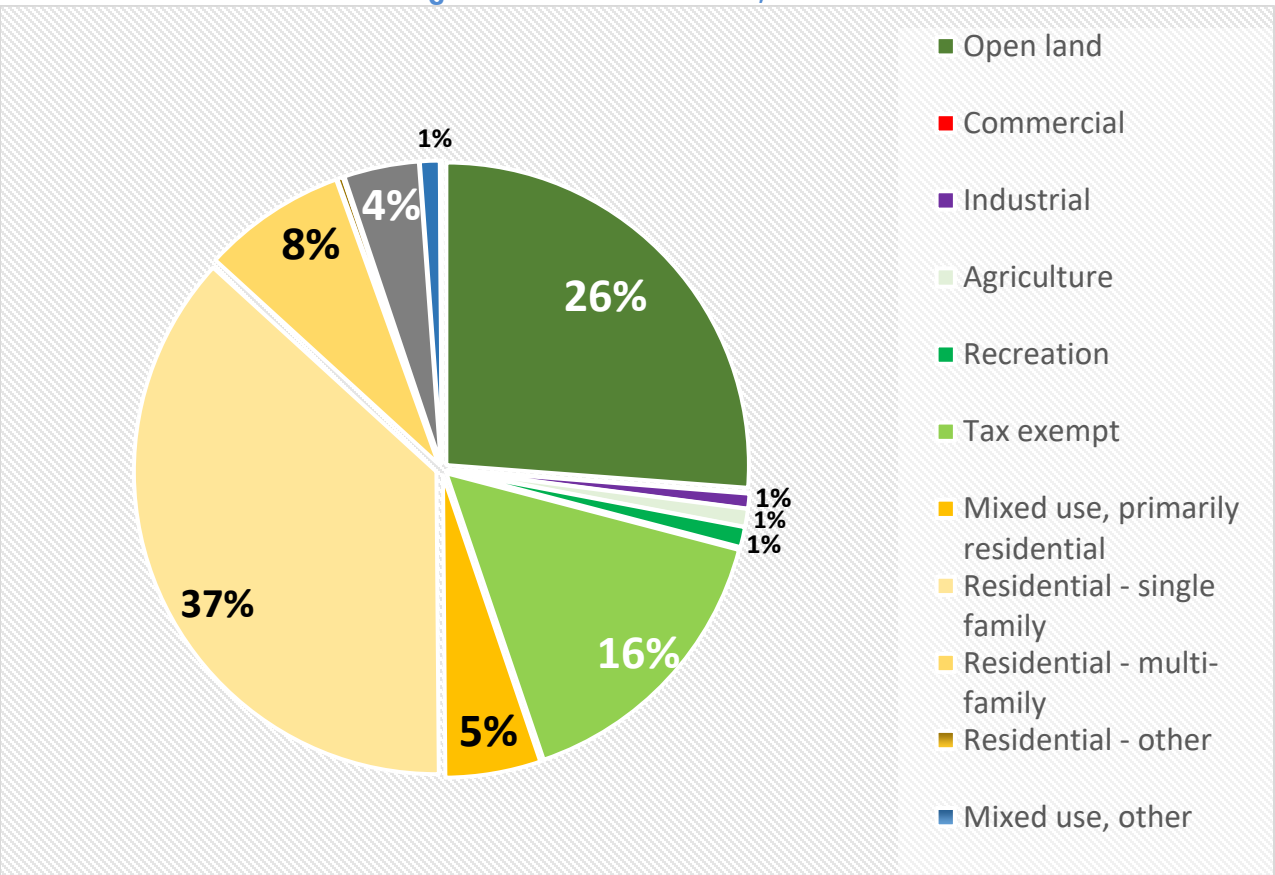
Table 36: Town of Dover Land Use

Land Use Type	Acres	Percentage
Open land	2585	26.20
Commercial	6	0.06
Industrial	78	0.79
Agriculture	94	0.96
Recreation	106	1.08
Tax exempt	1550	15.71
Mixed use, primarily residential	502	5.09
Residential - single family	3642	36.91
Residential - multi-family	761	7.71
Residential - other	29	0.29
Mixed use, other	5	0.05
Right-of-way	395	4.00
Water	104	1.05
Unknown	10	0.10
Total	**9,867**	**100**

Source: MassGIS 2016 Land Use Database

For more information on how the land use statistics were developed and the definitions of the categories, please go to http://www.mass.gov/mgis/lus.htm.

Figure 27: Dover Land Use, 2016



Development Pattern

The Town of Dover has developed around a town center. The Town Center is the governmental, institutional, retail, social and service center of the Town. It is surrounded by residential development built at a density of one housing unit per half-acre. Surrounding this core, there is a corridor of one-acre zoning running from the south end of Town along the Walpole town line through the center to the north part of Town where it abuts Natick, Wellesley and Needham. Except for the corner of Town that abuts Natick and Sherborn (which is also zoned for one-acre house lots), the remainder of the Town is zoned for two-acre residential lots.

Historic and Cultural Resource Areas*

Dover's natural, historic and cultural resources include all the vestiges and products of its natural and cultural history that its residents use or can use to enrich life in the community. Town policies and strategies for protection and management of these resources are guided by the belief that these resources are intertwined. It is fundamental that policies in these areas regard Dover's natural and cultural resources not separately, but as interdependent and mutually-reinforcing - historically, at present, and very likely in the future.

The inventory of Dover's cultural resources includes significant archeological and historic sites, buildings and structures dating back to the Native American and Colonial periods Dover has one historical preservation institution: the Dover Historical Society (DHS) which is privately funded and governed and open to public membership. The Society's mission is to preserve, collect, and share the cultural and material history of the town. It has detailed listings of more than 150 historic Dover houses and buildings and is currently cooperating with the Dover Historical Commission in a joint house marker program. The Society's headquarters is located in the Sawin Museum, which focuses on Dover local history and archeology. The Society also collects and conserves significant material pertaining to culture and history. The Society also maintains and interprets the two town-owned historic properties: the Caryl House (1777), the home of the Reverend Benjamin Caryl, Dover's first minister from 1762 to 1811, and the Fisher Barn (1777).

A major cultural resource is a branch of the venerable Massachusetts Horticultural Society, located on 36 acres of the 188-acre Elm Bank Estate, now owned and managed by the Commonwealth's Department of Conservation and Recreation. The estate attracts large numbers of visitors and tourists to Dover, not just from our neighboring communities but also from all over the Commonwealth, New England, and the nation.

The Dover Town Library, which has been slightly expanded and made accessible to the physically challenged, also serves as a site for community meetings and cultural programs and exhibits. The 2011 survey found that 86% of respondents believe that the library is adequate for future needs without major improvements or renovations. The library became a full member of the Minuteman Library Network in 1997 which network allows residents access to the collections of 40 other public and college libraries. *(from the Dover Master Plan)*

Development Trends

Dover has experience moderate growth since the last Hazard Mitigation was approved in 2016, all of which was residential. Dover's Land Use Director provided the following information on developments that have occurred since the last Hazard Mitigation was approved (Table 37). None of these development sites are located within the FIRM flood hazard area, and all are in areas of low landslide risk . The letters show the location of each site on Map 3 in Appendix A.

Table 37 Summary of New Developments in Dover Since 2016

Map #	Development	Type	# Units	Current Status	In Flood Zone?	Landslide
A	Dover Farms (40B)	Housing	20	Complete	No	Low
B	Atwood Circle/Betsy Lane	Housing	6	Complete	No	Low
C	Kirby Farm/Stagecoach Lane	Housing	8	Complete	No	Low
D	Dancer Farm	Housing	8	Complete	No	Low
E	Dover Village	Housing	4	Complete	No	Low

Source:: Dover Land Use Director

Potential Future Development

MAPC consulted with the Town's Land Use Director to determine areas that may be developed in the future, based on the Town's current planning initiatives and current trends and projects. These areas are described below. None of these sites are in a flood hazard zone (see Table 38).

Table 38 Summary of Pending New Developments in Dover in 2022

Map #	Development	Type	# Units	Status	In Flood Zone?	Landslide
F	Wilson's Way	Housing	6	Under Construction	No	Low
G	Red Robin (40B)	Housing	39	Pending @ ZBA	No	Low

Source:: Dover Land Use Director

Critical Infrastructure in Hazard Areas

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

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

There are 37 facilities identified in Dover. These are listed in Table 39 and are shown on the maps in Appendix B.

Explanation of Columns in Table 38

Column 1: ID #: The first column in Table 21 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. If no name appears in this column, this information was not provided to MAPC by the community.

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.

Column 5: Snowfall. Areas designated "low" receive an annual average of 36.1 to 48.0 inches of snow. Areas designated "high" receive an annual average of 48.1 to 72 inches of snow, as shown on Map 6 in Appendix B.

Column 6: Landslide Risk: The sixth column indicates the degree of landslide risk for that site. This information came from NESEC. The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature.

Table 39: Relationship of Critical Infrastructure to Hazard Areas

ID	Name	Type	FEMA Flood Zone	Average Area Snowfall	Brushfire	Landslide Risk
1	Protective Agency Division	Emergency Operations Center	No	36" – 48"	No	Low
2	Protective Agency Division	Police Station	No	36" – 48"	No	Low
3	Protective Agency Division	Fire Station	No	36" – 48"	No	Low
4	Town House	Municipal	No	36" – 48"	No	Low
5	DPW Garage	Municipal	No	36" – 48"	No	Low
6	Charles River School	School	No	36" – 48"	No	Low
7	Chickering School	School	No	36" – 48"	No	Low
8	Dover/Sherborn Regional School	School	No	36" – 48"	No	Low
9	Connors Family Retreat & Conference Ctr	School	No	36" – 48"	No	Low
10	Bridge Street Bridge	Bridge	AE	36" – 48"	No	Low
11	Fisher Bridge	Bridge	AE	36" – 48"	No	Low
12	Centre Railroad Bridge	Bridge	No	36" – 48"	No	Low
13	Willow Street Bridge	Bridge	AE	36" – 48"	No	Low
14	Cochrane Dam	Dam	AE	36" – 48"	No	Low
15	Willow Street Spillway	Dam	AE	36" – 48"	No	Low
16	Chestnut Street Bridge	Bridge	AE	36" – 48"	No	Low
17	Dover Road Bridge	Bridge	AE	36" – 48"	No	Low
18	Mass Horticultural Society	School	No	36" – 48"	No	Low
19	Natick Water Treatment Plant	Waste Water Treatment	No	36" – 48"	No	Low
20	NStar Power Substation	Power Substation	No	36" – 48"	No	Low
21	AT&T Cell Tower	Communication Tower	No	36" – 48"	No	Low
22	AT&T Cell Tower	Communication Tower	No	36" – 48"	No	Low
23	Dover Church	Child Care	No	36" – 48"	No	Low
24	St. Dunstan Church	Child Care	No	36" – 48"	No	Low
25	Grace Church	Child Care	No	36" – 48"	No	Low
26	The Meadows	Sewer Pump Station	No	36" – 48"	No	Low
27	Dover/Sherborn Regional Complex	Sewer Pump Station	No	36" – 48"	No	Low
28	Dover/Sherborn Regional Middle	School	No	36" – 48"	No	Low

ID	Name	Type	FEMA Flood Zone	Average Area Snowfall	Brushfire	Landslide Risk
	School					
29	Cap Grossman's Camp		No	36” – 48”	Yes	Low
30	Solid waste & recycling transfer station, solar field	Waste management, energy facility	No	36” – 48”	Yes	Low
31	DCR Fire Tower		No	36” – 48”	Yes	Low
32	Caryl Park Water Treatment Plant	Water Supply	No	36” – 48”	No	Low
33	Town Library	Library	No	36” – 48”	No	Low
34	Most Precious Blood Church	Faith	No	36” – 48”	No	Low
35	Town-owned site building	Municipal	No	36” – 48”	No	Low
36	Dover/Sherborn CDC Daycare	Daycare	No	36” – 48”	No	Low
37	Worthington Pond Dam	Water Infrastructure	No	36” – 48”	Yes	Low

As shown in the table above. Seven sites are within FEMA flood zone AE, but these are all bridges and dams, facilities that by their nature are located in or in close proximity to waterways. All sites in Dover are in areas of low landslide risk, and moderate snowfall, an average of 36 to48 inches annually. Four facilities are in areas with potential for brushfires, including the DCR Fire Tower, the solid waste transfer station, a camp and a dam. Overall, Dover’s critical infrastructure sites have limited exposure to these hazards.

