NORTH ANDOVER

MULTI-HAZARD MITIGATION and MUNICIPAL VULNERABILITY PLAN

SEPTEMBER 2021

TOWN OF NORTH ANDOVER

With assistance from

Merrimack Valley Planning Commission

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Executive Summary

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This process results in a Multi-Hazard Mitigation Plan (HMP) that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term community vision. The Federal Disaster Mitigation Act of 2000 requires all municipalities to adopt a local HMP and update their plan every five years to be eligible for FEMA funding for hazard mitigation grants. North Andover was previously included in the regional Merrimack Valley Multi-Hazard Mitigation Plan Update, completed by the Merrimack Valley Planning Commission (MVPC), which expires in 2021.

The Massachusetts Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) grant program helps communities assess local vulnerabilities to climate change and to develop appropriate action-oriented response strategies. The program provides technical support, guidance, and financial incentives for cities and towns to undertake community vulnerability self-assessments and prioritize projects and actions that can make a community more resilient and better prepared to mitigate long-term risks and adapt to climate change impacts. This planning process is very similar to that which is required to complete a local hazard mitigation plan.

This plan, a compilation of both planning processes, meets the requirement for North Andover to update its current HMP while incorporating resiliency to climate-related impacts. The result will be a more comprehensive tool for addressing risk to human life and property associated with hazards that will be exacerbated by climate change.

SECTION 1. INTRODUCTION

This section provides a general introduction to the updated **North Andover Multi-Hazard Mitigation and Municipal Vulnerability Preparedness Plan** (hereinafter "North Andover HMP-MVP"). It consists of the following four subsections:

- Disaster Mitigation Act
- Background
- Plan Purpose
- Geographic Scope

Hazard Mitigation
Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.

1.1 Disaster Mitigation Act

Congress enacted the Disaster Mitigation Act of 2000 (DMA 2000) on October 10, 2000. Also known as the Stafford Act Amendments, the bill was signed into law by President Clinton on October 30, 2000, creating Public Law 106-390. The law established a national program for pre-disaster mitigation and streamlined the federal administration of disaster relief. Specific rules on the implementation of DMA 2000 were published in the Federal Register in February 2002 and required that all communities have an approved Multiple Hazards Mitigation Plan in place to qualify for future federal disaster mitigation grants following a Presidential disaster declaration.

According to federal regulations, every five years regional and local jurisdictions must review and revise their plan to reflect changes in development, progress in mitigation efforts, and changes in priorities. The updated plan must be resubmitted to MEMA and FEMA for review and approval to continue to be eligible for mitigation project grant funding. Plan updates must demonstrate that progress has been made in the last five years through a comprehensive review of the previous plan.

The regional and local plans emphasize measures that can be taken to reduce or prevent future disaster damages caused by natural hazards. Mitigation, in the context of natural hazard planning, refers to any action that permanently reduces or eliminates long-term risks to human life and property. In 2006, FEMA performed a cost-benefit analysis based on a sampling of hazard mitigation grants and determined that every dollar spent on mitigation saved society an average of four dollars.[1]

A variety of mitigation actions are available to reduce the risk of losses from natural hazards. These activities, which can be implemented at the local and state levels, include hazard mitigation planning, the adoption and enforcement of development codes and standards, the use of control structures such as floodwalls and culverts, and the protection of wetlands, floodplains, and open space. Many of the strategies identified in

[1] National Institute of Building Sciences, *Natural Mitigation Saves: An Independent Study to Assess Future Savings from Mitigation Activities*, 2006.

hazard mitigation planning are implemented through land use planning tools and development regulations that can prevent or limit development in hazard-prone areas. Where development has already occurred in hazard-prone areas, buildings can be retrofitted or modified to increase the chances of surviving a known hazard. Strict enforcement of the state building code is critically important to effectively minimize natural hazard losses.

In addition to addressing natural hazard mitigation, this updated hazard mitigation plan includes an overview of non-natural hazards and assesses the interrelationship of climate change and hazard mitigation.

1.2 Municipal Vulnerability Preparedness

Governor Baker in September 2016 issued Executive Order 569, directing the Secretary of the Energy and Environmental Affairs and the Secretary of Public Safety to coordinate efforts across the Commonwealth to strengthen the resilience of communities, prepare for the impacts of climate change and mitigate damage from extreme weather events. The State agencies were charged with establishing a framework that each city and town could use to assess local vulnerabilities to climate change and to develop appropriate action-oriented response strategies.

The Commonwealth's agency response is the Municipal Vulnerability Preparedness Grant Program (MVP) which provides support to Massachusetts communities to plan for resilience and implement key adaptation actions. The MVP framework, developed by The Nature Conservancy, employs a workshop-based model designed to help local stakeholders in:

- Characterizing climate-related and extreme weather hazards of highest concern to the community;
- Understanding the science of climate change and adaptation. EOEEA has established a website www.resilientma.org as a data clearinghouse for science and state-specific geographic data on climate change;
- Identifying existing and future vulnerabilities and asset strengths in areas of infrastructure and critical facilities, socio-economic characteristics, and environmental resources;
- Developing and prioritizing actions for community resilience based on identified opportunities for risk reduction and resilience building; and
- Implementing key actions through community partnerships.

With the completion of the resilience-building planning process, a city or town can become a formally designated MVP community, eligible for MVP action grants to undertake technical plans as well as design and construct priority resilience projects.

In 2018, the Commonwealth of Massachusetts adopted the **State Hazard Mitigation and Climate Adaptation Plan (SHMCAP)**. The plan was the first of its kind to comprehensively integrate climate change impacts and adaptation strategies with hazard mitigation planning to comply with current federal requirements for state hazard mitigation

plans under the Stafford Act. Following the State's example, cities and towns are eligible for additional funding to combine the MVP Planning process with hazard mitigation planning.

1.3 Background

Natural hazards, such as floods, hurricanes, and severe winter storms, are a part of the world around us. Their occurrence is natural and inevitable, and our capacity to control their frequency, intensity, or duration is limited. Also, climate change is altering the frequency and intensity of these events requiring municipalities to examine climate projections as part of their planning.

The Merrimack Valley region is vulnerable to a wide array of natural hazards, including ***floods***, ***hurricanes***, ***northeasters***, ***snow and ice storms***, ***drought***, ***wildfires***, and even ***tornadoes*** and ***earthquakes***. These hazards threaten the safety of our residents and have the potential to damage or destroy public and private property, disrupt the local economy, and diminish the overall quality of life of those who live, work, and play in the region.

While we cannot eliminate natural hazards, there is much we can do to lessen their impacts on communities and citizens. By reducing a hazard's impact, we can decrease the likelihood that such an event will result in a disaster. The concept and practice of reducing risks to people and property from known hazards is generally referred to as ***hazard mitigation***. Also, by incorporating the best available scientific information on climate change, communities are better able to develop adaptation strategies to increase resilience.

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This process results in a Multi-Hazard Mitigation Plan that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term community vision. To ensure the functionality of each action, responsibility is assigned to a specific individual, department, or board, along with a timeframe for its implementation. Plan maintenance procedures are established for the routine monitoring of implementation progress, as well as the evaluation and enhancement of the Mitigation Plan itself. These Plan maintenance procedures are intended to ensure that the Plan remains a current, dynamic, and effective planning document over time.

Mitigation planning has the potential to produce long-term, recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demands for post-disaster assistance by

lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices will enable residents and businesses to re-establish themselves in the wake of a disaster, getting the community and its economy back on track sooner and with less disruption to lives and vital services.

The benefits of mitigation planning go beyond solely reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can achieve multiple community goals, such as preserving open space, maintaining environmental health, and enhancing recreational opportunities. Thus, it is vitally important that any local mitigation planning process be properly integrated with other concurrent local planning efforts, such as the Town's Master Plan or Open Space and Recreation Plan. Similarly, any proposed mitigation strategies and actions should take into account other community goals and initiatives that could complement (or possibly hinder) their future implementation.

1.4 Plan Purpose

The purpose of the North Andover HMP-MVP is to identify and characterize hazards associated with natural disasters and climate change; determine specific locations, populations, and facilities that are vulnerable to these hazards; and formulate mitigation goals, strategies, and actions to reduce the risks and impacts associated with these hazards. By developing and implementing a hazard mitigation and vulnerability preparedness plan *before* disaster strikes, North Andover will be better able to prevent or minimize loss of life and property. Anticipated Plan benefits include:

- A community that is a safer place to live, work, and visit;
- Qualification for local grant funding in the pre-disaster and post-disaster environments;
- Qualification for MVP grant funding;
- Speedier physical and economic recovery and redevelopment following disaster events; and
- Compliance with state and federal regulatory requirements for natural hazard mitigation plans and the MVP designation process.

FEMA, within the Department of Homeland Security, is responsible for leading the country's efforts to prepare for, prevent, respond to, and recover from disasters. FEMA has made hazard mitigation a primary goal in its efforts to reduce the long-term effects of natural hazards. FEMA provides guidance to state, regional and local governments in developing their hazard mitigation plans, reviews and approves the plans, and administers several hazard mitigation grant programs to fund mitigation activities.

Some state and federal grant programs mandate that local governments develop and maintain up-to-date natural hazard mitigation plans. The Federal Disaster Mitigation Act of 2000 requires all communities to have such plans in place to be eligible for future federal post-disaster mitigation funds under the Federal Emergency Management

Agency's (FEMA) Hazard Mitigation Grant Program (HMGP). This Hazard Mitigation Plan is intended to assist the communities in complying with this requirement.

The mitigation planning process is also directed at ensuring that local mitigation strategies and implementation actions: 1) address the *priority* mitigation needs identified by each community, and 2) are properly coordinated among the region's communities to maximize limited resources, minimize inter-municipal conflicts, and avoid duplication of effort.

As stated previously, to remain current, hazard mitigation plans must be updated and resubmitted to FEMA for approval every five years. Plan updates must demonstrate that progress has been made in fulfilling the commitments made in the previous plan. This requires a review and update of each section of the plan and a discussion of the progress made over the past five-year period. North Andover was previously part of the regional Merrimack Valley Multi-Hazard Mitigation Plan which was approved in 2016. Given the opportunity to update its Hazard Mitigation Plan as part of the MVP Planning process, North Andover sought additional funding to accomplish this task as part of its MVP Planning Grant. The North Andover HMP-MVP describes occurrences of hazards included in the previous plan and assesses North Andover's capacity to adapt to changing hazards and climate conditions in the future. The plan has also been updated to include changes in development patterns and changes in local and regional priorities. The goals contained in the prior plan have been reviewed and either reaffirmed or revised to reflect new information, priorities and a changing climate.

1.5 Planning Project Vision Statement

Through a series of Community Resilience-Building workshops, North Andover seeks to develop an action plan to substantially and sustainably improve its resilience to and preparedness for local climate-related hazards. North Andover seeks to achieve this by:

1) defining local climate-related hazards;
2) identifying the town's strengths and vulnerabilities regarding each of these hazards, now and in the future;
3) developing a prioritized action plan to improve the town's resilience to and preparedness for these hazards; and
4) use this information to inform and update the North Andover Multi-Hazard Mitigation Plan.

In developing this action plan, the following factors should be considered:

- Maintaining and improving quality of life in North Andover;
- Maintaining fiscal balance and stability despite large and unforeseeable municipal expenses during and after events;
- Maintaining communication pathways, and information technology systems, during events (including power outages);
- Maintaining water quality and protecting our natural resources through changing conditions;
- Maintaining and replacing aging infrastructure to withstand current and future hazards;
- Protecting transportation systems against hazards, including public transportation reliability;
- Avoiding and mitigating damage to private and public property during events;
- Providing emergency shelter options to vulnerable populations during events;
- Culling at-risk trees and removing fallen trees during storms in a timely manner;
- Avoiding poor air quality as temperatures rise, especially during heat waves;
- Accommodating increasing energy use and the resulting strain on the electrical grid during heat waves; and
- Managing insects, pests, wildlife, and invasive plant species with changes in precipitation patterns and increasing temperatures.

SECTION 2. PLANNING PROCESS & PUBLIC PARTICIPATION

This section describes the process undertaken to update the plan by the Town of North Andover and its core team and other stakeholders to develop the **North Andover HMP-MVP.**

2.1 Planning Process Summary

The Town of North Andover in 2020, seeking to become an MVP-designated community, applied for and received an MVP Planning Grant to organize a series of community resilience building planning workshops. These workshops follow a framework developed by The Nature Conservancy and outlined in the *Community Resilience Building Workshop Guidebook* (2019). The Guidebook details an inclusive community driven process that guides participants in identifying top hazards, vulnerabilities and strengths, and priority actions to increase resilience to natural and climate related hazards.

44 CFR Requirement

Part 201.6(c)(1): *The plan shall include documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

To lead this process, Town of North Andover engaged the Merrimack Valley Planning Commission, MVPC, as its certified provider. MVPC coordinated and completed the Merrimack Valley Multi-Hazard Mitigation Plan Update 2016-2021, in which North Andover was included. North Andover's Community and Economic Development Director served as the lead for the MVP-HMP planning process. A kick-off with the Core Team was slated for March 16th of 2020. But crisis events intervened, and Town Offices were closed due to the COVID-19 pandemic. As a result, the Core Team Meeting was held on March 27, 2020 with over 20 participants in attendance on a virtual meeting platform.

North Andover's Core Team included the following representation:

Melissa	Rodrigues	Town Manager
Denise	Casey	Assistant Town Manager
Andrew	Shapiro	Community & Economic Development Director
Brian	LaGrasse	Health Director
Paul	Hutchins	Inspector of Buildings
Irene	O'Brien	Elder Service Director
Amy	Maxner	Conservation Administrator
Charles	Gray	Police Chief
William	McCarthy	Fire Chief
John	Borgesi	Assistant DPW Director/Town Engineer
Steve	Foster	Facilities Director

Jean	Enright	Planning Director
Laurie	Burzlaff	Chair Affordable Housing Trust/Director of Administrative Services
Jim	Mealey	Assistant Superintendent NA Public Schools
Jeff	Coco	Emergency Management Director
Deanna	Lima	Community Support Coordinator
Glen	Aspeslagh	Friends of North Andover Trails
Jeff	French	Ability Assistance Commission
Phyllis	Jones	Ability Assistance Commission, Chair

In 2008, MVPC completed the Merrimack Valley region's initial HMP. In 2015/16 MVPC completed the first update of that Plan. This update builds upon that planning initiative with North Andover as the sole planning area focus. Updated data regarding natural hazard events, demographics, non-natural hazards, and critical infrastructure have been incorporated into the document as well as the results of the North Andover's Municipal Vulnerability Preparedness Planning which further incorporates climate change into the existing plan. New information regarding changes in development patterns, progress in local mitigation efforts, and changes in local and regional priorities have been incorporated into the update as well.

During the prior plan development of the Merrimack Valley Multi-Hazard Mitigation Plan, MVPC and local staff took numerous steps to coordinate all aspects of emergency management planning. Each municipality had a Comprehensive Emergency Management Plan (CEMP), and a Regional Homeland Security Plan in place. Accordingly, North Andover's Hazard Mitigation Plan update includes goals and objectives that meet local needs and complement local and regional goals established in the CEMPs and Homeland Security Plan.

2.2 Preparing for Plan Updating Process

In preparation for the Plan update, MVPC staff attended FEMA- and MEMA-sponsored hazard mitigation planning conferences including a one-day Local Mitigation Planning Workshop that included a Planning for a Resilient Community module. MVPC also reviewed state and federal guidance documents on the development of an updated and combined Hazard Mitigation and Climate Adaptation Plan. MVPC utilized the instructional manual, "Natural Hazards Mitigation Planning: A Community Guide" (January 2003), prepared jointly by the Massachusetts Department of Environmental Management (now the Department of Conservation and Recreation), the Massachusetts Emergency Management Agency, and the Massachusetts Hazard Mitigation Team. Special attention was given to the planning requirements described in FEMA's updated guidance document, "Local Mitigation Plan Review Guide" (October 1, 2011) and the *Local Mitigation Planning Handbook (2013)*. Appendix A of that document, titled "A *Local Mitigation Plan Review Tool*," provides a detailed summary of FEMA's current minimum standards of acceptability for an updated plan's compliance with the Disaster Mitigation Act of 2000.

MVPC is a certified MVP provider and staff leading the HMP-MVP planning process are trained in workshops to provide technical assistance to communities in completing the assessment and resiliency plan using the Community Resilience Building Framework (CRB). Certified staff is well versed in relevant resources including climate change projections for the Commonwealth and the region, found at the Climate Change Clearinghouse (resilientma.org). MVPC staff is also knowledgeable on how to incorporate nature-based solutions into the planning process, and how to integrate the MVP process with creating and/or updating a local Hazard Mitigation Plan.

North Andover's Hazard Mitigation plan update included a review of Town and regional planning documents including the 2016 Update of the Merrimack Valley Natural Hazard Mitigation Plan, the 2019 Regional Housing Production Plan, North Andover Master Plan (2018) and the North Andover Open Space and Recreation Plan (2016) as well as interviews with key staff within the Town.

Comprehensive hazard maps were developed using the best available data for each with input from the Town's Emergency Management and Public Works Departments. The maps depict the locations of natural hazard areas such as flood zones, as well as critical facilities and infrastructure. They also depict the location of residences and other buildings within the flood zones and form the basis for estimating the probable losses from potential natural disasters, such as severe flooding. These maps can be found in Appendix A.

The hazard identification and assessment process also included compiling information on the region's high-risk dams and structurally deficient bridges. This information was culled from several state data sources, including the DCR Office of Dam Safety and the Massachusetts Highway Department, and, where possible, was updated through input from knowledgeable local officials.

2.3 Local HMP/MVP Core Team and Stakeholders

Project Announcement. In late January 2020, The Town of North Andover was notified of its award of an MVP Planning grant by EOEEA.

Core Team Meeting. After assembling a Core Team, North Andover planned a kick-off meeting for March 16, 2020. As discussed previously, the meeting was abruptly canceled when the global COVID-19 pandemic required all work to be conducted remotely due to the highly contagious nature of the virus. As the town, state and country began sheltering in place to slow the infection rate, alternate meeting platforms were considered and an online meeting on a virtual platform (GoToMeeting) allowed both audio and video participation along with presentation capabilities. Over 23 individuals attended, including Town leadership, local emergency management personnel (police, fire), planning department staff, health and conservation agents, DPW staff, the building inspector, and representatives of North Andover public schools. Also represented were the Ability Assistance Commission and the North Andover Housing Trust.

The purpose of the workshop was to introduce the core team members to the MVP workshop process as well as introduce the requirements of the HMP update. The session began with an ArcGIS Storymap presentation by MVPC that introduced Executive Order 569 and the evolution of the MVP Program. Other agenda items included review of a survey to identify natural hazards of greatest concern, the need to update existing inventories including those of critical facilities and infrastructure, dams, bridges, and flood-prone areas, as well as new developments and changes in land use.

The Town's Director of Community and Economic Development served as the Core Team lead, organizing meetings and assisting with data updates. Members of the Core Team were also integral in updating existing hazard areas and critical facilities inventories. The resulting information was then used to compile the "Existing Protections Matrix" element of the Plan. Core Team members also provided valuable information to identify mitigation projects that have been completed or initiated since the prior Multi-Hazard Mitigation Plan was approved in 2016.

Stakeholders and Community Resiliency Building Workshops. The Core Team coordinated with MVPC to develop a list of stakeholders including a broad representation of community groups, board and commission members, and Town staff with subject matter expertise from public works, building, planning, conservation, the Council on Aging, library, and other departments. The stakeholder list also included local elected officials and mayors and managers from neighboring communities as well as representatives from the business community, and nonprofit and environmental organizations. This broad representation of local and regional entities ensures the HMP-MVP Plan aligns with the policies, planning, and hazard mitigation strategies at different levels of government.

The Stakeholder representatives included:

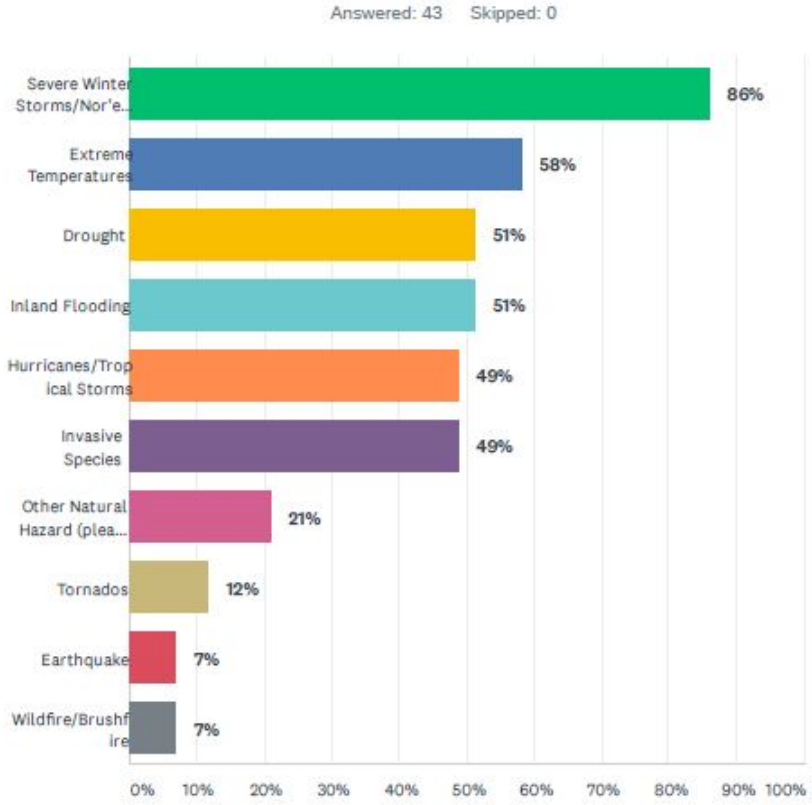
Stakeholders

- Glen Alt, Water Treatment Plant Superintendent, North Andover;
- Charley Anderson, High School Science Teacher, North Andover;
- Liz Armstrong, Friends of North Andover Trails & Bay Circuit Trail, North Andover;
- Alan Benson, Town Administrator, Boxford;
- Christine Berry, Dept. of Conservation and Recreation (DCR), MA;
- Joe Bevilacqua, Merrimack Valley Chamber of Commerce, Lawrence;
- Peter Boynton, Harbormaster & Planning Board, North Andover;
- Wayne Castonguay, Executive Director, Ipswich River Watershed Association, Ipswich;
- Bob Coppola, Facilities Director, Edgewood Lifecare Facility, North Andover;
- Joseph Costanzo, MVRTA, Haverhill;
- Cheri Cousens; Executive Director, Greater Lawrence Sanitary District, North Andover;

- Jeremy Dick, Trustees of Reservations, North Andover;
- Diana DiZoglio, State Senator, First Essex District;
- Margaret Duffy, Greenscapes Northshore, Salem;
- Joy Duperault, State NFIP Coordinator, Boston;
- James Fiorentini, Mayor, City of Haverhill;
- Andrew Flanagan, Town Manager, Andover;
- Brian Fraser, North Andover CAM & North Andover Rotary, North Andover;
- Rick Gorman, Executive Director of Youth & Recreation Services, North Andover;
- Paul Griffin, Brooks School, North Andover;
- Caroline Ibbitson, Public Health Nurse, North Andover;
- Jeff Isbell, General Manager, North Andover Country Club, North Andover;
- Lawrence Jay, Executive Director, Rolling Ridge, North Andover;
- Vanessa Johnson-Hall, Essex County Greenbelt, Essex;
- Kathleen Keenan, Director Stevens Memorial Library, North Andover;
- Joseph Leblanc, Veterans Agent, North Andover;
- Stan Limpert, Friends of North Andover Trails (FONAT);
- Patrick Lynch, Ipswich River Watershed Association, Ipswich;
- Christina Minicucci, State Representative, North Andover;
- Chris Palermo, North Andover Merchant's Association, North Andover;
- Neil Perry, Mayor, City of Methuen;
- Daniel Rivera, Mayor, City Lawrence;
- Lyne Savage, Finance Director, North Andover;
- Felipe Schwarz, Merrimack College, North Andover;
- Joe Sergi, Council on Aging, North Andover;
- Andrew Sheehan, Town Administrator, Middleton;
- Matthew Thorne, Merrimack River Watershed Council, Lawrence;
- Richard Vaillancourt, Chair Board of Selectmen, North Andover;

Core Team and Stakeholder Survey. In preparation for the community resilience workshops, the project team sent out a survey asking stakeholders to identify the top four potential hazard events of most concern. Over two-thirds of stakeholders responded to the survey question which generated the following response levels:

Q1 Hazard TypeWhat are the top four potential natural hazard events that are of most concern to you as a Town of North Andover stakeholder? (Select your top 4 hazard concerns from the menu below.)



Informed by the survey, the Core Team characterized the top North Andover hazard concerns (additional survey results in Appendix B).

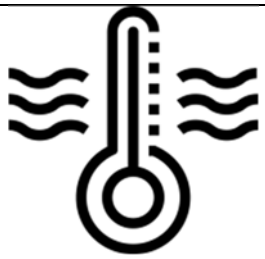
Town of North Andover Primary Hazard Concerns Identified

Nor'easters/Severe Winter Storms

Storms of heavy winds and rain along with severe winter storms are the most frequent naturally occurring hazard in Massachusetts. And with climate change, the intensity and frequency of these storms will rise. Nor'easters have caused major tree damage and infrastructure disruption to many Merrimack Valley Communities, memorably in March 2018 and October 2017 when storms precipitated road closures and extended power outages.

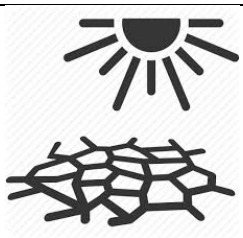
Flooding

Approximately 19.5% of North Andover's land area lies within either the designated flood zone areas with either a 1% (100-Year) or 0.2% (500-year) chance of occurrence. The risk of flooding events is heightened by the effects of climate change which portends higher precipitation levels in winter/spring seasons and more frequent, intense storms. Parameters of the so-called 100-year storm are changing. In the 1960s, a 24-hour event that produced 6.5 inches of rain was categorized as a 100-year storm. By 2015, the threshold for the 100-year storm (i.e. storm with 1% occurrence odds in any year) was 8.4 inches of rain over 24 hours. [2] Significant flood events occurred in North Andover most recently in Spring 2010 and the Mother's Day Flood of 2006.



Extreme Temperatures

Average summer and fall temperatures in the Merrimack River Basin could increase 12° F by century's end. The number of extreme heat days greater than 90° F is expected to increase by as much as 32 more days in 2050. [3] Extended heat waves could significantly impact public health as well as infrastructure, economic systems including agriculture and ecosystems of forests and wetlands.



Drought

As noted above, temperatures in the Merrimack River Basin are expected to increase over time, which coupled with changing precipitation patterns, may lead to exacerbated drought conditions. Also, the likely range of consecutive dry days per year is projected to increase by up to 20 days in 2090, compared to the annual statewide baseline of approximately 16 days per year from 1971 to 2001.[4] Extended drought could significantly impact water supplies and agriculture in the region. Brush fires are also more common under dry conditions.

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[2] https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html National Oceanic and Atmospheric Administration, Atlas 14 Precipitation Frequency Atlas of the United States & Technical Paper # 40, U.S. Dept. of Commerce.
[3] http://www.resilientma.org/resources/resource::2152 National Climate Science Center at the University of Massachusetts Amherst, Massachusetts Climate Change Projections, March 2018.
[4] https://www.mass.gov/files/documents/2018/09/17/SHMCAP-September2018-Chapter4.pdf SHMCAP, 4-48

2.4 Community Resiliency Building Planning Process and Outcomes

Due to the ongoing COVID-19 virus outbreak and state-wide stay-at-home orders, the traditional workshop format was revised into an online forum. The in-person workshops were organized to meet virtually on the GoToMeeting platform. The first workshop focused on characterizing the Town's top hazards and was organized into four virtual small group meetings to identify community features most vulnerable to natural hazards exacerbated by climate change and to define community assets that contribute to mitigating risk and aiding recovery. Workshops were organized with participants grouped into the categories according to their professional expertise: environment, infrastructure, emergency management, and health/society. Each group identified vulnerabilities and strengths using three lenses: infrastructure, society, and environment. Groups then voted virtually using Polleverywhere.com.

The second part of the CRB process centered on identifying community actions to address the top-voted strengths and vulnerabilities in the realms of infrastructure, society, and the environment. This work was also done virtually with stakeholders completing a partially completed matrix by identifying action items in their field of expertise.

All meetings were held on the GoToMeeting virtual meeting platform which enables audio, video, and screen sharing capabilities. Meeting agendas and attendance lists are provided in Appendix B.

MVPC utilized the interactive ArcGIS StoryMap as a presentation tool during each of the virtual workshops. The North Andover StoryMap can be found at the following link:

https://mvpc.maps.arcgis.com/apps/MapJournal/index.html?appid=23bee51907574d3dbf12a7cff4d0308d

As noted above, the first workshops included an opening presentation with summaries of the MVP Program and planning framework, climate change data and projections and North Andover's history of hazard events all incorporated into the StoryMap. Following the presentation, participants identified and categorized as strengths and/or vulnerabilities critical community infrastructure, societal and environmental features using Poll Everywhere. This interactive tool allowed group members to vote on the most vulnerable infrastructure, societal and environmental features in the community. The summary results of this voting are below, and the full matrices are included as an appendix to this plan.

North Andover Infrastructure Features

Vulnerabilities	Strengths
Culverts (Undersized/Beaver Issues) Riverside Pump Station (in Floodplain) Public Works Facility (in Floodplain) Lake Cochichewick Shoreline Erosion Sewer Pump Stations Drinking-Water Supply Aboveground Power Lines Gas, Electric, Telecom Utilities Mill Dams	Sewer Upgrades/IDDE Program Wastewater Treatment Plant (GLSD) Water Storage Backup Power at town Facilities Sewer Pump Stations (Rea's Pond) Gas Infrastructure Upgrades

North Andover Societal Features

Vulnerabilities	Strengths
Seniors and Homebound Internet/Wi-Fi Availability Smart 911 Profiles (incomplete) Language Barriers Cooling Center Capacity/HS Field House (lack of Air Conditioning) Availability of Fresh Food (Emergencies) Transportation Capacity (Vulnerable Populations) Senior Housing (Backup Power)	Smart 911 System Police/Fire/Emergency Mgt. & DPW High School Emergency Facility Triad Group Civic Groups Town Government (Emergency Response)

North Andover Environmental Features

Vulnerabilities	Strengths
Water Supply/Water Quality Unprotected Farmland Privately Owned Land in Watershed Beaver Management Invasive Species Lack of Tree Cover/Heat Islands Loss of Trees on Private Property (Esp. Watershed) Riparian/Pond Buffers	Watershed and Conservation Bylaws Water Storage and Backup Water Supply Mosquito Control District Water Treatment Plant Private Land Trusts Prescribed Burns Watershed Protection District Trails & Friends of NA Trails

Prior to a second workshop with North Andover Stakeholders, MVPC solicited action items from the various stakeholders based on their area of expertise (infrastructure, emergency management, health/society, and environment). Stakeholders were provided with a link to the StoryMap which introduced them to "nature-based" solutions and regional collaboration as well as other projects that might be eligible for MVP Action Grant funding. Stakeholders also received examples of a completed matrix to guide them in identifying their own community actions. This information was used to complete the matrices in preparation for the second workshop.

Recommendations for Hazard Mitigation and Climate Resiliency. At the virtual workshop, Core Team members reviewed the completed stakeholder matrices and prioritized actions as high, medium, and low and further identified urgency and timing. The top recommended priority resilience projects for North Andover in each of the designated categories (critical infrastructure, socio-economic, and environmental) are listed below and the completed matrices are included as an appendix to this plan.

High Priority Actions - Infrastructure

- Procure funding to implement the existing plan to address shoreline erosion on Lake Cochichewick along Great Pond Road.
- Work with wireless/cell service providers to help increase coverage for Wi-Fi and cell service in areas lacking coverage. Study interim solutions in emergencies such as mobile hotspots. For critical areas consider installing Town-owned antennas.
- Maintain electricity outage data and use it to prioritize tree trimming/maintenance to prevent line damage. Place utilities underground where possible.
- Increase Town's ability to address downed trees after a storm. Review existing equipment for the tree department and prioritize additional purchases to expedite downed tree removal from roadways.
- Develop culvert investigation program using GIS. Develop a program for prioritizing improvements and replacement including funding to design and construct remedies. Develop a long-term operation and maintenance program. Include beaver management plan.
- Study/fund water main extensions in non-hydrant areas of town.

High Priority Actions – Society

- Increase sign-up and information updates of Smart 911 especially with seniors and other vulnerable populations. Work with other community organizations, including faith-based ones, to increase sign-up. Provide outreach in additional languages.
- Plan for wider availability of fresh food in an emergency including partnerships with grocery stores, non-profit/civic organizations, and schools.
- Provide important announcements in multiple languages.
- Continue emergency/disaster training for town staff including shelter training, NIMS, and ALICE. Continue HAZMAT training for Fire Department.

- Back-up power is being supplied to community rooms within senior housing. Continue contingency planning for emergencies not addressed by this upgrade.

High Priority Actions – Environmental

- The Town has funding to update the Lake Cochichewick Watershed Plan. Strategy to implement and fund recommendations will be needed.
- Action to protect North Andover's sole source drinking water supply (Lake Cochichewick) including:
    - Prioritize land acquisitions and obtaining conservation restrictions in the Lake Cochichewick Watershed.
    - Continue work on regulations for Lake Cochichewick with a focus on docks and dog walking/pet waste to maximize water supply protection.
    - Continue education and outreach to private property owners about the impacts of lawn care, runoff, and tree removal.
- Beaver Management to prevent flooding of roads and other infrastructure including:
    - Identify vulnerable areas that cannot accommodate beaver damming activity and develop a management plan.
    - Continue advocacy for additional solutions for beaver management and monitor trouble spots.
    - Educate residents on the role beavers play in the environment and offer humane methods for managing their activity.
- Increase use of Green Infrastructure to manage stormwater from larger storm events including:
    - Reducing impervious surfaces and increasing vegetated buffers.
    - Utilizing LID on public projects and identifying upgrades/retrofits of existing stormwater BMPs.
    - Continue work with Greenscapes North Shore to promote lawn alternatives and other water conservation efforts.
    - Update local bylaws/regulations (wetlands, watershed, stormwater) to require LID techniques. Consider updates to the Wetlands Bylaw/Regulations to address climate change specifically.
- Protect undeveloped farmland by working collaboratively with partners (Essex County Greenbelt, Trustees of Reservations) on acquisitions and conservation restrictions. Consider incentives for farm owners to preserve their land.

Medium Priority Actions – Infrastructure

- Investigate low-lying wet areas and potential flooding impact to roadways; study alternatives for potential remedies.
- Consider preparing existing tree inventory for long-term maintenance planning.
- Conduct a comprehensive evaluation of pump stations.
- Develop a plan to investigate the remaining Lake Cochichewick shoreline; prepare a long-term plan for repair and maintenance of shoreline.
- Most pump stations have emergency back-up and generators and are currently being upgraded. Continue to secure funding to upgrade remaining

pump stations and emergency back-up generators; review possible pump station elimination locations and develop a design for elimination. Procure funding to construct gravity and eliminate pump stations where applicable; investigate Winter Street pump station and potential upgrade to mitigate impacts during flooding events.
- Continue to work with the Mills in future coordination of dam/weir operations. Investigate ownership of weir downstream of Mills near Sutton Street and consider ownership opportunities.
- Work with MassDOT on flooding issues of major evacuation routes (Route 114 & 495).
- Continue to investigate and fund "Flats Bridge" area improvements (Route 133).
- Continue to study flooding issues at DPW site including upgrades to drainage and improvements to underground storage tanks/canopy (30 years old).
- Develop a tracking system for annual maintenance of privately owned stormwater BMPs (short-term). Identify and assess - public BMPs (long-term).
- Investigate areas with aging utilities; develop a long-term replacement plan; procure funding to replace aging utilities. Continue upgrade of water lines from cast iron to ductile iron.

Medium Priority Actions – Society

- Assess logistics for food, bedding, sanitation, and other needs at High School Emergency Shelter.
- Identify outside organizations for language/translation support. Implement language learning software/tools. Identify languages spoken in town (including sign language). Emphasis on training for first responders.
- Continue work to increase mental health recognition skills and awareness of unconscious bias.
- Identify and survey homebound seniors to determine needs/vulnerability. Conduct similar work for residents with disabilities.

Medium Priority Actions – Environment

- Continue participation in Mosquito Control District and work to reduce mosquito breeding habitat. Educate/incentivize the elimination of standing water on residential and business sites through the installation of rain gardens and other nature-based solutions to increase groundwater recharge. Explore opportunities to decrease the risk of vector-borne diseases (EEE, Lyme) through nature-based solutions.
- Actions related to tree health and tree planting:
    - Educate landowners in watershed about negative impacts of tree removal/clearing. Keep track of changes in ownership and educate new owners. Promote tree planting initiatives.
    - Perform a comprehensive evaluation of street trees. Prioritize removal of hazardous trees and replant with appropriate native species tolerant to roadside conditions.

    - Identify locations where trees/foliage could mitigate “heat islands”. Plant native tree for shade, cover and habitat.
- Assess/inventory invasive species on town property. Develop priorities and strategies for management. Involve volunteers/interns.
- Develop town-wide trail network and implementation plan. Work with partners (PIE-Rivers, FONAT, ECGA, neighboring communities) to increase connectivity.

Other Actions

- Support needs of Greater Lawrence Sanitary District including vegetation management for utility lines and study of Riverside Pump station for weaknesses related to flooding by the Merrimack River.
- Consider alternative shelter/cooling locations including the public library. Increase preparedness for long-term sheltering.
- Increase pandemic planning.
- Consider increasing wetland bylaw/riparian buffers.
- ‘Consider “Neutral Growth” bylaw and other water conservation efforts.

This section summarizes the priorities of the Core Team and Stakeholders. The full list of action items can be found in the completed matrices in Appendix D of this plan. The resulting information was then used to update the “Existing Protections Matrix” element of the plan. These discussions allowed Town staff to identify gaps in their community’s natural disaster mitigation efforts, and to explore potential mitigation actions/projects. The MVP Planning process will serve to update the Hazard Mitigation Strategy developed in the 2016 Plan into the new 2020 Hazard Mitigation Strategy.

2.5 Listening Sessions and Other Public Forums and Opportunities for Community Involvement

Efforts to adopt new mitigation activities can be constrained by the general public’s lack of awareness and understanding of natural hazards and their risks. Collaboration aimed at clarifying goals, priorities, and desired outcomes is essential to an effective hazard mitigation planning process. Accordingly, a public involvement process was utilized to encourage governmental entities, adjacent communities, residents, businesses, and nonprofit organizations to participate in the planning process.

In addition to including these public entities in the stakeholder groups, North Andover held two listening sessions; one to review the outcomes of the MVP Planning process and draft plan and the second to review the final MVP/HMP Plan before approval.

The first session was held virtually on April 5, 2021. The public meeting was advertised on the Town Calendar and in the Events section of the Town website and was also promoted on the Town’s social media accounts. All Core Team members and Stakeholders were invited via email. The meeting was held virtually with over thirty participants. Following a StoryMap presentation by MVPC, North Andover’s Community and Economic Development Direcor, Andrew Shapiro, presented the

priority actions identified during the planning process and facilitated discussion with the attendees. Priority actions discussed included the following:

- Flooding of Route 133 in the Flats Bridge area;
- Utility/Electric outages following severe storm events;
- North Andover's Fire Chief provided information on pre and post storm coordination with National Grid including work with a community liaison;
- Discussion of facilities with generators for backup power.

Following receipt of final approval and comments from MEMA and FEMA, stakeholder representatives held a second listening session during the September 13, 2021 public meeting of the Select Board. The Select Board discussed the plan and opened up the meeting for public comment. At the conclusion of the listening session, the Select Board voted unanimously to adopt the North Andover Multi-Hazard Mitigation and Municipal Vulnerability Plan. Agendas for all meetings can be found in Appendix C and within the ArcGIS Storymap.

2.6 Continuing Public Outreach

Following EOEEA and FEMA approval of North Andover's HMP/MVP Plan, the town's Core Team will regularly review the plan and include accomplishments as achieved. Also, the Core Team will meet annually to evaluate the effectiveness of the mitigation and risk reduction strategy and update as needed. All plan revisions/additions will include public participation and meetings will be publicly noticed per Town and State open meeting laws.

SECTION 3. COMMUNITY PROFILE

This section of the Plan provides an overview of North Andover and includes updated information on the town's population and economy, land use, transportation network, water resources, protected open space, and historic/cultural resources. It is intended to provide context for the natural hazard characterizations, assessments, and mitigation actions that follow later in the Plan.

The Town of North Andover is located in Essex County in the northeastern part of Massachusetts, on the banks of the Merrimack River and approximately 24 miles from Boston. North Andover is bordered by the towns of Andover, North Reading, Boxford, and Middleton, and the cities of Methuen, Haverhill, and Lawrence.

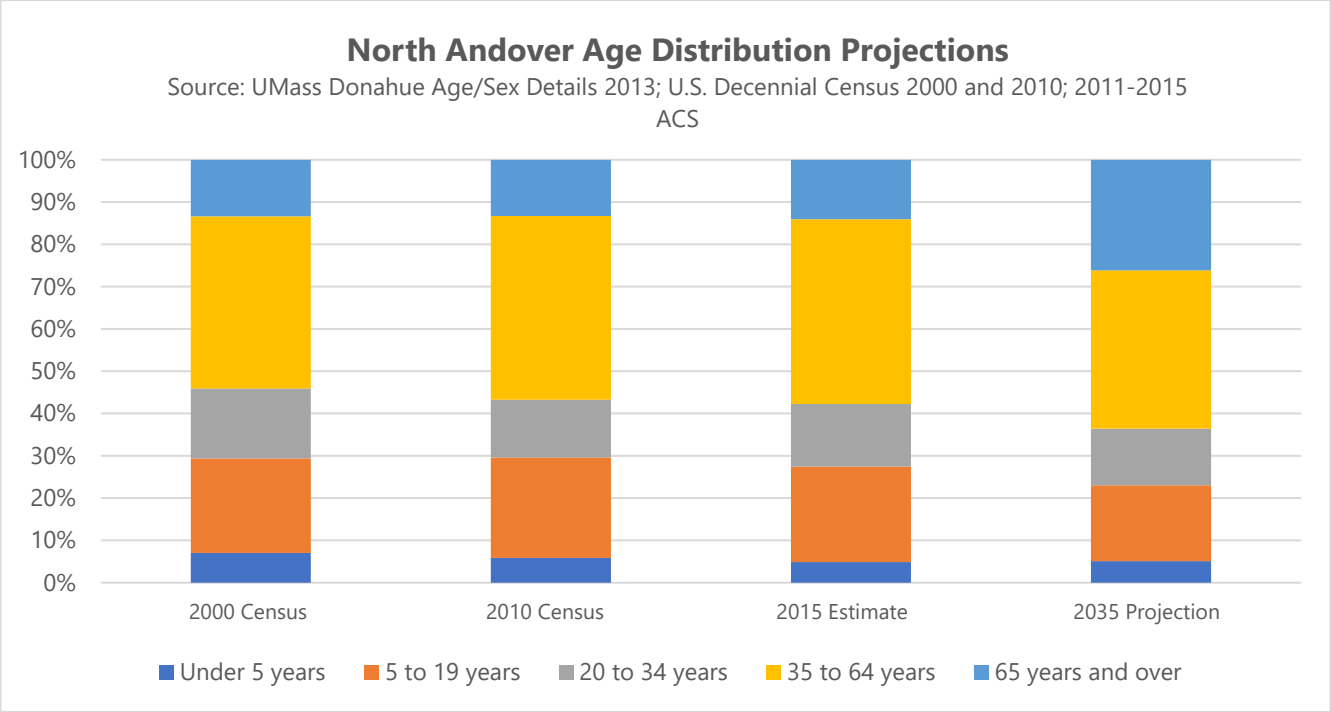
The town has a total area of 27.8 square miles, of which 26.3 square miles is land and 1.4 square miles, or 5.18%, is water. The town lies to the south of the Merrimack River, which makes up part of its northwest boundary, along with the Shawsheen River. The northeast quadrant of town is dominated by Lake Cochichewick, which is also bordered by the Osgood Hill Reservation, Weir Hill Reservation, and the Rea's Pond Conservation Area. The town is also home to portions of Harold Parker State Forest, Boxford State Forest, and the Charles W. Ward Reservation.

3.1 Current Population, Housing, and Employment

Population. North Andover's estimated population per the 2015 American Community Survey (ACS) is 29,271 people – an increase of about 7.6 percent from 2000. The population of Massachusetts (state) and Essex County (county) both increased about 5.6 percent between 2000 and 2015. The estimated population of the region increased 8.75 percent in the same period. The most recent 2019 data shows North Andover population at 31,941, a 9.1 percent increase since 2015.

Per UMass Donahue Institute projections, the age composition of North Andover's population is anticipated to change with a 110 percent increase in the number of older adults (age 65 years and over), a 20 percent decrease in the number of school-age children, and a smaller percentage of adults age 20 to 34 years. The median age in North Andover was estimated to be 41.4 years in 2015, according to the 2011-2015 ACS, which is higher than the county's median age of 40.6 years and the state's median age of 39.3 years.[5]

[5] Town of North Andover Housing Production Plan 2018-2022 prepared by Merrimack Valley Planning Commission with JM Goldson community preservation & planning



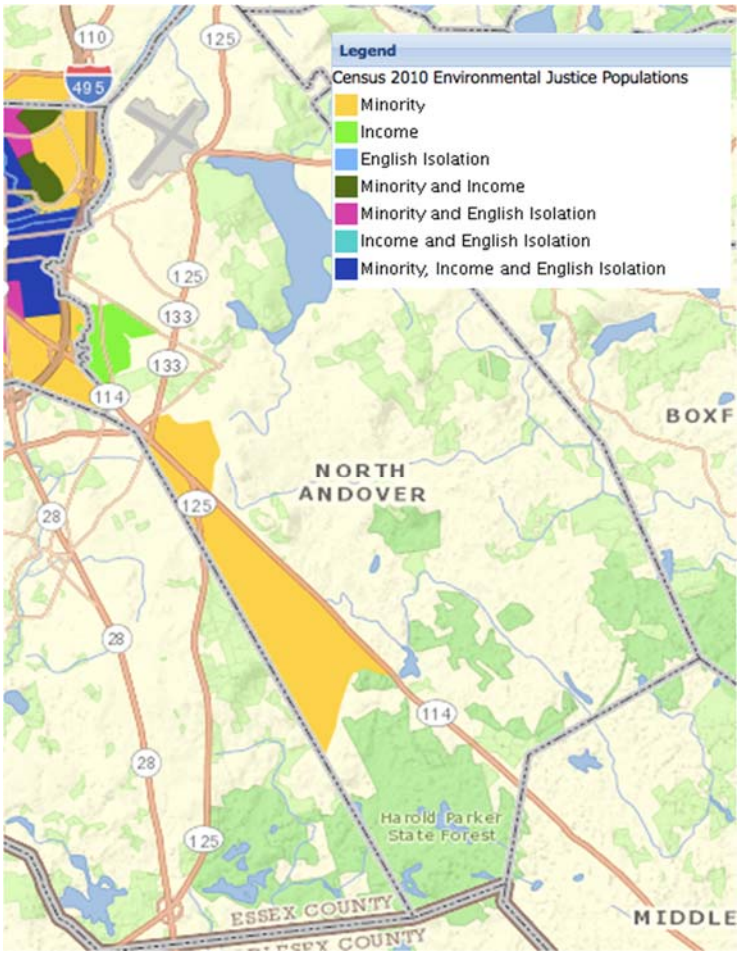
The U.S. Census Bureau, per the ACS, defines disability as individuals who report having any one of six disability types: hearing difficulty, vision difficulty, cognitive difficulty, ambulatory difficulty, self-care difficulty, independent living difficulty.[6] North Andover's estimated disability rate (8 percent of the total non-institutionalized population)[7] is lower than the region (11 percent), county (12 percent), and state (12 percent). The estimated percentage of children under 18 years with a disability in North Andover (2 percent) is lower than the region (5 percent), county (6 percent), and state (5 percent). The estimated percentage of adults age 18 to 64 years with a disability is also lower in North Andover (6 percent) than the estimated 9 percent of the population in this age cohort in the region, county, and state.

However, there is still an estimated 30 percent (about 1,145) of older adults age 65 years and over with disabilities. North Andover stakeholders identified senior populations and individuals with disabilities as more vulnerable to climate change and emergencies and disasters overall.

[6] U.S. Census Bureau, American Community Survey definition of disability: How Disability Data are Collected from The American Community Survey (census.gov)

[7] The U.S. Census Bureau defines non-institutionalized population as all people living in housing units, including non-institutional group quarters, such as college dormitories, military barracks, group homes, missions, or shelters. Whereas, institutionalized population includes people living in correctional facilities, nursing homes, or mental hospitals. https://www.census.gov/topics/income-poverty/poverty/guidance/group-quarters.html.

Environmental Justice. Since 2002, the Massachusetts Executive Office of Energy and Environmental Affairs has been implementing an Environmental Justice (EJ) Policy to help ensure that all Massachusetts residents experience equal protection and meaningful involvement concerning development, implementation, and enforcement of environmental laws, regulations, and policies, and the equitable distribution of environmental benefits. Historically, land-use decisions in Massachusetts caused lower-income people and communities of color to experience a disproportionate share of environmental burdens and often lacked environmental assets in their neighborhoods.[8] The state has identified Environmental Justice (EJ) neighborhoods that are comprised of EJ populations.[9] Vulnerable populations such as EJ neighborhoods should be given special consideration when planning for current and future hazards.



Per MassGIS data, North Andover has two designated EJ Areas: one for minority population along the western border with Andover and one for income near the border with Lawrence (residential area southwest of Massachusetts Avenue to Winthrop Ave/Route 114 including Green Hill Ave, Linden Ave, Meadow Lanes, Waverly Road, Wood Lane, and Woodstock Street, among others).

Also, of note, North Andover's racial and ethnic diversity is increasing somewhat, especially the population identifying as Asian and Hispanic/Latino. The population of other racial and ethnic minorities including Black/African Americans is growing slightly. Language barriers were identified as needing consideration during the hazard

[8] Source: MA Executive Office of Energy and Environmental Affairs, www.mass.gov/eea/grants-and-tech-assistance/environmental-justice-policy.html.

[9] Environmental Justice (EJ) Populations are those segments of the population that the Massachusetts Executive Office of Energy and Environmental Affairs has determined to be most at risk of being unaware of or unable to participate in environmental decision-making or to gain access to state environmental resources. They are defined as neighborhoods (U.S. Census Bureau census block groups) that meet one or more of the following criteria: 1) The median annual household income is at or below 65 percent of the statewide median income for Massachusetts; or 2) 25% of the residents are minority; or 3) 25% of the residents are foreign born, or 4) 25% of the residents are lacking English language proficiency. Source: http://www.mass.gov/eea/docs/eea/ej/ej-policy-english.pdf.

mitigation planning process and actions to increase communication in multiple languages were made.

Economic. Roughly 56 percent of North Andover's total labor force is employed in the industries of management, business, science, and arts. About 22 percent is employed in sales or office occupations, and about 12 percent is employed in the service industry. The remaining employed population works in the fields of natural resources, construction, and maintenance and production, transportation, and material moving. In March of 2020, the COVID-19 pandemic shuttered many businesses, with the greatest losses seen in the leisure and hospitality industries. At that time, the unemployment rate in North Andover was reported at 2.3 percent with the Lower Merrimack Valley being reported at 3.2 percent. In December of 2020, the North Andover rate was reported 6.1 percent with the Lower Merrimack Valley Region at 8.3 percent[10].

Per 2015 estimates, about 51 percent of North Andover's households have less than 30-minute travel time to work. This is lower than the estimated population in the region (57 percent), county (57 percent), and state (56 percent) that have less than 30-minute travel time to work. About 15 percent of North Andover's households commute over an hour, which is slightly higher than the region, county, and state.

The Town of North Andover's economic activity is concentrated in four primary commercial and industrial areas. These include the Route 114 corridor; the Central Business District; the airport industrial area; and the Route 125/Osgood Street corridor.[11] The highest concentration of jobs in North Andover includes healthcare and social assistance, manufacturing, and educational services.

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Housing. The demand for housing in the Merrimack Valley has typically outpaced the available supply. The 2015 ACS estimated 11,366 housing units in North Andover, with 10,830 year-round occupied units (95 percent) and an estimated 536 vacant units (5 percent of total housing units), with 87 of these (16 percent) for seasonal, recreational, or occasional use. The estimated rental vacancy rate in North Andover was 2.5 percent and the ownership vacancy rate was 0.7 percent. These vacancy rates indicate a need for both more rental and ownership housing. The county and state had higher vacancy rates for owner and rental housing.[12]

An estimated 73 percent of North Andover's total occupied housing units were owner-occupied, while 27 percent were renter-occupied per the 2015 ACS estimates. In comparison, the region, county, and state had a greater percentage of renter-occupied units (37, 37, and 38 percent, respectively).

Although the rate of single-family residential growth has fluctuated with economic cycles, single-family development has generally been strong and consistent over the

[10] Labor Market Information | Mass.gov
[11] North Andover Master Plan, RKG Assoc. et al 2018
[12] Town of North Andover Housing Production Plan 2018-2022 prepared by Merrimack Valley Planning Commission with JM Goldson community preservation & planning

past 30 years. While single-family development continues, there has been a recent shift to mult-family housing with 996 multi-family units either planned, permitted, under construction, recently completed, or envisioned according to the 2018 Master Plan. This is a reflection of current consumer demand and may be preferable to the continued “sprawl” development occurring in the region’s suburban and semi-rural communities. From a natural disaster (especially *flooding*) perspective, the sprawl pattern of development has undesirable consequences, not the least of which are an accelerated loss of open space and natural flood storage capacity, increased impervious surface cover, and increased stormwater runoff. While recent progress has been made in the use of open space residential design (OSRD) as a means of “clustering” housing development and preserving a greater proportion of the natural landscape, this style of development is still less common and remains a small percentage of the total housing starts.

3.2 Land Use Characteristics and Trends

The Town of North Andover encompasses 27.8 square miles of land area and is the third-largest municipality in the Merrimack Valley Planning region. North Andover is comprised of distinct geographic areas that have evolved in different ways over the centuries, due to the prevalence of the natural resources in the area. The fertile land and abundant water supply fostered agriculture when the town was settled near the Old Center in the 1640s. During the 19th century, waterpower from the Merrimack River and Cochichewick Brook brought industrialization to the northern section of town, permanently changing the land use and development pattern to an intensely settled enclave which serves today as the town’s commercial and governmental center. The shift of development from the Old Center to the north sparked a period of significant physical and social change. Development in the Old Center ceased as industrial enterprises blossomed in the northern section of town. This change ultimately helped to preserve the rural character of the Old Center.

Table 3.2-1 presents the most recent (FY2020) land use information available for North Andover. The information was developed based on assessment data/parcel land use codes. The table shows total acreage within each category as well as the percent cover of each category within the town. Also included is the percentage of land within the Zone A and Zone X Flood Areas per the FEMA Flood insurance rate maps. These areas are further defined in Chapter 4 (Natural Hazards section) of the plan.

Table 3.2.1

North Andover Land Use FY20						
	Acres	Rounded Percent	Acres in Zone A	% in Zone A	Acres in Zone X	% in Zone X
Agriculture	776.966	4.38%	125.6	16.17	9.18	1.18
Commercial	321.647	1.81%	25.94	7.93	14.86	4.54
Industrial	261.447	1.47%	43.83	16.76	22.113	8.46
Institutional	1455.92	8.21%	367.91	17.52	65.24	3.11
Mixed Use	323.5	1.82%	22.36	6.91	2.27	0.7
Multi Family	1801.49	10.16%	31.11	4.18	5.93	0.8
Open Space	3924.3	22.12	846.19	19.55	100.38	2.32
Single Family	5958.3	33.59	541.19	9.08	65.73	1.1
Vacant Commercial	66.037	0.37	31.42	47.58	13.72	20.78
Vacant Industrial	93.16	0.52	13.96	14.98	13.46	14.45
Vacant Residential	934.27	5.27	313.45	33.53	34.72	3.71
Water	671.86	3.79	671.04	99.88	0.034	0.01
ROWs & Rail ROWs	1140.13	6.43	50.52	4.43	36.1	3.17
Unknown Parcels	10.79	0.06	5.83	48.99	0.097	0.82
Total	**17739.817**	**100**	**3090.35**	**347.49**	**383.834**	**65.15**

The largest category of developed land use in the Merrimack Valley region is residential. This includes all residential dwelling types, from large lot, single-family homes to multi-family apartments and condominiums. In North Andover, assessment data shows the Town is almost evenly split between land that currently supports development and land that supports agriculture, open space, and recreation. Land used for open space and recreation and land used for single-family residential continue to dominate the landscape of North Andover. [13]

Of the undeveloped land that remains in North Andover, the majority is zoned as residential (5.27%). Unprotected agricultural land could also be a source of developable land (4.38%) and was a point of discussion for many North Andover stakeholders who expressed concerns about the loss of large pervious areas, scenic

[13] Source: North Andover Master Plan, RKG Assoc. et al, September 2018

resources, and water supply. An additional concern is that more than one-third of all vacant residential land lies within a floodplain area. Development in floodplain areas is regulated by the North Andover Zoning Bylaw and the North Andover Conservation Commission.

Osgood Landing–site of future Amazon distribution center

The North Andover Planning Board is the primary agency responsible for regulating development in the town. The Town's Planning Director, who administers the Planning Board, was heavily involved in the development of the Hazard Mitigation Plan update. In addition, MVPC, the State-designated regional planning authority for North Andover, works with all agencies that regulate development in its region, including municipal entities and state agencies, such as the Department of Conservation and Recreation (DCR) and MassDOT. This regular involvement ensured that during the development of the North Andover Hazard Mitigation Plan update, the operational policies and any mitigation strategies or identified hazards from these entities were incorporated.

Commercial development and redevelopment continue to be dispersed beyond traditional municipal centers to locations along state-numbered routes and major travel corridors, such as Route 114 and Route 125. As more land is developed, additional impervious surface is created, thereby decreasing the area available for flood storage and increasing the flood risk. As population and housing density increase, the potential for property damage and economic loss as a result of a natural disaster also increases.

3.3 Transportation Network

North Andover's regional highways, Routes 114, 125, and 133, and the two major interstate highways, Routes 93 and 495, are important to the town's development and economy. Of North Andover's 13,896 employed residents, 80% of them commute in single-occupant automobiles with an average commute time of just under half an hour. Interstate 495 runs through the northern corner of town, providing access to the Lawrence Municipal Airport, industrial parks, and residential areas. Route 114 crosses through the southern half of North Andover and offers connections to Routes 125 and 133.

Virtually all of the roads in the Merrimack Valley region are administered by either the Massachusetts Department of Transportation (MassDOT) or the municipality in which the road is located. While individual communities often make minor improvements to the federal-aid roadway network in the region, the federal government and/or MassDOT fund almost all major highway improvements.

Public Transportation. North Andover receives public transportation services from various sources, including public and private entities. At the forefront of the region's public transportation system is the Merrimack Valley Regional Transit Authority (MVRTA), which is the sole administrator of the region's local bus system. The MVRTA offers fixed route, demand response, and special employment transportation services to 14 of the 15 communities within the region. Additionally, the MVRTA operates a commuter bus service between the Merrimack Valley and the Boston metropolitan area.

The Massachusetts Bay Transportation Authority (MBTA), based in Boston, supplements the MVRTA bus system by providing commuter rail services to the region. Seven stations along two commuter rail lines are located in the Merrimack Valley. The closest stations to the North Andover area in the neighboring communities of Andover, Haverhill, and Lawrence.

AMTRAK (officially known as the National Railroad Passenger Corporation) offers "*Downeaste*r" passenger rail service between Boston, Massachusetts, and Portland, Maine. With a stop in downtown Haverhill, the *Downeaster* further connects the Merrimack Valley to the greater New England region and beyond.

Air Transportation. Aviation services in the Merrimack Valley region are offered at the Lawrence Municipal Airport in North Andover and two privately-owned airports in Methuen and Newburyport. The Lawrence Airport, located on Sutton Street in North Andover, is the largest in the region, with 132 hangar units within 36 hangar buildings and 106 tie-downs, and a capacity of 360 aircraft. There are currently 191 aircraft (184 planes, 7 helicopters) based at this airport, the majority of which are small, single-engine private planes. For the year ending December 31, 2019, there were 39,755 takeoffs and landings.

Lawrence Municipal Airport

3.4 Water Resources and Public Water Supplies

Water Resources. North Andover was one of the first communities in the Commonwealth to organize a Conservation Commission in 1961 when it adopted Chapter 40, §8C of the Massachusetts General Laws. The Commission quickly went to work on the very general task of protecting the town's natural resources. Since the passage of the Wetlands Protection Act (M.G.L. Chapter 131, §40) in 1972, the Commission has rigorously enforced the provisions of this Act. The Commission not only enforces the state Wetlands Protection Act, but also a local Wetlands Protection Bylaw and

Regulations. This Bylaw (and its subsequent revisions) has been in effect since 1979. Comprehensive Wetlands Protection Regulations were adopted early in 1991. These regulations provide detail and performance standards to support the local Bylaw. The Town of North Andover's Wetlands Protection Bylaw was last revised in 1998 and the Regulations most recently in 2016. The Wetlands Protection Regulations implement various setbacks for no disturbance and no-build zones, based on the use and type of wetland being protected.

In a regional context, much of North Andover is a highland at the junction of three watersheds: the Merrimack River and the headwaters of two rivers: the Ipswich River (via Boston Brook and Mosquito Brook) and the Parker River. Much of the southern and southeastern portion of town drains into the Ipswich River. The northern and western portion of town drains into the Merrimack River. Two (2) Merrimack River sub-drainage areas of note are the Shawsheen River and Cochichewick Brook. The Ipswich River Watershed Association participated as a Stakeholder in North Andover's MVP process and expressed concerns regarding issues related to water quantity and stream continuity during the workshops.

Public Water Supply The protection of the sole source drinking water supply remains one of the primary goals of North Andover. Increased drought as a result of climate change will put additional pressure on this valuable resource.

Lake Cochichewick, North Andover

Reservoirs should be surrounded by as much protected land as possible to protect water quality. More than 30% of land in the watershed is protected open space[14]. Since the adoption of the Community Preservation Act in 2001, the Town has acquired several important open space parcels within the watershed in pursuit of this goal. North Andover has been proactive in collaborations with local land trusts to work with property owners when parcels become available. Continued land protection in the watershed was echoed by North Andover stakeholders throughout the planning process.

Protecting the town's drinking water supply ranked as the highest priority by respondents to a 2016 online community survey and was a focus of several of the virtual MVP/HMP workshop discussions. The Town has also enacted legal protection measures and regulations designed to promote water protection. Areas of special importance include:

- A comprehensive review of any planned development of open space within the watershed to assess potential impacts to water resources. Town boards review

[14] Source: North Andover Master Plan, RKG Assoc. et al, September 2018

and assess development and disturbance in and around tributaries feeding into Lake Cochichewick, including its buffer zones. Continued elimination of septic systems within the watershed district.

- An update of the Watershed bylaw to reflect consistency with the town's wetland regulations and with the state's stormwater regulations.
- Appropriated funding to update the 1987 Lake Cochichewick Watershed Plan to be completed in FY21. Additional funding will be needed to implement plan recommendations.

Stakeholders identified a greater need to educate private landowners around the lake about contamination through runoff and the value of trees and canopy cover for watershed protection.

3.5 Protected Open Space and Prime Farmland

North Andover is blessed with an abundance of ecologically rich and visually stunning open space resources. This range includes an intricate tapestry of forests, fields, farms, and hilltops in both wetland and upland areas. Approximately one-third of the land in North Andover is protected open space or currently in agricultural use.

Together, these rich resources provide outstanding and diverse:

- **habitat and migration corridors** for numerous wildlife species, birds, fish, and plants;
- **surface and groundwater source protection** for the public surface water supply as well as private drinking water wells;
- **productive soils** for agriculture, horticulture, and farming; and
- **natural buffers** for protection against flooding.

View from Half Mile Hill over Lake Cochichewick

They also serve as a draw for recreational hikers and other outdoor enthusiasts and naturalists. North Andover's prime open space resources are critically important to the overall character, economic vitality, and quality of life, and as such warrant ongoing maintenance and sustainable use.

Prime Farmland

A number of the town's prominent farmlands – including Smolak Farms, Barker Farm, and Boston Hill Farm – are proximate to rivers, streams, and other water bodies. In addition to the abundant crops they produce, the farms' broad alluvial soils provide important stormwater infiltration/retention and flood storage functions. Future development of these lands for more intensive residential and commercial uses would result in the loss or of these functions.

Open, productive farm tracts are typically the most easily developed land because their deeper soils make excavation easier, their drainage is good, and they lack wooded cover. As a result, they are ideal for most commercial and residential development projects and can often command top dollar. In the face of this constant development pressure, local farmers are finding it increasingly difficult to hold on to their coveted lands indefinitely. North Andover stakeholders recognized the vulnerability of the critical natural resource functions these open lands provide and recommended a collaborative effort to implement strategies that both strengthen the economic viability of farming and protect farmland in perpetuity.[15]

3.6 Historic and Cultural Resources

The preservation of historic and cultural resources must be carefully considered to protect the character of the Merrimack Valley region's city, town, and village centers. Many colonial-era residences, mill structures, and village greens are already protected to some extent through the establishment of historic districts. However, additional consideration should be given to protecting such resources from potential natural hazards. Historic inventories and plans are essential in guiding historic preservation initiatives, and such plans should consider hazard mitigation. Effective preservation of these resources requires active stewardship and support of the community as a whole.

North Andover Historic Districts include:

- Machine Shop Village Historic District
- North Andover Historic District
- Tavern Acres Historic District

COSTEP-MA (Coordinated Statewide Emergency Preparedness in Massachusetts https://mblc.state.ma.us/costepma/) is a collaborative of representatives of cultural and historical institutions and agencies as well as first responder and emergency management professionals from federal, state, and municipal governments. COSTEP-MA promotes proactive steps to reduce losses from natural hazards, especially flooding or water damage following fires, through cooperative, team-building activities in communities through educational activities within the cultural heritage and emergency management communities. COSTEP-MA has worked to develop an Annex to the state's CEMP and to promote education and cooperation in communities to enhance the protection of cultural resources from natural disasters.

[15] Town of North Andover Housing Production Plan 2018-2022 prepared by Merrimack Valley Planning Commission with JM Goldson community preservation & planning

3.7 Demographic & Development Trends and Projections

In considering exposure to natural hazards it is important to assess population and development trends. As more land is developed, the additional impervious surface increases the flood risk and decreases available flood storage area.

MVPC forecasts of North Andover population and employment growth project a 2030 Town population of 32,200 people (13.5% increase from 2010) and 14,400 jobs (9.5% increase from 2010. Major development activity completed, in construction or planning since the 2016 plan update includes:

Table 3.7.1 Major Developments

Project Name	Location	Project Type	Status	Completion Year	Total Housing Units	Approx. S.F. NonRes
Princeton Properties	Osgood Street	Residential	All 4 buildings have CO	2019	192	
East Mill Pond Building	High Street	Residential	Permitted	est. 2022	51	
Avalon Bay	High Street	Residential	Permitted	est. 2023	170	
Sutton Street Redevelopment	Sutton Street	Residential	Permitted	unknown	136	
Edgewood Small Home	Osgood Street	Retirement Community	Constructed	2018	40	
0 Rea Street Subdivision	Rea Street	Subdivision	Under Construction	2021	7	
Great Lake Lane	75 Great Pond Road	Subdivision	Constructed	2018	5	
Merrimack Condominiums	Compass Point Road	Residential	Constructed	2018	52	
Wellington Way	602 Boxford Street	Subdivision	Constructed	2019	7	
Regency Place	Off Blue Ridge Road	Subdivision	Constructed	2020	8	
Sutton Hill Road	101 - 115 Sutton Hill Road	Subdivision	Constructed	2017	4	
Berry Farms	Berry Street	Apartment Complex	Constructed	2016	196	
Kelsey Lane	off Molly Towne Road	Subdivision	Constructed	2020	2	
Signature Commons	Parcel ID: 034.0-0049-0000.0	Commercial	Under Construction	2022		43,000 s.f.
Osgood Landing Redevelopment	1600 Osgood Street	Residential	Under Development	2024		3.6 million gsf
Senior Center	Sutton Street	Residential	permitted	est. 2022		

In order to characterize any change in North Andover's vulnerability associated with new developments as shown above, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map. The analysis shows that only the redevelopment of 1600 Osgood is located within a flood hazard area, however all buildings at the site are located outside of the 100-year floodplain.

North Andover's Floodplain Zoning, adopted in 1979, restricts development in the 100-year floodplain. With an increase in extreme storm events and changes in precipitation patterns, areas previously not prone to flooding may be susceptible to inundation in the future. Other natural hazards such as wind speed and snowfall rates do not vary across the town and recent development does not coincide with any previously identified hazard areas. In addition, new development adheres to higher regulatory standards (building code, wetland protection, floodplain, stormwater) than existing developments as such it is generally expected to be less vulnerable to natural hazards.

However, natural hazards such as increased storm events, high precipitation, or high wind events are expected to become more frequent and/ or more severe due to changing climate conditions (compare risk assessment section 4). It is advisable that land use boards pay particular attention to redevelopment in identified flood problem areas in the future. Overall, North Andover's new and potential development do not significantly increase the Town's vulnerability.

3.8 Critical Infrastructure

In preparing for the workshops, the North Andover Core Team reviewed and updated a database of the community's critical facilities and infrastructure. These facilities are vital to the delivery of key government services and may significantly impact the public during a time of emergency or while recovering from an emergency. The primary sources of information relative to the critical facilities were North Andover Emergency Management, and Fire, Police, and Public Works personnel on the Core Team. Updates include a new fire station, relocated police station, and two new schools. Some of these new facilities have emergency backup generators, and therefore, are a logical choice for emergency shelter locations. These facilities are identified on the table below. Critical infrastructure located in a flood hazard area, as determined by review of the most recent FEMA Flood Insurance Rate Maps, is also identified. These facilities include:

Table 3.8.1 North Andover Critical Infrastructure			
Name	**Type**	**FEMA Flood Zone (100/500)**	**Facility has Backup Generator**
Ashland Farms at North Andover	ASSISTED LIVING FACILITY	N	Y
Meadows of Edgewood Assisted Living	ASSISTED LIVING FACILITY	N	Y
North Andover School Administration	CITY/TOWN OFFICES	N	N
North Andover Town Hall	CITY/TOWN OFFICES	N	Y
Merrimack College	COLLEGE	N	Y
High Street (East Mill)	DAM CONTROL	Y	N
New England Montessori School	DAYCARE FACILITIES	N	*
Kindercare Learning Center	DAYCARE FACILITIES	N	*
Kindercare @ Meritor Academy	DAYCARE FACILITIES	N	*
After The Bell - North Andover Middle School	DAYCARE FACILITIES	N	*
Little Learners Child Care Center	DAYCARE FACILITIES	N	*
Community Cooperative Preschool	DAYCARE FACILITIES	N	*
Family Cooperative Preschool	DAYCARE FACILITIES	N	*
Little Sprouts - North Andover	DAYCARE FACILITIES	N	*
Foulds Terrace	ELDERLY HOUSING	N	*
Fountain Drive	ELDERLY HOUSING	N	
Bingham Way	ELDERLY HOUSING	N	
O'Connor Heights	ELDERLY HOUSING	N	
McCabe Court	ELDERLY HOUSING	N	

Morkeski Meadows	ELDERLY HOUSING	N	
Osgood Landing	EMERGENCY SHELTER	Y	*
Middle School	EMERGENCY SHELTER	N	Y
Senior Center	EMERGENCY SHELTER	N	Y
North Andover High	EMERGENCY SHELTER	N	Y
North Andover Fire Department - Station #2	FIRE STATION	N	Y
North Andover Fire Department - Headquarters	FIRE STATION	N	Y
Archives – North Andover Historical Society	SPECIAL LIBRARY	N	N
Stevens Memorial Library – Public Library	LIBRARY	N	N
Sutton Hill Nursing Center	NURSING HOME	N	*
Prescott House	NURSING HOME	N	*
North Andover Police Department	POLICE STATION	N	Y
North Andover Post Office	POST OFFICE	N	*
Mass Electric Substation – Pleasant Street	POWER SUBSTATION	N	*
Mass Electric Substation – Marbleridge Road	POWER SUBSTATION	N	*
NE Power Facility – Foster Street	POWER SUBSTATION	N	*
New England Montessori School	POWER SUBSTATION	N	*
North Andover Public Works Department	PUBLIC WORKS GARAGE	Y	Y
Merrimack Valley Transitional Care	RESIDENTIAL CARE	N	*
Kittredge	SCHOOL	N	N
Franklin School	SCHOOL	N	N
Annie L Sargent School	SCHOOL	N	N

Thomson	SCHOOL	N	N
Atkinson	SCHOOL	N	N
Anne Bradstreet Early Childhood Center	SCHOOL	N	N
St Michael Elementary	SCHOOL	N	*
Brooks School	SCHOOL	N	*
Meritor Academy	SCHOOL	N	*
Coachmans Lane Sewage Pumping Station	SEWAGE PUMPING STATION	Y	Y
Hawthorne Place Sewage Pump Station	SEWAGE PUMPING STATION	Y	Y
Johnson Circle Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Flagship Drive Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Holly Ridge Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Alcott Village Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Bonny Lane Sewage Pumping Station	SEWAGE PUMPING STATION	Y	Y
Village Way/Dale St. Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Boston Hill Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Winter Street Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Rae's Pond Sewage Pumping Station	SEWAGE PUMPING STATION	Y	Y
Willow Street Pumping Station	SEWAGE PUMPING STATION	N	Y
Forest View Estates Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Jasmine Plaza/Rte 114 Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Carter Field Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Butcher Boy Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Saile Way Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y
Campbell Road Sewage Pumping Station	SEWAGE PUMPING STATION	N	Y

Riverside Pump Station (GLSD)	SEWAGE PUMPING STATION	Y	Y
Wheelabrator Inc.	SOLID WASTE TRANSFER/	N	*
Boston Hill Cell Tower	TELEPHONE/COMMUNICATIONS/CELL	N	*
Johnson Street Cell Tower	TELEPHONE/COMMUNICATIONS/CELL	N	*
Chestnut Street Cell Tower	TELEPHONE/COMMUNICATIONS/CELL	N	*
Foster Street Cell Tower	TELEPHONE/COMMUNICATIONS/CELL	N	*
Lawrence Municipal Airport	TRANSPORTATION HUB	N	N
Greater Lawrence Sanitary District (GLSD)	WASTEWATER TREATMENT PLANT	N	Y
Water Treatment Plant	WATER SUPPLY/PUMPING/ST	Y	Y
Bear Hill Standpipe	WATER SUPPLY/PUMPING/ST	N	N
Sutton Hill Standpipe	WATER SUPPLY/PUMPING/ST	N	N
Bradford St Standpipe	WATER SUPPLY/PUMPING/ST	N	N
"The Hatch"	WATER SUPPLY/PUMPING/ST	Y	N
Water Pumping Station (Foxwood Drive)	WATER SUPPLY/PUMPING/ST	N	Y
Water Pumping Station (Empire Drive)	WATER SUPPLY/PUMPING/ST	N	Y
Mill Pond Dam (Harkaway Road)	WATER SUPPLY/PUMPING/ST	Y	N

* Unknown

SECTION 4. NATURAL HAZARDS IDENTIFICATION

A. Natural Hazards Inventory

This section of the Hazard Mitigation Plan identifies and describes natural hazards that are likely to occur in the Merrimack Valley Region of Massachusetts and North Andover in particular. A natural "hazard" is defined as "an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, and agricultural loss, damage to the environment, interruption of business or other types of harm and loss". Natural hazards are inevitable, but the impacts of natural hazards can, at a minimum, be mitigated or, in some instances, prevented entirely. However, natural hazard impacts can also be exacerbated by societal behavior and practices, such as building in a floodplain or on a barrier beach.