Vulnerability Assessment

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

Introduction to HAZUS-MH

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

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

There are three modules included with the HAZUS-MH software: hurricane wind, flooding, and earthquakes. There are also three levels at which HAZUS-MH can be run. Level 1 uses national baseline data and is the quickest way to begin the risk assessment process. The analysis that follows was completed using Level 1 data. Level 1 relies upon default data on building types, utilities, transportation, etc. from national databases as well as census data. While the databases include a wealth of information on the Town of Dover, 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 40 - Estimated Damages from Hurricanes

Vulnerability Factors	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	1,000	
Estimated total building replacement value	$858,000,000	
Building Damages		
# of buildings sustaining minor damage	60	327
# of buildings sustaining moderate damage	2	40
# of buildings sustaining severe damage	0	2
# of buildings destroyed	0	1
Population Needs		
# of households displaced	0	6
# of people seeking public shelter	0	1
Debris		
Building debris generated (tons)	7,919	10.083
Tree debris generated (tons)	1,173	3,138
# of truckloads to clear building debris	7	35
Value of Damages		
Total property damage (buildings and content)	$ 6,030,000	$ 19,500,780
Total losses due to business interruption	$ 156,380	$ 799,780

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.

Table 40: Estimated Damages from Earthquakes

Vulnerability Factors	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	1,000	
Estimated total building replacement value	$858,000,000	
Building Damages		
# of buildings sustaining slight damage	554	55
# of buildings sustaining moderate damage	231	413
# of buildings sustaining extensive damage	39	612
# of buildings completely damaged	6	839
Population Needs		
# of households displaced	13	850
# of people seeking public shelter	6	436
Debris		
Building debris generated (tons)	10,000	120,000
# of truckloads to clear debris (@ 25 tons/truck)	325	4,880
Value of Damages (Millions of dollars)		
Total property damage	$76,860,000	$ 702,040,000
Total losses due to business interruption	$6,630,000	$ 65,480,000

Estimated Damages from Flooding

Although HAZUS-MH was used to estimate damages from hurricanes and tornadoes, MAPC did not use HAZUS-MH to estimate flood damages in Dover, due to technical problems with running the HAZUS software. Instead, MAPC developed a methodology to provide an approximation of flood damages. The methodology is described below.

Approximately 26.4 acres of Dover's total land area of 9,878 acres have been identified by local officials as areas of flooding. This amounts to 0.27 percent of the town's total land area. The number of structures in the locally identified flood area was estimated by applying the percentage of the total land area to the total number of structures in Dover, HAZUS uses an average value of $858,000 per structure for the building replacement value in this community. The calculations were done for a low estimate of 10% building damages and a high estimate of 50% as suggested in the FEMA September 2002 publication, "State and Local Mitigation Planning how-to guides." The range of estimates for flood damages is $456,138.54 to $2,280,692.70. These calculations are approximate only and are meant to show an order of magnitude of damage. The results are summarized in Table 41.

Table 41: Estimated Damages from Flooding

ID	Flood Hazard Area	Area Acres	% Land Area	Struc-tures	Replacement Value-$	Low Damage Estimate $	High Damage Estimate $
1	Dedham St at Needham line	8.6	0.09%	1.8	$ 1,520,461	$ 152,046	$760,230
2	Turtle Lane near Dover Road	1.2	0.01%	0.2	$168,940	$16,894	$ 84,470
3	Claybrook Road at Cullen Road	1.4	0.01%	0.2	$168,940	$16,894	$ 84,470
4	Claybrook Road at Trout Brook	0.9	0.01%	0.2	$ 168,940	$16,894	$ 84,470
5	Wilsondale St at Powissett Bk	3.6	0.04%	0.8	$ 675,760	$67,576	$ 337,880
6	Mill St, USGS gauging station	2.5	0.03%	0.6	$ 506,820	$50,682	$ 253,410
7	54 Yorkshire Road	3.9	0.04%	0.8	$675,760	$67,576	$337,880
13	Haven Street	4.3	0.04%	0.8	$675,760	$67,576	$ 337,880
	TOTAL	**26.4**		**5.3**	**$4,561,385**	**$ 456,138**	**$2,280,692**

SECTION 5: HAZARD MITIGATION GOALS

The Dover Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2016 Hazard Mitigation Plan for the Town of Dover. These remain the Town's goals, with the addition of one new goal (#12) related to climate change. All of the goals are considered critical for the Town and they are not listed in order of importance.

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

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

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

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

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

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

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

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

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

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

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

Goal 12: Consider the impacts of climate change. Incorporate climate sustainability and resilience into hazard mitigation planning and the Town's other plans and policies.

SECTION 6: EXISTING MITIGATION MEASURES

The existing protections in the Town of Dover are a combination of zoning, land use, and environmental regulations, infrastructure maintenance and drainage infrastructure improvement projects, and public education. Infrastructure maintenance generally addresses localized drainage clogging problems, while large scale capacity problems may require pipe replacement or invert elevation modifications. The Town's existing mitigation measures are listed by hazard type in Table 43 below. Some mitigation is provided by state and federal programs such as the FEMA Flood Insurance Program and the Massachusetts State Building Code. These are described below.

Mitigation Provided by State and Federal Programs

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

Comprehensive Emergency Management Plan (CEMP)

Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain important information regarding flooding, hurricanes, tornadoes, dam failures, earthquakes, and winter storms. Therefore, the CEMP is relevant to most of the hazards discussed in this plan.

- Multi-department review of developments
- Comprehensive Emergency Management Plan (CEMP)
- Enforcement of State Building Code
- Local Emergency Management Planning Committee (LEPC)
- Emergency Preparedness public education on the town website
- Dover/Sherborn High School is designated as a community shelter (although it has no generator)
- Police and Fire Stations have backup generators (although they are on natural gas or are limited diesel)
- Medical Reserve Corps
- Spectra Gas Energy company monitors its gas line; Columbia and Eversource also have lines through town
- Sheltering available for elderly during extreme heat and cold

Flood Related Hazards

National Flood Insurance Program (NFIP) – Dover participates in the NFIP with 39 policies in force as of 2021. FEMA maintains a database on flood insurance policies and claims.

The following information is provided for the Town of Dover:

Flood insurance policies in force (as of July 31, 2015)	39
Coverage amount of flood insurance policies	$12,490,000
Premiums paid	$27,977
Total losses (all losses submitted regardless of the status)	13
Closed losses (Losses that have been paid)	11
Open losses (Losses that have not been paid in full)	0
CWOP losses (Losses that have been closed without payment)	2
Total payments (Total amount paid on losses)	$83,449.38

All 39 policies are for single family residences. Of these, 33 are located in a FEMA Flood Zone X (500-year) and 6 are located in FEMA Flood Zone A or AE (100-year). There are no Repetitive Loss properties in Dover.

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.

Massachusetts State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads. The town has adopted the state building code.

Dam Failures

DCR dam safety regulations –In 2002 the Massachusetts legislature enacted revisions of the Dam Safety Statute, MGL Chapter 253 §§ 44-50, which significantly changes the responsibilities of dam owners to register, inspect and maintain dams in good operating condition. Amendments to Dam Safety Regulations 302 CMR 10.00-10.16 became effective November 4, 2005 and are reflective of the statutory changes. MGL Chapter 253 and 302 CMR 10.00 requires Emergency Action Plans be prepared, maintained and updated by dam owners, for High Hazard Potential dams and certain Significant Hazard Potential dams. There are no High Hazard or Significant Hazard Potential Dams in Dover.

Wind-Related Hazards

Massachusetts State Building Code – The town enforces the Massachusetts State Building Code whose provisions are generally adequate to protect against most wind damage. The code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence. If a tornado were to occur, the potential for severe damages would be extremely high.

Winter-Related Hazards

Massachusetts State Building Code: The town enforces the Massachusetts State Building Code, which contains regulations regarding snow loads on building roofs. The town has adopted the state building code.

Geologic Hazards – Landslides and Earthquakes

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

Section 1612.2.5 sets up seismic hazard exposure groups and assigns all buildings to one of these groups according to Table 1612.2.5. Group II includes buildings which have a substantial public hazard due to occupancy or use and Group III are those buildings having essential facilities which are required for post-earthquake recovery, including fire, rescue and police stations, emergency rooms, power-generating facilities, and communications facilities.

MITIGATION CAPABILITIES AND LOCAL CAPACITY FOR IMPLEMENTATION

Under the Massachusetts system of "Home Rule," the Town of Dover 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 Ordinances, Subdivision and Site Plan Review Regulations, Wetlands Ordinance, Health Regulations, Public Works regulations, and local enforcement of the State Building Code and the State Sanitary Code (Title 5). Local bylaws may be amended by a vote of the Town Meeting 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 Dover has recognized several existing mitigation measures that require implementation or improvements and will work to increase capacity within its local boards and departments to address these.

The Dover Public Works Department will address the upgrades to drainage infrastructure, culverts, and bridges described in this plan and needs for catch basin cleaning. The Town's Planning Board will address implementation of the Zoning Ordinance, Floodplain District, and Subdivision Rules and Regulations. The Conservation Commission will oversee implementation of the Wetlands Conservancy District and implementation and update of the Open Space Plan. The Board of Health will address needs for increasing resilience of the Town's water supplies and managing wells and drinking water quality.

The Town can improve its hazard mitigation capabilities with the following measures:

• The Town can update the Floodplain Ordinance to incorporate the next iteration of the Flood Insurance Rate Maps. New Preliminary FIRMs and a new Flood Insurance Study for Norfolk County were released by FEMA in 2021, and should become the official maps early in the five-year term of this 2022 updated plan.

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

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

• Prepare a town-wide Forest Management and Resilience Plan to address vulnerabilities to drought, fire hazards, invasive species, insects and diseases, and soil erosion. Since much of the Town's forested land is owned by private, nonprofit land trusts, coordinate the plan across public and private property owners.

• Work to create more drought-resilient water supply; protect water quality from over-pumping; adopt drought management regulations; evaluate options for interconnections to supplement the town's water sources.
• The Town can complete an assessment of bridges and culverts that are vulnerable to flooding and drainage problems and prioritize drainage upgrades for implementation.

• Coordinate with utilities to enhance resilience of the electric grid; develop a long term electric reliability program, including short-term tree management and long-term burial of power lines; install solar and generators for independent backup power.
•. Expand the Town's tree trimming operations, in coordination with the utilities, to reduce vulnerability to high winds and winter storms and the risk of power outages.

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

• Review and update the Town's water conservation plan to enable a more robust mitigation of drought, which has occurred more frequently in the last decade and is projected to increase in the future due to climate change.

• Take advantage of opportunities to collaborate on regional mitigation issues such as the Charles River Watershed's Climate Compact, which has prepared a watershed-wide flood model. Collaborate with neighboring communities in subregional planning groups coordinated by MAPC, such as the Southwest Area Planning Committee (SWAP, which covers much of the Charles River watershed area) and the Three Rivers Interlocal Council (TRIC, which covers most of the Neponset River watershed area).

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

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

Existing Town mitigation measures are summarized in Table 43 below.