Hazard identification details the geographic extent, the significance, and the probability of a particular natural hazard affecting a region, based on historical records and other information available from local, state, and federal sources. The identification includes an assessment of risks, to provide communities with information needed to prioritize mitigation strategies.

The State Hazard Mitigation and Climate Adaptation Plan identifies 11 natural hazards that are likely to affect the Commonwealth. These include:

Coastal Erosion • Landslide • Dam Failure • Nor'easter • Earthquake • Severe Weather • Fire • Severe Winter • Flood • Tsunami • Hurricane

Natural hazards that are likely to occur in the Merrimack Valley region, and documented in the 2016 Merrimack Valley Regional Multi-Hazard Mitigation Plan Update, were grouped – in order of frequency – in the following seven categories:

- **Flood-related hazards**
- **Wind-related hazards**
- **Winter-related hazards**
- **Fire-related hazards**
- **Geologic hazards**
- **Heatwaves/extreme heat**
- **Climate change/sea level rise**

44 CFR Requirement

Part 201.6(c)(2)(i): *The risk assessment shall include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future events.*

It is important to note that the above hazard categories are not always mutually exclusive. Indeed, they are often interrelated. For example, flooding can be the result of a hurricane, a nor'easter, a thunderstorm, or a winter storm. Similarly, tornadoes can be spawned by, and accompany hurricanes. Also, the geographic extent and the impacts of the hazards can vary widely. Some hazards, such as severe winter storms,

may impact a large area yet cause little damage, while other hazards, such as tornadoes, may impact a small area yet cause catastrophic damage.

Through a survey, the North Andover Core Team and Stakeholders identified Severe Winter Storms/Nor'easters, Inland Flooding, Extreme Temperatures, and Drought as the top four hazards of concern.

The following discussion describes the natural hazards that affect the Merrimack Valley region and the Town of North Andover, including their historical presence and probability of recurrence incorporating the likely impacts of climate change on each hazard. Some Hazards covered in the previous Merrimack Valley Regional Hazard Mitigation Plan are unlikely to affect North Andover in its inland location. These include coastal hazards and tsunamis.

4.1 Flood-Related Hazards

As is the case nationally and throughout New England, floods are the Merrimack Valley region's most frequent and costly natural disaster in terms of human hardship and economic loss. Flooding is generally the direct result of moderate to severe weather events such as coastal storms ("nor'easters"), heavy rainstorms, and hurricanes. Total annual precipitation at the century's end is projected to increase by as much as 18% above the 1971-2000 baseline of 45", with most high precipitation events concentrated in the winter and spring months. Increased frequency of high-intensity events, the Northeast experiencing a 71% increase in precipitation during storms[16]. With extreme rainfall events becoming more frequent, the severe impacts from flooding are also likely to increase.

Flooding poses a significant, and recurring, risk to life and property in the Valley region. Three types of flooding typically affect the region: *riverine* flooding, *coastal* flooding, and *urban* (stormwater) flooding. Also, there are scattered low-lying wetland areas that have the potential to flood. According to the National Climatic Data Center, sixty-seven (67) flood events were reported in Essex County from January 1, 1950, to April 30, 2020. While the Merrimack River is generally prone to minor flooding, on May 15, 2006, rainfall raised the river to more than 8 feet (2.4 m) above flood stage, forcing evacuations and damaging property. Reports of total rainfall vary, but most areas appear to have received around a foot of rain, with some areas, in the Merrimack Valley, receiving as much as 17 inches. According to the Boston Globe, around 1,500 people evacuated their homes to escape the flood.

The most significant flood in the recorded history of the Merrimack River was in March 1936, when rain, melting snow and ice swelled the Merrimack in Lowell to 68.4 feet (20.8 m), 10 feet (3 m) higher than the 2006 flood. Downstream in Methuen, Lawrence, North Andover, Haverhill, and other riverfront communities, densely developed

[16] http://www.resilientma.org/resources/resource::2152 National Climate Science Center at the University of Massachusetts Amherst, Massachusetts Climate Change Projections, March 2018

downtown centers and riverfront neighborhoods were devastated by the floodwaters. In addition to the 1936 flood, the 1852 flood, the Mother's Day Flood of 2006, the New England Hurricane of 1938, and the Patriots Day Flood of April 2007 are among the region's most serious flood events. Most recently, from March 14 through 21, 2010, a major rain event caused several local rivers and streams to reach or exceed flood stage. Table 4.1.1 below lists all flood events in Essex County between 1958 and 2019.

Table 4.1.1 Merrimack Valley Flood Events 1998 - 2019

Location	County/Zone	Date	Deaths	Injuries	Property Damage
Totals:			2	3	20.712M
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	10/22/1996	0	0	0.00K
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	10/22/1996	0	0	0.00K
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	06/17/1998	0	0	0.00K
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	06/18/1998	0	0	0.00K
EASTERN ESSEX (ZONE)	EASTERN ESSEX (ZONE)	03/05/2001	0	0	0.00K
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	04/03/2004	0	0	0.00K
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	04/03/2004	0	0	0.00K
EASTERN ESSEX (ZONE)	EASTERN ESSEX (ZONE)	10/15/2005	0	0	50.00K
EASTERN ESSEX (ZONE)	EASTERN ESSEX (ZONE)	10/25/2005	0	0	45.00K
COUNTYWIDE	ESSEX CO.	05/13/2006	2	0	7.000M
COUNTYWIDE	ESSEX CO.	05/13/2006	0	0	0.00K
LYNN	ESSEX CO.	07/11/2006	0	0	10.00K
PEABODY	ESSEX CO.	07/28/2006	0	0	20.00K
PEABODY	ESSEX CO.	03/02/2007	0	0	20.00K
HAVERHILL	ESSEX CO.	04/16/2007	0	0	45.00K
HAVERHILL	ESSEX CO.	02/13/2008	0	0	30.00K
LITTLE NAHANT	ESSEX CO.	03/08/2008	0	0	0.00K
SALEM	ESSEX CO.	08/08/2008	0	0	25.00K
TAPLEYVILLE	ESSEX CO.	09/06/2008	0	0	5.00K
SOUTH ESSEX	ESSEX CO.	03/14/2010	0	1	9.800M
NEWBURY	ESSEX CO.	03/30/2010	0	2	3.270M
NEWBURY	ESSEX CO.	04/01/2010	0	0	0.00K
LYNN	ESSEX CO.	08/05/2010	0	0	7.00K
SALEM MARITIME NHS	ESSEX CO.	08/25/2010	0	0	0.00K
HAWTHORNE	ESSEX CO.	10/04/2011	0	0	0.00K
SOUTH LAWRENCE	ESSEX CO.	10/04/2011	0	0	5.00K
TOPSFIELD	ESSEX CO.	10/04/2011	0	0	300.00K
PEABODY	ESSEX CO.	06/23/2012	0	0	0.00K
SOUTH LYNNFIELD	ESSEX CO.	06/23/2012	0	0	0.00K

LYNN	ESSEX CO.	08/10/2012	0	0	0.00K
NORTH SAUGUS	ESSEX CO.	06/24/2013	0	0	5.00K
MARSH CORNER	ESSEX CO.	07/01/2013	0	0	0.00K
SALEM MARITIME NHS	ESSEX CO.	07/01/2013	0	0	0.00K
RIVERVIEW	ESSEX CO.	07/01/2013	0	0	0.00K
SALEM MARITIME NHS	ESSEX CO.	07/27/2014	0	0	0.00K
LYNN COMMON	ESSEX CO.	10/23/2014	0	0	30.00K
METHUEN	ESSEX CO.	10/23/2014	0	0	0.00K
(BVY)BEVERLY MUNI AR	ESSEX CO.	10/23/2014	0	0	0.00K
PEABODY	ESSEX CO.	12/09/2014	0	0	0.00K
SOUTH MIDDLETON	ESSEX CO.	12/09/2014	0	0	0.00K
ROOTY PLAIN	ESSEX CO.	12/09/2014	0	0	0.00K
SALEM MARITIME NHS	ESSEX CO.	12/09/2014	0	0	0.00K
TOZIER CORNER	ESSEX CO.	08/18/2015	0	0	0.00K
EAST SAUGUS	ESSEX CO.	08/18/2015	0	0	0.00K
CARLETONVILLE	ESSEX CO.	09/30/2015	0	0	0.00K
DEVEREUX	ESSEX CO.	06/29/2016	0	0	0.00K
WEST ANDOVER	ESSEX CO.	04/06/2017	0	0	0.00K
LYNNFIELD	ESSEX CO.	06/27/2017	0	0	1.00K
SOUTH MIDDLETON	ESSEX CO.	06/27/2017	0	0	1.00K
HAWTHORNE	ESSEX CO.	07/08/2017	0	0	0.00K
SOUTH GROVELAND	ESSEX CO.	07/18/2017	0	0	0.00K
LAWRENCE	ESSEX CO.	09/06/2017	0	0	0.00K
LAWRENCE	ESSEX CO.	09/06/2017	0	0	0.00K
SOUTH LAWRENCE	ESSEX CO.	09/15/2017	0	0	10.00K
CARLETONVILLE	ESSEX CO.	09/30/2017	0	0	4.00K
TAPLEYVILLE	ESSEX CO.	10/25/2017	0	0	0.00K
RIVERVIEW	ESSEX CO.	10/25/2017	0	0	0.00K
DANVERS	ESSEX CO.	01/13/2018	0	0	5.00K
LAWRENCE	ESSEX CO.	08/11/2018	0	0	10.00K
DEVEREUX	ESSEX CO.	08/12/2018	0	0	0.00K
MIDDLETON	ESSEX CO.	11/03/2018	0	0	0.00K
SOUTH LAWRENCE	ESSEX CO.	11/03/2018	0	0	0.00K
WEST ANDOVER	ESSEX CO.	04/15/2019	0	0	0.00K
EAST SAUGUS	ESSEX CO.	07/31/2019	0	0	3.00K
LYNN	ESSEX CO.	07/31/2019	0	0	0.00K
EAST LYNN	ESSEX CO.	09/02/2019	0	0	10.00K
LYNN COMMON	ESSEX CO.	09/02/2019	0	0	0.50K

Riverine floods are most likely to occur in Spring. They result from the "overbanking" of swollen rivers and streams and are typically caused by a large-scale weather event that generates an unusual amount of precipitation or by rapid snowmelt. *Coastal floods* commonly occur during the winter months and are the result of storm surges spawned by northeast coastal storms (northeasters). Packing sustained wind speeds of up to 40 miles per hour and wind gusts of up to 70 mph, these storms cause repeated wave and erosion-induced damage to structures and natural resources, such as beaches and dunes. Although the Merrimack River is still tidal in North Andover, this type of flooding is not typically a concern. Other communities in the Merrimack Valley region are especially vulnerable. *Urban (stormwater) floods* may occur year-round and are caused by inadequate stormwater drainage in areas with a high percentage of impervious surface (rooftops, roads, parking lots, etc.) that prevents groundwater infiltration. Flooded roadways and basements often result from this type of flood event.

Floodwaters can be extremely dangerous, as the force of six inches of rapidly moving water can knock people off their feet. Flash flood waters move very quickly and often happen unexpectedly. Flash floods usually result from an intense storm, typically a thunderstorm, that dumps a large amount of rainfall over a short period. Flash floods can destroy buildings and obliterate bridges. Around the country, most flood deaths are due to flash floods, and nearly half of all flash flood deaths are auto related.

Methodology

Flood hazard identification is the first phase of flood hazard assessment. Identification is the process of estimating the geographic extent of the floodplain. The intensity of flooding that can be expected in specific locations, and the probability of occurrence of flood events.

North Andover Market Basket - May 2006

The methodology for assessing the hazard presented by flooding involved mapping the FEMA Flood Insurance Rate Maps as an overlay to North Andover's critical infrastructure. Additionally, repetitive loss structures were identified based on records from the National Flood Insurance Program (NFIP). Vulnerable critical facilities and infrastructure, including dams and bridges, were then mapped in relation to their proximity to rivers, streams, and flood-prone areas. Definitions of the various flood hazard areas/zones are as follows:

Zone A - Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths

are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone AE - Areas subject to inundation by the 1-percent-annual chance-flood event determined by detailed methods. Base Flood Elevations are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone X - An area of moderate flood hazard that is determined to be outside the Special Flood Hazard Area between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a federal program, administered by FEMA. The NFIP provides subsidized flood insurance within communities that agree to adopt corrective and preventative floodplain management regulations that will reduce future flood damages. Congress created the NFIP in 1968, with the passing of the National Flood Insurance Act. The Act was passed to benefit homeowners whose insurance does not cover flood damage. In general, flood insurance from private companies is either not available or extremely expensive. NFIP flood insurance is available anywhere within a participating community, regardless of the flood zone in which a property is located. Federal law requires that flood insurance be purchased as a condition of federally insured financing used for the purchase of buildings in the Special Flood Hazard Area (SFHA).

FEMA produces Flood Insurance Rate Maps, commonly known as FIRMs, to support the National Flood Insurance Program. The FIRMs depict SFHAs, including the areas subject to inundation from the 1% annual chance flood (also known as the Base Flood or the 100-Year Flood). The SFHA determines where flood insurance is required as a condition of a federally insured loan through the NFIP mandatory purchase requirement. This requirement is intended to shift flood damage and recovery costs away from the general taxpayer and on to those who live in floodplains. The risk zones and flood elevations shown on the FIRMs within the SFHA are used to determine flood insurance rates.

The SFHA also determines where NFIP floodplain management requirements must be enforced by communities that participate in the program. These include land use and building code standards. In addition to the NFIP, the FIRMs are also used within FEMA's Individual and Public Disaster Assistance programs and FEMA's Mitigation Grant Programs, in emergency management, and they are also used to identify areas where certain State Building Code and Wetland Protection regulations must be enforced. Massachusetts State Building Code covers the entire state, applies to both public and private construction, and is administered through the local building inspectors with state oversight. Section 3107 of the State Building Code contains most of the construction requirements related to buildings or structures.

In 2010, and again in 2012 and 2014, new FEMA floodplain maps were released for the communities located in the Merrimack Valley region. The most current FIRM maps for North Andover are dated July 3, 2012.

It is important to note that the term "100-year flood" is misleading. It is not a flood that will occur only once every 100 years. Rather, it is a flood that has a one percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood, which is the standard used by most federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance. A structure located within a Special Flood Hazard Area (SFHA) shown on an NFIP map has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage.

Community Rating System

The Community Rating System (CRS) is part of the NFIP. The CRS program encourages communities to reduce their flood risk by engaging in floodplain management activities. CRS provides discounts on flood insurance for communities that establish floodplain management programs that go beyond the minimum requirements of the NFIP. Depending on the level of activities that communities undertake in four areas – public information, mapping, and regulatory activities, flood damage reduction, and flood preparedness - communities are categorized into 1 to 10 CRS classes. A Class 1 rating provides the largest flood insurance premium reduction, while a community with a Class 10 rating receives no insurance premium reduction.

Although communities are not required to participate in CRS to receive approval of a hazard mitigation plan, FEMA encourages jurisdictions to integrate the CRS planning steps in their multi-hazard mitigation plans.

NFIP and Repetitive Loss Structures

North Andover participates in the National Flood Insurance Program (NFIP). This Federal program, administered by FEMA, allows property owners in participating communities to obtain flood insurance to protect against flood losses and recover more quickly following an event. To participate, communities must adopt and enforce floodplain management regulations to mitigate future flood damage.

According to the most recent data provided by the Massachusetts Flood Hazard Management Program (FHMP), North Andover has 126 policies in force, insuring over $34.4 million in property. Over the years, flood damage to these structures has resulted in the payment of over $1.4 million in insurance claims under the National Flood Insurance Program (NFIP).

According to FEMA and the NFIP, Repetitive Loss Properties are properties that have received flood insurance claim payments greater than $1,000 twice in any 10-year

period years since 1978. There are currently six repetitive loss structures in North Andover. All of them are single-family residences. Three of these residences lie within the Zone A, while the remaining structures are in the B, C, or X Zones, defined by FEMA as areas of moderate or minimal flood hazard. For these 6 buildings, there have been a total of 17 losses totaling $446,159 in payments.

Table 4.1.2 Summary of Repetitive Loss Structures North Andover

	Total
RL Buildings (Total)	6
RL Buildings (Insured)	4
RL Losses (Total)	17
RL Losses (Insured)	12
RL Payments (Total)	$446,159.19
Building	$427,473.50
Contents	$18,685.69
RL Payments (Insured)	$366,667.29
Building	$360,300.85
Contents	$6,366.44

Source: MA Department of Conservation and Recreation, data as of 01/28/2020

Flooding was one of the top 3 hazards of concern in the survey of North Andover Stakeholders and according to the State Hazard Mitigation and Climate Adaptation Plan, the Commonwealth experiences a substantial flood event once every three years.

Flood Prone Areas

The Town of North Andover spans parts of four major watersheds, as defined by the state: Ipswich River (59.2% of the town), Merrimack River (32.7%), Shawsheen River (7.2%), and Parker River (0.9%). In 2004, with grant funding from the MA Department of Environmental Management (now DCR) and technical assistance from an engineering consultant, the Town prepared the planning document, "Town of North Andover Flood Hazard Mitigation Plan." This plan identifies, describes, and maps in detail North Andover's FIRM flood hazard areas, critical facilities, and key flooding issues and hot spots. Based on local knowledge, several geographic areas that were of particular concern were highlighted.

According to Town officials, during extreme flood events, there are typically three neighborhoods that require the evacuation of residents. These are 1) the Elmwood,

Glenwood, Jetwood, Inglewood Street neighborhoods in the northwestern part of town; 2) the Massachusetts Avenue and Commonwealth Avenue neighborhood to the west of Mass. Avenue in the northwestern part of town; and 3) the Riverview and North Main Street neighborhood on the south bank of the Merrimack River in the north section of town.

To assess the extent of vulnerability to flooding of different land uses, the flood hazard extent zones as shown on the 2012 FIRM Maps were overlaid with parcel data (see North Andover Land Use Table 3.2.1). This analysis shows that approximately 18.5% of single and multi-family residences in North Andover are within high-risk areas that have a one percent chance of being flooded in any year (often referred to as the "100-year floodplain"). Also analyzed were vacant residential parcels, nearly 20% of which are located in the FEMA designated Flood Hazard Areas.

The Town typically experiences flooded roads that require closure to traffic at the following locations: Great Pond Road (at bridge/culvert between Rea's Pond and Lake Cochichewick), Brook Street, Elmwood Street, Glenwood Street, Jetwood Street, Inglewood Street, Mass. Avenue, Commonwealth Avenue, Bradford Street, Riverview Street, and North Main Street.

Special Flooding Concerns

The prior MVHMP identified several areas of special concern in North Andover including several areas where action by the Town has mitigated prior hazards.

This includes moving the Rea's Pond Sewage Pump station outside of the FEMA identified flood hazard areas and raising manholes along several major sewer lines to prevent infiltration from rising floodwaters. This work was accomplished following the most costly and disruptive flooding event in memory that occurred May 13-15, 2006 ("Mothers Day Flood") and was characterized as a 100-year flood event. This event caused severe surcharging of the Rae's Pond and Winter Street lift stations and cost the town $7,799 in regular pay and $1,448 in emergency response pay for the services of the responding Water Treatment personnel. It also cost the Town $17,515 in contractual services for a private vacuum truck to pump and haul sewage from the two surcharging lift stations. There were additional costs for pumping and treating the sewage at the Greater Lawrence Sanitary District wastewater facility, but these costs are not quantifiable. The Winter Street lift station is located by the bank of a tributary stream to the Lake, less than 500 feet from the edge of the Lake. With the Rae's Pond Pump Station now rebuilt outside of the flood hazard area, North Andover's Core Team advocated continuing to pursue funding to mitigate the Winter Street Pump Station's vulnerability.

Rae's Pond lies immediately adjacent to Lake Cochichewick and is directly connected to the Lake through an approximately 50-foot long conduit under Great Pond Road (Rt. 133). This area is within the Zone A associated with the two resource areas. Flooding in major storm events has resulted in closure of this emergency access route. Also, of concern is the low-lying area of Route 114 in front of 350 Winthrop Street/Market Basket Plaza. This area was also subject to severe flooding from the Shawsheen River during the 2006 Mother's Day Flood. Although the roadway lies in Lawrence, the Plaza is located in North Andover. The road is also a major evacuation route for the area.

Flooding Rea's Pond 2006 – MVPC Photo

Land Use

With a growing population and continued pressure for additional housing, vacant land is scarce in North Andover. Vacant residential parcels make up just 5% of land in North Andover. As discussed above, nearly 1/3 of that land lies within a designated FEMA Flood Hazard Area (100 or 500-year floodplain). Of vacant commercial and industrial land, less than 5% is within a Flood Hazard Area. North Andover regulates development in the Floodplain through the North Andover Zoning Bylaw which creates a Floodplain District (Section 195-4.25-4.32) requiring compliance with the following regulations:

The Floodplain District is established as an overlay district to all other districts. All development in the district, including structural and nonstructural activities, whether permitted by right or by special permit, must comply with MGL c. 131, § 40 (The Wetlands Protection Act) and with the following:

(1) Section of the Massachusetts State Building Code which addresses floodplain and coastal high-hazard areas (currently 780 CMR 120G);
(2) Wetlands Protection Regulations, Department of Environmental Protection (DEP) (currently 310 CMR 10.00);
(3) Inland Wetlands Restriction, DEP (currently 310 CMR 13.00);
(4) Minimum Requirements for the Subsurface Disposal of Sanitary Sewage, DEP (currently 310 CMR 15, Title 5);

Any variances from the provisions and requirements of the above-referenced State regulations may only be granted per their required variance procedures.

Further analysis of vacant residential parcels (Land Use Codes 130 Developable land and 131 Potentially developable lands) shows that 12 parcels totaling over 107 acres contain land in some portion of the floodplain as shown on FIRM maps. In the survey

of North Andover Stakeholders and Core Team members, People (Loss of life and other injuries) were determined to be the most vulnerable to natural hazards. As the frequency and intensity of rainfall events increases, flooding is likely to increase. Development of residential structures and redevelopment should be prioritized outside of designated Flood Hazard Areas to protect North Andover residents.

Commercial and Industrial properties are also vulnerable to flooding. Commercial and industrial properties are not only subject to possible loss of property and revenue during flood events but also the valuable services, products, and jobs they provide to the community and region. Approximately 12% of existing commercial and industrial property in North Andover is within a Flood Hazard Area with an additional 8.5% of commercial and industrial land in these zones.

As stated earlier, North Andover land use departments and regulatory boards strictly adhere to state and local requirements regarding development in the floodplain. Redevelopment in floodplain is also regulated. Following the Mother's Day Flood in 2006, a home in the Shawsheen River floodplain was raised

Flooding and Critical Infrastructure

Critical Infrastructure identified by the North Andover Core Team was identified on maps used in the workshop process. These mapped facilities were overlaid with the FEMA Flood Insurance Rate maps to identify what critical infrastructure might be vulnerable to flood events. Of over 100 facilities, only the following were located in a Flood Hazard Area:

Table 4.1.3 North Andover Critical Facilities in Flood Hazard Areas

Facilities in *100-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2020 Buildings Valuation**
Riverside Pumping Station - GLSD	28-3/0 Riverview	$1,393,000.00
Coachman's Lane Sewage Pumping Station	37.A-0-29/ 0 Coachman's Ln.	Not Available
Hawthorne Place Sewage Pumping Station	026-0016; 41 Hawthorne Place	$267,300
Bonny Lane Sewage Pumping Station	062-0049; 133 Bonny Lane	$595,700
Facilities in 500-*Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2020 Buildings Valuation**
DPW Garage	094-0002/ 384 Osgood Street	$1,185,100

In addition to threatening homes and other building structures, flood events pose risks to critical infrastructure, such as bridges and dams. The ability of these structures to withstand flood events depends in part on their current maintenance and repair status. Dam failure during a flood event can pose a serious threat to downstream properties by releasing a surge of water that was stored behind the dam before its failure.

Bridges

Bridges in Massachusetts are rated in accordance with standards set by the American Association of State Highway and Transportation Officials (AASHTO). AASHTO standards rate bridges on a scale of 1 to 100, with one being the least compliant with the ideal and 100 being the most compliant. Bridges with an AASHTO rating lower than 50 are considered in need of improvement and are placed on a state bridge repair list. In some cases, a bridge may have an AASHTO rating greater than 50 but is considered deficient due to a specific key structural problem with a particular component. A bridge may also be considered functionally obsolete, meaning that the roadway carried by the bridge does not meet current design standards for features such as roadway width. For flood-related hazards, the designation of structurally deficient is the most critical.

Currently, the only structurally deficient bridge listed in North Andover based on this rating scale is on the Interstate 495 northbound ramp. The bridge is listed as temporarily shored. The North Andover Division of Public Works reported that two local bridges are inspected by Mass DOT every two years. These include one on the town line with Lawrence and a second on Boxford Street over Fish Brook. During the most recent inspection of the Boxford Street location, inspectors identified that the roof and railings were in fair and poor condition.

Dams

A *dam* is an artificial barrier that can impound water, wastewater, or any liquid for the purpose of storage or control. Dam failure can be defined as a catastrophic failure characterized by the sudden, rapid, and uncontrolled release of impounded water. Dams can fail for several reasons:

- Overtopping caused by floods that exceed the capacity of the dam
- Deliberate acts of sabotage
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate maintenance and upkeep

Dam failures are potentially the worst of flood events. Typically, a dam failure is the result of neglect, poor design, or structural damage caused by a major event such as an earthquake. When a dam fails, huge volumes of water are often released, causing widespread destruction and potential loss of life. Although infrequent, floods due to

dam failures have occurred in New England in the past. On May 16,1874, in Williamsburg, Massachusetts, a landslide destroyed a 43-foot dam on Mill Creek, a tributary of the Connecticut River, resulting in the deaths of 144 people.

Dams are classified by the Massachusetts Department of Conservation and Recreation's Office of Dam Safety according to their "hazard potential." Dams are classified as *High Hazard* (Class I), *Significant Hazard* (Class II), and *Low Hazard* (Class III). Each level of classification has an associated hazard potential. Class I dams are located in areas where "failure or misoperation will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s), or railroad(s)". Class II dams are located in areas "where failure or misoperation 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". Class III dams are located in areas "where failure or misoperation may cause minimal property damage to others". Loss of life is not expected from the failure of Low Hazard dams.

It is important to note that a dam's hazard classification is not an assessment of its potential for failure. For example, a Class I – High Hazard Dam does not have a higher potential for failure than a Class III – Low Hazard Dam. The hazard classification identifies the potential damage that would be caused if failure were to occur. However, because of the greater risk posed by higher hazard dams, the state requires more frequent inspections of such dams. The higher the hazard classification, the more frequently dam inspections must be performed. Low Hazard dams must be inspected at least once every ten years. Significant Hazard dams must be inspected at least once every five years, while High Hazard Dams must be inspected once every two years.

In addition to the requirement that high hazard dams be inspected every two years, owners are also required to develop Emergency Action Plans (EAPs) that outline the activities that would occur if the dam failed or appeared to be failing. This plan should include a notification flow chart, a list of response personnel and their responsibilities, a map of the inundation area that would be impacted, and a procedure to warn and evacuate residents in the inundation area. The EAP must be filed with local and state emergency agencies.

According to DCR Office of Dam safety records, as of May 2020, there is only one High Hazard dam located in North Andover. A table showing all of the Dams in North Andover and their current status per the Office of Dam safety can be found in **Table 4.1.4** below.

Table 4.1.4 North Andover Dams			
Dam Name	**Impoundment Name**	**Hazard Classification**	**Date of Most Recent Inspection**
Lake Cochichewick Outlet Dam	Lake Cochichewick	High Hazard Potential	09/10/2019
Mill Pond Dam	Stevens Pond	Non-Jurisdictional	Not required for N-J dams
Stearns Pond Dam	Stearns Pond	Low Hazard Potential	03/06/2017
Farnums Mill Pond Dam	Farnums Mill	Low Hazard Potential	10/22/2009
Boston Brook Dam	Boston Brook	Non-Jurisdictional	Not required for N-J dams
Cochichewick River Dam	Cochichewick River	Non-Jurisdictional	Not required for N-J dams
Farm Pond* - On Skug River D #10	Skug River*	Non-Jurisdictional	Not required for N-J dams
Cochichewick River Dam	Cochichewick River	Significant Hazard Potential	06/13/2019
Salem Pond Dam	Salem Pond	Low Hazard Potential	03/06/2017
Sudden Pond Dam	Sudden Pond	Non-Jurisdictional	Not required for N-J dams
Farr Pond Dam	Farr Pond	Non-Jurisdictional	Not required for N-J dams
Osgood Pond Dam	Osgood Pond	Significant Hazard Potential	04/05/2018
Lake Cochichewick Tributary Dam	Unknown	Non-Jurisdictional	Not required for N-J dams

- Dam is located in Andover – Town has notified DCR of error N-J (non-jurisdictional)

Members of North Andover's Core Team spoke to major improvements that have been made to the Lake Cochichewick Outlet Dam and identified a need to explore ownership of the Cochichewick River Dam listed as "Significant Hazard Potential." This dam is located adjacent to Sutton Street just upstream of the structure carrying Cochichewick Brook under the road.

4.2 Wind-Related Hazards

High winds pose a risk to the communities of the Merrimack Valley region. As wind speed increases, pressure against an object increases at a disproportionate rate. For example, a 25 mile per hour wind causes about 1.6 pounds of pressure per square inch. When the wind speed increases to 75 mph, the force on that same object increases to 450 pounds per square inch. At a wind speed of 125 mph, the force increases to 1,250 pounds per square inch. High winds can cause considerable damage to structures, infrastructure, and trees. Winds sustained at 31 to 39 mph for at least one hour, or any gusts of 46 to 57 mph, cause the National Weather Service to issue a Wind Advisory. W h i l e w inds 58 mph or higher would lead to the issuance of a High Wind Warning.

North Andover has experienced the effects of high winds including downed trees and/or power lines and damage to roofs, windows, etc. Workshop participants identified that down trees and powerlines happen with some frequency in North Andover. High winds can cause scattered power outages, which in some cases have lasted for over a week in some areas of town. High winds are also a hazard for the aviation industry including Lawrence Municipal Airport. The region is susceptible to high wind from several types of weather events: before and after frontal systems, hurricanes and tropical storms, severe thunderstorms, and Nor'easters. The State Building Code incorporates engineering standards for wind loads. Calculating wind load is important in the design of the wind force-resisting systems (including structural members, components, and cladding) to ensure against shear, sliding, overturning, and uplift actions.

The three major wind-related hazards that can occur in the region are hurricanes, tornadoes, and coastal storms (Nor'easters). While less frequent than coastal storms, hurricanes and tornadoes have the greatest potential to cause massive, widespread damage and loss of life in North Andover. Unlike flooding, where historical river flow records allow the potential extent of flooding to be delineated with some accuracy within each community, delineating the exact area where a hurricane or tornado will strike is not possible. A brief description of hurricanes and tornadoes, along with the general risks associated with each for this region, follows.

Hurricanes

A hurricane is a type of tropical cyclone, an organized rotating weather system that develops in the tropics. Tropical cyclones are classified as follows:

Tropical depression: An organized system of persistent clouds and thunderstorms with a low-level circulation and maximum sustained winds of 38 mph or less.

Tropical storm: An organized system of strong thunderstorms with a well-defined circulation and maximum sustained winds of 39-73 mph.

Hurricane: An intense tropical weather system with a well-defined circulation and maximum sustained winds of 74 mph or higher.

The typical hurricane moves at an average speed of approximately 12 miles per hour. While in the lower latitudes, hurricanes tend to move from east to west. However, when a storm drifts further north, the westerly flow at the mid-latitudes tends to cause the storm to curve toward the north and east. When this occurs, the storm may accelerate its forward speed. This explains why some of the strongest hurricanes have reached New England.

Tropical depressions and tropical storms, while generally less dangerous than hurricanes, can be deadly. The winds of tropical depressions and tropical storms are usually not the greatest threat. Heavy rains, flooding, and severe weather such as tornadoes, create the greatest problems associated with tropical storms and depressions. Serious power outages can be associated with hurricanes and other tropical storms. After Hurricane Gloria in 1985, some area residents were without power for many days. Although not considered a Hurricane in eastern Massachusetts, storms associated with Hurricane Sandy in 2012 also left North Andover residents without power for several days.

Hurricanes can occur along the East Coast of the United States anytime in the period between June and November. Based on the number and intensity of previous storms, mid-August through mid-October is defined as the peak hurricane season. Hurricane intensity and the potential property damage posed by a hurricane are rated from 1 to 5 according to the Saffir-Simpson Hurricane Scale. Hurricanes reaching Category 3 and higher are considered major hurricanes given the potential for loss of life and property damage. The wind intensity and potential damage of each category are summarized in **Table 4.2.1** below.

Figure 4.2.1 Hurricane Categories

Category 1 – Winds 74 to 95 miles per hour (mph). Damage potential to unanchored mobile homes, trees, shrubbery, and poorly constructed signs.

Category 2 – Winds 96 to 110 mph. Damage to roofing material, doors, and windows. Considerable damage to mobile homes and poorly constructed signs. Significant damage to trees and shrubs, with some trees blown down.

Category 3 – Winds 111 to 130 mph. Small residences and buildings may experience some structural damage. Minor curtainwall* failure possible. Destruction of mobile homes and poorly constructed signs. Foliage is blown off trees and trees may be blown down.

Category 4 – Winds 131 to 155 mph. Small residences may experience complete roof structure failures. Mobile homes completely destroyed. All signs, trees, and shrubs blown down. Doors and windows extensively damaged.

Category 5 – Winds greater than 155 mph. Many residences and industrial buildings experience complete roof failure. Complete building failures possible. Small utility buildings blown over or away. All signs, trees, and shrubs blown down. Mobile homes completely destroyed. Windows and doors severely and extensively damaged.

* Removable protective shutters or coverings temporarily placed over windows and doors during hurricanes to prevent damage by wind and flying debris

Hurricane-force winds can destroy buildings and mobile homes. Debris, such as signs, roofing materials, siding, and lawn furniture can become missiles. Tree branches and even entire trees are downed and with them the telephone and power lines. Hurricanes can also spawn tornadoes. Tornadoes generally occur in thunderstorms embedded in rain bands well away from the center of the hurricane. They can also occur near the eyewall. Usually, tornadoes produced by tropical cyclones are relatively weak and short-lived.

A hurricane watch is issued when a hurricane or hurricane conditions pose a threat to an area in the next 36 hours. A hurricane warning is issued when hurricane winds of 74 mph or higher are expected in the next 24 hours. If a hurricane's path is erratic or unusual, the warning may be issued only a few hours before the beginning of hurricane conditions.


October 2017 Nor'easter

While there have been relatively few direct hits from hurricanes in New England, peripheral effects from offshore hurricanes and tropical storms that track inland are not uncommon. In the period of time that records have been kept for hurricanes, Massachusetts has experienced 45 wind-related occurrences associated with

hurricanes. Of those, six have had a direct impact and 39 have had an indirect impact. The most recent hurricane to affect the region was Hurricane Bob, which passed through in 1991. **Table 4.2.1** provides a summary of hurricanes that have affected New England since 1938.

Table 4.2.1 New England Hurricanes and Tropical Storms (1938-Present)

Date	Storm Event	Description	Deaths	Injuries	Property Damage
9/21/1938	New England Hurricane	Highest sustained winds-121 mph. Forward motion in excess of 50 mph. 17 inches of rain; extensive flooding.	564	1700+	9,000 homes and businesses destroyed, 15,000 damaged.
9/15/1944	Great Atlantic Hurricane	Forward motion in excess of 40 mph.	390	NA	$925 million
9/12/1950	Hurricane Dog	Center passed offshore Cape Cod. 4.42 inches of rain in 24 hours.	0	0	$2 million
9/07/1953	Hurricane Carol	Moved through the Bay of Fundy with only minor damage.	0	0	
8/31/1954	Hurricane Carol	First of three devastating hurricanes of 1954. Forward motion in excess of 50 mph. Category 3. Extensive flooding and damage.	60	NA	$438 million
9/11/1954	Hurricane Edna	Over 7 inches of rainfall. Extensive flooding.	29	NA	$40.5 million
10/15/1954	Hurricane Hazel	Forward motion over 50 mph.	600	NA	$350 million
8/00/1955	Hurricane Connie	Extensive flooding with 4-6 inches of rainfall	43	NA	$40 million
8/18/1955	Tropical Storm Diane	20 inches of rainfall caused devastating floods	184	NA	$832 million
8/29/1958	Hurricane Daisy	New England felt only periphery gales.	0	0	NA
9/12/1960	Hurricane Donna	Category 2. Forward motion of 39 mph.	133	NA	$387 million
9/21-25/1961	Hurricane Esther	Did unusual loop-de-loop southeast of Cape Cod. 7-8 inches of rainfall. Forward motion slowed approaching New England.	0	NA	NA
10/10/1961	Hurricane Frances	Category 3 storm, 110 mph winds. Some wind damage in New England	NA	NA	NA
8/29/1962	Hurricane Alma	Minor damage only.	NA	NA	NA
10/6-7/1962	Hurricane Daisy	14.25 inches of rainfall over 48 hours in Wakefield, MA. Significant flooding occurred throughout New England. Set record for 24-hour precipitation which remained unbroken until Hurricane Bob in 1991.	24	NA	NA
10/29/1963	Hurricane Ginny	Famous snow hurricane in Maine with up 18 inches falling in the Maine mountains.	0	0	$300,000
9/14/1964	Hurricane Dora	Moderate rainfall.	3	NA	$200 million
9/24/1964	Hurricane Gladys	Moderate to heavy precipitation.	2	NA	$6.7 million
6/13/1966	Hurricane Alma	Minor damage.	5	NA	$1.5 million
9/9/1969	Hurricane Gerda	Center passed directly over Nantucket with gusts to 140 mph.	NA	NA	NA
8/28/1971	Tropical Storm Doria	Wind gusts to 80 mph. Heavy rains, flooding.	3	NA	NA

Table 4.2.1 New England Hurricanes and Tropical Storms (1938-Present)					
Date	**Storm Event**	**Description**	**Deaths**	**Injuries**	**Property Damage**
9/14/1971	Tropical Storm Heidi	Moderate rainfall, little damage.	0	0	NA
9/3-4/1972	Tropical Storm Carrie	Hurricane-force wind gusts. Heavy rainfall	1	NA	$1.2 million
7/27/1975	Hurricane Blanche	Most heavy weather remained offshore	0	NA	NA
8/9-10/1976	Hurricane Belle	Category 1. Forward motion 32 mph. Heavy rainfall causes some flooding.	3	3	NA
9/6/1979	Tropical Storm David	Minor effects	1,100 Virgin Islands	NA	$60 million
9/25/1985	Tropical Storm Henri	Minor effects	0	0	NA
9/27/1985	Hurricane Gloria	Category 2. Forward motion of 72 mph. Gusts to 80 mph.	NA	3	$1 billion
8/7/1988	Tropical Storm Alberto	Winds of 50 mph.	31	NA	$500 million
8/19/1991	Hurricane Bob	Category 2. Forward motion of 51 mph. Wind speeds of up to 60 mph. Set new 24- hour precipitation record. Major flooding and power outages	18	NA	$1.5 billion
10/30-11/01/1991	Unnamed “Halloween” storm	Huge storm surge caused extensive damage along the coast	12	NA	$210 million
7/13/1996	Hurricane Bertha	Forward motion of 48 mph. Very heavy rainfall and strong gusty winds. Spawned one tornado in Massachusetts	12	NA	$275 million
9/02/1996	Hurricane Edouard	Left 40,000 residents without power, 3 inches of rain fell	0	0	$3.5 million
7/25/1997	Tropical Storm Danny	Dropped 3-5 inches of rain	0	0	
9/16-17/1999	Tropical Storm Floyd	Forward motion of 56 mph. No significant damage in Massachusetts.	0	0	$4.5 billion
9-3-2010	Hurricane Earl	Tropical Storm passed 98 miles east of New England with winds of 40+ mph producing high surf, heavy rain, and coastal flooding	1	0	NA
8/21/11	Tropical Storm Irene	Hurricane Irene became a tropical storm as it moved inland over NY, CT, MA, NH, and ME	42	NA	7-10 billion (est.)
10/29-30/2012	Hurricane Sandy	Category 1. Schools and public transportation closed in many communities.	285		75 billion (est.

Source: National Climatic Data Center, NOAA, U.S. Dept. of Commerce

The National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center provides a searchable database that allows one to query hurricane records dating back to as early as 1851. Query results show historical storm tracks by storm intensity within a specified radius of a site. Query results for this region for hurricanes of Category 1 or above, passing within a 75-mile radius, show eight Category 1-5 hurricanes, as depicted in **Figure 4.2.2** According to NOAA's Historical Hurricane Tracker, 39 hurricane or tropical storm events have occurred in the vicinity of Massachusetts between 1842 and 2019. Within this period the Commonwealth was not impacted by any Category 4 or 5 hurricanes, however, the state was impacted by three Category 3 hurricanes, four Category 2 hurricanes, ten Category 1 hurricanes, and 25 tropical storms. Also, within this time a total of 31 tropical depressions and extratropical events impacted the Commonwealth.[17]

Figure 4.2.2 Historical Hurricane Tracks over Massachusetts

As noted above, however, a hurricane's wind intensity alone does not speak to the threat posed by intense rains that can cause serious inland flooding. Less intense hurricanes, or tropical storms, can carry higher rainfall amounts independent of wind speed. **Figure 4.2.3** on the following page shows all Tropical Storms whose centers have passed within 10 nautical miles of the Massachusetts state boundary from 1851 to 2018.

[17] Commonwealth of Massachusetts Tropical Cyclone Profile, July 2020

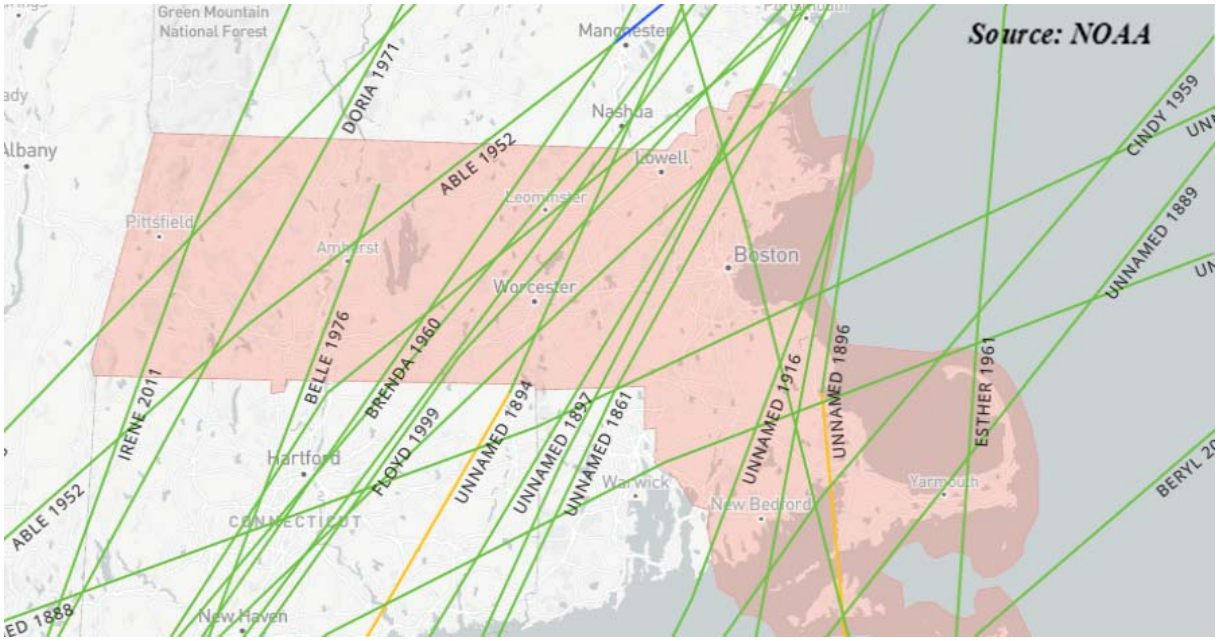


Figure 4.2.3 Tropical Storm Tracks over Massachusetts (1851-2019)

Hurricanes in North Andover are considered a Medium frequency event. As defined by the 2018 Massachusetts State Hazard Mitigation and Adaptation Plan, this hazard occurs more frequently than once in 5 years (a greater than 20% chance per year). Hurricanes and tropical storms will impact the planning area equally although it was noted by North Andover stakeholders that regions outside the town center are more often impacted by extended power outages due to the higher percentage of tree cover and impacts to utility lines caused by high winds. Vulnerable populations, especially the elderly and disabled, are often left without access to vital services during these outages. Hurricanes and tropical storms may also bring heavy rains and associated inland flooding. Areas identified in the prior section as flood-prone may experience inundation during these events requiring evacuations and/or road closures.

Tornadoes

According to the American Meteorological Society's Glossary of Meteorology, a tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." The most deadly and destructive tornado forms from a supercell, which is a rotating thunderstorm with a well-defined circulation called a mesocyclone. Normally a tornado will stay on the ground no longer than twenty minutes.

Tornadoes can appear from any direction, but most move from southwest to northeast, or west to east. Tornadoes can last from several seconds to more than an hour. Most last less than ten minutes. Over 80% of tornadoes strike between noon and midnight. "Tornado season" is generally from March through August, although a tornado may occur any time of the year. 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 (i.e., from the southeast at the surface to west aloft);
- Increasing wind speed 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; and
- A forcing mechanism, such as a cold front or leftover weather boundary from a prior shower or thunderstorm activity.

The most devastating tornado to occur in New England was the Worcester tornado of July 9, 1953, killing 96 people and injuring over 1,300. The most recent tornado to strike New England occurred on May 29, 1995, in Great Barrington, Massachusetts, killing three people and injuring 23. On average, six tornadoes per year touch down somewhere in New England. Those most at risk include people in automobiles, anyone not in a secure structure, and residents of mobile homes. Since 1951, there have been 166 tornadoes in Massachusetts, which resulted in 109 fatalities and 1,562 personal injuries. Within the Merrimack Valley region, there have been seven tornadoes since 1951, as shown in **Table 4.2.2** below.

Table 4.2.2 Tornadoes in the Merrimack Valley Region (1951- Present)

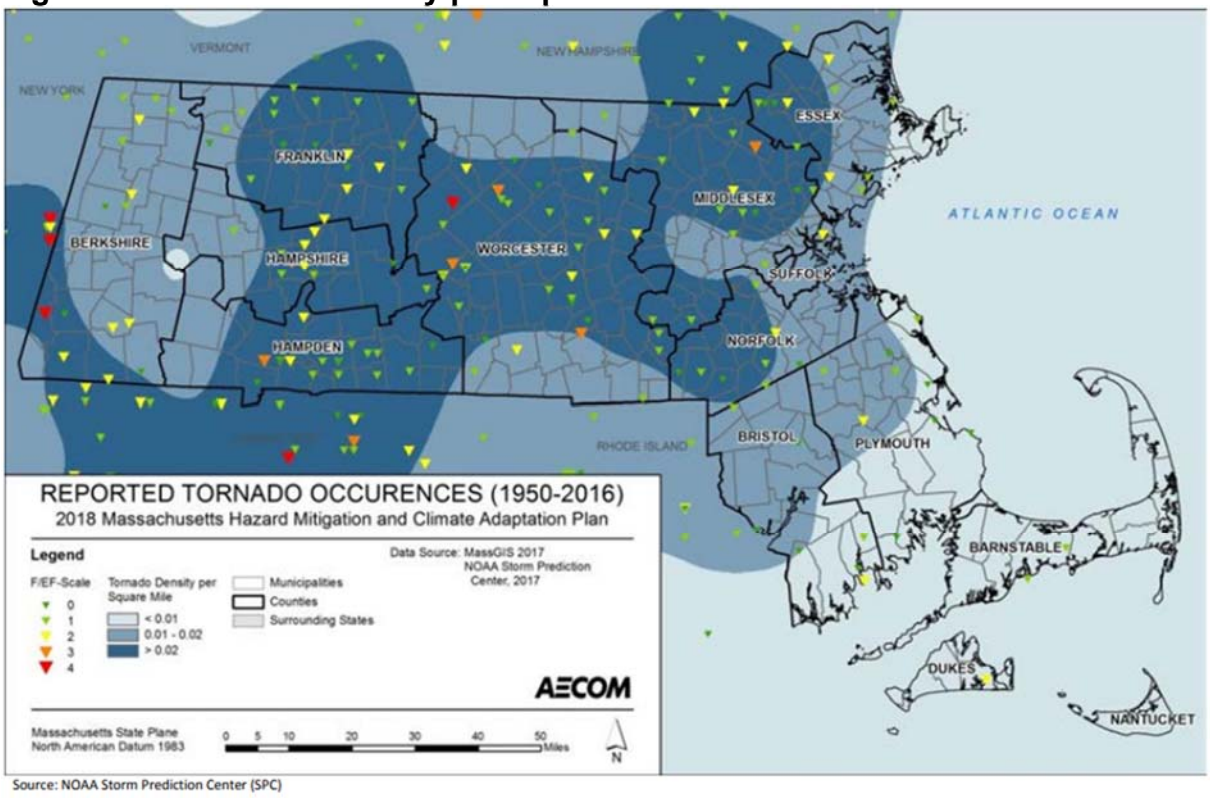
Year	Date	Tornadoes	Category	Injuries	Fatalities
1951	8-21-51	1	F2	0	0
1956	6-13-56	1	F1	0	0
1956	11-21-56	1	F2	0	0
1960	7-13-60	1	F0	0	0
1964	5-19-64	1	F0	0	0
1971	7-1-71	1	F1	1	0
1991	8-15-91	1	F1	0	0

Source: www.tornadohistoryproject.com

According to the Commonwealth's 2018 SHMCAP, used an ArcGIS kernel density tool to calculate an average score per square mile based on all-time initial touchdown

locations across the Commonwealth as documented in the NOAA NCDC Storm Events Database.[18] The following Figure 4.2.4 shows the area of the state at greatest risk runs from central to northeastern Massachusetts including a portion of the Merrimack Valley region and portions of North Andover.

Figure 4.2.4 Tornado Density per Square Mile



Source: NOAA Storm Prediction Center (SPC)

The National Weather Service (NWS) issues tornado forecasts through each local NWS office. In predicting severe weather, meteorologists look for the development of instability, lift and wind shear for tornadic thunderstorms. Real-time weather observations from satellites, weather stations, weather balloons, and radar become highly important as a storm approaches. A tornado watch defines an area where tornadoes and other types of severe weather are possible in the next several hours. A tornado warning means that a tornado has been spotted, or that Doppler radar indicates a thunderstorm with a circulation that can spawn a tornado.

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 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale). It is considerably more complicated than the original F-scale, and it allows surveyors to create more precise assessments of tornado severity. **Tables 4.2.3** and **4.2.4** illustrate the EF-scale and the damage indicators. Its uses three-second gusts estimated at the point of damage as judged by

[18] Massachusetts SHMCAP, September 2018

eight levels of damage to the 28 indicators listed in Table 4.2.4. These estimates vary with height and exposure.

Table 4.2.3 The Enhanced F-Scale

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

Source: www.noaa.gov

Table 4.2.4 Enhanced F-Scale Damage Indicators		
Number	**Damage Indicator**	**Abbreviation**
1	Small barns, frames outbuildings	SBO
2	One or two-family residences	FR12
3	Single-wide mobile home	MHSW
4	Double-wide mobile home	MHDW
5	Apt, Condo, townhouse (3 stories or less)	ACT
6	Motel	M
7	Masonry Apt. or motel	MAM
8	Small retail building (fast food)	SRB
9	Small professional (Doctor office, Bank)	SPB
10	Strip Mall	SM
11	Large shopping mall	LSM
12	Large, isolated (big box) retail building	LIRB
13	Automobile showroom	ARS
14	Automobile service building	ASB
15	School – 1-story elementary (interior or exterior halls)	ES
16	School – jr. or sr. high school	JHSH
17	Low-rise (1-4 story) building	LRB
18	Mid-rise (5-20) building	MRB
19	High-rise (over 20 stories	HRB
20	Institutional bldg. (hospital, govt. or university)	IB
21	Metal building system	MBS
22	Service station canopy	SSC
23	Warehouse (tilt-up walls or heavy timber)	WHB
24	Transmission line tower	TLT
25	Free-standing tower	FST
26	Free-standing pole (light, flag, luminary)	FSP
27	Tree - hardwood	TH
28	Tree - softwood	TS

Source: www.noaa.gov

The Disaster Center evaluated tornado statistics from 1950-1995 by state. When compared with other states across the country, Massachusetts ranked 35th in frequency, 16th in the number of tornado-related deaths, 21st in the number of injuries, and 12th for the cost of tornado-related damages. In terms of tornado frequency per square mile, Massachusetts ranked 14th in overall frequency, and first in terms of fatalities, injuries, and cost per area.

On June 9, 1953 one of the most powerful tornadoes ever recorded struck Worcester, Massachusetts, killing 96 people. The damage caused by this one event, relative to the State's small size, accounts for the statistical rankings previously cited.

In Essex County, 12 tornadoes were recorded from 1950 to 2019 (source: NOAA National Climatic Data Center). Of these, all fell within the lower F0 to F2 windspeed and damage categories. Since 1991, no tornadoes have been recorded for Essex County according to the NOAA database. On July 27th-28th, 2014, however, four tornado strikes occurred in New England, the closest taking place in the North Shore community of Revere, MA just south of the Merrimack Valley region. The EF2 force tornado of 120 mph winds accompanied by torrential rain lasted about four minutes and cut a swath of destruction two miles long and 3/8-mile-wide through the coastal community of Revere. According to the City Fire Department, 65 buildings were substantially damaged including 13 homes left uninhabitable.

Tornado of July 5, 1643

Governor John Winthrop is believed to have recorded Essex County's (and New England's) first tornado when he wrote, "*There arose a sudden gust so violent for one-half hour as it blew down multitudes of trees. It lifted up their meeting house at Newbury, the people being in it. It darkened the air with dust, yet through God's great mercy it did no hurt, but only killed one Indian with the fall of a tree*."

Severe Thunderstorms

The National Weather Service considers a thunderstorm to be severe if it produces hail at least ¾ inch in diameter, has winds of 58 mph or higher, or has the potential to produce a tornado. Lightning accompanies all thunderstorms and can cause death, injury, and property damage. Straight-line winds can exceed 100 mph and are responsible for most thunderstorm wind damage. A downburst, a small area of rapidly descending air beneath a thunderstorm, can reach speeds equal to that of a strong tornado.

Three basic ingredients are required for a thunderstorm to form: moisture, rising unstable air (air that keeps rising when given a nudge), and a lifting mechanism to provide the impetus. The sun heats the surface of the earth, which warms the air above it. When this warm surface air begins to rise, such as in areas with hills or mountains, or areas where warm/cold or wet/dry air bump together, it will continue to rise as long

as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (a process known as convection). The water vapor in the air begins to cool, releases heat, and condenses into a cloud. The cloud eventually expands upward into areas where the temperature is below freezing. Some of the water vapor turns to ice, and some of it turns into water droplets. Both ice particles and water droplets have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up, they are eventually discharged in a bolt of lightning, which causes the sound waves we hear as thunder.

An average thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. *Severe* thunderstorms can be much larger and last much longer. Southern New England typically experiences about 10-15 days per year in which there are *severe* thunderstorms. It is not unusual for the Merrimack Valley region to experience a few moderate-to-severe thunderstorms throughout the spring and summer. The greatest hazard caused by this type of storm is flash flooding. Additionally, hail can cause substantial damage to property and crops. Large hailstones can fall faster than 100 mph and be very costly in terms of economic losses.

Every thunderstorm has an updraft (rising air) and a downdraft (sinking air, usually with the rain). However, sometimes, there are extremely strong downdrafts, known as downbursts, which can cause tremendous straight-line wind damage at the ground, similar to that of a tornado. A small (< 2.5-mile path) downburst is known as a "microburst" and a larger downburst is called a "macroburst." An organized, fast-moving line of an embedded microburst that travels across large portions of a state is known as a "derecho" and this can occasionally occur in Massachusetts. The strongest downburst ever recorded was 175 mph, near Morehead City, North Carolina. Winds exceeding 100 mph have been measured in Massachusetts from downbursts.

There have been several damaging thunderstorms in Massachusetts. In June of 1998, a very slow-moving and complex storm system moved through southeast New England. The combination of its slow movement and presence of tropical moisture across the region produced rainfall of 6 to 12 inches over much of eastern Massachusetts. This led to widespread urban, small stream, and river flooding. As a result, the counties of Bristol, Essex, Middlesex, Norfolk, and Suffolk received a Presidential Disaster Declaration for the Individual Household Program (Individual Assistance) on June 23, 1998.

According to the NOAA Storm Events Database, Essex County, including the town of North Andover, experienced 19 days of Thunderstorm Wind events causing nearly $712 thousand in property damage since 2015. This includes an event on July 8, 2016, which began in neighboring Methuen and ended in Haverhill which resulted in over $100 thousand in recorded property damage. Highest winds were reported at 80 mph.

4.3 Winter-Related Hazards

Severe winter storms can produce a wide variety of hazardous weather conditions, including heavy snow, freezing rain, sleet, and extreme wind and cold. A severe winter storm is one that results in four or more inches of snow over 12 hours, or six or more inches over 24 hours. The leading cause of death during winter storms is from an automobile or other transportation accident. Exhaustion or heart attacks caused by overexertion are the second most likely cause of winter storm-related deaths.

The National Weather Service issues outlooks, watches, warnings, and advisories for all winter weather hazards. These statements are defined as follows:

Outlook: Winter storm conditions are possible in the next 2-5 days
Watch: Winter storm conditions are possible in the next 36-48 hours
Warning: Life-threatening severe winter conditions have begun or will begin
Advisory: Winter weather conditions are expected to cause significant inconveniences and may be hazardous

The most severe winter storm to ever strike New England was the Blizzard of 1888. This storm occurred from March 11-14, 1888, and deposited up to 50 inches of snow. A century later, the Blizzard of 1978 dumped 24-36 inches of snow on the eastern part of the state and paralyzed much of the area for nearly a week. The winter of 2010-2011 produced some of the largest snowfall totals in the region's and state's history and included two blizzards, both occurring in January 2011. According to the National Weather Service, Boston received 80.1 inches of snow that winter, while the Merrimack Valley region received 74.5 inches.

The most significant snowfalls in the region, as recorded in Newburyport, occurred in 1956 (120.5"), 2005 (110"), and 1969 (102.3"). Most recently, the October 2011 snowstorm left 640,000 Massachusetts homes and residents without power, according to MEMA. North Andover residents will not soon forget the winter storms of March 2018 when downed trees resulted in power outages lasting several days. The following is an event narrative from the NOAA Storm Events Database:

"From eleven to twenty-eight inches of snow fell on Western Essex County. At 5:24 AM EST a tree was down on Waverly Road near Massachusetts Avenue in North

Andover. At 114 PM EST a tree was down on an occupied car on Turnpike Street in North Andover, but no injuries were reported. At 5:47 PM EST a tree fell on a house and wires were down, both on Jenkins Road in Andover."

Property damage in Western Essex County, estimated at $37,000, was reported during the March 7 and 13, 2018 events. The March 13, 2018 event resulted in a FEMA Major Disaster declared on Jul 19, 2018.

Table 4.3.1 below details some of the most recent winter storms that have resulted in property damage since the prior MV Multi-Hazard Mitigation Plan.

Table 4.3.1 Winter Storm Events and Property Damage, Western Essex County, 2015-2019
(NOAA)

Date of Event	Deaths	Injuries	Property Damage ($)
2/9/2017	0	0	0
2/12/2017	0	0	0
4/1/2017	0	0	0
12/9/2017	0	0	0
1/4/2018	0	0	0
2/17/2018	0	0	0
3/7/2018	0	0	17,000
3/13/2018	0	0	20,000
1/19/2019	0	0	0
3/3/2019	0	0	0

Northeasters/Nor'easters

Northeasters occur in New England more frequently than hurricanes and typically have a longer duration than hurricanes. A Northeaster is a large New England storm formed from a weather system traveling from South to North, passing along or near the seacoast. The Northeaster derives its name from the northeasterly direction of its counterclockwise cyclonic winds. It is not unusual for the sustained winds of a Northeaster to meet or exceed hurricane force. The duration of a Northeaster may outlast a hurricane event by many hours or even days. High winds associated with a Northeaster can last from 12

hours to 3 days, while the duration of a hurricane rarely exceeds 12 hours.

Northeasters pose a threat to infrastructure, including critical facilities. During the height of a storm, blizzard conditions present a hazard to driving or any other outdoor activity. A blizzard is defined as a storm with winds in excess of 35 mph, with falling and blowing snow reducing visibility to less than ¼ mile for at least three hours. Heavy snow disrupts transportation and may impede the passage of emergency vehicles. Heavy snow may also bring down power lines and trees, and lead to roof collapses. The Blizzard of 1978 dumped 24-48 inches of snow on eastern Massachusetts and paralyzed the region for many days.

The Merrimack Valley region experienced a significant Northeaster on March 5-7, 2001, that resulted in a Presidential Disaster Declaration on April 10, 2001. Two feet of snow fell over three days (March 5-7). Wind gusts up to 64 miles per hour were reported in some areas. The combination of heavy wet snow and high winds resulted in broken tree limbs that blocked roadways and downed power lines. More than 16,000 people in the Merrimack Valley were left without power on March 6, 2001. This late-season snow also set the stage for flooding. Two subsequent rainstorms, on March 20-22 and 29-30, 2001, resulted in the flooding of more than 10,000 residences and businesses in northeastern Massachusetts. Most of the damage due to flooding occurred along smaller rivers and tributary streams rather than the larger mainstems such as the Merrimack River. Other major Northeasters occurred in the Merrimack Valley region in April of 2007, October 2011 (known as the Halloween Northeaster), March 2013, October 2017, and March 2018.

2017 Storm Damage (MVPC Photo)

On October 29-30, 2011, the region experienced a significant Northeaster, known as the Halloween Northeaster. This storm produced a snowfall over 30 inches in some parts of the state, and, due to the amount of foliage still on the trees, resulted in power outages for hundreds of thousands of electrical customers for up to seven days. (The National Weather Service estimated that approximately 3 million electrical customers were without power at the height of the event). As a result of the storm, a Presidential disaster declaration was approved on November 1, 2011.

Recovery during the aftermath of a major snowstorm poses its challenges. Prolonged curtailment of all forms of transportation can have significant adverse impacts for people stranded at home, preventing the delivery of critical services such as home heating fuel supplies or the ability to get to a local food store. The cost of snow removal,

repairing damages, and the loss of business can have severe economic impacts on local communities.

While the Fujita and Saffir-Simpson Scales characterize tornadoes and hurricanes, respectively, there is no widely used scale to classify snowstorms. The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service characterizes and ranks high-impact northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater. The NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus, NESIS indicates a storm's societal impacts. This scale was developed due to the impact northeast snowstorms can have on the rest of the country in terms of transportation and economics.

NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. **Table 4.3.2** illustrates the NESIS values as calculated within a geographical information system (GIS). The aerial distributions of snowfall and population information are combined in an equation that calculates a NESIS score, which varies from around one for smaller storms to over ten for extreme storms. The raw score is then converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers.

Table 4.3.2 The Northeast Snowfall Impact Scale (NESIS)

Category	NESIS	Value Description
1	1 – 2.499	Notable
2	2.5 – 3.99	Significant
3	4 – 5.99	Major
4	6 – 9.99	Crippling
5	10.0+	Extreme

Source: Paul Kocin and Louis Uccellini

Table 4.3.3 provides a listing of winter snowstorms impacting Massachusetts from 1953 through 2012. The table also ranks the storms on the NESIS scale. Eleven storms were rated as “Crippling” or “Extreme” during this time.

Table 4.3.3 NESIS Data for Massachusetts (1953-2012)

Rank	Year	Date	NESIS	Category	Description
1	1993	March12-14	13.20	5	Extreme
2	1996	January 6-8	11.78	5	Extreme
3	2003	February 15-18	8.91	4	Crippling
4	1960	March 2-5	8.77	4	Crippling
5	1961	February 2-5	7.06	4	Crippling
6	1964	January 11-14	6.91	4	Crippling
7	2005	January 21-24	6.80	4	Crippling

8	1978	January 19-21	6.53	4	Crippling
9	1969	December 25-28	6.29	4	Crippling
10	1958	February 14-17	6.25	4	Crippling
11	1983	February 10-12	6.25	4	Crippling
12	1966	January 29-31	5.93	3	Major
13	1978	February 5-7	5.78	3	Major
14	2007	February 12-15	5.63	3	Major
15	2010	February 23-28	5.46	3	Major
16	1987	January 21-23	5.40	3	Major
17	1994	February 8-12	5.39	3	Major
18	2011	January 9-13	5.31	3	Major
19	2011	February 1-3	5.30	3	Major
20	2010	December 24-28	4.92	3	Major
21	1972	February 18-20	4.77	3	Major
22	1979	February 17-19	4.77	3	Major
23	1960	December 11-13	4.53	3	Major
24	2010	February 22-28	4.29	3	Major
25	1969	February 22-28	4.29	3	Major
26	2010	February 9-11	4.10	3	Major
27	2006	February 12-13	4.10	3	Major
28	1961	January 18-21	4.04	3	Major
29	2009	December 18-21	4.03	3	Major
30	1966	December 23-25	3.81	2	Significant
31	1958	March 18-21	3.51	2	Significant
32	1969	February 8-10	3.51	2	Significant
33	1967	February 5-7	3.50	2	Significant
34	1982	April 6-7	3.35	2	Significant
35	2007	March 15-18	2.55	2	Significant
36	2000	January 24-26	2.52	2	Significant
37	2000	December 30-31	2.37	1	Notable
38	1997	March 31- April 1	2.29	1	Notable
39	2011	January 26-27	2.17	1	Notable
40	1956	March 18-19	1.87	1	Notable

Source: Massachusetts State Hazard Mitigation Plan (2013)

Since the prior MV Regional Multi-Hazard Mitigation Plan, Massachusetts has experienced several extreme Nor'easter events including the following detailed in the 2018 SHMCAP:

- Severe Winter Storm, Snowstorm, and Flooding (FEMA DR4110)—February 8-10, 2013 which resulted in a state of emergency declaration for all counties on April 19, 2013.
- Severe Winter Storm, Snowstorm, and Flooding (FEMA DR-4214) —January 26-29, 2015 with the governor declaring a travel ban on January 27 and Logan International Airport closed through January 28.
- Severe Winter Storm and Flooding (FEMA DR-4372)—March 2-3, 2018 followed less than two weeks later by Severe Winter Storm and Snowstorm (FEMA DR-4379)—March 13-14, 2018 which resulted in a Federal Disaster Declaration on July 19, 2018, for Essex and several other Massachusetts counties.
- Nor'easter October 17, 2019

As noted previously, the back-to-back storms of March of 2018 left many North Andover residents without power for more than a week.

Ice Storms

Ice storms occur when a mass of warm moist air collides with a mass of cold Arctic air. As the less dense warm air rises moisture may precipitate as rain. The rain falls through the colder, denser air and comes in contact with cold surfaces where ice forms. Ice may continue to form until the ice is as much as several inches thick.

Ice storms may strain tree branches, telephone and power lines, and even transmission towers to the breaking point, and often create treacherous conditions for highway travel and aviation. The weight of formed ice (especially with a following wind) may cause power and phone lines to snap and the towers that support them to collapse under the load. The resulting debris-clogged roads can make emergency access, repair, and cleanup extremely difficult.

The December 2008 ice storm in New England and the Merrimack Valley region storm resulted in one fatality and left over one million people without power, some for as long as two weeks. Damage from the storm was measured in millions of dollars in property damage, lost business, and cleanup costs. Many of the expenses incurred were related to the clearing and disposal of downed trees and tree limbs. Given the magnitude of damage, the storm resulted in a Presidential Disaster Declaration. More recently, the Halloween Northeaster in 2011, caused billions of dollars in damage along the Eastern Seaboard. In Massachusetts, the ice storm accompanied by wind gusts up to 69 mph was responsible for six deaths and 420,000 power outages. *(Associated Press report 11/1/2011)*

Ice storms equally as severe have been recorded in New England since 1929. The U.S. Army Corps of Engineers/Cold Regions Research and Engineering Laboratory estimates a 40 – 90-year return period for an event with a uniform ice thickness of between 0.75 and 1.25 inches. In other words, on average, a one-inch ice storm is likely every fifty years.

Ice Jams

Ice jams occur when warm temperatures and heavy rain cause rapid snow melting. The melting snow combined with the heavy rain causes frozen rivers to swell, breaking the ice layer into large chunks that float downstream and pile up near narrow passages or near obstructions such as bridges and dams. Historically, there have been hundreds of ice jams in New England. Although relatively rare in the Merrimack Valley region, ice jams have been recorded on the Merrimack River in the neighboring community of Lawrence and on the Spicket River in neighboring Methuen. The major hazard associated with an ice jam is flooding.

4.4 Fire Related Hazards

Fire poses a danger to both densely developed and rural areas of North Andover, as well as to forested and grassland areas. Wildland fire can be defined as any non-structure fire that occurs in wildland that contains grass, shrub, leaf litter, and forested tree fuels. Three distinct wildland fires have been defined and include wildfire, naturally occurring or human-caused, and prescribed fire. However, as this Plan focuses on natural hazards, the discussion is limited to wildfire/brush fire hazards.

Wildfires

A wildfire is an uncontrolled fire that spreads due to the presence of vegetative fuel. These fires often begin unnoticed and spread quickly. In this area of the country, wildfire season generally begins in March and ends in late November. Human beings start four out of every five wildfires through arson or carelessness; lightning strikes account for most of the remainder. If heavy rain follows a major wildfire, other natural disasters can occur, including landslides and floods. Once groundcover is burned away, there is little left to hold soil in place on steep slopes. Water supplies can also be affected. The loss of ground cover materials and the chemical transformation of burned soils can make some watersheds more susceptible to erosion.

A surface fire is the most common type of wildfire, burning slowly along the floor of a forest, destroying or damaging trees. Lightning typically starts a ground fire and burns on or below the forest floor; such fires are difficult to detect and extinguish. Crown fires spread quickly along the tops of trees and are driven by wind. Crown fires are seen when a high-intensity surface fire spreads or “ladders” upward through the lower foliage to the canopy.

The Massachusetts Department of Fire Services/Division of Fire Safety maintains a comprehensive database of all reported fire incidents in the Commonwealth, including wildfires and brush fires. According to statistics compiled by the Massachusetts Fire Incident Reporting System (MFIRS), during the five years from 2014 to 2018, there were 5,245 fires classified as “other fires” in Essex County (i.e., non-structure and non-vehicle fires), the vast majority of which were local brush fires. MFIRS reports 145 “other fires” for North Andover during that period.

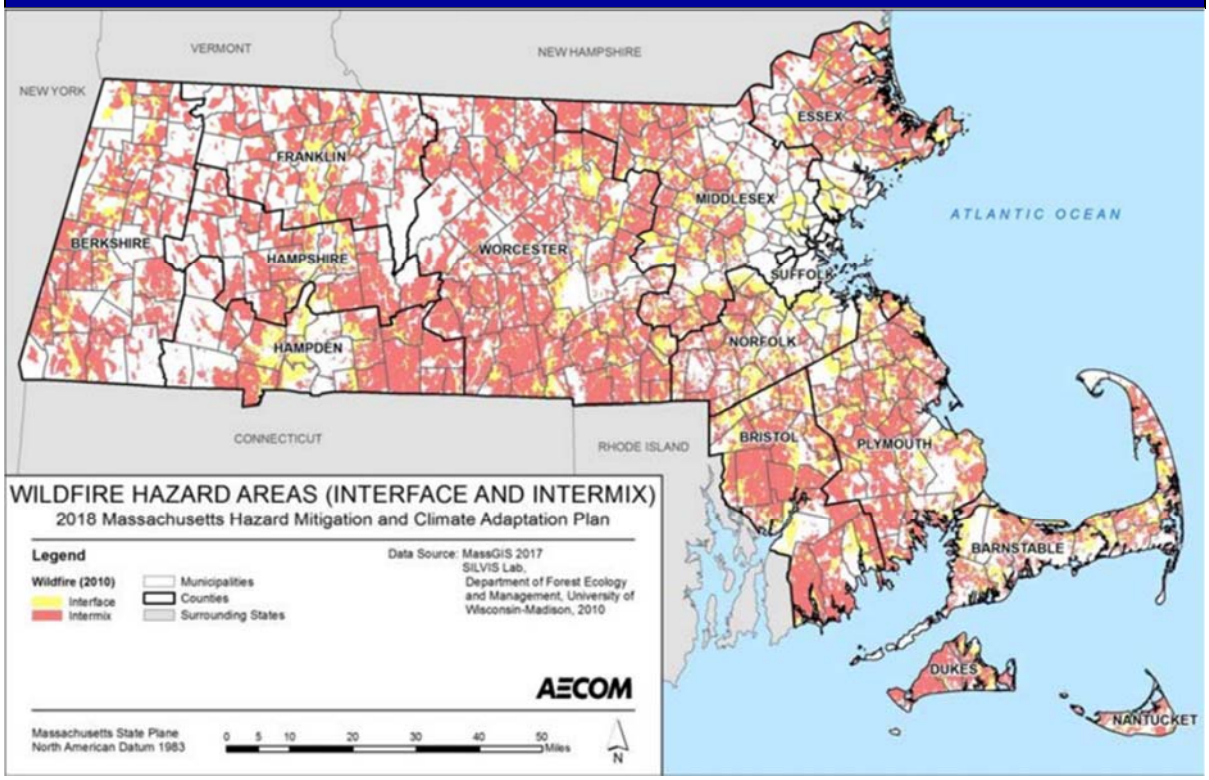
Historically there are more brush fires in April than any other month. Over a ten-year average, there are 24% more brush fires in April than in May, the next busiest month for brush fires according to the Massachusetts Department of Fire Safety.

Wildland/Urban Interface

Wildland/urban interface areas exist wherever homes and businesses are built among trees and other combustible vegetation. Such areas are becoming increasingly prevalent throughout the Merrimack Valley region and North Andover, as development continues to encroach into forest land. The wildland/urban interface problem stems from two different sources of fire and their impact on the community. Fire can move from forest, brush, or pastureland into the community or from the community into adjacent wild areas. In temperate areas, vegetative decay is a slow process, and logs, leave, and evergreen needles pile up on the forest floor. This accumulation of fuel increases the probability of large fires that are difficult to control. Ignitions are more frequent in the wildland/urban interface because of the increased presence of people. Carelessness, recreation use, damaged power lines, and industrial activity all are potential ignition sources.