Table 43: Existing Mitigation Measures

Mitigation Measure	Area Covered	Effectiveness /Changes
MULTIPLE HAZARDS		
A) Multi-department review of developments B) Comprehensive Emergency Management Plan (CEMP) C) Enforcement of State Building Code D) Local Emergency Management Planning Committee (LEPC) E)Emergency Preparedness public education on the town website F)Dover/Sherborn High School is designated as a community shelter (although it has no generator) G) Police and Fire Stations have backup generators (although they are on natural gas or are limited diesel) I) Medical Reserve Corps J) Spectra Gas Energy company monitors its gas line; *Columbia and Eversource* also have lines through town K) Sheltering available for elderly and vulnerable residents during extreme heat and cold	Town-wide	Effective; the former Caryl School is now a community center and has generators, so it could serve as an alternate shelter to Dover/Sherborn High School. A new Council on Aging facility is being constructed at the site of the Caryl Center
FLOOD RELATED HAZARDS		
A) Participation in the National Flood Insurance Program	Town-wide	Effective, the town has 39 policies in force
B) Annual catch basin cleaning and annual street sweeping		Effective; catch basins cleaned twice a year, spring and fall; streets are swept in compliance with the MS4 Stormwater Permit
C) Drainage system maintenance is performed as needed, and under a general order for emergency repairs issued by the Conservation Commission		Ongoing inspections and improvements are made; MS4 Stormwater Permit requires additional improvements such as Illicit Discharge Detection and Elimination
D) Long-term stormwater plan and funding, and ongoing system improvements		
E) Beaver mitigation		Conducted as needed; town uses Beaver Solutions for trapping; may do more scheduled trapping and for requests from neighborhoods

Mitigation Measure	Area Covered	Effectiveness /Changes
F) Flood Plain District		Effective
G) Wetlands Conservancy District		Conservation Rules were changed in 2020, increased buffer zone from 100 to 150 feet; a bylaw change is pending for spring 2022 to increase No Disturbance zone from 25 to 50 feet and No Structure zone from 40 to 70 feet.
H) Massachusetts Stormwater Policy		DEP is preparing revisions to address increasing heavy precipitation due to climate change
I) Stormwater Requirements in Subdivision Regulations and Site Plan Review		Effective
J) Open Space Residential Developments		Dover does not have an OSRD Bylaw, but is planning to adopt a Natural Resources Protection District
K) Groundwater Conservancy District		The Town would like to address issues with the protection of Zone1 recharge area.
L) Protected open space and proactive land preservation programs		Effective
M) Public Education on stormwater through the NPDES Phase II program		The Town provides public education as required by the MS4 permit, and the Planning Dept. conducts the "Water Wednesdays" campaign on Facebook, Twitter, and the town website
Existing culverts require regular maintenance to operate properly and remove excess water from storm events and spring runoff.	Dedham Street at Needham town line (1)	Effective
Turtle Lane is built along banks of Charles River and can flood frequently. Residents of this private way have resisted town offers to mitigate the impacts	Turtle Lane at intersection of Dover Road (2)	Town took over the street from the State and it is now fixed.

Mitigation Measure	Area Covered	Effectiveness /Changes
Existing culverts need maintenance but may be too small already.	Clay Brook Road near Cullen Road (3)	Effective with proper maintenance
Existing culvert requires regular maintenance and monitoring during snowmelt.	Clay Brook Road at Trout Brook (4)	Effective with proper maintenance
Infrequent flood threat managed with small private dam that requires manual alteration. Existing culvert and adjacent roadway requires regular maintenance.	Wilsondale Street at Powissett Brook (5)	Effective with proper maintenance
Small culvert under the roadway requires regular maintenance. Additional measures could be sought.	Springdale Avenue at Trout Brook (8)	Effective with proper maintenance
Existing culvert at this site is regularly maintained but may need to be expanded or enlarged to handle the volume of that causes moderate flooding problems here.	USGS Gauging Station at Haven Street on Trout Brook (16)	Effective with proper maintenance
Erosion issues in several areas, along the Charles River at Oxbow, bend in the river with steep banks; Claybrook Road and Main Street sliding into the river.	Claybrook Road, Main St along the Charles River	Major infrastructure improvements are needed to address these issues. Mitigation recommendations are included in this plan.
DAM FAILURES		
A) DCR Dam Safety Regulations; B) Construction permits required	State-wide; Town-wide	Effective
WIND-RELATED HAZARDS		
Tree Maintenance Program by Public Works	Town-wide	Effective; Tree Warden is now completing a 5year program and that will be followed by a new 5-year program. The town coordinates tree trimming work with the utility, Eversource.
WINTER-RELATED HAZARDS		
A) Standard snow operations, restricted salt B) Public Education on snow operations and winter maintenance is on the town website	Town-wide	Effective

Mitigation Measure	Area Covered	Effectiveness /Changes
C) Snow and Ice Disposal Bylaw D) Public Education on how to prevent roof collapses from snow loads E) Sufficient space for municipal snow storage		Effective
BRUSH FIRE RELATED HAZARDS		
A) Open burning permits required B) Fire Department reviews all development plans C) Fire Department provides public education on its website D) Town provides public education on drought watches	Town-wide	Effective
GEOLOGIC HAZARDS - Landslides		
A) Maximum slopes for subdivision roads B) Earth Removal Bylaw C) State open trench permits	Town-wide	Effective
GEOLOGIC HAZARDS - Earthquakes		
A) Shelters and backup facilities available (see multi-hazard mitigation above) B) Evacuation plan in CEMP	Town-wide	Effective
DROUGHT		
A) The Town has increased public information on the town website's Water Resources page, which includes a section on drought status.	Town-wide	The Town is preparing an Irrigation Bylaw. Broader drought management and water supply resilience measures are being considered.

SECTION 7: MITIGATION MEASURES FROM THE 2016 PLAN

IMPLEMENTATION OF THE PREVIOUS PLAN

At a meeting of the Dover Hazard Mitigation Planning Committee, Town staff reviewed the mitigation measures identified in the 2016 Dover 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 2022 updated plan. The Dover Land Use Director followed up with a detailed review and summarized the recommendations for carrying over some mitigation recommendations into this 2022 updated plan, as well as including several new measures that were not in the 2016 plan. The decision on whether to delete or retain a particular measure was based on the team's assessment of the continued relevance or effectiveness of the measure. Table 44 summarizes the status of mitigation measures and indicates those measures the team recommended should be included in the 2022 plan update.

Table 44: Status of Mitigation Measures from the 2016 Plan

Mitigation Measure	Priority in 2016 Plan	Priority in 2022 Plan	Current Status 2021 • Completed • Partially Completed • Not Completed	Retain in 2022 Plan? Revise or Replace?
FLOODNG HAZARDS				
A. Enlarge Culvert at Claybrook Road	High	High	Not Completed	**YES, REVISE** Replace flood vulnerable culverts along Claybrook Road and the Charles River
B. Elevate Utilities in Homes on Turtle Lane	Medium	Medium	Not Completed	**NO, REPLACE WITH:** Provide educational resources on elevating Utilities in Homes on in low lying or flood prone areas

Mitigation Measure	Priority in 2016 Plan	Priority in 2022 Plan	Current Status 2021 • Completed • Partially Completed • Not Completed	Retain in 2022 Plan? Revise or Replace?
C. Open Space Protection and Land Acquisition of critical parcels to mitigate storm water runoff	High	High	Not Completed	**YES**
D. Regulatory Revisions for Stormwater Management	High	High	Not Completed	**YES**
E. Replace old stone culvert at Wilsondale Street at Powissett Brook with a box culvert	High	High	Not Completed	**YES, REVISE** Delete "Box Culvert;" Add: Replace culvert at Wilsondale Street at Powissett Brook with an appropriate remedy.
F. Conduct River Hazards Management Plan to identify and prioritize Charles River related flood hazards and infrastructure vulnerabilities.	N/A	High	N/A	**NEW MEASURE** Add to plan
WINTER STORM HAZARDS				
G. Assessment of Municipal Structures for Susceptibly to Snow Loads	Medium	Medium	Not Completed	**NO, REPLACE WITH:** Enhanced tree trimming
H. Conduct Forestry Management plan to identify tree-related hazards near roadways and public buildings.	N/A	Medium	N/A	**NEW MEASURE** Add to plan

Mitigation Measure	Priority in 2016 Plan	Priority in 2022 Plan	Current Status 2021 • Completed • Partially Completed • Not Completed	Retain in 2022 Plan? Revise or Replace?
I. Do enhanced tree trimming per the forestry mgmt. plan.	N/A	Medium	N/A	**NEW MEASURE** Add to plan
DROUGHT HAZARDS				
J. Promote drought-tolerant landscaping and site design and rain barrels	Medium	Medium	Completed	**YES, REVISE** Add to plan: protection of water supplies
K. Adopt drought management regulations	N/A	High	In process	**NEW MEASURE** Add to plan
EXTREME TEMPURATURE HAZARDS				
L. Promote Green Building and Cool Roof designs	Low	Low	Not Completed	**NO, REPLACE WITH:** Provide cooling at Council on Aging
WIND HAZARDS				
M. Public Education: to educate homeowners about proper clearance of vulnerable trees	Medium	Medium	Not Completed	**YES, REVISE** Add enhanced tree trimming
BRUSHFIRE HAZARDS				
N. . Institute Neighborhood Fire Watches and Education	Medium	Low	Not Completed	**NO, REPLACE WITH:** Provide public education on brushfire
GEOLOGIC HAZARDS				

Mitigation Measure	Priority in 2016 Plan	Priority in 2022 Plan	Current Status 2021 • Completed • Partially Completed • Not Completed	Retain in 2022 Plan? Revise or Replace?
O. Investigate options to make all public safety buildings earthquake resistant	Low	Low	Not Completed	**YES**

TRANSITIONING TO THE 2022 UPDATED PLAN

As shown in Table 27, three of the mitigation measures from the 2016 plan will be carried over to this 2022 plan, four will be carried over with revisions. Four mitigation recommendations will not be carried over, but will be replaced by different measures to address each respective hazard. Finally, four new mitigation recommendations that were not in the previous plan were identified and will be added to this 2022 plan update.

All but one of the 2016 recommendations being carried over to the 2022 plan will retain the same priority, only one will change from medium to low. Two of the four new mitigation measures are ranked high priority and two others are ranked medium. Of the 15 total recommendations included in this 2022 plan update, six are high priority, six are medium priority, and three are low priority.

The challenges the Town of Dover has faced in implementing mitigation measures have primarily been due to funding constraints and available staff time. This plan update should help the Town prioritize the best use of its limited resources for enhanced mitigation of natural hazards. Moving forward into the next five year plan implementation period the Town will pursue opportunities to implement priority mitigation projects and incorporate hazard mitigation into the town's decision making processes, as described in Section 9 below.

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.

http://www.fema.gov/government/grant/hmgp/index.shtm
http://www.fema.gov/government/grant/pdm/index.shtm
http://www.fema.gov/government/grant/fma/index.shtm

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 areas such as the metropolitan Boston region, 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 local and state agencies including the Town of Dover, the Department of Conservation and Recreation (DCR), and the Massachusetts Department of Transportation (MassDOT). The planning, construction, operation and maintenance of these structures are integral to the flood hazard mitigation efforts of communities. These agencies must be considered the communities' regional partners in hazard mitigation. These agencies also operate under the same constraints as communities do including budgetary and staffing constraints and they must make decisions about numerous competing priorities.

Regional Issues

The Town of Dover is aware that most communities within the region share common concerns including the following:

- The regional impacts of drought, as many other towns also rely on local groundwater sources for public drinking water.
- The potential for local water systems to be supplemented by the Massachusetts Water Resources Authority (MWRA), as is the case with Needham and the Dedham-Westwood Water District.
- The regional risks of flooding in the Charles River watershed, as documented in the Charles River Water Shed Association's Flood Model.
- Maintenance and drainage from state highways
- Inspection and maintenance of state and privately owned dams
- Coordinated response to wildfires on state and privately owned properties
- Emergency Planning: the Local Emergency Planning Committee (LEPC) has a list and significant Hazardous Waste Sites that could impact a community during a disaster

NEW DEVELOPMENT AND INFRASTRUCTURE

As part of the process of developing recommendations for 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 Town's

Floodplain Zoning District, the Stormwater Management bylaw enforced for new development, the Subdivision Rules and Regulations enforced for new development, the Groundwater Protection Zoning District, the Master Plan, and the Open Space and Recreation Plan, the town determined that existing regulatory measures are taking full advantage of local Home Rule land use regulatory authority to minimize natural hazard impacts of development.

RECOMMENDED MITIGATION MEASURES

Flood Hazards

A. Replace culverts at 3 locations along Claybrook Rd.
B. Provide public education on elevating utilities in homes subject to flooding (Turtle Lane)
C. Open Space / Land Acquisition of parcels to mitigate stormwater runoff
D. Regulatory Revisions for Stormwater Management
E. Replace old stone culvert on Wilsondale Street at Powissett Brook
F. Replace Central Avenue Bridge over the Charles River.
G. Replace Willow Street Bridge over the Charles River
H. Assess the flood vulnerability of culverts and bridges town-wide; identify potential upgrades

Winter Hazards
I. Implement enhanced tree trimming to reduce vulnerability to power outages; coordinate with utilities.

Drought Hazards

J. Promote drought-tolerant landscaping and site design and rain barrels

K. Create more drought-resilient water supply; protect water quality from over-pumping; adopt drought management regulations; evaluate options for interconnections to supplement the town's water sources

Extreme Temperature Hazards

L. Evaluate options for providing cooling at the Library (COA is getting a new building)

Wind Hazards

M. Public Education to educate homeowners about clearance vulnerable trees
(See Winter Hazards)
I. Implement enhanced tree trimming to reduce vulnerability to power outages; coordinate with utilities.

Brushfire Hazards

N. Provide public education on outdoor fire safety and vegetation management.

Geologic Hazards

O. Evaluate vulnerability of older public buildings to earthquake damage; investigate options to increase earthquake resilience

Other/Multi-Hazards

P. Develop a Forest Management and Resilience Plan to include:
• A town-wide assessment of tree cover focusing on drought and fire hazards;
• Forest Maintenance plan
• Invasive species plan
• Resilience to insects and diseases
• dress soil erosion
• Fire prevention
• Fire roads and equipment
• Coordination across all properties (Town, DLCT, TTOR, private)

Q. Enhanced resilience of the electric grid:
• Add solar and generators for independent backup power, public and private.
• Develop a long-term electric reliability program, including short-term tree management and long-term burial of power lines.
• Coordinate with utilities to implement

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 Committee has limited access to detailed analyses of the cost and benefits of any given measure, so prioritization is based on the committee member's knowledge of the existing and potential hazard impacts and an approximate sense of the costs associated with pursuing any given measure.

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

Table 45 summarizes the factors considered for prioritizing the recommended hazard mitigation measures. For each mitigation measure, the geographic extent of the potential benefiting area is identified as well as an estimate of the overall benefit and estimated

cost of the mitigation measures. The overall priority of each measure was evaluated in terms of these factors.

Priorities for all mitigation measures are shown in Table 46, and the project type, implementing responsibility, timeframe, and potential funding sources are shown in the following table, Table 47.

Table 45 – Factors for Prioritizing Mitigation Measures

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 $200,000
Medium	Estimated costs between $50,000 to $200,000
Low	Estimated costs less than $50,000 and/or staff time
Mitigation Priority	
High	Action very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure
Medium	Action may have political and public support and necessary maintenance has potential to occur following the project
Low	Not clear if action has political and public support and not certain that necessary maintenance can occur following the project

Table 46 – Prioritization of the Recommended Mitigation Measures

Mitigation Measure	Geographic area covered	Benefit Estimate	Cost Estimate	Overall Priority
FLOOD HAZARDS				
A) Replace culverts at 3 locations along Claybrook Rd.	Claybrook Road, critical corridor	High	High ($200k)	High
B) Provide public education on elevating utilities in homes subject to flooding Turtle Lane	Turtle Lane neighborhood	Low	Low	Low
C) Open Space / Land Acquisition of parcels to mitigate stormwater runoff	Town-wide	High	High	High
D) Regulatory Revisions for Stormwater Management	Town-wide	Medium	Low	Medium
E) Replace old stone culvert on Wilsondale Street at Powissett Brook	Wilsondale Street, critical corridor	High	High ($200-300k)	High
F) Replace Central Avenue Bridge over the Charles River.	Central Avenue, critical corridor	High	High	High
G) Replace Willow Street Bridge over the Charles River	Willow Street, critical corridor	High	High	High
H) Assess the flood vulnerability of culverts and bridges town-wide; identify potential upgrades	Town-wide	High	High	High
WINTER HAZARDS				
I) Implement enhanced tree trimming to reduce vulnerability to power outages; coordinate with utilities.	Town-wide	High	Medium-High	High
DROUGHT HAZARDS				
J) Promote drought-tolerant landscaping and site design and rain barrels	Town-wide	Low	Low	Low

Mitigation Measure	Geographic area covered	Benefit Estimate	Cost Estimate	Overall Priority
K) Create more drought-resilient water supply; protect water quality from over-pumping; adopt drought management regulations; evaluate options for interconnections to supplement the town's water sources	Town-wide	High	High	High
EXTREME HEAT HAZARDS				
L) Evaluate options for providing cooling at the Library (COA is getting a new building)	Town-wide, vulnerable populations	Medium	Medium	Medium
WIND HAZARDS				
M) Public Education to educate homeowners about clearance vulnerable trees	Town-wide	Medium	Low	Medium
(See also Winter Hazards) I. Implement enhanced tree trimming to reduce vulnerability to power outages; coordinate with utilities.	Town-wide	High	Medium-High	High
BRUSHFIRE HAZARDS				
N) Provide public education on outdoor fire safety and vegetation management.	Town-wide	Medium	Low	Medium
GEOLOGIC HAZARDS				
O) Evaluate vulnerability of older public buildings to earthquake damage; investigate options to increase earthquake resilience	Public buildings town-wide	Low	Low	Low

Mitigation Measure	Geographic area covered	Benefit Estimate	Cost Estimate	Overall Priority
OTHER/MULITI-HAZARDS				
P) Develop a Forest Management and Resilience Plan to include: • A town-wide assessment of tree cover focusing on drought and fire hazards; • Forest Maintenance plan • Invasive species plan • Resilience to insects and diseases • dress soil erosion • Fire prevention • Fire roads and equipment • Coordination across all properties (Town, DLCT, TTOR, private	Forested lands town wide	High	Medium-High	High
Q) Enhance resilience of the electric grid: • Add solar and generators for independent backup power, public and private. • Develop a long term electric reliability program, including short-term tree management and long-term burial of power lines. • Coordinate with utilities to implement	Town-wide	Medium	High	Low

DESCRIPTION OF RECOMMENDED MITIGATION MEASURES

The recommended mitigation measures are shown in Table 46 along with designations of overall priority, the lead local agency or board, estimated cost, timeframe, and potential funding sources to implement each measure. These are described in Table 46 as follows: Items shaded green are new mitigation measures for this 2022 updated plan that were not in the previous plan.

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

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

Abbreviations For Funding Sources

DCR = MA Department of Conservation and Recreation

DHCD = MA Department of Housing and Community Development

DHS/EOPS = Department of Homeland Security/Emergency Operations

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

Mass DOT = Massachusetts Department of Transportation

Table 47: Recommended Mitigation Measures for the 2022 Plan

Mitigation Action	Lead Agency	Priority	Estimated Cost*	Estimated Timeframe (2022-26)	Potential Funding Sources
FLOOD HAZARDS					
A. Replace culverts at 3 locations along Claybrook Rd.	DPW	High	High ($200k)	2022	FEMA BRIC Project Grants Town of Dover
B. Provide public education on elevating utilities in homes subject to flooding (Turtle Lane)	Building	Low	Low	2022-2026	Town of Dover
C. Open Space / Land Acquisition of parcels to mitigate stormwater runoff	Town Staff; Conservation Commission	High	High	2022-2026	Town of Dover Community Preservation MA EOEEA
D. Regulatory Revisions for Stormwater Management	DPW; Planning Board	Medium	Low	2022-2023	Town of Dover
E. Replace old stone culvert on Wilsondale Street at Powissett Brook	DPW	High	High ($200-300k)	2022-2023	FEMA-BRIC Project Grant Town of Dover
F. Replace Central Avenue Bridge over the Charles River.	DPW	High	High	2022-2026	Infrastructure Federal funding Town of Dover
G. Replace Willow Street Bridge over the Charles River	DPW	High	High	2022-2026	Infrastructure Federal funding Town of Dover
H. Assess the flood vulnerability of culverts and bridges town-wide; identify potential upgrades	DPW	High	High	2022	FEMA-BRIC C&CB Grants; Town of Dover
WINTER HAZARDS					
I. Implement enhanced tree trimming to reduce vulnerability to power outages; coordinate with utilities.	Tree Warden; Utilities	High	Medium-High	2023	Town of Dover

Mitigation Action	Lead Agency	Priority	Estimated Cost*	Estimated Timeframe (2022-26)	Potential Funding Sources
DROUGHT HAZARDS					
J. Promote drought-tolerant landscaping and site design and rain barrels	Board of Health; Water Comm; Conservation Commission; Planning Board	Low	Low	Ongoing	Town of Dover
K. Create more drought-resilient water supply; protect water quality from over-pumping; adopt drought management regulations; evaluate options for interconnections to supplement the town's water sources	Town Staff	High	High	2022-2026	Town of Dover; Infrastructure Federal funding
EXTREME TEMPERATURE HAZARDS					
L. Evaluate options for providing cooling at the Library (COA is getting a new building)	Library	Medium	Medium	2022	Green Communities
WIND HAZARDS					
M. Public Education to educate homeowners about clearance vulnerable trees	DPW; Conservation Commission	Medium	Low	2022-2026	Town of Dover
(See Winter Hazards) l. Implement enhanced tree trimming to reduce vulnerability to power outages; coordinate with utilities.	DPW	High	Medium-High	2022-2026	Town of Dover
BRUSHFIRE HAZARDS					
N. Provide public education on outdoor fire safety and vegetation management.	Fire Department; Conservation Commission	Medium	Low	2022-2026	Town of Dover

Mitigation Action	Lead Agency	Priority	Estimated Cost*	Estimated Timeframe (2022-26)	Potential Funding Sources
GEOLOGIC HAZARDS					
O. Evaluate vulnerability of older public buildings to earthquake damage; investigate options to increase earthquake resilience	Building Dept; Town Engineer	Low	Low	2024-2025	Town of Dover
OTHER / MULTI-HAZARDS					
P. Develop a Forest Management and Resilience Plan to include: • A town-wide assessment of tree cover focusing on drought and fire hazards; • Forest Maintenance plan • Invasive species plan • Resilience to insects and diseases • dress soil erosion • Fire prevention • Fire roads and equipment • Coordination across all properties (Town, DLCT, TTOR, private)	Conservation Commission; DPW; Open Space Committee; Planning Board	High	Medium-High	2023-2025	MVP Action Grant; Town of Dover
Q. Enhanced resilience of the electric grid: • Add solar and generators for independent backup power, public and private. • Develop a long term electric reliability program, including short-term tree management and long-term burial of power lines. • Coordinate with utilities to implement	Building Dept, Planning Board, Utilities	Low	High	2023-2026	Green Communities Act

***Cost categories for 2022 Plan Update:**

Low: <$50,000 and/or staff time
Medium: $$50,000 to $200,000
High: >$200,000

SECTION 9: PLAN ADOPION AND MAINTENANCE

PLAN ADOPTION

The Dover Hazard Mitigation Plan was adopted by the Board of Selectmen on [ADD DATE]. See Appendix D for adoption 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 Dover Hazard Mitigation Planning Team to prepare this plan. After approval of the plan by FEMA, this group will meet on a regular basis to function as the hazard mitigation implementation team, with the Land Use Director designated as the team coordinator. Additional members could be added to the local implementation team from other Town departments, local 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 of the local team members and other interested local stakeholders. The survey will poll the members on any changes or revisions to the plan that may be needed, 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 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 Building Resilient Infrastructure and Communities 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 Team decides to update the plan, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes. Once the next draft plan update is prepared, the 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 Dover Hazard Mitigation Plan 2015 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 Department
- Emergency Management
- Police Department
- Department of Public Works
- Engineering
- Planning Board
- Tree Warden
- Board of Health
- Building Department

Other groups that will be coordinated will include land conservation organizations, watershed groups, business groups, and nonprofit institutions. The posting of the plan on the Town's web site 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 Dover Master Plan, Open Space and Recreation Plan, Comprehensive Emergency Management Plan, and Capital Investment Program.

SECTION 10: LIST OF REFERENCES

Blue Hill Observatory

Charles River Watershed Association, *Charles River Watershed Model*, 2020

City of Somerville, *The Wellbeing of Somerville* (2017)

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

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

FEMA, *Local Mitigation Plan Review Guide;* October 1, 2011

Mass. Audubon Society, *Encouraging Low Impact Development in Dover*

Mass. Emergency Management Agency, *State Hazard Mitigation Plan,* 2013

Mass. Emergency Management Agency, *State Hazard Mitigation and Climate Adaptation Plan*, 2018

Mass. Geographic Information System, *McConnell Land Use Statistics*, 2005

Massachusetts Office of Dam Safety, Inventory of Massachusetts Dams 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

NOAA, National Centers for Environmental Information

Northeast Climate Adaptation Science Center

Northeast States Emergency Consortium

Tornado History Project

Town of Dover Comprehensive Emergency Management Plan

Town of Dover Master Plan (2012)

Town of Dover Open Space and Recreation Plan (2011)

Town of Dover Stormwater Management Plan (2021)

Town of Dover Subdivision Regulations

Town of Dover Town Bylaws

USDA Forest Service, Wildfire Risk to Communities

U.S. Geological Survey, National Water Information System

U.S. Census, 2020 and American Community Survey, 2019

U.S. Global Change Research Program, *Fourth National Climate Assessment*, 2018

APPENDIX A: HAZARD MAPPING

APPENDIX A

HAZARD MAPPING

APPENDIX A: HAZARD MAPPING

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

The map series consists of eight maps as described below. The maps in this appendix are necessarily reduced scale versions for general reference. Full sized higher resolution PDF's of the maps can be downloaded from the MAPC File Transfer Protocol (FTP) website at: ftp://ftp.mapc.org/Hazard_Mitigation_Plans/maps/Dover/

Map 1.	Population Density
Map 2.	Potential Development
Map 3.	Flood Zones
Map 4.	Earthquakes and Landslides
Map 5.	Hurricanes and Tornadoes
Map 6.	Average Snowfall
Map 7.	Composite Natural Hazards
Map 8.	Hazard Areas Identified Locally
Map 9	Sea Level Rise (N/A for Dover)
Map 10	Hot Spots

Map1: Population Density – This map uses the US Census block data for 2010 and shows population density as the number of people per acre in seven categories with 60 or more people per acre representing the highest density areas.