Wildland/urban interface fires can cause large economic losses and severe social impacts. The impact to residents can include the loss of, or damage to, homes and irreplaceable items, and even death or serious injury. Financial costs include building and infrastructure damage and loss, business disruption, and fire suppression and evacuation costs. While North Andover responds to several brush fires annually, none have resulted in significant property damage or death. The following map taken from the 2018 SHMCAP depicts wildlife hazard as “interface” or “intermix.”

Figure 4.4.1



4.5 Geologic Hazards

The Merrimack Valley region is vulnerable to earthquakes and landslides, although both of these geologic hazards are infrequent.

Earthquakes

In the Northeast, earthquakes are not associated with specific known faults, as they are in California. In New England, the immediate cause of most earthquakes is the sudden release of stress along a fault or fracture in the earth's crust. Much of the research on earthquakes in the northeast has involved attempts to identify pre-existing faults and other geological features that may be susceptible to such stress, but this has proven to be quite difficult. Unlike the situation in the western part of the country, where many plate boundary earthquakes occur, it is unclear whether faults mapped at the earth's surface in the northeast are the same faults along which earthquakes are occurring.

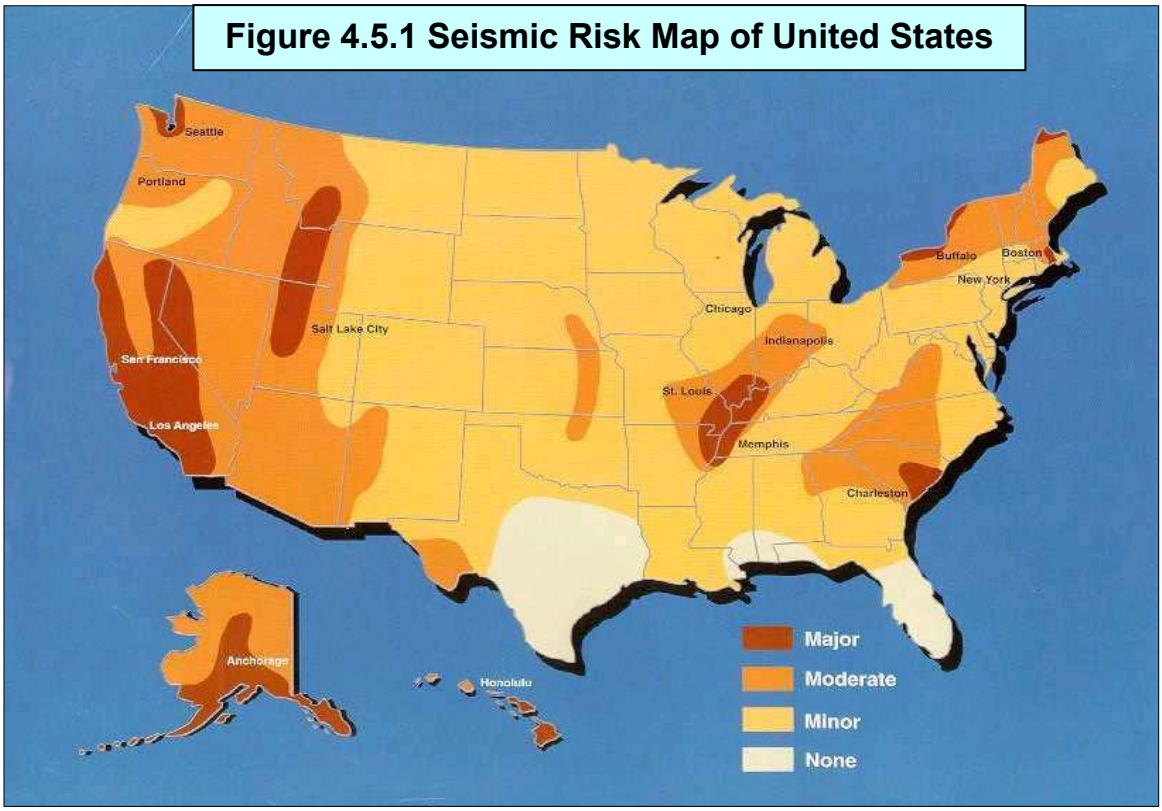
It is impossible to predict the time and location of future earthquakes in New England. The United States Geological Survey (USGS) has produced a series of earthquake hazard maps for the United States. These maps show the amount of earthquake-generated ground shaking that is predicted to have a specific chance of being exceeded over a certain period. Ground shaking caused by earthquakes is often expressed as a percentage of the force of gravity. Due to the difficulty of identifying specific seismically active geological features in the Northeast, the level of seismic hazard is based primarily on past seismic activity. These maps generally show that there is a 1 in 10 chance that in any given fifty-year period a potentially damaging earthquake will occur.

Essex County in Massachusetts is considered to be at moderate risk to the threat of an earthquake. Moderate risk means that there is a relatively long period between strong earthquakes. Between 1627 and 1989 there were 316 earthquakes recorded in Massachusetts. From 1924-1989 there were eight earthquakes with a magnitude of 4.2 or greater in New England. According to the Weston Observatory, the last earthquake to hit the New England Region with a magnitude of 3.0 or greater occurred on September 26, 2010, in the area of Contoocook, New Hampshire. New England experiences 30-40 earthquakes each year, although most are not felt. Potential earthquake losses total $4.4 billion annually in the United States, with the Northeast ranking third in the nation for annualized losses, according to FEMA. The $4.4 billion estimate includes only losses to buildings and business interruption; it does not include damage and losses to critical facilities, transportation infrastructure, and services, utilities, or indirect economic losses.

An area's vulnerability to a devastating earthquake is based primarily on two elements: the density of the population in the region, and the age of the region's buildings, and the lack of earthquake-proof design. Additionally, seismic waves travel further in the eastern U.S. than in other parts of the country. Seismologists have determined that the

likelihood of an earthquake with a magnitude of 5.0 or greater in the New England area is 41-56% by the year 2043.

Figure 4.5.1 Seismic Risk Map of United States



Earthquake magnitude is measured on two scales, the Richter Scale and the Mercalli Scale. The Richter Scale (expressed as “mb”) is an open-ended logarithmic scale that measures the amount of energy released by an earthquake. An earthquake registering 1.5mb on the Richter Scale represents that point at which some disturbance may be felt. At 4.5mb slight damage may be caused. An 8.5mb is considered a devastating earthquake. The Mercalli Scale is measured on a scale of I to XII and expresses more directly the damage caused by an earthquake. A Scale I earthquake on the Mercalli Scale would barely be felt, whereas a Scale XII quake would destroy all buildings. The intensity of the quake is evaluated according to observations at specific locations.

Ground movement during an earthquake is seldom the direct cause of injury or death. Collapsing walls, falling objects, and flying glass cause most casualties. Buildings with foundations resting on unconsolidated landfills, old waterways, or other unstable soils are most at risk. Buildings, trailers, and manufactured homes not tied to a reinforced foundation anchored to the ground are also at risk since they can be shaken off their mountings during an earthquake. In the eastern part of the U.S., a magnitude 5.5 earthquake can be felt as far as 300 miles from where it occurred and can cause damage out to 25 miles from the epicenter.

Based on records, the maximum experienced earthquake intensities on the Mercalli Scale in Essex County have been in the range of VI (where there is damage to objects indoors, the tremor is felt by all people indoors and outdoors, movement is unsteady, moderately heavy furniture moves, and pictures fall off walls) to VII (where there is damage to architecture, the tremors are frightening, it is difficult to stand, cracks occur in chimneys and plaster, bricks may fall, and stream banks may cave in).

Figure 4.5.2 New England Earthquake Probability

Source: Weston Observatory, Boston College

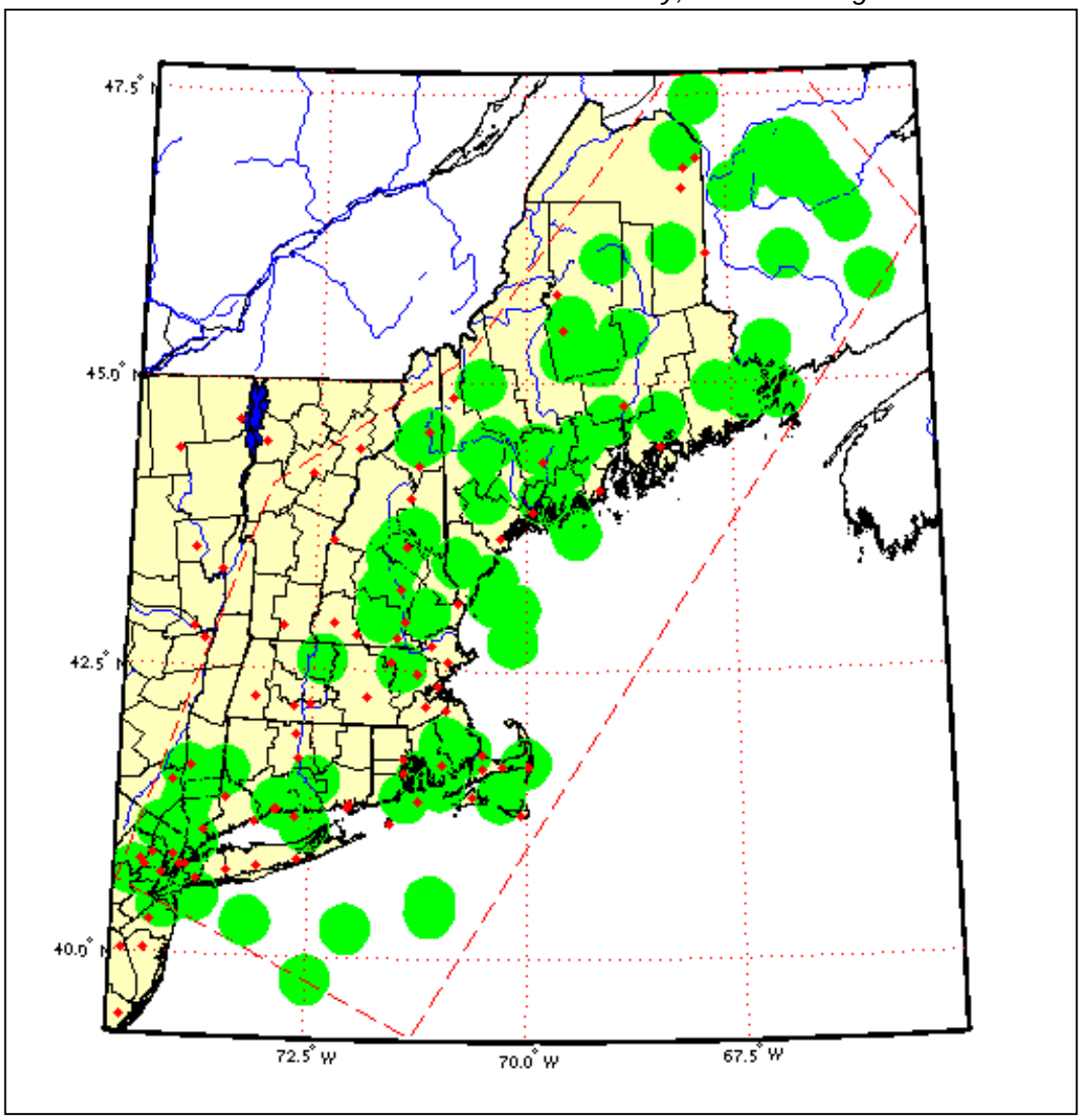


Figure 4.5.2 above shows the results of an earthquake probability analysis conducted by the Weston Observatory at Boston College. The study examined earthquake activity of magnitude greater than 2.7 between 1975 and 1998. According to the analysis, there is a 66% chance that the next earthquake of magnitude greater than 2.7 will occur in

the green areas shown on the map above. A record of all seismic activity in the Northeast can be found at the following link on the Weston Observatory website: Latest New England Earthquakes (bc.edu).

Failure to design structures with earthquakes in mind will also affect the potential damage caused by an earthquake. Regulations that require buildings and structures to meet some minimum seismic criteria were only recently put in place. North Andover's Emergency Management Director specifically mentioned the Town's Route 114 corridor, with several hazardous materials facilities and taller condominium and apartment complexes, as an area of concern. Impacts to infrastructure, including water and sewer, as well as road closures which may isolate neighborhoods or cut off emergency access.

Landslides

A landslide is the downward movement of a slope and its materials under the force of gravity. Human activity such as construction and mining, and natural factors such as topography, geology, and precipitation influence landslides. Landslides often develop when water rapidly accumulates in the ground, such as during periods of heavy rainfall or rapid snowmelt. Other factors contributing to a landslide include earthquakes and erosion by rivers and streams. Construction-related failures related to road cuts and trenching can also occur.

Nationally, landslides constitute a major geologic hazard, as they are widespread, occurring in every state, cause an estimated 25 fatalities annually, and result in $1-2 billion in property damage each year. Landslides are common throughout New England but are generally limited to mountainous or hilly terrain. North Andover and the Merrimack Valley region are considered to be at **very low risk** for this type of natural hazard. The SHMCAP identifies a very small portion of the population (2010 Census) in Essex County vulnerable to unstable slopes that may be more prone to landslides (SHMCAP 4-68).

Table 4.5.1 2010 Population in Unstable Slope Areas

County	Population	Unstable Areas		Moderately Unstable		Low Instability	
		Number	% Total	Number	% Total	Number	% Total
Essex	743,159	290	0.0	7,708	1.0	13,739	1.8

Source: 2010 U.S. Census, Slope Stability Map, 2017

4.6 Heat Waves/Extreme Heat

A heat wave is three consecutive days during which the air temperature reaches or exceeds 90 degrees Fahrenheit on each day. Temperatures that hover ten degrees or more above the average high for the region and last for several weeks are defined as extreme heat. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a dome of high-pressure traps hazy, damp air near the surface.

Heat kills by pushing the human body beyond its limits. Most heat disorders occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. The most severe heat-induced illnesses are heat exhaustion and heatstroke. If left untreated, heat exhaustion can progress to heatstroke and possible death. Young children, the elderly, and those with existing illnesses are more likely to become victims. Other conditions that can cause heat-related illness include stagnant atmospheric conditions and poor air quality.

Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. Recent statistics indicate that approximately 200 deaths per year are attributable to heatstroke. In 1980, high summer temperatures in central and southern States caused an estimated 1,700 excess deaths directly attributable to the heat. In July 1995, a heat wave in the mid-west caused 670 deaths, 375 in the Chicago area alone. High cooling demands also increase the risk of utility blackouts as transmission systems are stretched to their limits. The occurrence of a heat wave in combination with a loss of air conditioning due to a blackout could have serious consequences for confined senior citizens and other at-risk populations in North Andover.

Drought

Drought is a normal recurrent feature of climate, occurring in virtually all climate zones. Drought originates from a deficiency in precipitation over an extended period, typically two winter seasons or more. Drought should be considered relative to the long-term average condition based on precipitation and evapotranspiration.

The first evidence of drought is usually seen in rainfall records. Within a short period, soil

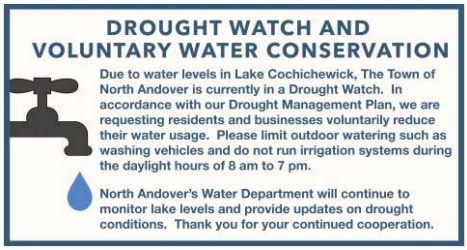
moisture can begin to decrease. The effects on stream and river flow, or water levels in lakes and reservoirs, may not be noticed for several weeks or months. Water levels in wells may not be impacted for a year or more after a drought begins.

Massachusetts is generally considered to be a water-rich state, receiving an average of 45 inches of precipitation each year. This region can experience extended periods of dry weather, from single-season events to multi-year events, such as occurred in the mid-1960s. Historically, droughts in Massachusetts have started with dry winters, rather than dry summers.

A serious drought occurred in Massachusetts during the spring and summer of 1999. Cumulative precipitation deficits reached 8-12 inches below normal over one year. Stream flows routinely fell below the 25th percentile of historical flows for the month. Groundwater levels were also below normal throughout the summer over nearly the entire state. During this period, the Massachusetts Emergency Management Agency developed a Massachusetts Drought Management Plan. The Plan includes groundwater data, surface water data, reservoir data, precipitation data, and streamflow conditions, as well as a report on fire danger and agricultural conditions. The Drought Management Plan provides specific action items to be implemented during a drought watch, drought warning, or drought emergency. A drought emergency is one in which state-mandated water restrictions or the use of emergency supplies is necessary. The Plan underwent minor updates and was formally adopted in 2013.

In the subsequent 2016/2017 Drought, the most severe in Massachusetts since the 1960s, the 2013 Plan was implemented but was followed by an in-depth review of the previously developed indices by the Drought Management Task Force. This review resulted in a substantial update to the Plan. This included a change in methodology for calculating the indices and for calculating the thresholds for drought levels as well as the introduction of new and substantially updated actions for local and state government.[19] Unlike most droughts, which are slow-developing and long-lasting, the drought of 2016-2017, developed rapidly with conditions declining quickly from one month to the next which resulted in a new concept of “flash drought”.

Massachusetts has experienced multi-year drought episodes in 1879-1873, 1908-1912, 1929-1932, 1939-1944, 1961-1969, and 1980-1983. Recently, in September of 2020, all seven regions of the Commonwealth were in Level 2 – Significant Drought status. In October of 2020, due to low water levels in Lake Cochichewick, North Andover’s surface water supply, the town issued a Drought Watch including voluntary water conservation measures per the Town’s Drought Management Plan.



[19] Drought Management Plan 2019, Executive Office of Energy and Environmental Affairs & Massachusetts Emergency Management Agency, 2019.

4.7 Climate Change

Climate change is expected to alter the frequency and severity of weather-related natural hazards, increasing North Andover's vulnerability to such hazards. North Andover's Core Team identified severe winter storms/nor'easters, inland flooding, extreme temperatures, and drought as the hazards of greatest concern. Using the most recent information available from resilientma.org, the Climate Change Clearinghouse for the Commonwealth, the effects of climate on these hazards will be explored in greater detail below.

Severe Winter Storms and Nor'easters

According to the Fourth National Climate Assessment issued in 2018, heavy precipitation events in most parts of the United States have increased in both intensity and frequency since 1901. There are important regional differences in trends, with the largest increases occurring in our northeastern United States.

The frequency and intensity of heavy precipitation events in North Andover and the Merrimack Valley are projected to continue to increase throughout the 21st century. The northern United States, including New England, is projected to receive more intense precipitation in the winter and spring, while parts of the southwestern United States are projected to receive less precipitation in those seasons. Winter precipitation (generally in the form of rain) is expected to increase by 12% to 30%, while the number of snow events is expected to decrease.[20] While more winter precipitation is likely to fall as rain than snow, historical data show that the frequency of extreme snowstorms in the U.S. doubled between the first half of the 20th century and the second.[21] Consequences of more extreme storm events include infrastructure failures, disruptions to local economies, and increased public safety risks with more demands on local government and first responder capacity.

Storms of heavy winds and rain along with severe winter storms are the most frequent naturally occurring hazard in Massachusetts. With climate change, the intensity and frequency of these storms will rise. Nor'easters have caused major tree damage, flooding, and infrastructure disruption to North Andover, memorably in October 2017 and March 2018 when storms precipitated road closures and extended power outages throughout the region. The shift toward more rainy and icy winters would have serious implications in terms of possible damaging ice storms, similar to the storm that severely impacted the region in December 2008.

[20] Massachusetts Climate Adaptation Report, Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, September 2011.
[21] Massachusetts SHMCAP, September 2018

Inland Flooding

The risk of flooding events is heightened by the effects of climate change which portends higher precipitation levels in winter/spring seasons and more frequent, intense storms. ¦Between 1958 and 2012, the Northeast saw more than a 70% increase in the amount of rainfall measured during heavy precipitation events, more than in any other region in the United States. The parameters of the so-called 100-year storm are changing. In the 1960s, a 24-hour event that produced 6.5 inches of rain was categorized as a 100-year storm. By 2015, the threshold for the 100-year storm (i.e. storm with 1% occurrence odds in any year) was 8.4 inches of rain over 24 hours. [22] Significant flood events occurred in North Andover most recently in Spring 2010 and the Mother's Day Flood of 2006.


Merrimack River – MVPC Photo

Further, more winter rain is expected to cause more high-flow and flooding events during the winter, earlier peak flows in the spring, and extended low-flow periods in the summer months. Such hydrologic changes would impact water resources, including an increase in flooding, pollutant-laden overflows from stormwater and wastewater systems during high periods of flow and increased stress on surface and groundwater drinking sources during periods of low flow or drought.

Floods caused by high-intensity precipitation will also impact the region and the state. Should these events occur with greater frequency as many climate experts predict, future damage may be severe and cumulative, straining local and state resources. Extreme weather events can disrupt power, limit access to safe and nutritious food, damage property, and impact health care services.

Extreme Temperatures

Massachusetts' climate is changing – nineteen of the 20 warmest years all have occurred since 2001, according to the NASA climate change website. Average global temperatures have risen steadily in the last 50 years.[23] Ambient temperature has increased by approximately 1.8°F from 1970 through the first decade of the 21st century and sea surface temperature has increased by 2.3° F. These warming trends have also been associated with more frequent days with temperatures above 90°F, reduced snowpack, and earlier snowmelt and spring peak flows.[24] The Intergovernmental Panel on Climate Change predicts that, by the end of the century, Massachusetts will experience a 5° to 10°F increase in average ambient temperature, with several more

[22] https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html National Oceanic and Atmospheric Administration, Atlas 14 Precipitation Frequency Atlas of the United States & Technical Paper # 40, U.S. Dept. of Commerce.
[23] https://climate.nasa.gov/vital-signs/global-temperature/
[24] Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser and D.J. Wuebbles, 2006. Climate Change in the U.S. Northeast: A Report of the Northeast Climate Change Impacts Assessments, Union of Concerned Scientists, Cambridge, MA.

days of extreme heat during the summer months. From 1971 to 2000, the Merrimack Valley annually had an average of seven days with temperatures above 90 °F. By the end of the century, North Andover and the region are projected to have fourteen (14) to as many as fifty-six (56) more days per year with temperatures rising above 90 degrees.

Higher temperatures will have a negative effect on air quality and human health. Increased rates of respiratory illness, worsening of allergies and asthma, increased vector-borne diseases, and degraded water quality are expected. With higher temperatures, electricity demand in Massachusetts could increase by 40% in 2030. Total heating degree days will be 15-37% lower, but cooling degree days are projected to triple by the century's end, requiring significant investment in peak load capacity and energy efficiency measures.[25]

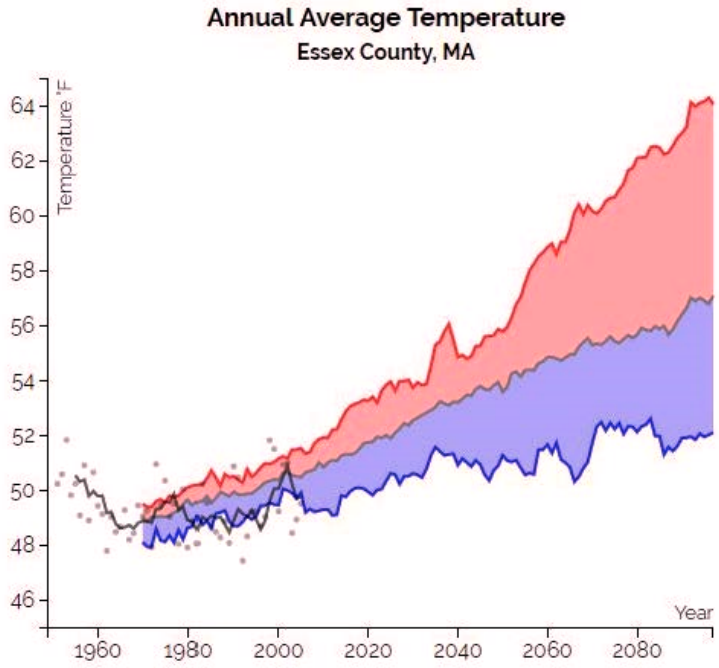


Figure 4.7.1 Northeast Climate Adaptation Science Center

Drought

Higher summer temperatures, less summer precipitation, and an increase in drought frequency will impact water quality and quantity. Intermittent streams will cease flowing earlier in the season and some coldwater habitat will be replaced with warm water habitat. As discussed above, average summer and fall temperatures in the Merrimack River Basin could increase 12° F by the century's end. The annual number of extreme heat days greater than 90°F is expected to increase by as much as 32 more days in 2050. [26] Extended heat waves could significantly impact public health as well as

[25] Ibid.

[26] http://www.resilientma.org/resources/resource::2152 National Climate Science Center at the University of

infrastructure, economic systems including agriculture and ecosystems of forests and wetlands. As higher temperatures lead to greater evaporation and earlier snowmelt, the frequency and intensity of droughts are predicted to increase in summer and fall in the Northeast.[27]

Also, for summer and fall seasons, data projections are showing variable precipitation levels with the potential for a moderate change in the number of consecutive dry days (less than 1 mm precipitation). The 1971 to 2000 baseline is 17 on average annual consecutive dry days and that is projected to increase by 3 days by the end of this century.[28] Less winter snowpack, the result of more winter precipitation falling as rain, combined with earlier spring melt, may fail to adequately recharge groundwater aquifers.

Summary

Given the known natural hazard risks and the projected impacts of climate change, there are several reasons to integrate hazard mitigation and climate change adaptation. First, the decisions and choices made today will shape North Andover's future and impact its ability to be resilient. Second, since significant time is required to develop adaptive strategies and implementation capacity, acting now will allow the time needed for North Andover to work toward achieving long-term adaptation goals. Third, proactive planning is far less costly than reacting and responding to a disaster created by a hazard that has been exacerbated by the effects of climate change.

There are similar vulnerabilities across ecosystems based on projected temperature changes, increased storm intensity, precipitation changes, drought, and sea-level rise. Different organisms have different rates of response to climate change. It is expected that climate change will cause changes in species composition and forest structure. Climate change, in conjunction with other stressors, will alter forest function and its ability to provide wildlife habitat and could reduce the ability of forests to provide ecological services such as air and water cleansing. Also, the negative impacts of invasive species may increase, as native forests are increasingly stressed. In general, adaptive strategies for natural resources and habitats include land and water protection, land and water resource management, regulation changes, and increased monitoring.

To help protect existing structures and minimize or prevent exposure from natural hazards exacerbated by climate change, sound land-use decisions should be promoted through review and updates to local bylaws and regulations. Hazard mitigation, evacuation, and emergency response plans should also be evaluated and updated to reflect changing climate conditions and new development patterns.

Massachusetts Amherst, Massachusetts Climate Change Projections, March 2018.

[27] https://www.mass.gov/files/documents/2018/09/17/SHMCAP-September2018-Chapter4.pdf

[28] Ibid.

B. Non-Natural Hazards

The Massachusetts Emergency Management Agency (MEMA) is the state agency responsible for coordinating federal, state, local, voluntary, and private resources during emergencies and disasters in the Commonwealth of Massachusetts. MEMA provides leadership in developing plans for an effective response to all hazards, disasters, or threats; trains emergency personnel; provides information to the public; and assists individuals, families, businesses, and communities to mitigate against, prepare for, respond to, and recover from emergencies caused by both nature and humans.

Each municipality, including North Andover, has a Comprehensive Emergency Management Plan (CEMP) in place. The CEMP combines the four phases of emergency management: mitigation, preparedness, response, and recovery. In the interest of holistically addressing mitigation and its interrelationship with emergency management overall, this Hazard Mitigation Plan provides an overview of several hazards that are non-natural and pose a threat to the state, the region, and the Town of North Andover.

This section of the North Andover MVP/HMP is intended to highlight recent disasters in North Andover that have served as the backdrop to this community planning process and complement the state's Hazard Mitigation Plan. Strategies will not be provided for addressing these hazards at the regional and local levels. MEMA and the town maintain Comprehensive Emergency Management Plans (CEMPs), as well as other documents that outline the specific response and mitigation associated with non-natural disasters, crime, and other emergencies.

4.8 Public Health Emergencies and Hazards

North Andover and the world are currently battling COVID-19, a new strain of coronavirus (similar to the H1N1 virus of 2009) that was first discovered in Wuhan, China in December of 2019 and first recognized in the United States in January of 2020. This virus, unlike any other since the 1918 flu pandemic, is overwhelming public health systems. Infectious disease emergencies are extremely rare - while previously the Massachusetts Department of Public Health (MDPH) received 10,000 case reports annually, as of January 2021, there are over 430,000 cases of COVID-19 with over 13,000 deaths. While generally, health care providers, local boards of health, and the MDPH handle most infectious diseases routinely, this outbreak has presented unprecedented challenges including a state "stay at home" order in the spring of 2020.

Worldwide travel and the re-emergence of infectious diseases in more virulent forms may increase the rate of public health infectious disease emergencies in the future. The Massachusetts Department of Public Health is the primary agency responsible for the study, planning, isolation/quarantine and actions, surveillance, and reporting for all public health emergencies. Any cluster or outbreak of any unusual disease or illness

must be reported to the local board of health (or to MDPH if the local board of health is not available). While vaccines have only just become available to battle the current coronavirus outbreak, the country, state, and individual communities still have much work to do to bring this virus under control.

Furthermore, the public health challenges of this virus, the country, state, and communities have had to develop measures to address both social and economic fallout of the virus including high levels of unemployment and business closures as well as challenges to conducting the day to day operations of all state and town functions. All levels of society have been affected including education and social services. While many lessons have already been learned, new procedures to deal with future public health emergencies will certainly be needed once the current crisis has passed.

Government at all levels must also be prepared for bioterrorism, or the intentional use of (or threat to use) biological agents including but not limited to anthrax, botulism, brucellosis, cholera, pandemic influenza, plague, ricin, smallpox, tularemia, and viral hemorrhagic fevers.

4.9 Infrastructure Failure

Infrastructure failure includes technological emergencies that result in an interruption or loss of a utility service, power source, life support system, information system, or equipment needed to keep the businesses in operation. Examples include:

- Utilities such as electric power, gas, water, hydraulics, compressed air, municipal;
- Sewer systems, water treatment plants, and wastewater treatment plants;
- Security and alarm systems, elevators, lighting, life support systems, heating, ventilation, and air conditioning systems, and electrical distribution systems;
- Manufacturing equipment and pollution control equipment;
- Communication systems, both data and voice computer networks; and
- Transportation systems including air, highway, railroad, and waterways.

In late afternoon September 13, 2018, the Town of North Andover, along with neighboring communities of Lawrence and Andover, experienced a series of simultaneous natural gas explosions and fires caused by the release of high-pressure gas into a low-pressure distribution system. The event occurred as Columbia Gas-contracted construction crews were working on a major infrastructure upgrade to replace 7,506 feet of low-pressure gas mains including cast iron segments originally installed in the early 1900s.

The explosions and fires ignited by natural gas-fueled appliances damaged 131 structures in Andover, North Andover, and Lawrence. Leonel Rondon, an 18-year-old Lawrence resident, was killed when a house chimney collapsed onto his parked car in a building explosion on Chickering Road in Lawrence. At least 21 people received treatment at area hospitals for injuries.[29] The three municipal Fire Departments responded to initial calls and required mutual aid from departments throughout eastern Massachusetts, New Hampshire, and Maine.

Residents with homes served by natural gas were told to shut off gas service and to evacuate. As a safety precaution, National Grid shut down electrical power to the affected communities. Local roads and the regional highways became gridlocked as State Police closed Interstate 495 ramps into Andover, North Andover, and Lawrence and as resident evacuations took place through the afternoon commute peak and into the evening.

On September 14, 2018, in response to the severity of the situation, Governor Baker made a State of Emergency declaration. In Andover, officials on short notice set up an overnight shelter at the Senior Center. Schools were closed, and Merrimack College temporarily evacuated its buildings. Before power could be restored and people allowed to return to their homes and businesses in the days and weeks following, teams of inspectors would enter each building to conduct safety checks and ensure no concentrations of trapped gas were present.

By the weekend of Sept. 15-16, officials were transitioning from Emergency Response to the Recovery phase of operations, a massive effort that extended into December. Gas service restoration to the 8,600 impacted area Columbia Gas customers involved the replacement of 48 miles of gas lines in the three communities. With utility construction crews dispatched to the Merrimack Valley from throughout the country, the gas line replacement work was completed weeks ahead of the Nov. 19 scheduled completion date, but full-service restoration to individual properties was a time-consuming process complicated by requirements of code compliance in replacing appliances in older structures and the demand for more plumbers and contractors. Temporary housing for displaced residents in area hotels/motels and RV trailers was established. To house construction workers, Columbia Gas leased a cruise ship docked in Boston Harbor. Many North Andover businesses, including restaurants dependent on gas service, were forced to shut down for weeks and months as they awaited service restoration. Some reopened after converting their energy source to propane or electric. Restoration of heat and working appliances was finally completed for most properties by the end of December, but in some cases, work continued into 2019.

The Columbia Gas explosions emergency reinforced the importance of community engagement and planning on how to effectively respond and mobilize resources to protect and inform the public and shelter and provide for those displaced, especially the most vulnerable. Subsequent recovery efforts to bolster businesses that lost

[29] NTSB Preliminary Report PLD13MR003 10/11/2018 and Safety Recommendation Report PSR-18/02, 12/6/2018

revenue during the disaster provided important lessons which, tragically are being experienced again, and more severely, as a result of the COVID-19 pandemic.

Technological emergencies have the potential to occur in every municipality. Communities with limited infrastructure are more vulnerable to experiencing an incident because of the lack of redundant systems. North Andover should continue mitigation measures already in process including installing emergency generators, burying cable, installing back-up systems, and undertaking regular system maintenance including vegetation management (tree and brush pruning) to help reduce risks.

C. Risk Analysis

The Town of North Andover local planning team's risk analysis reviewed potential hazard events and based on frequency, intensity and potential impact to the community categorized potential hazards as high, moderate-high, moderate, low-moderate, or low risk to the community. The Core Team utilized the definitions based in the Commonwealth of Massachusetts State Hazard Mitigation Plan (2013) as follows:

Frequency

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

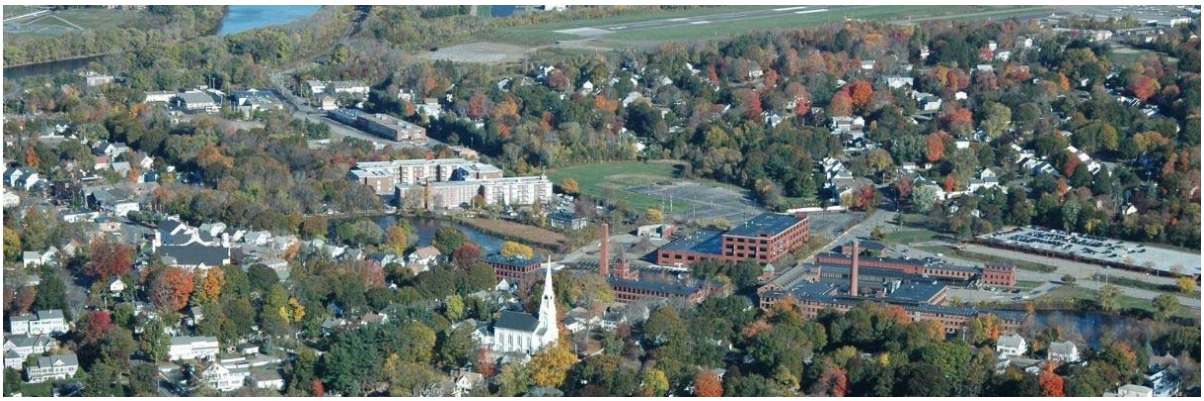
Severity: extent or magnitude of a hazard, as measured against an established indicator

- 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

On the basis of this analysis, North Andover considers itself to be at ***high risk*** from flooding, winter storms (blizzards/snow/ice storms), Nor'easters and power outages; ***moderate risk*** from hurricanes, tornados, drought, and brush fires; ***low risk*** from earthquakes, dam failure, and landslides.

Table 4.C. North Andover Natural Hazards Risk Assessment		
Hazard	**Frequency**	**Severity**
Winter Storms (blizzard/snow/ice)	**HIgh**	**Minor to Extensive**
Nor'easters	**High**	**Minor to Extensive**
Power Outages	**High**	**Minor**
Exteme Temperatures	**High**	**Minor to Serious**
Hurricanes	**Medium**	**Serious to Catastrophic**
Tornados	**Medium**	**Minor**
Drought	**Medium**	**Minor to Serious**
Forest/Brush Fires	**Medium**	**Minor to Serious**
Earthquakes	**Low**	**Minor to Extensive**
Dam Failure	**Low**	**Minor to Catastrophic**
Landslides	**Low**	**Minor**

SECTION 5. EXISTING PROTECTIONS MATRIX



This section of the Plan presents an **Existing Protections Matrix** for North Andover. The matrix is an inventory of zoning, land use, and environmental regulations already in place as well as ongoing or completed maintenance projects, and other programs and activities that are related to natural hazard mitigation. Compiling such an inventory allows gaps and deficiencies to be identified.

As part of the plan updating process, the 2016 information was reviewed and revised through a series of email communications and conversations with Core Team members and other North Andover municipal staff. Also, local zoning bylaws, subdivision rules and regulations, EPA MS4 stormwater management materials, North Andover Master Plan, Open Space and Recreation Plan, and the Town website were consulted.

The updated existing protections inventory reflects current conditions and incorporates new measures that have been put in place over the last five years, as shown in the following matrix.