Map 2: Development – This map shows potential future developments, and critical infrastructure sites. MAPC consulted with town staff to determine areas that were likely to be developed or redeveloped in the future. The map also depicts current land use.

Map 3: Flood Zones – The map of flood zones used the FEMA NFIP Flood Zones as depicted on the FIRMs (Federal Insurance Rate Maps) for Norfolk County as its source. This map is not intended for use in determining whether or not a specific property is located within a FEMA NFIP flood zone. The currently adopted FIRMS for Dover are kept by the Town. For more information, refer to the FEMA Map Service Center website http://www.msc.fema.gov. The definitions of the flood zones are described in detail on this site as well. The flood zone map for each community also shows critical infrastructure and repetitive loss areas.

Map 4: Earthquakes and Landslides – This information came from NESEC. For most communities, there was no data for earthquakes because only the epicenters of an earthquake are mapped.

APPENDIX A: HAZARD MAPPING

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

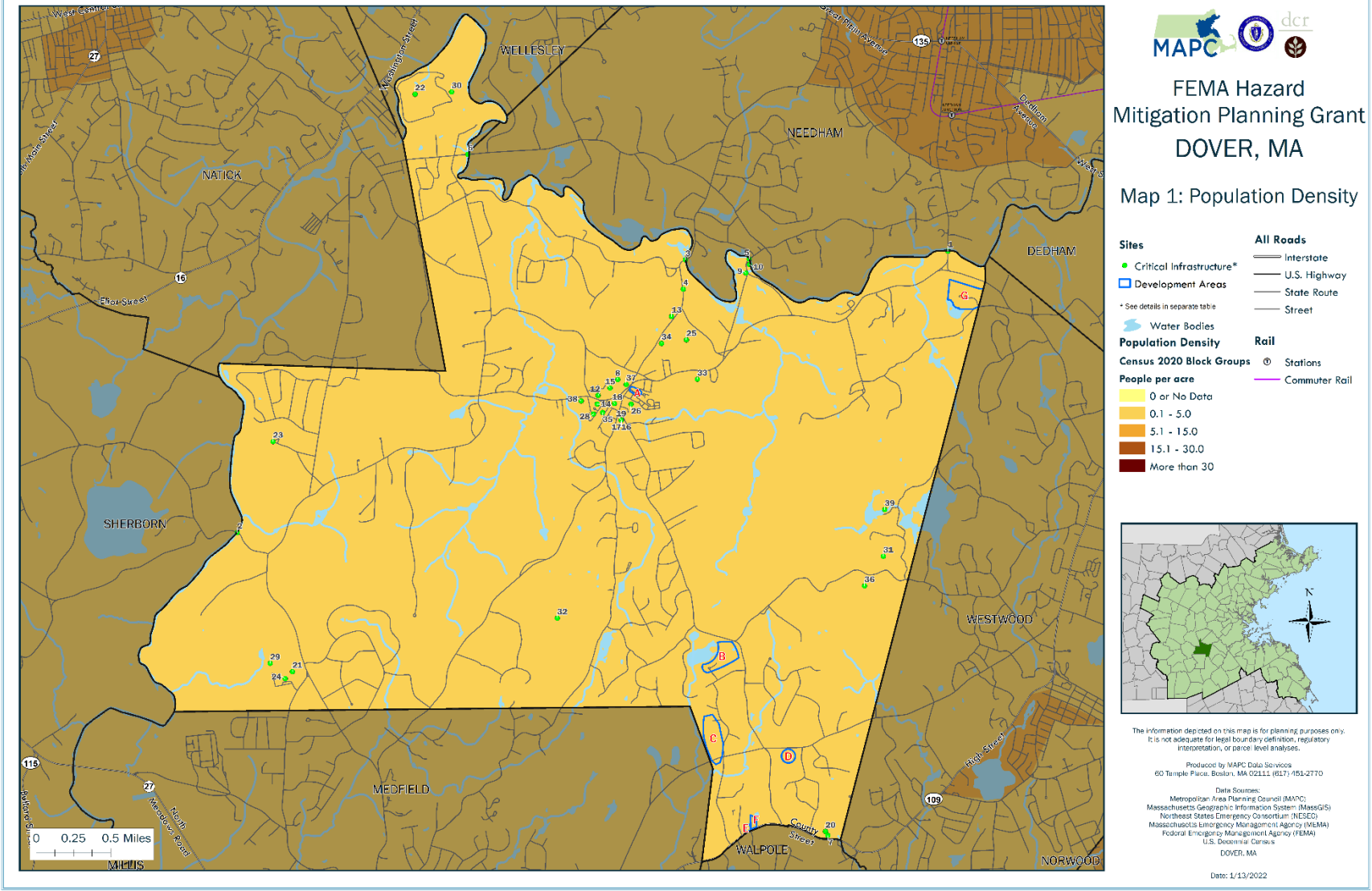
Map 5: Hurricanes and Tornadoes – This map shows a number of different items. The map includes the storm tracks for both hurricanes and tropical storms, if any occurred in this community. This information must be viewed in context. A storm track only shows where the eye of the storm passed through. In most cases, the effects of the wind and rain from these storms were felt in other communities even if the track was not within that community. This map also shows the location of tornadoes with a classification as to the level of damages. What appears on the map varies by community since not all communities experience the same wind-related events. These maps also show the 100 year wind speed.

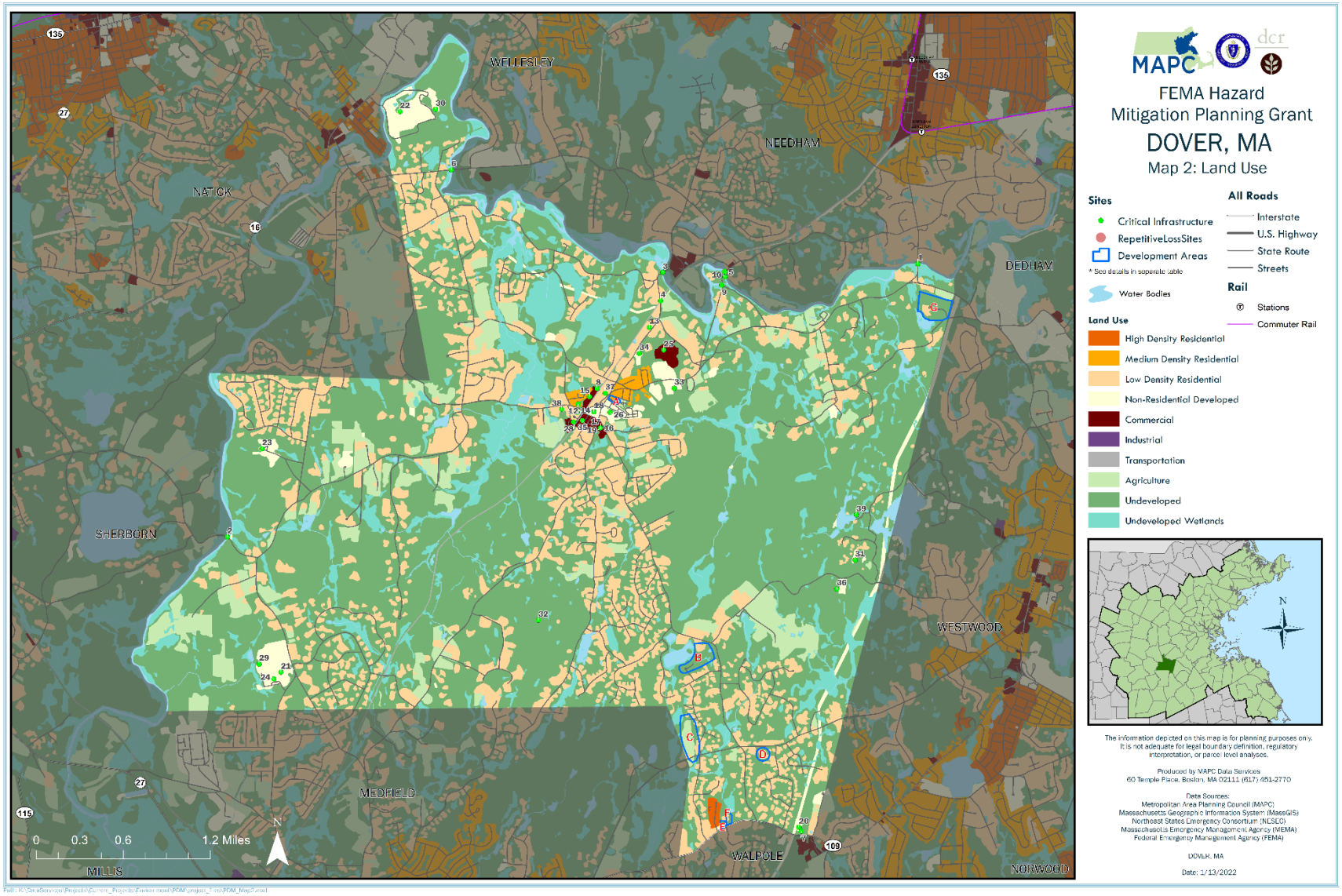
Map 6: Average Snowfall - - This map shows the average snowfall. It also shows storm tracks for nor'easters, if any storms tracked through the community.

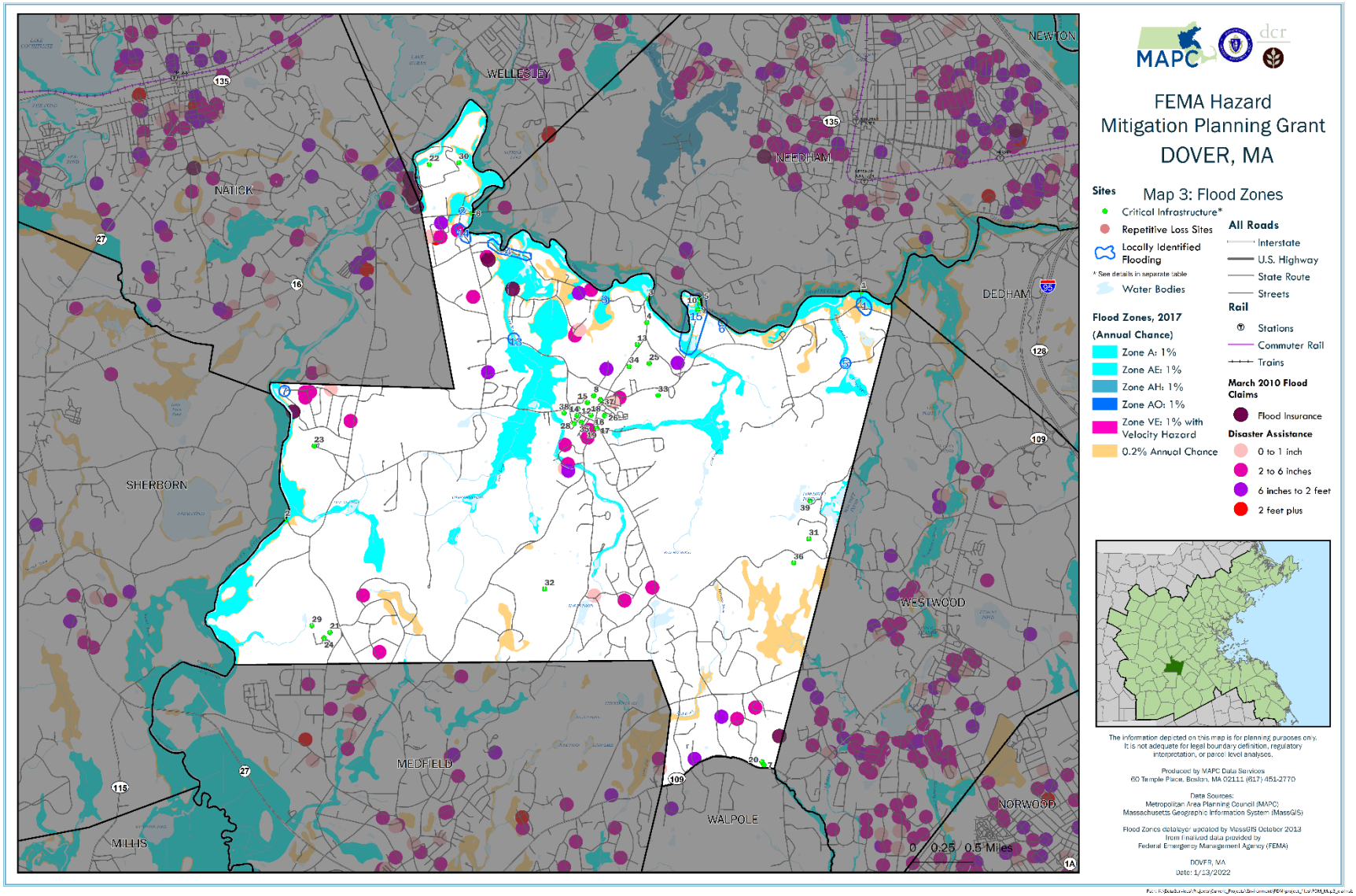
Map 7: Composite Natural Hazards - This map shows four categories of composite natural hazards for areas of existing development. The hazards included in this map are 100 year wind speeds of 110 mph or higher, low and moderate landslide risk, FEMA Q3 flood zones (100 year and 500 year) and hurricane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

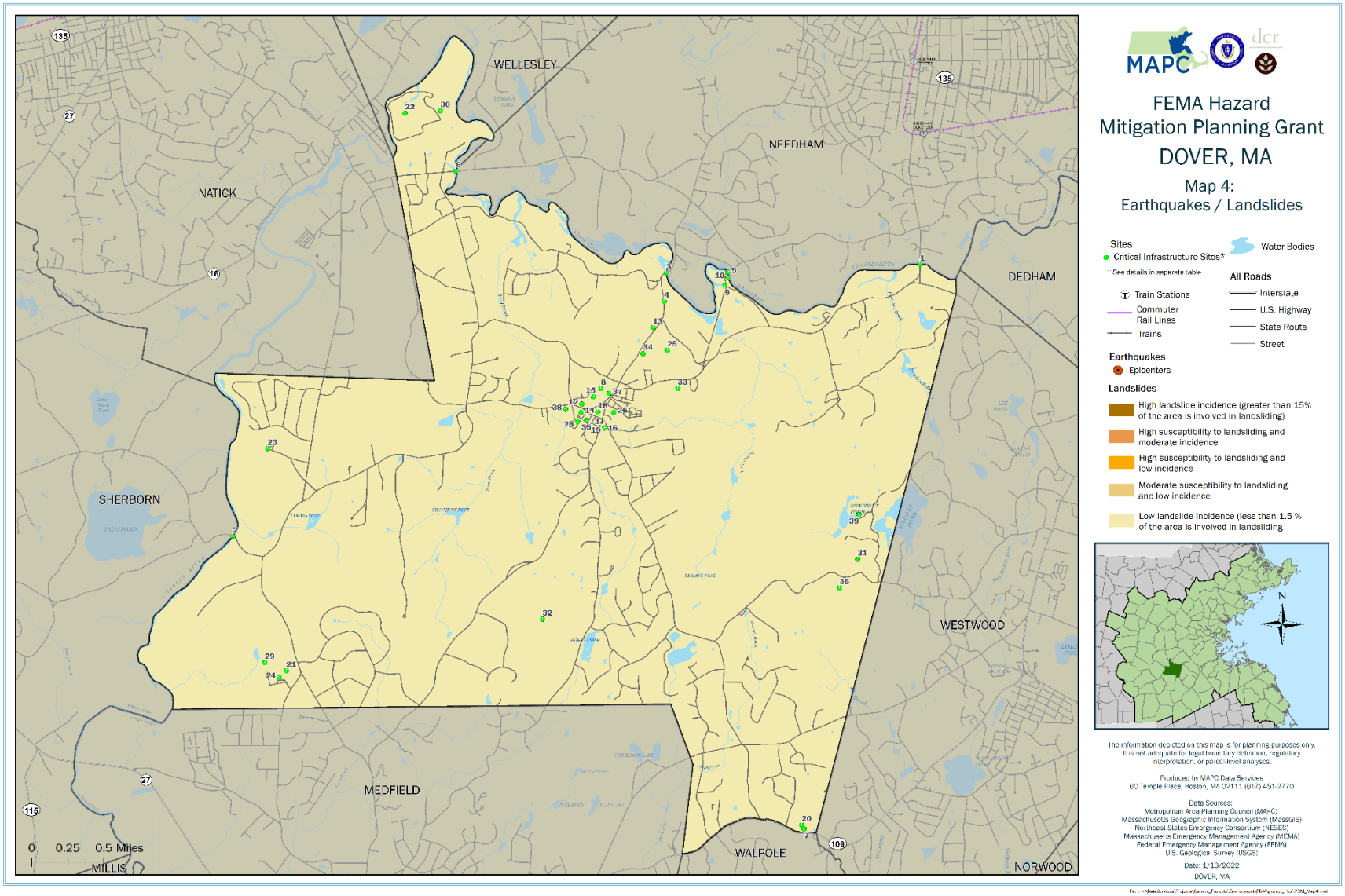
Map 8: Hazard Areas Identified Locally – For each community, locally identified hazard areas are overlaid on an aerial photograph. The critical infrastructure sites are also shown. The source of the aerial photograph is Mass GIS.

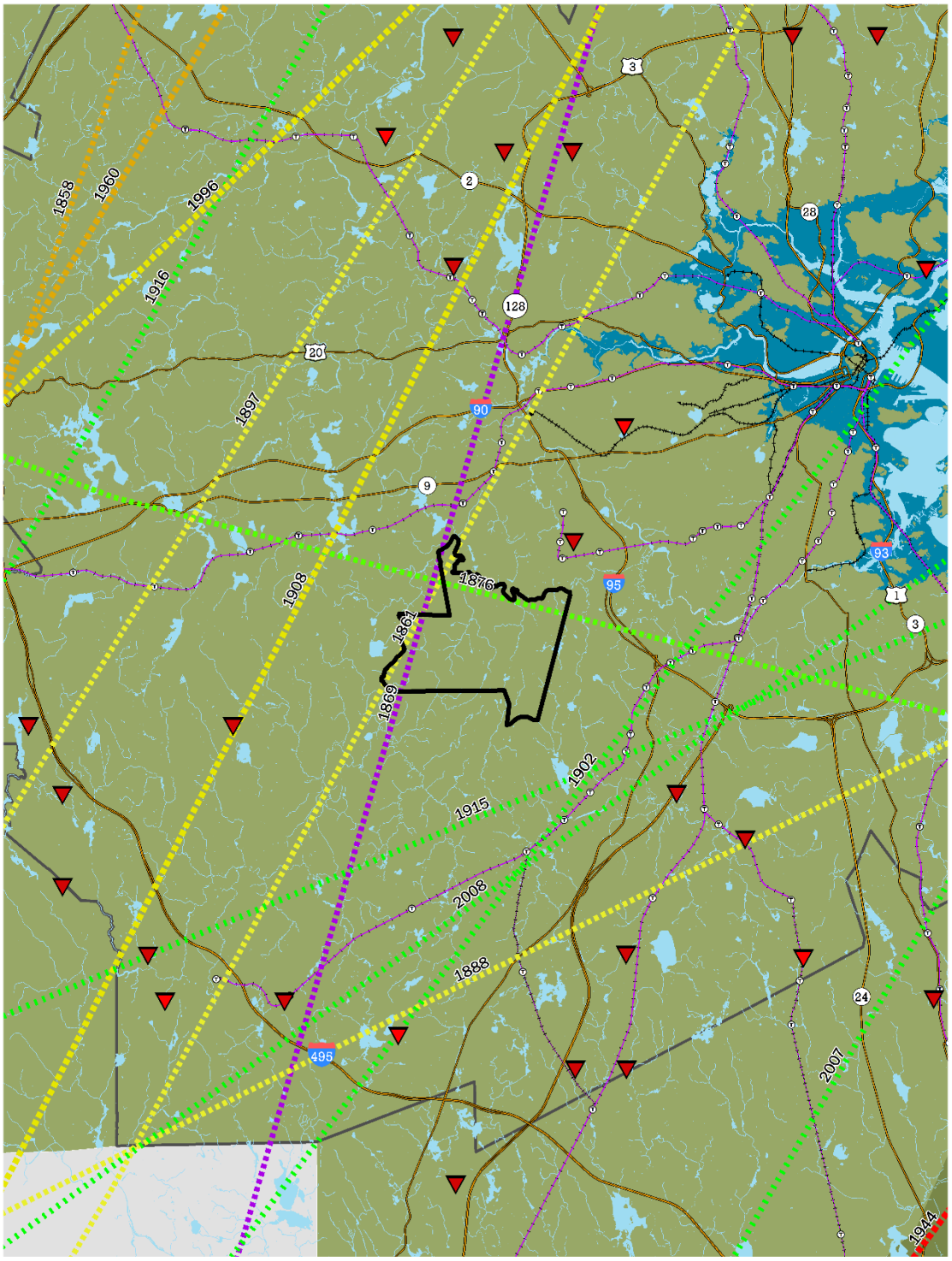
Map 9: Seal Level Rise – Not included as Dover is not a coastal community.


MAPC
dcr
FEMA Hazard Mitigation Planning Grant
DOVER, MA
Map 1: Population Density
Sites
Critical Infrastructure*
Development Areas
* See details in separate table
Water Bodies
Population Density
Census 2020 Block Groups
People per acre
0 or No Data
0.1 - 5.0
5.1 - 15.0
15.1 - 30.0
More than 30
All Roads
Interstate
U.S. Highway
State Route
Street
Rail
Stations
Commuter Rail
WELLESLEY
NEEDHAM
NATICK
DEDHAM
SHERBORN
MEDFIELD
WESTWOOD
WALPOLE
NORWOOD
MILLIS
0 0.25 0.5 Miles
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
U.S. Decennial Census
DOVER, MA
Date: 1/13/2022
Path: K:\DataServices\Projects\Current_Projects\Environment\PDM\project_files\PDM_Map1.mxd


WELLESLEY
NEEDHAM
NATICK
DEDHAM
SHERBORN
MEDFIELD
WESTWOOD
WALPOLE
NORWOOD
MILLIS
0 0.3 0.6 1.2 Miles
N
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
DOVER, MA
Map 2: Land Use
Sites
Critical Infrastructure
RepetitiveLossSites
Development Areas
* See details in separate table
Water Bodies
Land Use
High Density Residential
Medium Density Residential
Low Density Residential
Non-Residential Developed
Commercial
Industrial
Transportation
Agriculture
Undeveloped
Undeveloped Wetlands
All Roads
Interstate
U.S. Highway
State Route
Streets
Rail
Stations
Commuter Rail
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
DOVER, MA
Date: 1/13/2022


NEWTON
WELLESLEY
NEEDHAM
NATICK
DEDHAM
SHERBORN
WESTWOOD
MEDFIELD
WALPOLE
NORWOOD
MILLIS
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
DOVER, MA
Map 3: Flood Zones
Sites
Critical Infrastructure*
Repetitive Loss Sites
Locally Identified Flooding
* See details in separate table
Water Bodies
Flood Zones, 2017
(Annual Chance)
Zone A: 1%
Zone AE: 1%
Zone AH: 1%
Zone AO: 1%
Zone VE: 1% with Velocity Hazard
0.2% Annual Chance
All Roads
Interstate
U.S. Highway
State Route
Streets
Rail
Stations
Commuter Rail
Trains
March 2010 Flood Claims
Flood Insurance
Disaster Assistance
0 to 1 inch
2 to 6 inches
6 inches to 2 feet
2 feet plus
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Flood Zones data layer updated by MassGIS October 2013
from finalized data provided by
Federal Emergency Management Agency (FEMA)
DOVER, MA
Date: 1/13/2022