Examples of Local Hazard Mitigation Measures

Local Wetlands Protection Regulation

Regular Street Sweeping

Tree-pruning to Protect Utility Lines

Table 5.1 North Andover Existing Protections Matrix				
Type of Existing Protection	Description	Area Covered	Effectiveness/Improvements Needed	Hazard
Town participation in the National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	Flooding
Floodplain zoning district bylaw	Requires all development, including structural and non-structural activities, be in compliance with state building code requirements for construction in floodplains	FEMA flood zones	Generally effective for new construction, but some older structures pre-date bylaw/ Updates needed to conform with Mass 2020 Model Floodplain Bylaw	Flooding
Local Wetlands Protection Bylaw and Regulations (Chapter 190)	Regulates building in: - Wetlands - 100-ft Buffer Zones - 200-ft riverfront area - Bordering Land Subject to Flooding Establishes 25-foot No-Disturbance Zone and 50-foot No-Build Zone to Wetlands	Town-wide	Effective - actively enforced	Flooding
Subdivision Rules & Regulations, Section 6.14 (Stormwater)	Determines manner in which land parcels may be divided, and the specific stormwater/ flooding mitigation that is required	Town-wide	Effective - actively enforced	Flooding
Town Zoning Bylaw, 1972 (amended 2019) - Section 7 Dimensional Requirements - Section 8.3 Site Plan Review - Section 9 Lot /Slope requirements (prohibit slopes>3:1)	Promotes the health, safety, and welfare of Town residents. Cited sections detail the requirements relating to lot size, setbacks, contiguous buildable area, site plan review, and lot/slope requirements	Town-wide	Effective - actively enforced	Flooding/Geologic (Landslide)
Stormwater Management and Erosion Control Bylaw and Regulations (Chapter 250)	Protecting Quality of Town's Water Resources	Town-wide (including EPA MS4 Area)	Effective – actively enforced/ Updates need to conform to MS4 Permit Requirements	Flooding
Master Plan	Guide for community growth and preservation of open space and natural resources	Town-wide	Effective - Updated 2018/ As appropriate, integrate HMP/MVP goals in plan updates	Flooding/Drought
State Building Code	Town enforces the MA State Building Code	Town-wide	Effective	Multi-Hazard

Technical Review Committee (TRC)	Town provides multi-departmental review of all planned development projects	Town-wide	Effective	Multi-Hazard
Smart911 System (including mobile app, text, and email options) Social Media websites also used	Emergency notification systems for residents	Town-wide	Effective	Multi-Hazard
Comprehensive Emergency Management Plan	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective - actively enforced	Multi-Hazard
Continuity of Operations Project (COOP)	Plan to assist with minimizing the disruption of essential services, providing protection of essential record and equipment, and defining the resources required to ensure the continuation of essential operations	Town-wide	Effective (new)	Multi-Hazard
TRIAD Group	Mission is to develop and implement policies and programs to reduce criminal victimization, promote crime prevention and safety awareness, and serve the needs of the senior community	Town-wide	Effective	Multi-Hazard
Emergency Management Website	Safety information and preparation tips for most frequent natural disasters and emergency types	Town-wide	Effective	Multi-Hazard
Permits Required for Outdoor Burning	Outdoor burn permits issued by the fire chief. Permits are time of year restricted and weather dependent	Town-wide	Effective	Brushfire
Rae's Pond & Winter St. Pumping Station flood mitigation	Pumping station elements at Rae's Pond and Winter St. raised to ensure pumping stations remain isolated from floodwaters during even extreme flood events	Rae's Pond, Winter St., Lake Cochichewick	Effective	Flooding
Lake Cochichewick outlet	Water level in Lake Cochichewick is controlled by a sluice	Lake Cochichewick and surrounding areas	Effective/ New outlet structure built	Flooding/Drought
Stevens Pond outlet	Water level in Stevens Pond is controlled by a weir	Stevens Pond and surrounding areas	Effective	Flooding

Stormwater Management Maintenance (Catch Basin cleaning and Street Sweeping Program – part of town Stormwater Management Plan)	Regular clearing and cleaning of culverts and storm drains as part of Town stormwater infrastructure maintenance program	Town-wide	Effective	Flooding
Beaver mitigation measures	North Andover's beaver population has a significant influence on flooding risks. The Town implements several measures, such as "Beaver Deceivers", to mitigate beaver-related flooding	Town-wide	Moderately effective	Flooding
Community Preservation Act	As opportunities arise, CPA funds are used to purchase and protect key open space parcels, especially in the Lake Cochichewick watershed	Town-wide	Effective	Flooding/Drought
Updated Open Space Plan	Plan updated in 2016	Town-wide	Effective	Flooding/Drought
Update Site Plan Review Zoning	Update SPR Zoning to be consistent with Wetlands Bylaw & Land Disturbance Permit. NPDES Requirement	Town-wide	Effective	Flooding
Update Watershed Zoning	Update Watershed Zoning to be consistent with Wetlands Bylaw & Land Disturbance Permit as it relates to Stormwater	Town-wide	Effective/ Lake Cochichewick Watershed Plan update in Progress	Flooding/Drought
Updated Floodplain District Zoning	Floodplain Zoning reflects most recent FEMA Floodplain Maps	Town-wide	Effective	Flooding
Beaver Deceivers	DPW and outside contractor regularly monitor and maintain.	Town-wide	Effective	Flooding

Town Participates in Northeast Mosquito Control District	Detect and prevent spread of vector-borne diseases	Town-wide	Effective	Flooding
Tree Maintenance Program	Town's DPW maintains street trees and numerous trees on public grounds and park areas	Town-wide	Effective	Wind Related

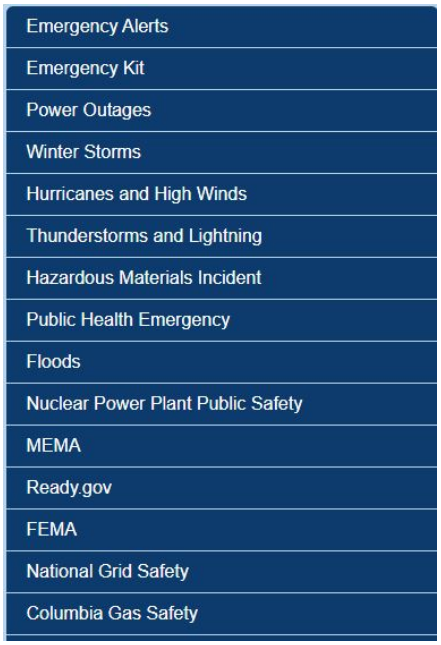
SECTION 6. 2016 MITIGATION MEASURES UPDATE

6.1 Implementation Progress from 2016 Plan

North Andover's 2016 Mitigation Actions were part of the Merrimack Valley Regional Multi-Hazard Mitigation Plan. These actions were reviewed by various members of the Core Team with responsibility for implementation and their status was updated to "complete," "in progress" or "not completed." Core Team members then reviewed the "in progress" and "not completed" actions to determine which should be carried forward into this Hazard Mitigation Plan Update.

The Town of North Andover has been proactive in its implementation of the prior mitigation actions. Completed actions include:

- Significant improvements to sewer infrastructure including raising manholes in flood-prone areas to prevent surcharging (Rae's Pond and Winter Street areas) and relocation of the Rae's Pond Pump Station out of the 100-year flood zone.
- Continued protection (purchase/conservation restriction) of land within the Lake Cochichewick Watershed for water supply protection.
- Completed DPW general order of conditions for routine maintenance within Conservation Commission jurisdiction to improve maintenance of drainage, stormwater, and other infrastructure.
- Implemented Smart911 and social media alert systems and improved Emergency Management website to include "tips and techniques" for hazard preparedness, mitigation, and response, with links to the MEMA and FEMA hazard mitigation websites.



In addition, the Town of North Andover has taken steps to implement findings from the 2016 Merrimack Valley Region Multi-Hazard Mitigation Plan Update via the following policy, programmatic areas and plans:

- 2018 Master Plan and the 2021 Lake Cochichewick Watershed Plan Update (currently underway).
- 2016 Town Meeting approved a Zoning Bylaw amendment for site plan review to require all stormwater management plans and drainage calculations to be submitted with a stamp and signature of a professional engineer licensed to conduct such work in the Commonwealth of Massachusetts. In addition, the application for site plan review is now required to include the submittal of a stormwater management plan in accordance with the latest version of the Massachusetts Stormwater Handbook and additional criteria, demonstrating full compliance with Massachusetts stormwater standards and the North Andover stormwater management and erosion control regulations promulgated Chapter 160 of the Town Bylaws (Stormwater Bylaw).
- The Town has also funded, via its Community Preservation Act funding, Leonhard Farm and Glennie Woodlot, both of which are within the Town's Watershed Protection District.

Table 6.1.1 NORTH ANDOVER Mitigation Action Plan						
Category of Action	**Description of Action**	**Hazard Addressed**	**Implementation Responsibility**	**Timeframe/ Priority in 2016**	**2021 Status (completed, in progress, not completed)**	**Include in 2021 Update?**
Structural Project	Design and construct physical upgrades to 37 sewer manholes that flow to Rae's Pond sewer lift station to prevent recurring sewer surcharging and potential degradation of Lake Cochichewick, Town's primary drinking water source	Flooding	Town Engineering and Public Works Departments	Short-term	Completed	No
Structural Project	Design and construct physical improvements to sewer manholes that flow to Winter Street lift station to prevent recurring sewer surcharging and potential degradation of Lake Cochichewick	Flooding	Town Engineering and Public Works Departments	Short-term	Completed	No
Prevention	Acquire/protect undeveloped open space in flood hazard areas, with special attention to properties in Lake Cochichewick watershed	Flooding	North Andover CPA Committee and Conservation Commission	On-going	In Progress	Yes
Prevention	Consistent with Phase II (MS4) Program requirements, develop and implement drainage system maintenance plan to ensure regular inspection, cleaning, and maintenance of municipal stormwater facilities and waterways	Flooding	North Andover Public Works Dept., Conservation Commission	On-going	In Progress	Yes
Prevention	Strictly enforce and, as appropriate, upgrade Town zoning bylaw, subdivision rules & regulations, and wetlands regulation to minimize incidence and impacts of flooding and other natural hazards	All Hazards	Town departments	On-going	In Progress	Yes

Table 6.1.1 NORTH ANDOVER Mitigation Action Plan						
Prevention	Incorporate hazard mitigation in local policies, plans, and programs (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan)	All Hazards	Town departments	On-going	In Progress	Yes
Prevention	Explore participation in NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public	Flooding	Town	Long-term	Completed – Town not planning to pursue at this time	No
Prevention	Amend local subdivision rules & regulations to require the maximum practicable use of low impact development (LID) techniques in all new development and redevelopment	All Hazards	North Andover Planning Board	Short-term	In Progress	Yes
Prevention	Maintain CEMP, Flood Hazard Mitigation Plan, and North Andover components of this Plan to ensure their completeness and relevance in disaster mitigation and response	All Hazards	Town departments	On-going	In Progress	Yes
Prevention	Minimize impervious surfaces and decrease stormwater runoff through use of LID.	Flooding	North Andover Conservation Commission Planning Board	Ongoing/ MEDIUM	In Progress	Yes
Prevention	Issue General Permit (Order of Conditions) to DPW to assist with routine maintenance.	Flooding	North Andover Conservation Commission	Ongoing/ MEDIUM	Complete	No
Prevention	Conservation Commission education through MACC – educating Commission members to increase enforcement of state and local wetland laws.	Flooding	North Andover Conservation Commission	Ongoing/ MEDIUM	Complete	No
Prevention/ Emergency Services	Develop and implement timely warning system (local access cable TV and/or radio) to alert	All Hazards	Town departments	Short-term	Complete	No

Table 6.1.1 NORTH ANDOVER Mitigation Action Plan						
	public about pending floods and other hazard emergencies					
Structural Project and Prevention	Implement drainage improvements to remedy recurring flooding problems along and around Mosquito Brook	Flooding	North Andover Public Works and Engineering Depts., Conservation Commission	Short-term	Complete	Yes – update to include beaver issues
Structural Project and Prevention	Implement drainage improvements to remedy recurring flooding problems along and around Lost Pond	Flooding	North Andover Public Works and Engineering Depts., Conservation Commission	Short-term	Complete	No
Structural Project and Prevention	Analyze existing flooding problem areas and design/implement appropriate corrective measures, such as re-directing floodwaters to uninhabited areas or wetlands	Flooding	North Andover Public Works and Engineering Depts.	Long-term	In Progress – most areas addressed	Yes- ongoing maintenance
Structural Project and Prevention	Develop a proactive program to analyze existing sewer backup locations and causes, and to design and implement appropriate corrective measures, rather than reacting to each incident after it occurs	Flooding	North Andover Public Works and Engineering Depts.	Long-term	In Progress	Yes
Prevention	Maintain current list of Repetitive Loss properties; encourage property owners to explore and implement appropriate mitigation measures	Flooding	North Andover Public Works and Engineering Depts. (add Building and Conservation)	On-going	In Progress	Yes
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Brushfire	North Andover Fire Dept.	Long-term	In Progress	Yes
Prevention	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in all new development and redevelopment	Power Outages/Storms	Town Departments and Private Developers	On-going	In Progress	Yes

Table 6.1.1 NORTH ANDOVER Mitigation Action Plan						
Prevention	To mitigate against damage from earthquakes and landslides, actively enforce applicable state and municipal building codes	Earthquakes/ Landslides	North Andover Building Inspection Dept.	On-going	In Progress	Yes
Prevention	To reduce risks from all natural hazards, establish and maintain Town web page describing “tips and techniques” for hazard preparedness, mitigation, and response, with links to the MEMA and FEMA hazard mitigation websites.	All Hazards	Town Departments	Short-term/HIGH	Complete	No
Prevention/ Emergency Services Response	Develop and implement timely warning system (local access cable TV and/or radio) to alert public about pending floods and other hazard emergencies	All Hazards	Town departments	Short-term/Low	Complete	No

SECTION 7. VULNERABILITY/RISK ASSESSMENT

7.1 Overview of Natural Hazards Vulnerability

Previous sections of this Multi-Hazard Mitigation Plan identify and describe the natural hazards that have occurred, or are most likely to occur, in North Andover and the Merrimack Valley region. Since 1991, there have been 26 Presidential disaster declarations that included Essex County, as summarized in **Table 7.1.1.** Since 2014, when the region's last Hazard Mitigation Plan was prepared, there have been three additional Presidential disaster declarations in Essex County, two of which were the result of severe winter storms with flooding and the third being the ongoing COVID-19 pandemic. The vulnerability and risk assessment for North Andover has been based on the frequency of disasters, data provided in the *2018 Massachusetts SHMCAP*, and the Hazard Assessment outlined in Sections 4 of this document.

TABLE 7.1.1 DISASTER DECLARATIONS FOR ESSEX COUNTY (1991 – 2020)

DISASTER NAME (DATE OF EVENT)	DISASTER NUMBER (TYPE OF ASSISTANCE)	DECLARED AREAS
Hurricane Bob (August 1991)	FEMA-914 (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)
Severe Coastal Storm (October 1991)	FEMA-920-DR-MA (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	FEMA-920-DR-MA (IMA)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	FEMA-920-DR-MA (HMGP)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
Blizzard (March 1993)	FEMA-3103-EM (PA)	All 14 Massachusetts counties
Blizzard (January 1996)	FEMA-1090-EM (PA) (Public)	All 14 Massachusetts counties
Severe Storms and Flooding (October 1996)	FEMA-1142-DR-MA (PA)	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk
	FEMA-1142-DR-MA (IFG)	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk
	FEMA-1142-DR-MA (HMGP) and FY1997 CDBG	Counties of Essex, Middlesex, Norfolk, and Plymouth, Suffolk (36 projects)
Heavy Rain and Flooding (June 1998)	FEMA-1224-DR-MA (IFG)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	FEMA-1124-DR-MA (HMGP) and FY1998 CDBG	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Severe Storms and Flooding (March 2001)	FEMA-1364-DR-MA (IFG)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	FEMA-1364-DR-MA (HMGP)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)

TABLE 7.1.1 DISASTER DECLARATIONS FOR ESSEX COUNTY (1991 – 2020)

DISASTER NAME (DATE OF EVENT)	DISASTER NUMBER (TYPE OF ASSISTANCE)	DECLARED AREAS
Snowstorm (March 2001)	FEMA-3165-DR-MA (IFG)	Counties of Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, Worcester
Terrorist Attack (September 11, 2011)	FEMA-1391(IFG)	MA residents who requested crisis counseling services following September 11th
Snowstorm (February 17-18, 2003)	FEMA-3175-EM (PA)	All 14 Massachusetts counties
Snowstorm (December 3-4, 2003)	FEMA-3191-EM (PA)	Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, Worcester
Flooding (April 2004)	FEMA-1512-DR-MA (IFG) FEMA-1364-DR-MA (HMGP)	Counties of Essex, Middlesex, Norfolk, Suffolk, Worcester
Severe Winter Storm (January 2005)	FEMA-1301-EM (PA)	All 14 Massachusetts counties
Hurricane Katrina (August 2005)	FEMA-3252-EM (PA)	All 14 Massachusetts counties
Severe Storms and Flooding (October 2005)	FEMA-1614-DR (IHP) FEMA-1614-DR-MA (HMGP)	Counties of Berkshire, Bristol, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, and Worcester HMGP funds available to all 14 Massachusetts counties
Severe Storms and Flooding (May 12-23, 2006)	FEMA-1642-DR-MA (PA) FEMA-1642-DR-MA (IHP) FEMA-1642-DR-MA (HMGP)	Counties of Essex, Middlesex Counties of Essex, Middlesex, Suffolk All 14 Massachusetts counties
Severe Storms and Flooding (April 2007)	FEMA-1701-DR-MA (PA) FEMA-1701-DR-MA (HMGP)	All 14 Massachusetts counties
Severe Winter Storm (December 2008)	FEMA-3296-EM-MA (HMGP)	Counties of Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, and Worcester
Severe Storms and Flooding (December 2008)	FEMA-1813-DR-MA ((PA) FEMA-1813-DR-MA (HMGP)	Counties of Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, and Worcester. HMGP funds available to all 14 Massachusetts counties
Severe Storm and Flooding (March-April 2010)	FEMA-1895-DR-MA (PA) FEMA-1895-DR-MA (IHP)	Counties of Essex, Suffolk, Plymouth, Middlesex, Norfolk, and Worcester
Severe Storm and Snowstorm (January 2011)	FEMA-1959-DR-MA (PA) FEMA-1959-DR-MA (HMGP)	Counties of Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, and Suffolk. HMGP funds available to all 14 Massachusetts counties
Severe Storm and Snowstorm (October 2011)	FEMA-4051-DR-MA (HMGP)	HMGP funds available to all 14 Massachusetts counties
Severe Winter Storm, Snowstorm, and Flooding (February 2013)	FEMA-4110-DR-MA	Counties of Barnstable, Berkshire, Bristol, Dukes, Essex, Hampden, Hampshire, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester
Severe Winter Storm and Flooding (January 26-28, 2015)	FEMA-4214-DR-MA (HMGP)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester
Severe Winter Storms and Flooding (March 2-3, 2018)	FEMA-4372-DR-MA (HMGP)	Counties of Barnstable, Bristol, Essex, Nantucket, Norfolk, and Plymouth HMGP Funds available to all 14 Massachusetts counties
Massachusetts COVID-19 Pandemic (January 20, 2020, and continuing)	FEMA-4496-DR-MA	All 14 Massachusetts Counties

TABLE 7.1.1 DISASTER DECLARATIONS FOR ESSEX COUNTY (1991 – 2020)

DISASTER NAME (DATE OF EVENT)	DISASTER NUMBER (TYPE OF ASSISTANCE)	DECLARED AREAS

Key:

PA-Public Assistance Project Grants: Supplemental disaster assistance to states, local governments, certain private non-profit organizations resulting from declared major disasters or emergencies.

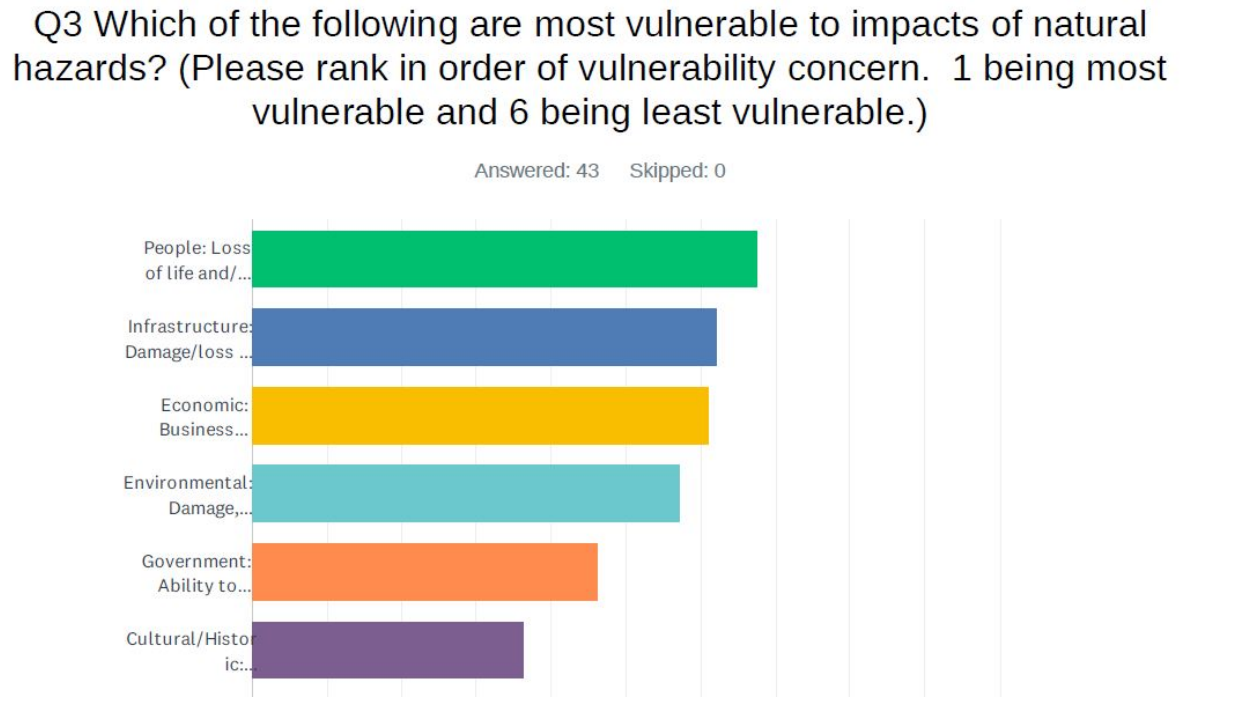
HMGP – Hazard Mitigation Grant Program: Project grants to prevent future loss of life or property due to disaster. A presidential declaration of a major disaster or emergency is needed to designate HMGP assistance.

IHP – Individual Household Program: Formerly named IFG, this program provides grants and loans to individual disaster victims to address serious needs and necessary expenses, under the FEMA Disaster Housing, State IFG Program, and/or SBA Home and Business Loan Programs.

CDBG – Community Development Block Grant: Project grants for community development-type activities to assist with long-term recovery needs related to both residential and commercial buildings.

7.2 Vulnerabilities Identified

Prior to the community resilience workshops, the project team sent out a survey asking stakeholders to identify and rank sectors of the community most vulnerable to natural hazards affected by climate change. The following graph and summary table detail the stakeholder response.



	1	2	3	4	5	6	7	8	TOTAL	SCORE
People: Loss of life and/or injuries	52.38% 22	9.52% 4	14.29% 6	9.52% 4	14.29% 6	0.00% 0	0.00% 0	0.00% 0	42	6.76
Infrastructure: Damage/loss of roads, bridges, power, schools etc.	23.26% 10	23.26% 10	18.60% 8	20.93% 9	13.95% 6	0.00% 0	0.00% 0	0.00% 0	43	6.21
Economic: Business interruptions, closures, job losses, personal property damage etc.	2.38% 1	38.10% 16	28.57% 12	28.57% 12	2.38% 1	0.00% 0	0.00% 0	0.00% 0	42	6.10
Environmental: Damage, contamination or loss of natural resource areas	19.05% 8	19.05% 8	9.52% 4	26.19% 11	21.43% 9	4.76% 2	0.00% 0	0.00% 0	42	5.74
Government: Ability to maintain order and/or provide public amenities & services	4.65% 2	6.98% 3	23.26% 10	9.30% 4	23.26% 10	32.56% 14	0.00% 0	0.00% 0	43	4.63
Cultural/Historic: Damage/loss to historic properties, neighborhood character	0.00% 0	2.33% 1	6.98% 3	4.65% 2	23.26% 10	62.79% 27	0.00% 0	0.00% 0	43	3.63

Figure 7.2.1 "Most Vulnerable" Stakeholder Survey Response

During the first community resilience workshop, stakeholders identified North Andover's vulnerabilities to natural disasters in three categories: society (encompassing people, government, and economy), infrastructure, and environment. These are further assessed, in order of relevance shown in the survey, below.

North Andover Societal Features – Vulnerabilities Identified

Seniors, Homebound, and Other Vulnerable Populations: North Andover is among the wealthier communities in the region. Despite its high average median household income, the Town has a number of residents considered vulnerable to hazard events and climate change including an increasing senior population and the homebound who may be unable to receive vital services in the event of a disaster. The greatest concern is for those living in single-family homes throughout the community who might not have access to transportation. Stakeholders also had concerns for seniors and other vulnerable populations who do not have access to backup power and/or cooling during storm events and heat waves.

Communication: Several portions of North Andover are without cellular service, communication infrastructure that is often relied upon when a severe storm impacts aboveground wires. Additionally, with the recent pandemic, stakeholders recognize the need for universal access to broadband internet for work-from-home and remote schooling. There are still portions of the community without these services. North Andover's Smart911 system also relies on these networks to communicate information to residents in an emergency. Furthermore, Smart911 profiles are often incomplete leaving residents at risk for missing critical information.

North Andover Schools have also identified students and families for whom English is not the primary language. North Andover stakeholders identified these residents as vulnerable and that the community needs multi-lingual tools to communicate and involve an increasingly diverse population.

Transportation and Access to Fresh Food: North Andover operates transportation for seniors and has bus service through the MVRTA. However, not all residents are on bus routes and the use of the Senior Center vans can be complicated when portions of town become inaccessible or when transportation of many individuals is complicated by other factors such as the current pandemic. Recent events have brought to light the need for better access to fresh foods as well as the transportation means to deliver them.

North Andover Infrastructure Features – Vulnerabilities Identified

Undersized Culverts: Undersized culverts can act as choke points restricting streamflow. Low-lying, flood-prone areas were previously identified in Chapter 4 of this plan. Areas of concern include Great Pond Road (Route 133) culvert between Rea's Pond and Lake Cochichewick, Brooks Street culvert, and culverts along

Mosquito Brook where issues with beavers are increasing flooding and drainage problems.

Sewer Pump Stations: North Andover has done extensive work to increase the resiliency of its sewer infrastructure, including moving Rea's Pond Pump Station out of the 100-year Floodplain and raising manholes and lining pipes to decrease infiltration and inflow. Additional pump stations remain vulnerable including Winter Street and the GLSD owned Riverside Pump Station.

Drinking Water Supply: North Andover provides the majority of its residents with high-quality drinking water from Lake Cochichewick which is treated at the town-owned and operated water treatment plant. The Town is currently undertaking an update to the 1987 Lake Cochichewick Watershed Plan but stakeholders expressed concern for the vulnerability of the sole source drinking water supply from excessive nutrients in stormwater runoff and the effects of warmer temperatures and changes in precipitation patterns that may result in drought.

Members of the Core Team also noted that the Lake is vulnerable to shoreline erosion. This issue is currently being addressed for a 600-foot stretch of Route 133 on Great Pond Road, a vital connection to northeastern communities, but is also an issue at other locations along the lakeshore.

Dams: North Andover has several public and privately-owned dams. While several dams including the outlet to Lake Cochichewick (public) and the dam/weir at the West Mill (private) have been recently reconstructed, private dams downstream of the Mills are considered vulnerable and have unclear ownership issues.

Utilities: Portions of North Andover have experienced long-term power outages related to severe storm events. Despite National Grid's and the Town's proactive tree maintenance programs, overhead electric lines remain vulnerable. Following the recent natural gas explosions in North Andover, gas infrastructure has been updated but other aging infrastructure (water, sewer, stormwater) remains vulnerable.

Public Works: The Division of Public Works provides critical operations and support during weather-related events, including during natural disasters. Portions of North Andover's DPW headquarters lie within the floodplain to Cochichewick Brook and may be vulnerable when services are needed most.

Shelter (cooling): North Andover's High School Fieldhouse serves as a community shelter location. However, this shelter does not have air-conditioning and may be vulnerable in the event of an extreme heat wave.

North Andover Environmental Features – Vulnerabilities Identified

Unprotected Farmland and Watershed Lands: While North Andover has protected many agricultural and watershed lands, stakeholders expressed concern that several

large farms and lands abutting Lake Cochichewick remain privately owned. The Town's Master Plan also notes that "many unprotected lands in North Andover are important contributors to both the town's character and the preservation of its natural resources." The following are emphasized as vulnerable and prioritized for acquisition:

- Land adjacent to a Lake Cochichewick tributary
- Land within the boundaries of the Lake Cochichewick Watershed District
- Land abutting existing/protected open space
- Farmlands
- Land with development risks (i.e. private ownership chapter 61, 61A, and 61B, or Agricultural Preservation (APR)
- status, town property)
- Unique aesthetics, historic value, and/or community character
- Feasibility of a trail network & adjacent network(s)
- Unique wildlife, wetlands, river corridors, and/or riparian habitat values as depicted on the North Andover
- BioMap and Living Waters Map produced by the Natural Heritage and Endangered Species Program (NHESP)

Loss of Trees on Private Property (especially on Watershed Lands): Stakeholders identified unauthorized clearing of trees, especially within the watershed, as a vulnerability. Once lost, the benefits of large trees cannot be replaced. Their ability to regulate the flow of water within watershed lands is vital. Trees intercept and absorb large amounts of precipitation, filtering runoff and slowly recharging groundwater, and protecting both the quantity and quality of North Andover's surface drinking water supply.

Lack of Tree Cover/Heat Islands: Similarly, the lack of trees in more urban settings was also identified as a vulnerability. Trees in more urban portions of North Andover not only mitigate intense storms and the pollutants associated with stormwater runoff but also reduce peak summer temperatures through shading and evapotranspiration[30].

West Mill, North Andover

Riparian/Lake/Pond Buffers: Wetland and riparian buffers act as sponges, soaking up floodwaters and releasing them slowly following storm events. These buffers reduce flooding, stream erosion and protect water quality. Increased development threatens these buffers and increases the vulnerability of North Andover's water resources and residents.

Beaver Management: North Andover works frequently with a specialist to install and maintain environmentally friendly flow management devices to deter beavers from

[30] Using Trees and Vegetation to Reduce Heat Islands | Heat Island Effect | US EPA

blocking culverts which prevents flooding. However, North Andover's large tracts of wetlands provide ideal beaver habitat and the Town is struggling to manage beaver activity to prevent road and private property flooding. More intense storm events are increasing vulnerability of both public infrastructure and private homes.

Invasive Species: North Andover stakeholders identified invasive species as a threat to the town's environment. These plants and insects out-compete native species and often flourish in disturbed areas and are more adaptable to drought and warmer temperatures. Invasive plant species are often not as deeply rooted and do not provide the same stormwater and erosion protection benefits as native species. Invasive insects, such as the Emerald Ash Borer, first found in North Andover in 2013, can result in the loss of an entire native tree species. Dead ash trees are also a hazard to the built environment when they are found near homes and overhead utility lines.

Potential Flood Damage as a Measure of Vulnerability

The most common and costly hazard in the Merrimack Valley is *flooding*. Estimates of the potential impact of flooding on North Andover were calculated as one means of measuring the Town's vulnerability to this most common natural hazard. Among all the hazards considered by this Plan, flooding is the one that is both most widespread and measurable. Also, methodologies to measure the geographic impact of flood events are well developed, and mitigation practices to reduce flood impacts are well understood.

Merrimack River at Lawrence Dam - May 2006

The methodology utilized by MVPC estimated the total value of buildings within the 100-year floodplain using assessed value data from the 2019 tax assessor records in each community. The 100-year floodplain is a well-defined geographical area for which digital (GIS) map files are readily available. The Flood Insurance Rate Map (FIRM Q3) data layers were obtained from MassGIS showing the 100-year floodplains (Zones A, A1-30, and AE). MVPC superimposed these data layers on the building location data for North Andover. The building location data was derived from a comprehensive, region-wide point file created by MVPC from recent digital aerial photography (2019). The buildings include both primary structures and secondary outbuildings (garages, barns, etc.), and are geo-referenced and linked to the assessors' property records.

From this intersection of floodplain and building location data layers, MVPC was able to determine both the total number of buildings in North Andover's 100-year floodplain *and* their corresponding assessed values. This information was organized and

recorded by land use category – i.e., residential (all types), commercial, industrial, and institutional – and is presented in **Table 7.2**.1

The last column of the table shows the total value of buildings within the 100-year floodplain. Given the limitations in funding and methodology, no attempt was made to estimate the probable amount of damage from a 100-year storm event. Instead, the total value of the buildings is considered to be the upper limit of potential damages. This limit would not be reached except in the case of a rare storm event exceeding the 100-year storm.

Table 7.2.1 Assessed Value of Buildings in the 100-Year Floodplain

City/Town	Number of Buildings	Assessed Building Value by Land Use Type				Total Assessed Value in 100-Yr
		Residential	Commercial	Industrial	Institutional	
North Andover	259	$217,490,200	$26,448,600	$31,971,900	$50,303,900	$326,214,600

Source: MVPC digital imagery and local assessor records

The total assessed value of all buildings in North Andover is $3,644,119,300 to provide context for the above. While the table figures provide an estimate of the building values, they do not include the estimated cost of replacing building contents. It is also important to note that loss of property does not reflect the entire cost of a region-wide flood event. There may also be added personnel (overtime) costs, rescue and evacuation costs, infrastructure repair/replacement costs, sediment and debris cleanup costs, and economic costs related to business closures.

7.3 Vulnerability to Future Natural Hazards

Based on the identification and profile of the natural hazards that have occurred throughout the region over time, a vulnerability matrix has been developed. The matrix, adapted from a prior Massachusetts Hazard Mitigation Plan developed by MEMA (this matrix was not used in the 2018 update), was used to categorize each hazard based on frequency, severity, extent of impact, and area of occurrence. Historical data were utilized, as well as the best available scientific assessments, published literature, and input from subject area experts. The criteria were formulated based on the hazard identification profile and from the prior assessment performed for the region. There have been no significant changes in the region's vulnerability since the completion of the 2016 Regional Multi-hazard Mitigation Plan in which this table was previously included.

Table 7.3.1 lists the natural hazards to which the region is vulnerable, describes the expected frequency of occurrence, and the potential severity of the damage resulting from each hazard. The key at the bottom of the table describes the criteria used in the assessment.

Table 7.3.1 North Andover's Potential Vulnerability to Natural Hazards

HAZARD	FREQUENCY				SEVERITY				AREA OF IMPACT			AREA OF OCCURRENCE		
	VERY LOW	LOW	MODERATE	HIGH	MINOR	SERIOUS	EXTENSIVE	CATASTRO-PHIC	ISOLATED	LOCAL/ MUNICIPAL	REGIONAL	ISOLATED	LOCAL/ MUNICIPAL	REGIONAL
FLOOD				X		X				X	X		X	X
DAM FAILURE		X				X				X			X	
HURRICANE			X			X					X			X
TORNADO			X				X			X	X		X	X
THUNDERSTORM				X	X						X			X
NOR'EASTER				X			X				X			X
SNOWSTORM/ BLIZZARD				X		X					X			X
ICE STORM			X			X					X			X
ICE JAM		X			X				X	X			X	
DROUGHT		X			X						X			X
WILDFIRE			X			X				X			X	
EARTHQUAKE			X			X					X			X
LANDSLIDES	X				X				X	X		X	X	
CLIMATE CHANGE				X			X				X			X

KEY:

FREQUENCY:
- Very Low: Occurs less frequently than once in 100 years
- Low: Occurs from once in 50 years to once in 100 years
- Moderate: Occurs from once in 5 years to once in 50 years
- High: Occurs more frequently than once in 5 years

SEVERITY:
- Minor: Limited and scattered property and infrastructure damage; essential services not interrupted
- Serious: Scattered major public and private property and infrastructure damage, brief service interruptions, injuries, and deaths possible
- Extensive: Widespread major public and private property and infrastructure damage with long term public service interruptions, many injuries, and fatalities probable
- Catastrophic: Destruction of private and public property and infrastructure with numerous deaths and injuries

AREA OF IMPACT:
- Isolated: Impact will only be realized in a small area within a local jurisdiction or parts of one or more local jurisdictions
- Local/Municipal: Impact will only be realized within a local jurisdiction or parts of one or more local jurisdictions
- Regional: Impact will be realized within two or more local jurisdictions on a more widespread basis

AREA OF OCCURRENCE:
- Isolated: Impact will only be realized in a small area within a local jurisdiction or parts of one or more local jurisdictions
- Local/Municipal: Impact will only be realized within a local jurisdiction or parts of one or more local jurisdictions
- Regional: Impact will be realized within two or more local jurisdictions on a more widespread basis

Hazards can be interrelated and the impacts of one hazard can create the occurrence of another. For example, an earthquake might trigger fires or landslides, and the impacts of climate change are known to increase the frequency and severity of storm events. **Table 7.3.2** graphically outlines the potential secondary effects of each natural hazard.