WELLESLEY
NEEDHAM
NATICK
DEDHAM
SHERBORN
WESTWOOD
MEDFIELD
WALPOLE
NORWOOD
MILLIS
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
DOVER, 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
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
U.S. Geological Survey (USGS)
Date: 1/13/2022
DOVER, MA



MAPC

dcr

FEMA Hazard
Mitigation Planning Grant

DOVER, MA

Map 5: Hurricanes / Tornadoes

Tornadoes
Tornado
All Roads
Interstate
U.S. Highway
State Route
Street
Train Stations
Commuter Rail Lines
Trains
Water Bodies

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

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

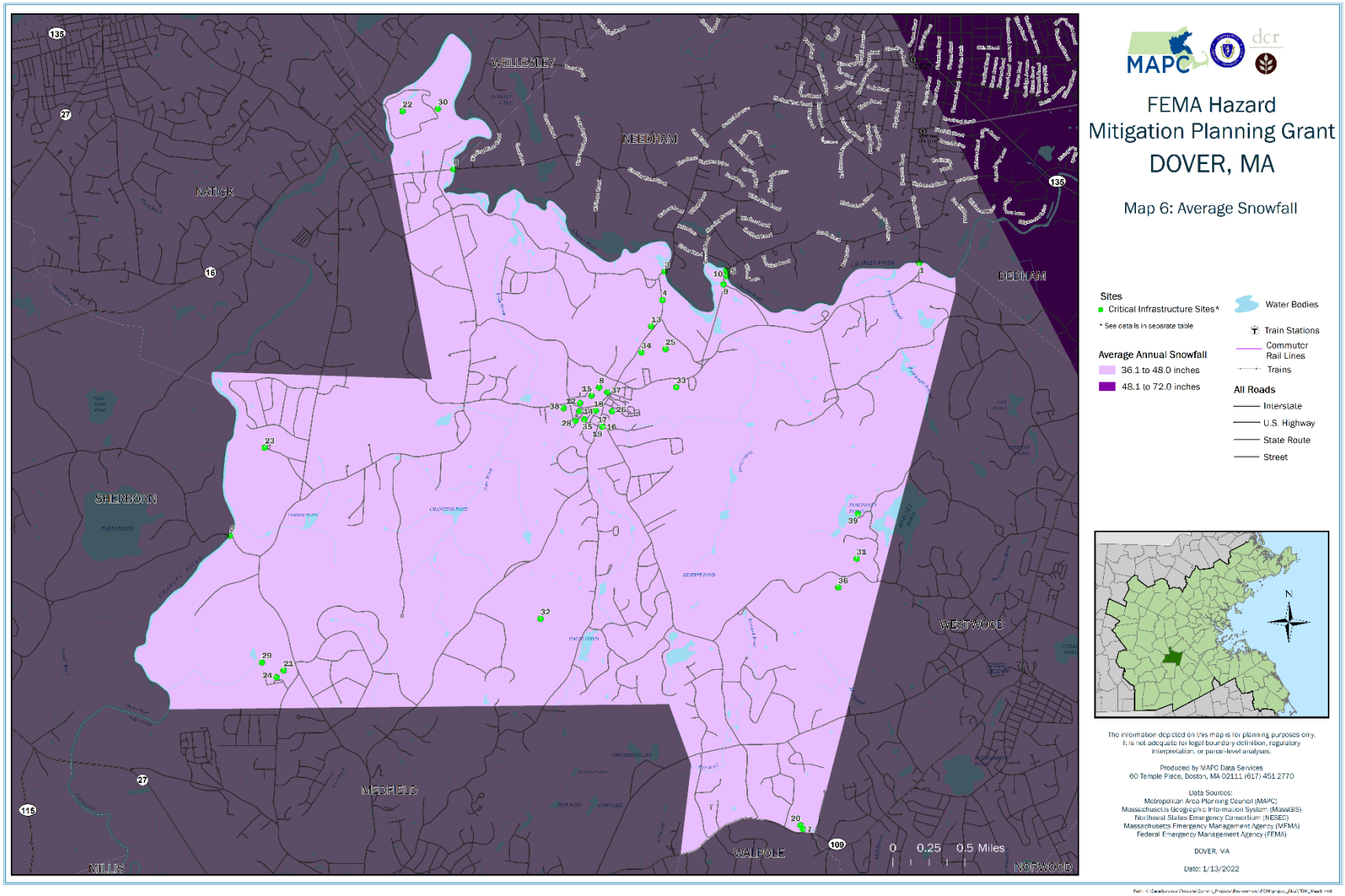
0 0.25 0.5 Miles

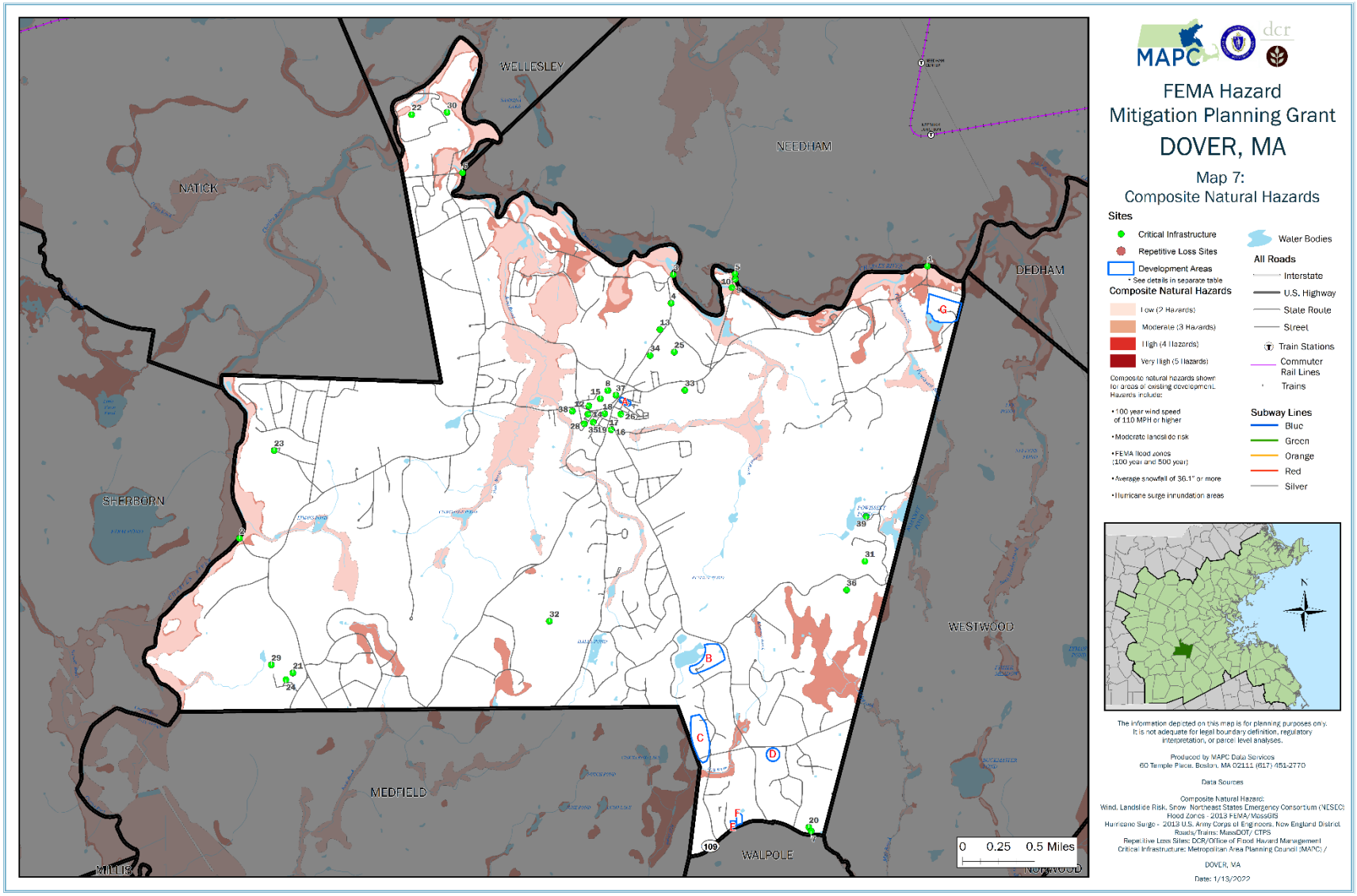
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

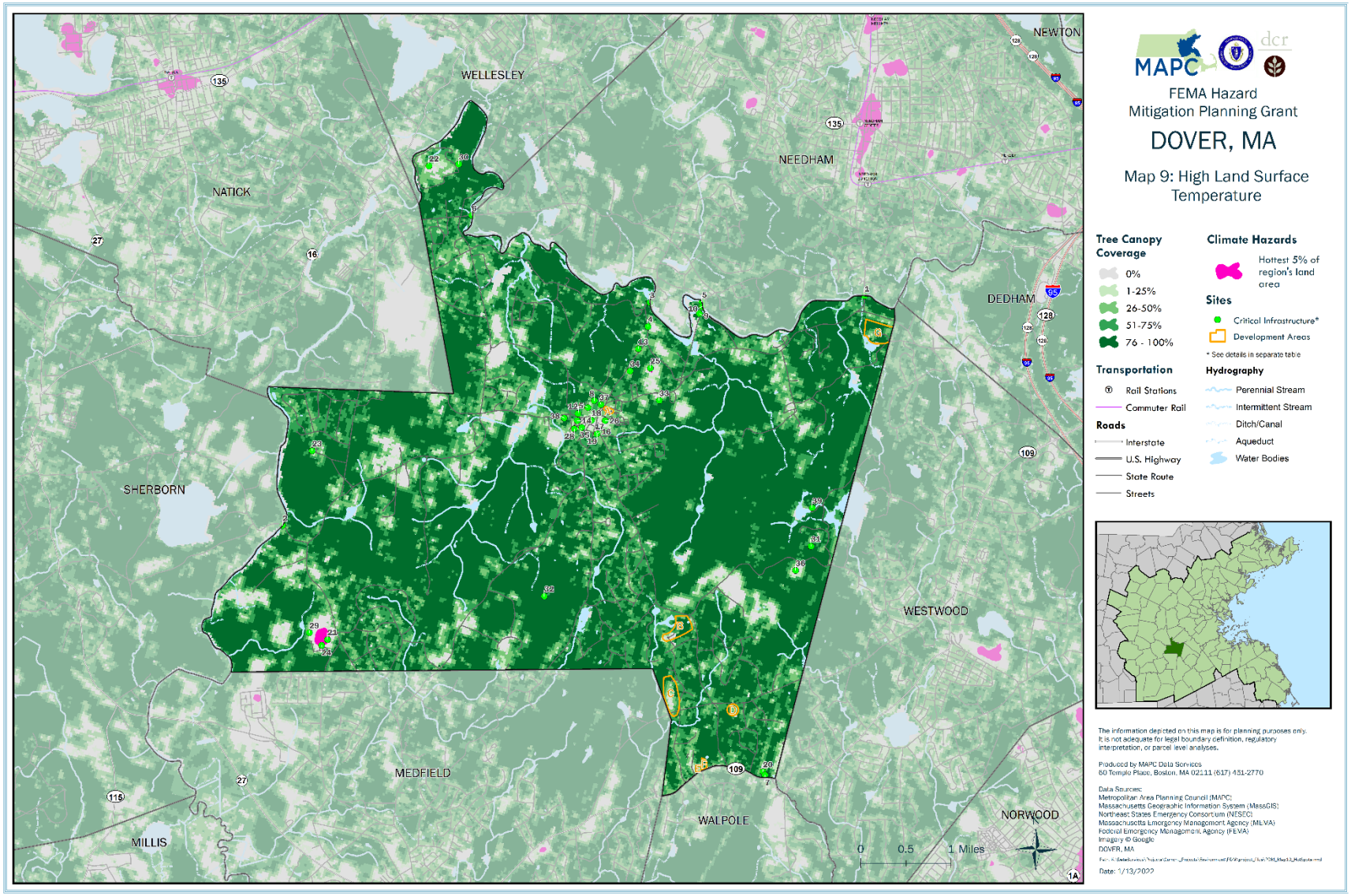
Produced by:
Metropolitan Area Planning Council
60 Temple Place, Boston, MA 02111 | (617) 933-0700

Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Massachusetts Department of Transportation (MassDOT)

January 2022


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
DOVER, 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
WELLESLEY
NEEDHAM
NATICK
DEDHAM
SHERBORN
MEDFIELD
WESTWOOD
WALPOLE
NORWOOD
MILLIS
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451 2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
DOVER, MA
Date: 1/13/2022


WELLESLEY
NEEDHAM
NATICK
DEDHAM
SHERBORN
WESTWOOD
MEDFIELD
WALPOLE
MILLIS
NORWOOD
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
DOVER, 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 inundation 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
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources
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) /
DOVER, MA
Date: 1/13/2022


NEWTON
WELLESLEY
NEEDHAM
NATICK
DEDHAM
SHERBORN
WESTWOOD
MEDFIELD
WALPOLE
NORWOOD
MILLIS
0 0.5 1 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
DOVER, 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
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google
DOVER, MA
Date: 1/13/2022

APPENDIX B: HAZARD MITIGATION TEAM MEETINGS

APPENDIX B

DOVER HAZARD MITIGATION PLANNING TEAM MEETING AGENDAS

APPENDIX B: HAZARD MITIGATION TEAM MEETINGS

Dover Hazard Mitigation Plan
Local Team Meeting #1

Thursday, July 29, 2021
10:00 – 11:30 AM

Zoom Meeting
https://zoom.us/j/98555912733

Meeting ID: 985 5591 2733
One tap mobile
+13017158592,,98555912733#
Dial by your location
+1 301 715 8592

AGENDA

1. Welcome and Introductions
2. Overview of the HMP Project
   - Overview of the FEMA Hazard Mitigation Plan
   - Project tasks and schedule
3. Local Data Updates from 2016 Plan
   - Update Local Flooding Areas of Concern
   - Update Critical Facilities Inventory
   - Update New and Planned Development sites
   - During the meeting we will update maps using *Google MyMaps*
4. Review and Update Hazard Mitigation Goals

Next Steps:

5. Review and Update of Existing Mitigation Measures
6. Public Meetings and Outreach
   - Two Public Meetings
   - Identify local stakeholders to invite

APPENDIX B: HAZARD MITIGATION TEAM MEETINGS

Dover Hazard Mitigation Plan
Local Team Meeting #2

Thursday, September 9, 2021
10:00 – 11:00 AM

Zoom Meeting
https://zoom.us/j/92924833365?pwd=eUtMb0M0WUR4ajZzK3BBUFVTSnJQUT09

AGENDA

1. **Welcome and Introductions**
2. **Review and Update of Mitigation Goals for the Plan**
   - See Goals from the 2016 plan attached
   - Revise, delete, or add new goals as the team decides
3. **Review Status of Existing Mitigation Measures**
   - Summary of Existing Mitigation from 2016 plan attached
   - Note any changes or new measures adopted since 2016
   - Comments on effectiveness, any changes or new measures needed
4. **Prepare for First Public Meetings**
   - To be hosted by the Planning Board on September 27
   - MAPC to give overview presentation on the plan
   - Opportunity for questions/comments from the Board and public
   - *Invitation and outreach:*
     - Identify local stakeholders to invite (see MVP list attached)
     - MAPC to prepare meeting notice for email & posting on web site
     - MAPC to prepare media advisory for local press

APPENDIX B: HAZARD MITIGATION TEAM MEETINGS

Dover Hazard Mitigation Plan
Local Team Meeting #3

Monday, November 29, 2021
10:00 – 11:00 AM

Zoom Meeting
h
https://zoom.us/j/99704495825?pwd=Nkc3UEJZWmpmSi9BZUpaelRiRiZ3QT09 (map)

AGENDA

1. Welcome and Introductions
2. Review Status of Recommended Mitigation Measures
   - *See **Worksheet #1**, Status of Recommended Mitigation from 2016 plan*
   - Please note mitigation that has been **completed** or **partially completed**
   - For mitigation **not completed**, please note any that should be **retained** for the 2021 updated plan; and if any **revisions** are needed
3. Update the Hazard Mitigation Strategy for the 2021 Plan
   - *See **Worksheet #2**, Updated Mitigation Strategy*
   - Include mitigation to be **retained** from the previous plan (Worksheet 1)
   - Add any **new Mitigation Measures** (such as climate resilience)
   - Identify lead agencies, estimated costs, time frames, and funding sources for each recommended measure
4. Next Steps
   - Second public meeting
   - Complete draft plan and submit to MEMA
5. Adjourn

APPENDIX C: PUBLIC MEETINGS

APPENDIX C
DOCUMENTATION OF PUBLIC MEETINGS

APPENDIX C: PUBLIC MEETINGS

PLANNING BOARD AGENDA

September 27, 2021
7:00 PM

To Be Held Remotely

Following guidance issued by Governor Baker regarding the Open Meeting Law, this public meeting will be held remotely, and individuals wishing to participate may do so by utilizing Zoom video conferencing technology.

To join the meeting by video conferencing using a computer or tablet, please click on the following link: https://zoom.us/j/93850795064?pwd=Y1M3a1F5SGFCYlBKVEx2b3o3dWM1UT09
If prompted enter Meeting ID: 938 5079 5064 and Passcode: 315730
To call in by phone, dial 1 646-876-9923 and enter meeting ID 938 5079 5064#

I. **Regular Business**

7:00 PM Review of meeting minutes from September 20, 2021

II. **New/Special Business**

7:05 PM Hazard Mitigation Plan Kick-Off

8:05 PM 25 Haven Street – Site Plan Review for a modification to a previously approved Site Plan application.

III. **General Town Business**

8:25 PM Town Planner Updates

Please be advised cases may be called up to ten (10) minutes before the time advertised.

Reasonable accommodations for people with disabilities are available upon request. Include a description of the accommodation you will need, including as much detail as you can and include a way we can contact you if we need more information. Please allow advance notice. Send an e-mail to cstarling@doverma.gov or call the Planning Board Office at (508) 785-0032 ex. 240.

APPENDIX C: PUBLIC MEETINGS

The Town of Dover invites you to a

Public Meeting on the Dover Hazard Mitigation Plan

Natural hazards and climate change can have serious impacts on Dover's residents and businesses



The Town of Dover is preparing a **Hazard Mitigation Plan** to reduce the Town's vulnerability to hazards such as flooding, droughts, hurricanes, and blizzards, and to increase its resilience to climate change. Dover's previous plan was prepared in 2016 and should be updated every five years. By completing this plan, the Town will be eligible for grants from the Federal Emergency Management Agency for mitigation projects

Please join the Town for a public presentation about Hazard Mitigation Plan at an online meeting of the Planning Board via Zoom. We want to hear your concerns and ideas for mitigating natural hazards in Dover!

Date: Monday, September 27 at 7:00 PM

Meeting via Zoom:
To join the meeting by video conferencing using a computer or tablet, please click on the following link:
https://zoom.us/j/93850795064?pwd=Y1M3a1F5SGFCYlBKVEx2b3o3dWM1UT09
If prompted enter Meeting ID: 938 5079 5064 and Passcode: 315730

To call in by phone, dial 1 646-876-9923 and enter meeting ID 938 5079 5064

APPENDIX C: PUBLIC MEETINGS

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

CALENDAR LISTING / MEDIA ADVISORY

DOVER'S HAZARD MITIGATION PLAN TO BE DISSUSSED AT SEPTEMBER 27 PUBLIC MEETING

What: On Monday, September 27, 2021 at 7:00 PM the Dover Planning Board will host an online public meeting via Zoom to discuss the town's Hazard Mitigation Plan, which is currently being updated.

The Town of Dover is preparing a Hazard Mitigation Plan to reduce the town's vulnerability to natural hazards such as flooding, droughts, hurricanes, and blizzards, and increase the Town's resilience to the impacts of climate change. Dover's previous plan was prepared in 2016 and should be updated every five years. By completing this plan, the Town will remain eligible for grants from the Federal Emergency Management Agency for mitigation projects.

Please join the meeting for a public presentation about the Hazard Mitigation Plan at a virtual meeting of the Planning Board. The presentation will be made by the Metropolitan Area Planning Council, which is preparing the plan for the Town.

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

When: Monday, September 27, 2021, 7:00 PM

Where: Online Planning Board meeting via Zoom
Please send an email to mpillsbury@mapc.org to request the Zoom information.

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

##

APPENDIX C: PUBLIC MEETINGS

[ADD PLANNING BOARD AGENDA FOR JAN. 24, 2022]

APPENDIX C: PUBLIC MEETINGS

The Town of Dover invites you to a

Public Meeting on the

Draft Dover Hazard Mitigation Plan 2022 Update

Natural hazards and climate change can have serious impacts on Dover's residents and businesses

The Town of Dover has prepared a draft Hazard Mitigation Plan to reduce the Town's vulnerability to natural hazards such as flooding, droughts, hurricanes, and blizzards, and to increase resilience to climate change. Dover's previous plan was prepared in 2016 and is due for an update. By completing this plan, the Town will be eligible for grants from the Federal Emergency Management Agency for mitigation projects.

Please join the Town for a public presentation about Hazard Mitigation Plan at an online meeting of the Planning Board via Zoom. We want to hear your concerns and ideas for mitigating natural hazards in Dover!

Date: Monday, January 24 at 7:00 PM

Meeting via Zoom:
To join the meeting by video conferencing using a computer or tablet, please click on the following link:
https://zoom.us/xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
If prompted enter Meeting ID: XXXXXXXXXXX and Passcode: XXXXXX
To call in by phone, dial 1 646-876-9923 and enter meeting ID 965 6103 6858#

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

CALENDAR LISTING / MEDIA ADVISORY

DOVER'S HAZARD MITIGATION PLAN TO BE DISSUSSED AT JANUARY 24 PUBLIC MEETING

What: On Monday, January 24, 2022 at 7:00 PM the Dover Planning Board will host an online public meeting via Zoom to discuss the town's draft Hazard Mitigation Plan, which has recently been completed.

The Town of Dover has prepared an updated draft Hazard Mitigation Plan to reduce the town's vulnerability to natural hazards such as flooding, droughts, hurricanes, and blizzards, and increase the Town's resilience to the impacts of climate change. Dover's previous plan was prepared in 2016 and is due to be updated. By completing this plan, the Town will remain eligible for grants from the Federal Emergency Management Agency for mitigation projects.

Please join the Town for a public presentation about the draft Hazard Mitigation Plan at a virtual meeting of the Planning Board. The presentation will be made by the Metropolitan Area Planning Council, which is preparing the plan for the Town.

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

When: Monday, January 24, 2022, 7:00 PM

Where: **Online Planning Board meeting via Zoom**
Please send an email to doverhazardplan@mapc.org to request the Zoom meeting link.

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

##

APPENDIX C: PUBLIC MEETINGS

NOTICE TO DOVER'S NEIGHBORING COMMUNITIES

TO: Town Clerks, Towns of Framingham, Medfield, Natick, Sherborn, Wellesley, and Westwood

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

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

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

Monday, January 24, 7:00 PM
Remote meeting via Zoom:
To request the Zoom meeting link, please send an email to
doverhazardplan@mapc.org

A flyer announcing the meeting is also attached.
The draft plan will be posted online by the date of the meeting at
www.mapc.org/doverhazardplant

Comments and questions may be submitted at this meeting or in writing after the meeting to doverhazardplan@mapc.org Please submit any comments and questions by February 18, 2022.

Thank you,

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

APPENDIX D: PLAN ADOPTION

APPENDIX D
DOCUMENTATION OF PLAN ADOPTION

TO BE ADDED WHEN FEMA SENDS NOTICE OF APPROVAL PENDING ADOPTION

<PRINT ON TOWN LETTERHEAD>

CERTIFICATE OF ADOPTION
BOARD OF SELECTMEN
TOWN OF DOVER, MASSACHUSETTS

A RESOLUTION ADOPTING THE
TOWN OF DOVER HAZARD MITIGATION PLAN 2022 UPDATE

WHEREAS, the Town of Dover established a Committee to prepare the *Town of Dover Hazard Mitigation Plan 2022 Update*; and

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

WHEREAS, duly-noticed public meetings were held by the Planning Board on September 27, 2021, and January 24, 2022,

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

NOW, THEREFORE BE IT RESOLVED that the Town of Dover BOARD OF SELECTMEN adopts the *Town of Dover Hazard Mitigation Plan 2022 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Dover.

ADOPTED AND SIGNED this Date. _____

Name _____

Title _____

Signature(s) _____