Table 7.3.2 Secondary Impacts from Primary Natural Hazards

PRIMARY HAZARD	SECONDARY IMPACTS													
	Structural damage	Utility outage	Chemical release	Commodity shortage	Emergency communications failure	Erosion	Structural fire	Disease	Flooding	Landslide	Dam failure	Tornado	Hail	Wildfire
FLOOD	X	X	X			X		X		X	X			
DAM FAILURE	X	X	X			X		X	X					
HURRICANE	X	X	X	X	X	X		X	X			X		
TORNADO	X	X	X										X	
THUNDERSTORM		X					X					X	X	X
NOR'EASTER	X	X		X		X	X		X					
SNOWSTORM/ BLIZZARD	X	X		X			X							
ICE STORM	X	X	X	X	X		X							
ICE JAM	X								X		X			
DROUGHT				X										X
WILDFIRE	X		X				X							
EARTHQUAKE	X	X	X	X	X		X			X	X			
LANDSLIDES	X					X								

Source: Derived from the 2013 Massachusetts State Hazard Mitigation Plan, MEMA

SECTION 8. MITIGATION STRATEGY

This section of the Plan provides the overall strategy for North Andover to follow in becoming less vulnerable to natural hazards. It serves as the framework for the specific mitigation actions which follow in Section 9 of the plan. It is based on MVPC's discussions with, and the consensus of, the Core Team and Stakeholders, along with the findings and conclusions of the hazard identification and analysis, MVP Workshops, and the existing protection measures matrix. The purpose of the mitigation strategy is to provide North Andover with the goals that will serve as the guiding principles for future hazard mitigation policy development, planning, and project design and implementation for the Town.

44 CFR Requirement

44CFR Part 201.6c(3)(i): *The mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

8.1 Mitigation Goals

The plan's mitigation goals represent broad statements that are achieved through the implementation of more specific, action-oriented initiatives by North Andover, acting independently and in concert with surrounding communities. In updating the Hazard Mitigation Plan, the goals of the earlier 2016 plan were reviewed and affirmed. Also, a new goal was added to address the impacts of climate change.

The overarching goal of the current plan is as follows:

Goal #1 Reduce the loss of or damage to life, property, infrastructure, and natural, cultural, and economic resources from natural disasters.

Complementing Goal #1 are the following additional goals:

Goal #2 Improve the breadth and quality of the best available data for conducting hazard risk assessments and developing appropriate mitigation actions.

Goal #3 Increase North Andover's financial capability to implement hazard mitigation measures through maximizing available outside grant funding opportunities as well as locally available fiscal resources.

Goal #4 Integrate hazard mitigation planning into existing local policies, plans, regulations, and practices to reduce or eliminate the impacts of known natural hazards.

Goal #5 Ensure that future development will meet all federal, state and local standards to reduce and prevent the impacts of natural hazards on public and private property throughout North Andover.

Goal #6 **Increase the general public's awareness of natural hazard risks in North Andover and the region, while also educating residents and businesses on the mitigation measures available to minimize those risks.**

Goal #7 **Develop and implement adaptation strategies and integrate climate resiliency and mitigation into community plans and policies to protect the public, critical infrastructure, property, and natural resources from the impacts of climate change.**

8.2 Mitigation Measures

The second step in formulating North Andover's mitigation strategy involved identifying the range of mitigation activities that can help to achieve the mitigation goals cited above. The mitigation actions that follow in Section 9 are organized into the following six categories, as recommended in the FEMA *Local Multi-Hazard Mitigation Planning Handbook* (2013).

1. Prevention

Preventive activities are intended to keep hazard problems from getting worse and are typically administered through government programs or regulatory actions that influence the way land is developed and structures are built. They are particularly effective in reducing a region's or community's future vulnerability, especially in areas where development has not occurred, or capital improvements have not been substantial. Examples of preventive activities include:

- Planning and zoning
- Building codes
- Open space preservation
- Floodplain regulation
- Stormwater management
- Drainage system maintenance
- Capital improvements programming
- Shoreline / riverine / wetland setbacks

2. Property Protection

Property protection measures involve the modification of existing buildings and structures to help them better withstand the forces of a hazard, or the removal of the structures from hazardous locations. Examples include:

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection

- Retrofitting (e.g., windproofing, floodproofing, seismic design techniques)
- Shutters, safe rooms, shatter-resistant glass
- Insurance

3. Natural Resource Protection

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, steep slopes, and sand dunes. Parks, recreation, and conservation agencies and organizations often implement these protective measures. Examples include:

- Floodplain protection
- Wetland preservation and restoration
- Beach and dune preservation/restoration
- Forest and vegetation management (e.g., brush removal, fuel breaks, fire-resistant landscaping)
- Slope stabilization and erosion and sediment control
- Watershed protection measures and best management practices

4. Structural Projects

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the natural progression of the hazard event via construction. Examples include:

- Dams / levees / dikes / floodwalls / seawalls
- Diversions / detention and retention basins
- Channel modification
- Beach nourishment
- Storm sewers

5. Emergency Services Protection

Emergency services protection measures are aimed at protecting emergency services before, during, and immediately after a hazard occurrence. Examples include:

- Emergency warning systems
- Emergency response training and exercises
- Evacuation planning and management
- Protection of critical facilities and public facilities
- Health and safety maintenance

6. Public Education and Awareness

Public education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about natural

hazards, hazard areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Community outreach projects
- School education programs
- Speaker series/demonstration events
- Hazard area maps
- Real estate disclosure of hazards
- Library exhibits and materials
- Regional and community websites, with links to MEMA and FEMA websites.

8.3 Mitigation Measures for Regional and Inter-Community Issues

North Andover included neighboring communities as well as state and regional agencies in its stakeholder workshops to help identify hazard mitigation issues that can best be addressed through regional or inter-community efforts. Transportation, flooding, sewage treatment, and land protection/management are three areas where North Andover relies on regional entities or partners to assist in the mitigation of natural hazards and resiliency to climate change. Understanding the capabilities of regional partners and their priorities is important to improving the outcomes of various hazard mitigation efforts proposed in Section 9. Regional partners include those who own land or infrastructure within North Andover, neighboring communities who provide support in emergencies and/or maintain interconnected infrastructure, and partners who assist in mitigation efforts such as watershed associations. These partners include:

- Greater Lawrence Sanitary District – Operates Riverside Pump Station and Sewage Treatment Plant within the Town of North Andover
- Merrimack Valley Regional Transit Authority (MVRTA) – Operates Regional Bus Service and other transportation services
- Massachusetts Department of Conservation and Recreation – Owns and manages Harold Parker State Forest and other properties within North Andover
- Essex County Greenbelt – Owns and manages several open space reservations and holds Conservation Restrictions on Town-owned and private properties including Windrush Farm and Edgewood
- The Trustees of Reservations – Owns and manages the Stevens-Coolidge Reservation and other properties and holds Conservation Restrictions on several Town-owned properties including Half-Mile Hill and Carter Hill.
- Town of Boxford – Provides mutual aid in the non-hydrant district (25% of Town)
- Other communities with connected infrastructure and/or mutual aid agreements – Andover, Lawrence, Haverhill, Middleton, Methuen
- Merrimack College – Campus located in Andover and North Andover
- Ipswich River Watershed Association – North Andover participates in the Parker Ipswich Essex initiative (PIE Rivers)
- Merrimack River Watershed Council (MRWC) – North Andover participates in Merrimack River related meetings

- Massachusetts Bay Transit Authority – Maintains rail infrastructure in North Andover with local stations in Lawrence, Andover, and Haverhill

8.4 Mitigation Measures and New Development and Infrastructure

As discussed in Chapter 3, by 2030, MVPC forecasts a North Andover population of 32,200 people (13.5% increase from 2010) and 14,400 jobs (9.5% increase from 2010). Hazard Mitigation Planning must consider this growth and any additional hazards that may occur. New development can increase existing vulnerabilities to infrastructure including water, sewer, and stormwater. New development and redevelopment must adhere to the Massachusetts State Building Code but must also consider local zoning, wetlands, and stormwater bylaws and regulations. To reduce flooding, increase groundwater recharge, and promote cooling, North Andover must prioritize Low Impact Development and green infrastructure as the community expands.

To determine appropriate mitigation measures for the North Andover, MVPC and the Core Team reviewed the MVP workshop findings, as well as the mitigation protections currently in place. Gaps in the existing protections were particularly instructive in identifying areas for potential mitigation enhancement. Section 9 of the Hazard Mitigation Plan details the specific mitigation actions, both local and regional, for the Town of North Andover.

SECTION 9. MITIGATION ACTION PLAN

This section of the Hazard Mitigation Plan presents North Andover-specific as well as regional mitigation actions that, if effectively implemented, will serve to minimize risks and reduce losses from natural hazards in the Merrimack Valley region. This section contains the **Local Mitigation Action Plan** to be carried out by the Town of North Andover. **Regional Mitigation Actions,** to be carried out collaboratively with neighboring municipalities, and partnering agencies and organizations on an inter-municipal level, have also been incorporated.

44 CFR Requirement

44 CFR Part 201.6c (3)(iii): ***The mitigation strategy shall include an action plan describing how the actions … will be prioritized, implemented, and administered by the local jurisdiction.***

Coordination. The proposed actions will be coordinated with other regional and community priorities, as well as with mitigation goals of state and federal agencies. Such coordination will improve access to technical assistance; provide broader support for implementation; and reduce duplication of effort. These actions have been further categorized into immediate, short-term projects and ongoing or longer-term measures.

Consistency with Goals & Objectives. In developing the mitigation action plans, MVPC and the North Andover Core Team were directed by the major goals articulated in the preceding section of the Plan (Section 8), as well as the following mitigation *objectives*:

- Increase coordination between the Federal, State, regional, and local levels of government;
- Discourage future development in hazard-prone areas, such as floodplains;
- Protect and preserve irreplaceable cultural and historic resources located in hazard-prone areas;
- Ensure that critical infrastructure is protected from natural hazards;
- Develop programs and measures that protect residences and other structures from natural hazards;
- Protect electric power delivery infrastructure from natural hazards;
- Protect drinking water supplies from contamination or disruption from a natural hazard;
- Increase awareness and support for natural hazard mitigation among municipalities, private organizations, businesses, and area residents through outreach and education;
- Implement a broad range of mitigation measures that protect the region's vulnerable populations and infrastructure;
- Protect critical public facilities and services from damage due to natural hazards;
- Develop a mitigation strategy that considers the needs of area businesses and protects the economic vitality of the region;

- Update and maintain the Plan as resources permit;
- Provide information concerning hazard mitigation funding opportunities, and assist the Town in the identification and development of specific mitigation projects; and
- Increase North Andover's capacity for responding to a natural hazard event by promoting the adequate provision of emergency services.

Prioritization of Mitigation Actions. As part of the planning deliberations, MVPC and consulted with Core Team members to prioritize the proposed mitigation actions and projects. The priorities were developed through a consensus-building process that consisted of meetings and conversations with board and commission members, municipal staff, and town leadership. The following factors were considered in establishing the timeframe/priority for each action:

- The cost of the measure vs. the mitigation benefits;
- The availability of funding;
- The lead time required for design and implementation;
- Political feasibility and acceptability;
- The need for institutional and interagency agreements;
- Consistency with local and regional plans and priorities; and
- Whether the measure has been through a public process, needs Town Meeting approval, or action by a permitting authority.

The cost of each mitigation action was not available for most listed action items. Projects categorized as "immediate" or "short term" are those which can go forward with little or no cost, or for which a funding source has been identified, and these projects are of high priority. Projects identified as "long-term" are either more costly or funding is not readily available, or the project may not be ready for implementation due to permitting issues or the need for design, or the project requires a long lead time, or new governmental processes will need to be established.

Those projects described as "annual" represent recurring actions that local, state, and regional bodies need to attend to regularly and factor into everyday decision-making. Examples include code enforcement (state building code, local zoning code, local wetlands regulation, etc.) and activities such as Planning Board promotion/approval of open space residential design projects that preserve 50% of a subdivision area as permanent green space. These projects are of the highest priority in that they mitigate natural hazards at a minimal cost and can be readily implemented.

It is envisioned that "immediate" projects will be implemented within 1 year, "short-term" projects within 2-3 years, and "long-term" projects in 4 or more years. The timeframe assigned to each project is indicative of local and regional project priorities.

This Mitigation Action Plan is an update of the 2016 Action Plan. It is organized in a series of matrices. The matrices note whether each particular action was included in the 2016 Plan or if it is a new action resulting from this planning process. The implementation status of prior projects is noted in Chapter 6. Several of the actions

contained in the 2016 Plan remain in the updated plan and continue to be a priority for North Andover. The actions put forth in this current Hazard Mitigation Plan will be implemented as resources are made available.

Benefits. Mitigation benefits for each action are evaluated using the following criteria:

- High – action will result in a significant risk reduction for people and/or property from a hazard event
- Medium – action will result in a moderate risk reduction for people and/or property from a hazard event
- Low – action will result in low risk reduction for people and/or property from a hazard event

Cost. Costs are estimated using the following criteria:

- High – costs greater than $100,000
- Medium – Costs between $10 to $100,000
- Low – Costs under $10,000 and/or staff time

Funding Sources. Funding sources listed are potential options that are not guaranteed. Projects may not necessarily qualify for all sources listed and/or may not be awarded funding. Once an action is advanced, the party responsible for implementation should further explore funding opportunities, including those identified.

The **North Andover Mitigation Action Plan** is presented in **Tables 9.1.1**

Table 9.1.1 NORTH ANDOVER Mitigation Action Plan								
Category of Action	**Description of Action**	**Hazard Addressed**	**Implementation Responsibility**	**Timeframe/ Priority**	**Cost**	**Benefit**	**Resources/ Funding**	**In Prior Plan? New?**
Natural Resource Protection/Structural Project	Repair of shoreline erosion along 600 feet of Lake Cochichewick. Design in place.	Multi-Hazard	Town Engineering and Public Works Departments	Short-term/High	High	High	FEMA, MEMA, MVP, Town	New
Emergency Services	Work with wireless/cell service providers to help increase coverage for Wi-Fi and cell service in areas lacking coverage. Study interim solutions in emergencies such as mobile hotspots. For critical areas consider installing town-owned antennas.	Multi-Hazard	Planning and Economic Development	Long-term/High-Medium	High	Medium	FEMA, MEMA, Town	New
Structural Project	Study/fund water main extensions in non-hydrant areas of town	Brush Fire	Town Engineering and Public Works	Long-term/High	High	Medium	Town	New
Preventative	Develop culvert investigation program using GIS. Develop program for prioritizing improvements and replacement including funding to design and construct remedies. Develop long-term operation and maintenance program. Include beaver management plan	Flooding	Public Works and Engineering	Long-term/High	High	Medium	FEMA, MEMA, DER, MVP	New
Prevention	Maintain electricity outage data and use it to prioritize tree trimming/maintenance to prevent line damage. Place utilities underground where possible	Wind	Public Works, Town	Long-term/High-Medium	Medium	Medium	Town, National Grid	New
Prevention	Increase Town's ability to address downed trees after a storm. Review existing equipment for tree department and prioritize additional purchases to expedite down tree removal from roadways	Wind	Public Works, Town	Long-term/	High	Medium	Town	New
Prevention	Consistent with EPA MS4 Program requirements, develop and implement drainage system maintenance plan to ensure regular inspection, cleaning, and maintenance of municipal stormwater facilities and waterways	Flooding	North Andover Public Works Dept., Conservation Commission	Immediate/Medium	Low/Medium	Medium	Town	Prior (Now MS4 Permit was previously Phase II Permit)
Emergency Services	Increase sign-up and information updates of Smart 911 especially with seniors and other vulnerable populations. Work with other community organizations, including faith-based, to increase sign-up. Provide outreach in additional languages	All Hazards	Elder Services, Emergency Management, Police and Fire Departments, Community Support Coordinator	Short-term/Medium	Low	Medium	Town	New
Emergency Services	Plan for wider availability of fresh food in an emergency including partnerships with grocery stores, non-profit/civic organizations, and schools	All Hazards	Town Administration, Elder Services, School Department	Short-term/High	Low	Medium	Town	New

Table 9.1.1 NORTH ANDOVER Mitigation Action Plan								
Emergency Services	Provide important announcements in multiple languages	All Hazards	Town Administration	Short Term/Medium	Low	Medium	Town	New
Emergency Services	Continue emergency/disaster training for town staff including shelter training, NIMS, and ALICE. Continue HAZMAT training for Fire Department	All Hazards	Public Safety Departments	Immediate/High	Low	High	Town	New
Structural/Emergency Services	Back-up power is being supplied to community rooms within senior housing. Continue contingency planning for emergencies not addressed by this upgrade	Wind/Flooding	Emergency Management, Facilities	Immediate/Medium	High	Medium	FEMA/MEMA, Town	New
Natural Resource Protection	Strategy to implement and fund recommendations Lake Cochichewick Watershed Plan (plan update in progress)	All Hazards	Planning, Conservation, and Water Departments	Short-Term/High	Medium	High	EPA, MVP, MassDEP, Town	New
Property Protection/Natural Resources Protection	Prioritize land acquisitions and obtaining conservation restrictions in the Lake Cochichewick Watershed	Drought/Climate Change	CPC, Planning and Conservation Departments	Long-Term/High	High	Medium	CPA, DCR, MVP	New
Public Education and Awareness/Natural Resources Protection	Action to protect North Andover's sole source drinking water supply (Lake Cochichewick) including: • Continue work on regulations for Lake Cochichewick with focus on docks and dog walking/pet waste to maximize water supply protection. • Continue education and outreach to private property owners about impacts of lawn care, runoff, and tree removal	Drought/Climate Change	Planning, Conservation, and Water Departments	Immediate/Medium	Low	Medium	Town	New
Prevention/Natural Resource Protection/Public Education and Awareness	Beaver Management to prevent flooding of roads and other infrastructure – including: • Identify vulnerable areas that cannot accommodate beaver damming activity and develop a management plan. • Continue advocacy for additional solutions for beaver management and monitor trouble spots. • Educate residents on the role beavers play in the environment and offer humane methods for managing their activity	Flooding	Conservation, Health, and Public Works Departments	Short-term/High	Low	Medium	Town, Division of Fish and Wildlife	New
Property Protection/Natural Resources Protection	Protect undeveloped farmland by working collaboratively with partners (Essex County Greenbelt, Trustees of Reservations) on acquisitions and conservation restrictions. Consider incentives for farm owners to preserve their land	Drought, Flooding, Climate Change	Community Preservation Committee, Planning and Conservation Departments	Long-term/Medium	High	Medium	CPA, DCS, Town, Land Trusts	New
Prevention	Strictly enforce and, as appropriate, upgrade Town zoning bylaw, subdivision rules & regulations, and wetlands regulation to minimize incidence and impacts of flooding and other natural hazards	All Hazards	Town departments	Annual/High	Low	Medium	Town	Prior

Table 9.1.1 NORTH ANDOVER Mitigation Action Plan								
Prevention	Incorporate hazard mitigation in local policies, plans, and programs (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan)	All Hazards	Town departments	Annual/Medium	Medium	High	Town	Prior
Prevention	Update local bylaws/regulations (Wetlands, Watershed, Stormwater) to require LID techniques. Consider updates to the Wetlands Bylaw/Regulations to address climate change specifically	Flooding/Drought	Conservation and Planning Departments	Short-term/High	Medium	High	Town, with advice and assistance from CZM Smart Growth staff; MA DEP; Stormwater Collaborative; EPA	Prior and New
Prevention	Maintain CEMP, Flood Hazard Mitigation Plan, and North Andover components of this Plan to ensure their completeness and relevance in disaster mitigation and response	All Hazards	Town departments	Annual/Medium	Low	Medium	Town, with advice and assistance from MVPC, DCR, MEMA	Prior
Prevention	Minimize impervious surfaces and decrease stormwater runoff through use of LID. Increase vegetated buffers between development and wetland resource areas.	Flooding	North Andover Conservation Commission Planning Board	Long-term/ Medium	Medium	Medium	Town	Prior & New
Prevention	Issue General Permit (Order of Conditions) to DPW to assist with routine maintenance.	Flooding	North Andover Conservation Commission	Annual/ Medium	Low	Medium	Town	Prior
Structural Project and Prevention	Inspect and maintain existing flood protection and implement corrective measures to prevent recurrence of issues	Flooding	North Andover Public Works and Engineering Depts.	Annual/low	Low	Low	Town	Prior
Structural Project and Prevention	Continue to identify sewer backup locations and causes, and design and implement appropriate corrective measures	Flooding	North Andover Public Works and Engineering Depts.	Short-term/High	High	Medium	Town (CIP funding)	Prior
Prevention	Maintain current list of Repetitive Loss properties; encourage property owners to explore and implement appropriate mitigation measures	Flooding	North Andover Public Works and Engineering, Conservation and Building Depts.	Annual/Medium	High	Medium	Town, with advice and information from DCR and MEMA	Prior
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Brushfire	North Andover Fire Dept.	Long-term/Low	Low	Low	Town, with advice and assistance from DCR	Prior
Prevention	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in all new development and redevelopment	Power Outages/Storms	Town Departments and Private Developers	Long-term/Medium	High	Medium	Town (for municipal facilities) and Private Developers	Prior
Prevention	To mitigate against damage from earthquakes and landslides, actively enforce applicable state and municipal building codes	Earthquakes/ Landslides	North Andover Building Inspection Dept.	Annual/Low	Low	High	Town	Prior

SECTION 10. PLAN ADOPTION AND MAINTENANCE

This section discusses how the North Andover Multi-Hazard Mitigation and Municipal Vulnerability Preparedness Plan will be adopted by the Town, and how the Plan will be evaluated and maintained over time. It also discusses how the public will continue to be involved in the hazard mitigation and vulnerability planning process.

10.1 Plan Adoption

Under 44 CFR Part 201, hazard mitigation plans must be sent to the State Hazard Mitigation Officer (SHMO) for initial review and coordination. The State then forwards the plan to FEMA for formal review and approval. The final draft is submitted to the State and FEMA before seeking formal adoption of the plan by the Town. FEMA reviewers document their evaluation of the Plan using the Local Mitigation Plan Review Tool. A copy of the Tool is included in Appendix E.

Mitigation plans are approved by FEMA when they receive a "satisfactory" for all requirements outlined under 44 CFR Section 201.6. Once a final plan is submitted, the FEMA Regional Office generally completes the review within 45 days. If the plan is not approved, the FEMA Regional Office will provide comments on the areas that need improvement. FEMA will the complete review of the re-submittal within 45 days of receipt.

Once FEMA determines that the Plan is "approvable pending adoption", the local adoption process is initiated. The plan is adopted by an affirmative vote of North Andover's Select Board. A resolution signed by the Select Board chair serves as documentation of the plan's local adoption. Upon submittal of the signed resolution to FEMA, FEMA issues a letter notifying the community of FEMA's approval of the plan.

10.2 Plan Maintenance

44 CFR Requirement

44 CFR Part 201.6c(4)(i): *The plan shall include a plan maintenance procedure that includes a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.*

The measure of success of the North Andover HMP/MVP will be the number of identified mitigation actions implemented, either wholly or in part. For North Andover to become more disaster and climate-resilient and better equipped to respond to natural hazards, there must be a coordinated effort between elected officials, appointed bodies, municipal staff, regional and state agencies, other stakeholder groups, and the general public. Thus, monitoring, evaluating, and updating the hazard mitigation plan are critically important steps to maintaining a viable, effective plan.

Accordingly, the Core Team will meet annually to review the plan. At this meeting, the Core Team will review the hazard mitigation measures that have been implemented as

of that date and determine if these measures have had an impact on mitigating the overall hazard risk(s). In the case of *structural* projects, in particular, this review will include site visits to locations where the measures have been implemented. Mitigation measures that have not been implemented will be reviewed to determine if they will still minimize natural hazards or if they are no longer a viable option. Additionally, the Core Team will determine any new options to include in an update of the plan.

Evaluation of the hazard mitigation plan in its entirety will be undertaken on a 5-year basis according to the Disaster Mitigation Act of 2000 or following any significant natural hazard disaster. Any new problems that arise will be reviewed by the Core Team and incorporated into the updated HMP/MVP. The updated plan will incorporate new or modified mitigation actions as determined from the review. This allows for updates to be made as the community grows and changes. The Town Manager or Community and Economic Development Director will oversee the Core Team's involvement in the review and updating process.

The public will be given opportunities to participate in the plan evaluation and updating process and to provide comments for consideration by the Core Team. Residents, businesses, and other potential stakeholders will be notified when plan updating deliberations are scheduled, and when significant hazard mitigation issues are brought before the Select Board. Notification will be done through posting of meeting agendas in Town Hall and on the Town of North Andover website.

North Andover will be responsible for updating the Hazard Mitigation portion of the plan every five years following FEMA approval. Ideally, the plan update will begin in the fourth year following approval of the plan to remain eligible for FEMA mitigation grants, specifically the new Building Resilient Infrastructure Communities or BRIC grants. North Andover may wish to pursue an update of its individual plan or rejoin the Merrimack Valley Regional Multi-Hazard Mitigation Plan which is anticipated to be updated in the coming year. Funding sources for the update may include the FEMA Hazard Mitigation Grant Program as well as the BRIC grants. Both grants provide 75% of the funding with a 25% local cost share.

SECTION 11. PLAN IMPLEMENTATION

11.1 Pivotal Role of Local Government

The Town of North Andover will play a pivotal role in hazard mitigation, especially in the area of floodplain management. The municipal Building Departments, Conservation Commissions, and Boards of Health have legal responsibilities to implement local floodplain bylaws, the National Flood Insurance Program (NFIP), construction standards incorporated into the Massachusetts State Building Code, floodplain guidelines incorporated into the Wetlands Protection Act, and Title 5 of the State Environmental Code (on-site wastewater disposal**). Table 11.1.1** on the following page provides a summary of local boards and departments and their corresponding roles in implementing the action items contained in the Hazard Mitigation Action Plans.

To the extent possible, these community-specific mitigation actions have been directed toward a particular department or board to assign responsibility and accountability and to increase the likelihood of implementation.

11.2 Broad Integration of Plan

The incorporation of the recommendations of this Plan into other local and regional planning documents and procedures is not only strongly encouraged but indeed is a requirement of the federal and state hazard mitigation planning process. Such planning documents typically include but are not limited to comprehensive or master plans, capital improvement plans, stormwater management plans, open space and recreation plans, building codes, zoning bylaws, subdivision regulations, and local wetland bylaws. Elected officials should be directly involved in the implementation of the Plan, as they can provide direction by establishing timeframes, assigning implementation responsibilities, and providing budget and financial oversight for implementation funding.

44 CFR Requirement

44 CFR Part 201.6c(4)(**ii**): *The plan maintenance process shall include a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.*

Table 11.1.1 Role of Local Boards and Departments in Plan Implementation

Department, Board, or Committee	Function	Effect on Loss Reduction
Building Department/Inspector	The building inspector enforces the Massachusetts State Building Code that incorporates NFIP construction standards. The building inspector also enforces locally adopted zoning bylaws. The state building code also contains sections on wind, snow, structural loads, and seismic retrofitting. The Inspector of Buildings is also responsible for assuring compliance with the local floodplain bylaw.	Insures that NFIP standards and other mitigation standards are uniformly applied across the community.
Public Works Department and/or Town Engineer	The Public Works Department and/or engineer are primarily responsible for municipal drainage and stormwater management issues, taking the lead in ensuring compliance with EPA MS4 Stormwater Permit requirements.	Ongoing maintenance and upgrading of local stormwater systems is crucial to reducing and managing flood risks.
Conservation Commission	The Conservation Commission is responsible for implementing the Wetlands Protection Act (MGL Chapter 131, Section 40, 310 CMR 10.00) including the Rivers Protection Act of 1996 (MGL Chapter 258, 310 CMR 10.58) and the Stormwater Standards. North Andover also reviews projects under the North Andover Wetlands Protection Bylaw and associated regulations. The Conservation Commission reviews, approves, or denies applications for projects in the 100-year floodplain, in the floodplain of a small water body not covered by a FEMA study, within 100 feet of any wetland or 200 feet of any river or stream. North Andover, the Conservation Administrator assists the Inspector of Buildings in maintaining local floodplain bylaw.	These regulations contain performance standards that address flood control and storm damage prevention. The regulations also address stormwater management.
Planning Board and Planning Department/Community and Economic Development Division	The Planning Board has authority under MGL Chapter 41 and implements local subdivision regulations. The Planning Board ensures that new development incorporates state and federal stormwater management “best management practices”.	In North Andover, the Director of Community and Economic Development coordinates the hazard mitigation planning process and the implementation of the HMP/MVP.
Board of Health	The Board of Health implements the State Environmental Code, Title 5, and 310 CMR 15: Minimum Requirements for the Subsurface Disposal of Sanitary Sewage. North Andover has adopted local board of health requirements that are stricter than the state requirements.	Title 5 protects public health and mitigates losses due to adverse effects of improper sewage treatment in high hazard areas. The Board is also involved in issues related to water quality and infectious diseases following a disaster.
Select Board	In North Andover, an elected five-member Select Board is responsible for overseeing all aspects of Town Government.	The Select Board must adopt the Hazard Mitigation Plan. Also, their approval is necessary for hazard mitigation grant applications and potential projects.
Emergency Management Department	North Andover has an emergency management director who is responsible for local emergency response and recovery, as well as mutual aid.	Emergency managers play a primary role in the development of the Comprehensive Emergency Management Plan (CEMP), as well as other plans required by MEMA and FEMA.

SECTION 12. FUNDING SOURCES

Appropriate action is needed to ensure that financial resources are available to implement hazard mitigation projects. Such projects need to be included in capital improvement programs at the state and local levels. Federal funding programs are available to eligible municipalities. The availability of current federal funding sources changes regularly and is dependent upon Congress' ongoing budget appropriations process. Currently, www.grants.gov is the comprehensive website to track available funding from federal agencies. Also, federal appropriations from Congress may be tracked through the Federal Registers at www.federalregister.gov.

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The following is a summary of FEMA and other programs which fund hazard mitigation and resiliency projects and activities, including the primary sources of federal hazard mitigation funding in Massachusetts:

Table 12.1 FEMA and Other Funding Programs

FEMA Program	Type of Assistance	Availability	Managing Agency	Funding Source
National Flood Insurance Program (NFIP)	Pre-Disaster Insurance	Any time (pre and post-disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA
Severe Repetitive Loss (SRL) (Part of the NFIP)	Grants to state emergency management offices to reduce damage to insured severe RLPs	Varies	MEMA	Up to 90% FEMA/ 10% state government
Repetitive Flood Claims Program (RFC) (Part of the NFIP)	Grants to states and municipalities to reduce damage to insured RLPs	Any time	FEMA	100% FEMA
Community Rating System (CRS) (Part of the NFIP)	Disaster Insurance Discounts	Any time (pre and post-disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA
Flood Mitigation Assistance (FMA) Program	Cost-share grants for pre-disaster planning and projects	Annual pre-disaster grant program	DCR & MEMA	75% FEMA/25% local government or organization
Hazard Mitigation Grant Program (HMGP)	Post-disaster Cost-Share Grants	Post disaster program	DCR & MEMA	75% FEMA/25% local government or organization
Building Resilient Infrastructure and Communities (formerly the Pre-Disaster Mitigation Program)	National, competitive grant program for multiple hazard mitigation projects and "all hazards"	Annual pre-disaster mitigation program	DCR & MEMA	75% FEMA/25% local government or organization
Small Business Administration (SBA) Mitigation Loans	Pre- and Post-disaster loans to qualified businesses	Ongoing	MEMA	Small Business Administration
Infrastructure Support Program (formerly Public Assistance)	Post-disaster aid to state and local governments	Post Disaster	MEMA	FEMA

Municipal Vulnerability Preparedness Action Grans	Funding for designated MVP Communities to advance priority climate adaptation actions to address climate change impacts	Annually	EOEEA	State of Massachusetts

The Federal Emergency Management Agency (FEMA), which is part of the Department of Homeland Security, administers the National Flood Insurance Program, the Community Rating System, the Flood Mitigation Assistance Program (FMA), the Hazard Mitigation Grant Program (HMGP), and the Building Resilient Infrastructure and Communities (BRIC). These programs are administered in coordination with DCR and MEMA. FEMA also prepares and revises flood insurance studies and maps as well as information on past and current acquisition, relocation, and retrofitting programs. The Mitigation Division provides expertise in other natural and technological hazards, including hurricanes, earthquakes, and hazardous materials, to state and local government agencies.

Immediately following Presidential declarations, FEMA's Response and Recovery Division works closely with state agencies, especially MEMA, in assisting in the short-term and long-term recovery effort. FEMA assists disaster-affected communities through emergency funding programs, such as Infrastructure Support and Human Services. In coordination with its Mitigation Division, Response and Recovery distributes information on hazard mitigation methods and acquisition/relocation initiatives as well as coordinating HMGP grants for mitigation projects to protect qualifying damaged public and private nonprofit facilities through the Infrastructure Support Program. In addition to these programs, FEMA also provides disaster recovery and hazard mitigation training at its Emergency Management Institute in Emmitsburg, Maryland.

For the latest information on this and other mitigation funding programs, go to FEMA's website at **www.fema.gov.**

National Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP), established by Congress in 1968, provides flood insurance to property owners in participating communities. This program is a direct agreement between the federal government and the local community that flood insurance will be made available to residents in exchange for community compliance with minimum floodplain management requirements. Since homeowners' insurance does not cover flooding, a community's participation in the NFIP is vital to protecting property in the floodplain, as well as ensuring that federally backed mortgages and loans can be used to finance property within the floodplain.

Pursuant to the Flood Disaster Protection Act of 1973, any federal financial assistance related to new construction or substantial improvements (greater than 50% of a structure's market value) of existing structures located in the 100-year floodplain is contingent on the purchase of flood insurance. Such federal assistance includes not only direct aid from agencies but also from federally insured institutions. Thus, for property

owners to be eligible for purchasing flood insurance, their respective community must be participating in the NFIP and in compliance with the NFIP.

Communities participating in the NFIP must:

- Adopt the Flood Insurance Rate Maps as an overlay regulatory district;
- Require that all new construction or substantial improvement to existing structures in the flood hazard area will be elevated; and
- Require design techniques to minimize flood damage for structures being built in high hazard areas, such as floodways or velocity zones.

The NFIP standards are contained in the Massachusetts State Building Code (Chapter 16 of the 9th Edition), which is implemented at the local level by municipal building inspectors. In Massachusetts, 341 out of 351 (97%) of Massachusetts municipalities participate in the NFIP.

Severe Repetitive Loss Program

The Severe Repetitive Loss Program was authorized by the Bunning-Beruter-Blumaneauer Flood Insurance Reform Act of 2004 with amended the National Flood Insurance Act of 1968 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss structures.

MEMA must apply for these funds but may work with other state agencies or local governments. Priority is given to programs that will have the greatest cost-benefit ratio in keeping with the purpose of the program. Grants may be used for acquisition, demolition, and relocation but cannot be used for maintenance or repair.

Funds are allocated to the state based on the percentage of validated SRL properties and may be up to 90 percent federal and 10 percent local.

Repetitive Flood Claims Program (RFC)

The Repetitive Flood Claims Program was authorized by the Bunning-Beruter-Blumaneauer Flood Insurance Reform Act of 2004 which amended the National Flood Insurance Act of 1968 to provide funding to reduce the risk of flood damage to repetitive loss structures.

The program is 100 percent federally funded and the applicant must demonstrate that the proposed activities cannot be funded under the Flood Assistance Program. (See below.)

Community Rating System (CRS)

A voluntary initiative of the NFIP, the Community Rating System (CRS) encourages communities to undertake activities that exceed the minimum NFIP floodplain

management standards. Communities participating in CRS can reduce flood insurance premiums paid by policyholders in that community by performing such activities as maintaining records of floodplain development, publicizing the flood hazard, improving flood data, and maintaining open space. Communities can gain additional credit under CRS by developing a flood mitigation plan.

Flood Hazard Mitigation Program

Authorized by the National Flood Insurance Reform Act of 1994, the Flood Mitigation Assistance (FMA) program makes cost-share grants available for flood mitigation planning and projects, such as property acquisition, relocation of residents living in floodplains, and retrofitting of existing structures within a floodplain. Flood hazard mitigation plans, approved by the state and FEMA, are a pre-requisite for receiving FMA project grants. Communities contribute a minimum of 25% of the cost for the planning and project grants with an FMA match of up to 75%.

Hazard Mitigation Grant Program (HMGP)

Established under Section 404 of the Stafford Disaster Relief and Emergency Relief Act (PL 100-707), this program provides matching grants (75% Federal, 25% Local) for FEMA-approved hazard mitigation projects following a federally declared disaster. These grants are provided on a competitive basis to state, local and tribal governments as well as non-profit organizations. The grants are specifically directed toward reducing future hazard losses and can be used for projects protecting property and other resources against the damaging effects of floods, hurricanes, earthquakes, high winds, and other natural hazards. HMGP in Massachusetts encourages non-structural hazard mitigation measures, such as:

- The acquisition of damaged structures and deeding the land to a community for open space or recreational use
- Relocating damaged or flood-prone structures out of a high hazard area
- Retrofitting properties to resist the damaging effects of natural disasters. Retrofitting can include wet- or dry-flood proofing, elevation of the structure above flood level, elevation of utilities, or proper anchoring of the structure.

Funding proposals are submitted for review by Massachusetts' Interagency Hazard Mitigation Committee with final approval given by the Commissioner of the DCR, the Director of MEMA, and FEMA's Region I office. The committee uses a list of criteria which is described on page 34 of this plan as well as in the Hazard Mitigation Grant Program Administrative Plan.

Pre-Disaster Mitigation (PDM) Program now BRIC

The Pre-Disaster Mitigation (PDM) Program was authorized by §203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 USC, as

amended by §102 of the Disaster Mitigation Act of 2000. As a result of amendments by the Disaster Relief and Recovery Act of 2018, the Pre-Disaster Mitigation program is being replaced with the new Building Resilient Infrastructure and Communities (BRIC) program. The BRIC program aims to shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience. All applicants must be participating in the National Flood Insurance Program (NFIP) if they have been identified through the NFIP as having a Special Flood Hazard Area (a Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM) has been issued). Also, the community must not be suspended or on probation from the NFIP. Applicants must also have an up-to-date HMP.

Small Business Administration Mitigation Loans

The SBA's Regional Mitigation Loan Program was developed in support of FEMA's Regional Mitigation program. Businesses proposing mitigation measures to protect against flooding must be located in a Special Flood Hazard Area (SFHA). Businesses may consult FIRM maps to find out if the business is located in a SFHA. For information pertaining to hazard identification mapping and floodplain management, contact the local community floodplain administrator or the State floodplain manager. To apply for a regional mitigation loan, a business must submit a complete Regional Mitigation Small Business Loan Application within the 30-day application period announced by the SBA. SBA will publish a Notice of Availability of Regional Mitigation Loans in the Federal Register announcing the availability of Regional mitigation loans each fiscal year. The Federal Register notice will designate a 30-day application period with a specific opening date and filing deadline, as well as the locations for obtaining and filing loan applications. Furthermore, SBA will coordinate with FEMA and will issue press releases to the local media to inform potential loan applicants where to obtain loan applications.

Public Assistance Program

The Federal Emergency Management Agency's Public Assistance Program is triggered for counties declared major disaster areas by the President. Communities and public agencies in designated counties are eligible for partial reimbursement (75%) of expenses for emergency services and removal of debris, and partial funding (75%) for repair and replacement of public facilities that were damaged by the declared disaster. Massachusetts funds an additional 12.5% of these projects. Eligible applicants for Infrastructure Assistance include:

- State government agencies/departments;
- Local governments (county, city, town, village, district, etc.); and
- Certain private non-profit organizations.

Typical federal/state aid can include:

- Reimbursable payment of 87.5% of the approved costs for emergency protective measures deployed in anticipation of the storm;

- Reimbursable payment of 87.5% of the approved costs for emergency services and debris removal;
- Payment of 75% of the costs for the permanent repair or replacement of damaged public property; and
- Funding for repair/construction of damaged highways other than those on the Federal Aid System.

Special Appropriations Following State Disasters

Although there is no separate state disaster relief fund in Massachusetts, the state legislature will enact special appropriations for those communities sustaining damages following a natural disaster that are not large enough for a presidential, disaster declaration.

State Revolving Fund

This statewide loan program through the Executive Office of Energy and Environmental Affairs assists communities in funding local stormwater management projects which help to minimize and/or eliminate flooding in poor drainage areas.

Massachusetts Land and Water Conservation Fund

The Land and Water Conservation Fund provides 50 percent of the total project costs to purchase land for conservation or recreation purposes. Massachusetts has spent $95.6 million since 1965 to purchase almost 4,000 acres of land under this program. The program is administered by DCR.

Major Flood Control Projects

The state provides 50% of the non-federal share on the costs of major flood control projects developed in conjunction with the U.S. Army Corps of Engineers. This program is managed by DCR.

Municipal Vulnerability Preparedness (MVP) Action Grants

Once designated an MVP Community, the Executive Office of Energy and Environmental Affairs (EEA), through the MVP Program, offers funding resources to advance climate adaptation actions identified in the community's MVP Summary of Findings. In FY21, the MVP Program offered over $10 million in Action Grant Funding.

Citations & Acknowledgements

For future referencing of this project and report, the following citation should be used: *Municipal Vulnerability Preparedness Program Summary of Findings and Multi-Hazard Mitigation Plan,* Town of North Andover, 2021. Prepared by Merrimack Valley Planning Commission.

This Town of North Andover planning project was funded through a Municipal Vulnerability Planning Grant awarded by the Massachusetts Executive Office of Energy and Environmental Affairs.

The Town and MVPC are appreciative of the state agency resource assistance for funding as well as technical aid provided. Special thanks to all stakeholders who participated in the planning workshops.

Appendix A
Map Series

Town of North Andover

Municipal Vulnerability Preparedness Program

(Critical Infrastructure)

Haverhill
Groveland
Georgetown
Methuen
Lawrence
Boxford
Andover
Middleton
North Reading
Merrimack River
Lake Cochichewick
Stevens Pond
Hoveys Pond
Pond Sperrys
Stiles Pond
Towne Pond
Masse Pond
Stearns Pond
Chadwick Pond

Legend

- Chronic Flooding Issues*
- Bridges
- Airport
- City Offices
- Clinic
- College
- Dam Control
- Day Care
- Emergency Shelter
- Fire Station
- Library
- Nursing Home/ Assisted Living
- Parking
- Police Station
- Post Office
- Power Substation
- Public Health Office
- Public Works Garage
- Recreation
- School
- Sewage Pumping Station
- Shopping Center
- Solid Waste Disposal
- Telephone/ Cell
- Waste Water Treatment Plant
- Water Supply/Pumping
- Municipal Boundary
- Property Parcels
- Pond, Lake, Reservoir

Restrictions

- APR
- CR

Chapter Land

- 61A
- 61B

Open Space

- State
- Municipal
- Private
- Nonprofit

- 100-Year Floodplain
- 500-Year Floodplain
- Evacuation Routes
- Commuter Rail
- Interstate
- Major Road
- Local Roads

*Included in Hazard Mitigation Plan

1 inch = 1,150 feet

2,300 1,150 0 2,300 Feet

N

Merrimack Valley Planning Commission

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Revised: 5/6/20 MM

Town of North Andover

Municipal Vulnerability Preparedness Program

(Socio-Environmental)

Haverhill
Groveland
Georgetown
Boxford
Middleton
North Reading
Andover
Lawrence
Methuen
Merrimack River
Lake Cochichewick
Stevens Pond
Hoveys Pond
Pond Sperrys
Stiles Pond
Towne Pond
Masse Pond
Stearns Pond
Chadwick Pond
125
133
114

Legend

- Chronic Flooding Issues*
- Activity Use Limit Sites
- Dams
- Subsidized Housing Locations

Chemical Release Sites

- Oil
- Hazardous Material
- Oil & Hazardous Material
- Unknown
- Tier II Filers
- Municipal Boundary
- Property Parcels
- Pond, Lake, Reservoir

Restrictions

- APR
- CR

Chapter Land

- 61A
- 61B

Open Space

- State
- Municipal
- Private
- Nonprofit
- 100-Year Floodplain
- 500-Year Floodplain

- Evacuation Routes
- Interstate
- Major Road
- Commuter Rail
- Local Roads

*Included in Hazard Mitigation Plan

1 inch = 1,150 feet

2,300 1,150 0 2,300 Feet

N

Merrimack Valley Planning Commission

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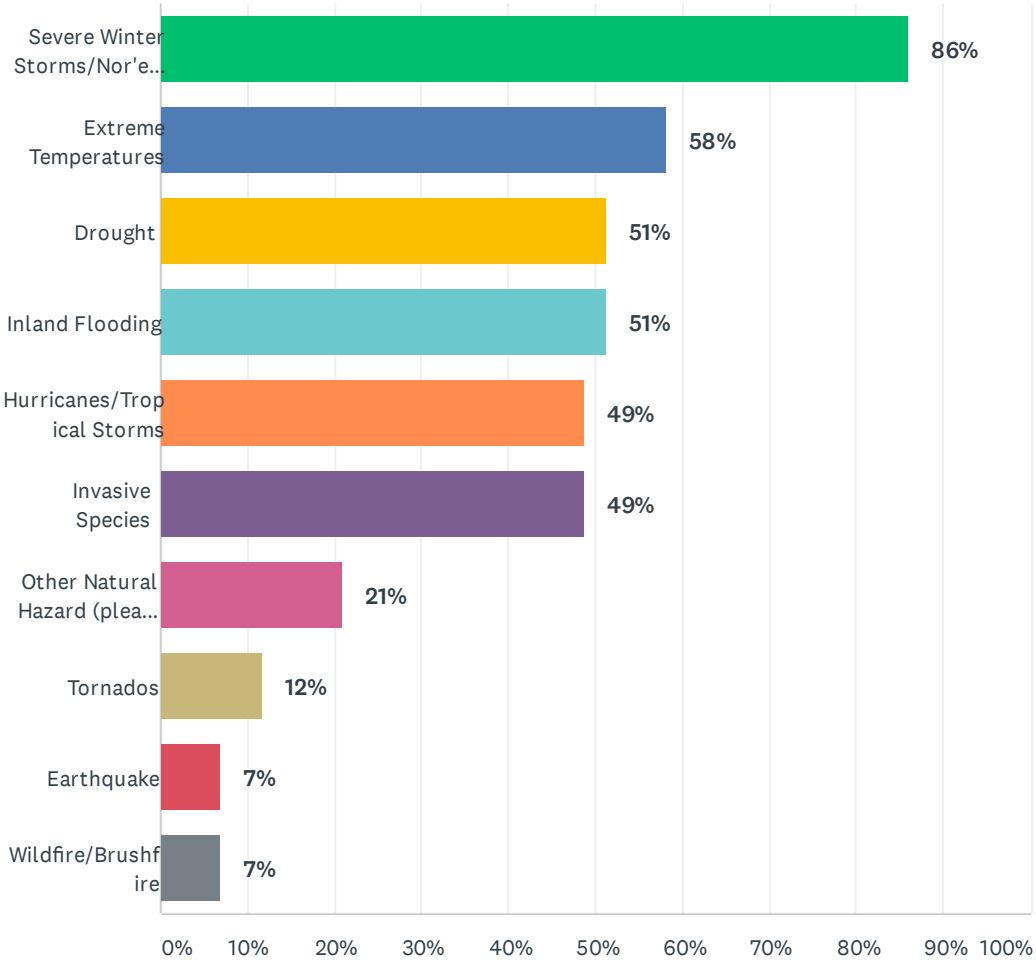
Revised: 5/6/20 MM

Appendix B
Additional Survey Results & Word Cloud Images

Q1 Hazard TypeWhat are the top four potential natural hazard events that are of most concern to you as a Town of North Andover stakeholder? (Select your top 4 hazard concerns from the menu below.)

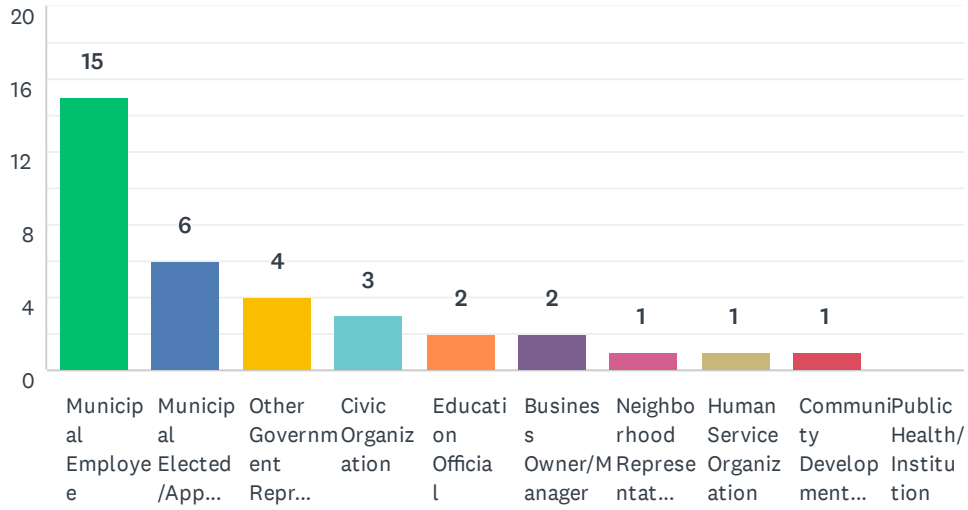
Answered: 43 Skipped: 0



ANSWER CHOICES	RESPONSES	
Severe Winter Storms/Nor'easters	86%	37
Extreme Temperatures	58%	25
Drought	51%	22
Inland Flooding	51%	22
Hurricanes/Tropical Storms	49%	21
Invasive Species	49%	21
Other Natural Hazard (please specify below)	21%	9
Tornados	12%	5
Earthquake	7%	3
Wildfire/Brushfire	7%	3
Total Respondents: 43		

Q2 Stakeholder PositionHow would you best characterize your role as a North Andover Stakeholder?

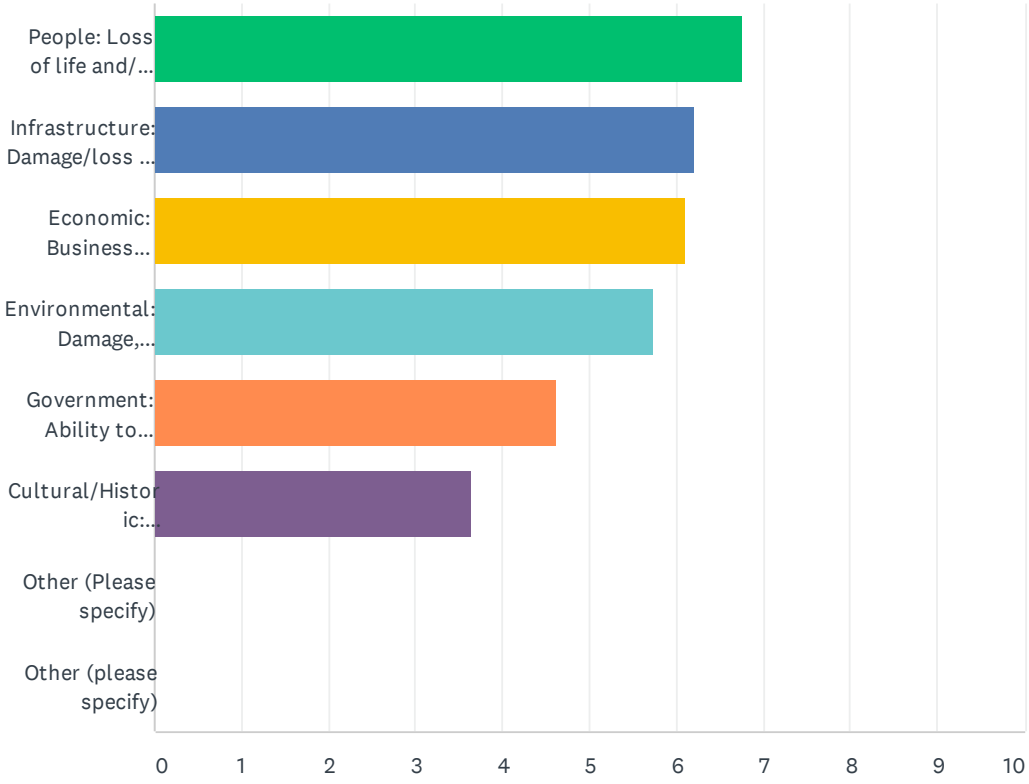
Answered: 43 Skipped: 0



ANSWER CHOICES	RESPONSES	
Municipal Employee	34.88%	15
Municipal Elected/Appointed Official	13.95%	6
Other Government Representative	9.30%	4
Civic Organization	6.98%	3
Education Official	4.65%	2
Business Owner/Manager	4.65%	2
Neighborhood Representative/Resident	2.33%	1
Human Service Organization	2.33%	1
Community Development Organization	2.33%	1
Public Health/Institution	0.00%	0
Total Respondents: 43		

Q3 Which of the following are most vulnerable to impacts of natural hazards? (Please rank in order of vulnerability concern. 1 being most vulnerable and 6 being least vulnerable.)

Answered: 43 Skipped: 0

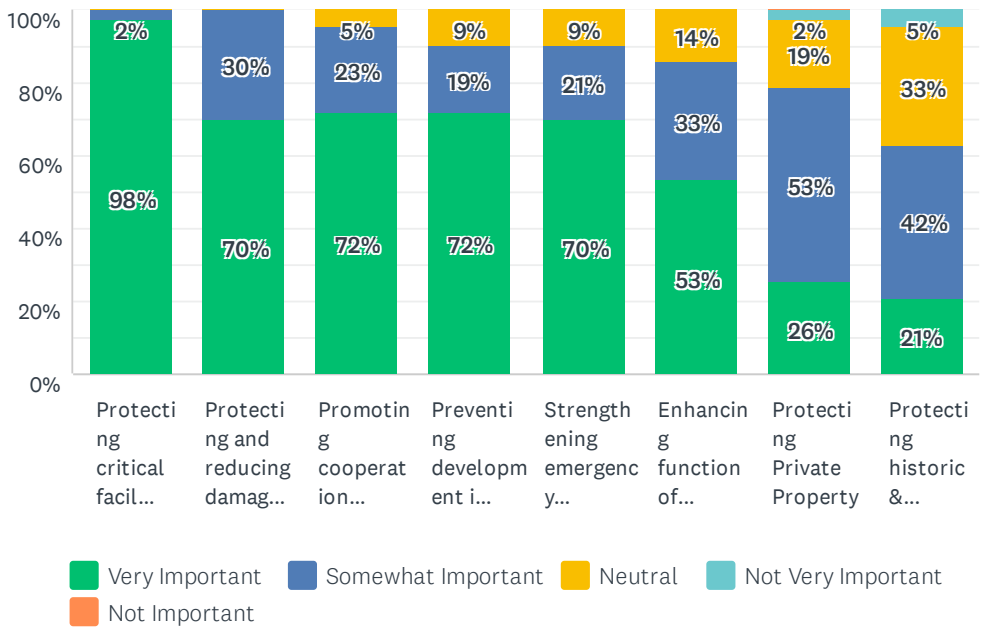


Municipal Vulnerability Preparedness (MVP) Project Stakeholder Survey for the Town of North Andover

	1	2	3	4	5	6	7	8	TOTAL	SCORE
People: Loss of life and/or injuries	52.38% 22	9.52% 4	14.29% 6	9.52% 4	14.29% 6	0.00% 0	0.00% 0	0.00% 0	42	6.76
Infrastructure: Damage/loss of roads, bridges, power, schools etc.	23.26% 10	23.26% 10	18.60% 8	20.93% 9	13.95% 6	0.00% 0	0.00% 0	0.00% 0	43	6.21
Economic: Business interruptions, closures, job losses, personal property damage etc.	2.38% 1	38.10% 16	28.57% 12	28.57% 12	2.38% 1	0.00% 0	0.00% 0	0.00% 0	42	6.10
Environmental: Damage, contamination or loss of natural resource areas	19.05% 8	19.05% 8	9.52% 4	26.19% 11	21.43% 9	4.76% 2	0.00% 0	0.00% 0	42	5.74
Government: Ability to maintain order and/or provide public amenities & services	4.65% 2	6.98% 3	23.26% 10	9.30% 4	23.26% 10	32.56% 14	0.00% 0	0.00% 0	43	4.63
Cultural/Historic: Damage/loss to historic properties, neighborhood character	0.00% 0	2.33% 1	6.98% 3	4.65% 2	23.26% 10	62.79% 27	0.00% 0	0.00% 0	43	3.63
Other (Please specify)	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0	0.00
Other (please specify)	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0	0.00

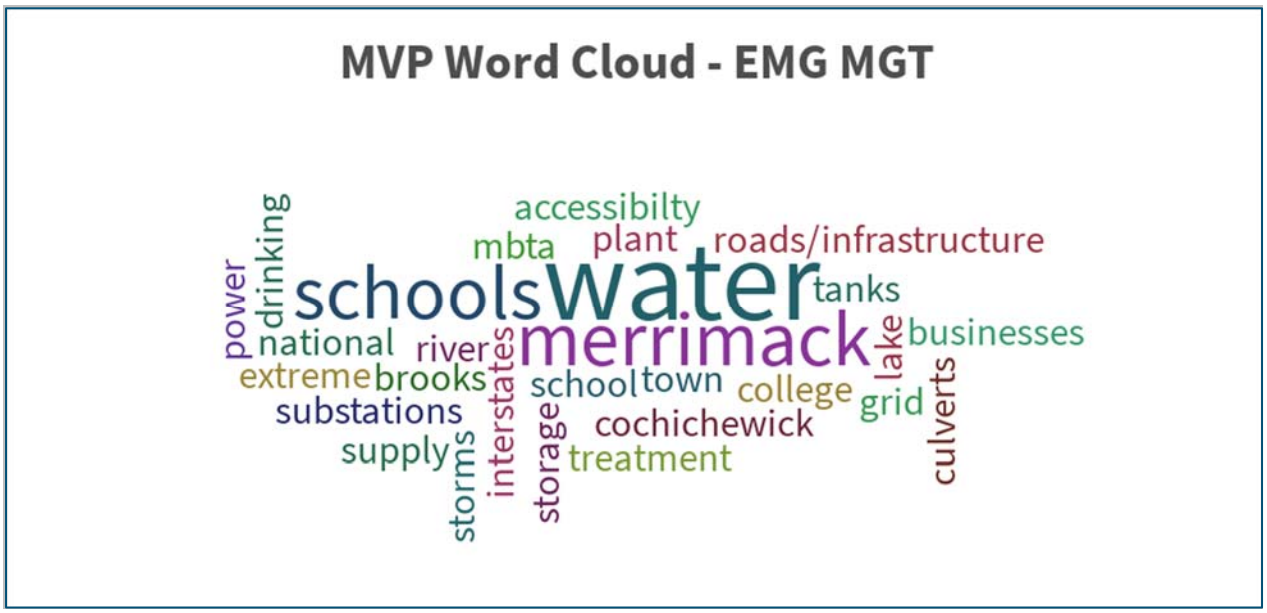
Q4 How would you make North Andover more resilient? Please tell us how important each community element is to you by checking the appropriate column box.

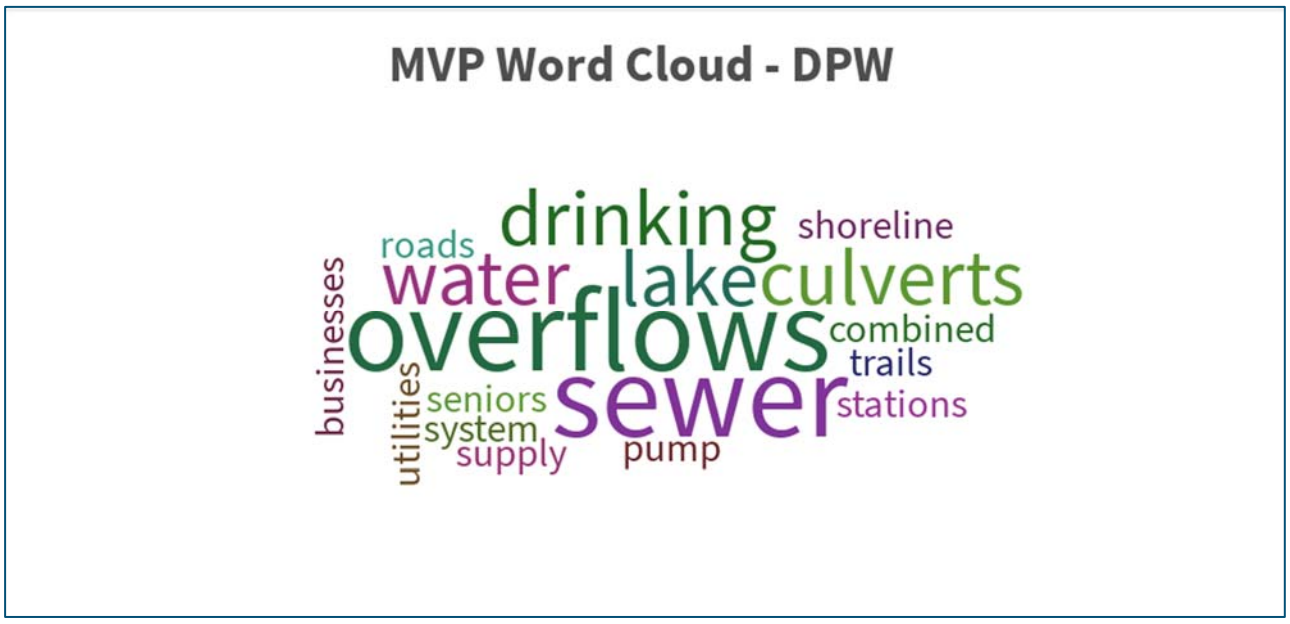
Answered: 43 Skipped: 0

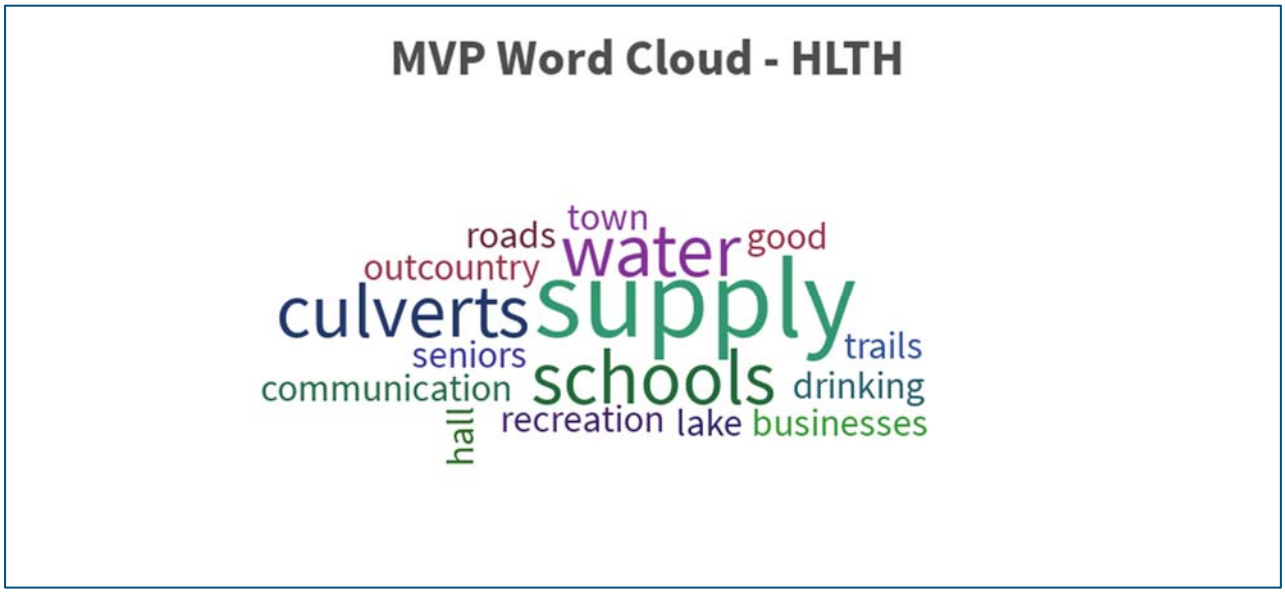


	VERY IMPORTANT	SOMEWHAT IMPORTANT	NEUTRAL	NOT VERY IMPORTANT	NOT IMPORTANT	TOTAL	WEIGHTED AVERAGE
Protecting critical facilities & infrastructure (transportation, water/sewer treatment plants, hospitals etc.)	98% 42	2% 1	0% 0	0% 0	0% 0	43	1.02
Protecting and reducing damage to utilities	70% 30	30% 13	0% 0	0% 0	0% 0	43	1.30
Promoting cooperation among public agencies, neighborhood groups, businesses & non-profits	72% 31	23% 10	5% 2	0% 0	0% 0	43	1.33
Preventing development in hazard areas	72% 31	19% 8	9% 4	0% 0	0% 0	43	1.37
Strengthening emergency services (police, fire, ambulance)	70% 30	21% 9	9% 4	0% 0	0% 0	43	1.40
Enhancing function of natural resource assets (wetlands, streams, open space areas etc.)	53% 23	33% 14	14% 6	0% 0	0% 0	43	1.60
Protecting Private Property	26% 11	53% 23	19% 8	2% 1	0% 0	43	1.98
Protecting historic & cultural landmarks	21% 9	42% 18	33% 14	5% 2	0% 0	43	2.21

Word Cloud Images from Workshops






MVP Word Cloud - HLTH
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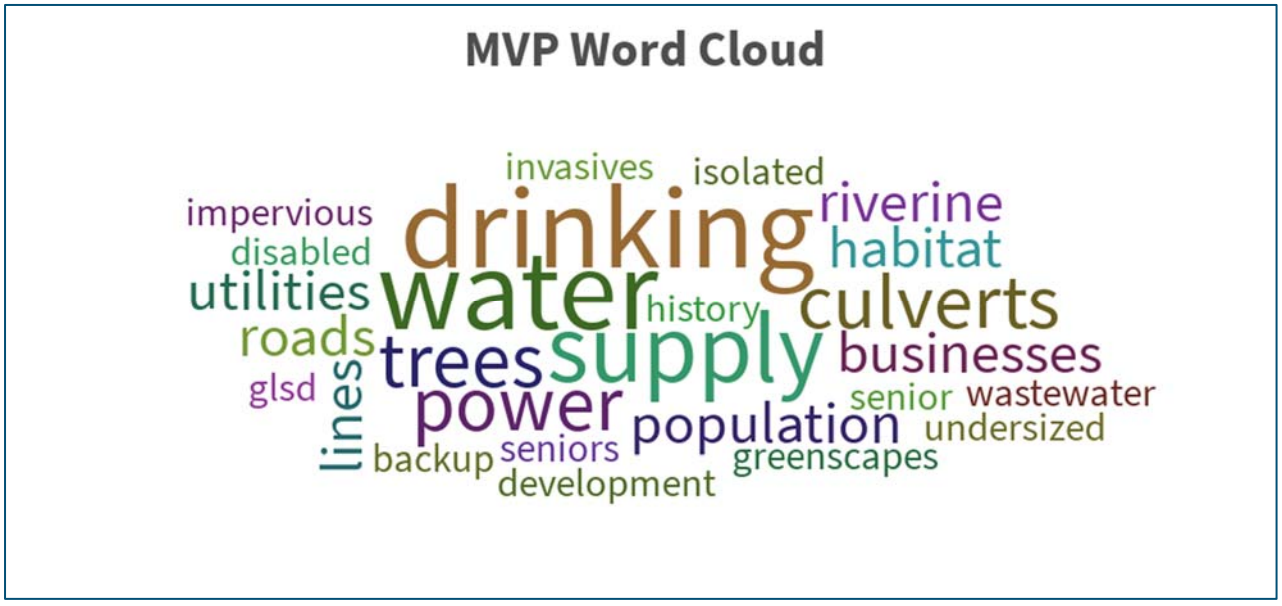
MVP Word Cloud
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population
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lines
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seniors
greenscapes
development

Appendix C
Meeting Agendas

AGENDA

NORTH ANDOVER MUNICIPAL VULNERABILITY PREPAREDNESS (MVP)
PROJECT CORE TEAM MEETING
MARCH 27, 2020 – 9-10:00 a.m.

1) Introductions

2) Introduction to Story Map http://bit.do/NorthAndoverMVP or

https://mvpc.maps.arcgis.com/apps/MapJournal/index.html?appid=23bee51907574d3dbf12a7cff4d0308d

3) Core Team Decisions
   a) Develop Schedule for Workshop(s) and Listening Sessions
   b) Determine Stakeholder List
   c) Assist with finding and updating data

4) Follow-up work for Core Team
   a) Review Summary of Findings/Updated HMP
   b) Continue outreach and engagement – meet annually
   c) Use the plan to inform planning & project activities

5) Survey to Define Top Hazards

6) Action Grants ($10.5 million to 52 cities & towns in last round)

7) Questions & Answers

AGENDA AND PROCESS

North Andover Municipal Vulnerability Preparedness & Hazard Mitigation Plan Update

Workshop 1 – Strengths and Vulnerabilities

May/June 2020

We thank you for your patience as we reconfigured our plans so that this could be a virtual workshop. You have all received an invitation to join us on GoToMeeting, and you should be able to access the meeting and its content from any computer, or the audio from any phone. **If you are having difficulties during the call with audio, video, etc. please use the CHAT feature to let us know, and we will have someone standing by to help you**. We will also be recording the meeting, so all ideas are captured, and no information is lost.

As you know, this MVP workshop process has been divided into three sections:

- **Workshop** 1 – (1.5 hours) to include introductions, presentation of North Andover Story Map including an introduction to the MVP Program and climate change data; and a work session to brainstorm ideas for

Workshop Agendas

North Andover Phase 1 Workshops - May 14, May 19, May 21 & June 1

1. MVP Program History

2. Community Resilience Building Framework & Objectives

3. Climate Change Hazards Overview

4. *Objective #1* - Identify Community Strengths & Vulnerabilities

5. Infrastructure, Societal & Environmental Vulnerability Defined

6. *Wrap up* - Vote on top vulnerabilities and strength

AGENDA

North Andover Municipal Vulnerability Preparedness & Hazard Mitigation Plan Update

Core Team Meeting 2 – Identify & Prioritize Community Actions

July 15, 2020

Thank you for participating in our virtual workshops and for submitting your completed matrices including community actions. To wrap up the Community Resiliency Building (CRB) process, we are meeting to finalize and prioritize action items.

Today's Agenda

1. Review of CRB process to date 1:00 – 1:05
2. Review of Community Actions & Prioritization 1:05 – 1:40
3. Determine Highest Priority Actions 1:40 – 1:55
4. Next Steps/Questions 1:55 – 2:00

TOWN OF NORTH ANDOVER
SELECT BOARD
120 MAIN STREET
NORTH ANDOVER, MASSACHUSETTS 01845

Laura M. Bates, Chair
Rosemary Connelly Smedile, Clerk
Chris Nobile
Richard Vaillancourt
Janice M. Phillips

TEL. (978) 688-9510

SELECT BOARD & LICENSING COMMISSIONERS
AGENDA
MONDAY, SEPTEMBER 13, 2021
6:30 EXECUTIVE SESSION
7:00 PM OPEN SESSION
SELECT BOARD MEETING ROOM
120 Main Street

Live broadcast can be heard on www.northandovercam.org

I. CALL TO ORDER

II. EXECUTIVE SESSION
- A. Pursuant to M.G.L. Chapter 30A, §21 (a)(3)- to discuss strategy with respect to litigation (Recreation Complex)
- B. Pursuant to M.G.L. Chapter 30A, §21 (a)(3)- to discuss strategy with respect to collective bargaining (Firefighter union)

III. GOVERNMENTAL REPORTS
- A. Swearing In- Lieutenant Matt Davis
- B. Recognition- Josmarie Vargas
- C. Update on COVID

IV. PUBLIC COMMENT

V. PUBLIC HEARING-Removal of Public Shade Trees- Gas Restoration Contract 2 Area

VI. PUBLIC HEARING-Joint pole petition from National Grid and Verizon New England- Forest Street

VII. NEW BUSINESS
- A. Vote on removal of public shade trees
- B. Vote on joint petition of National Grid and Verizon New England to install pole on Forest Street
- C. Request of Lee Bluemel of Interfaith Clergy to use the Common on September 19, 2021 from 3:00PM-4:00PM for an interfaith ritual to mark 3rd anniversary of MV gas disaster
- D. Vote to adopt Multi-hazard Mitigation and Vulnerability Plan 2021
- E. Select Board FY23 goals
- F. Set date for the annual Town Meeting
- G. Appointments:
  1. Remo Zimbaldi to the Council on Aging
  2. Daniel Moore to Emergency Management
  3. Tim Willett to Greater Lawrence Sanitary District Board of Commissioners
- H. Request of Fire Chief John Weir to surplus and donate a 2008 Chevrolet 4500 Ambulance to Rehab Five
- I. Approval of "Do Not Enter" signs on Beacon Hill Boulevard and Bay State Road at intersection with Chickering Road

VIII. LICENSING COMMISSIONERS

A. Change of manager-Stevens Estate
B. Application from Anh Le of Love Green LLC for a Common Victualler and Annual Entertainment License
C. Application from Paul Gallant on behalf of Merrimack College for a one day wine and malt liquor license from 5:00PM to 8:00PM for a Block Party to be held at 315 Turnpike Street Lot H on September 17, 2021.
D. Applications from Tricia Dunphy of Smolak Farms for four (4) one day wine and malt liquor licenses and a waiver of police detail for all four events, for all for a Fall Festival held in the festival tent behind the farm stand on September 18th, 19th, 25th and 26th from 10:00AM to 5:00PM
E. Applications from Deborah Ingalls of Butlers and Bars for three (3) one day liquor licenses for the following events in the large event tent and request for waiver of the police details: September 18th and 19th are Wedding Receptions and October 7th is an employee appreciation dinner.

IX. CONSENT ITEMS

A. Accept Green Communities Grant in the amount of $192,589.00
B. Surplus vehicle- Police Department
C. Accept donations to the Stevens Memorial Library
D. Surplus property-Fire Department
E. Affordable Unit Resales-106 Cortland Drive and 30 Ciderpress Way
F. Surplus property- Stevens Estate

X. APPROVAL OF MINUTES

A. Open session minutes of August 9, 2021
B. Open session minutes of August 30, 2021

XI. OLD BUSINESS

XII. TOWN MANAGER'S REPORT

XIII. SELECTMAN'S UPDATES/COMMENTS

XIV. NEXT MEETING DATE

Monday, September 27, 2021

XV. ADJOURNMENT

Appendix D
Community Resiliency Building Matrices

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Features	Location	Ownership	V or S	Top Priority Hazards: Severe Winter Storms/Nor'easters	Inland Flooding	Extreme Temperatures	Drought	Priority H-M-L	Time S Short L Long O Ongoing
Infrastructure				**Actions**					
Wireless Reception	Specific parts of town	Public/Pirvate	V	Engage cell phone companies, look to install our own antennas for critical area, look at augmenting with outdoor wifi calling				H/M	O
Water Main Breaks in extreme cold (loss of sprinklers/hydrants/fire response)	Townwide	Public	V	Majority of system updateed from cast iron to ductil iron, continue to update				M/L	O
Above-ground Electric Utilities	Townwide	Public/Pirvate	V	Maintain outage data, tree trimming/maintenance, place utilities underground where possible				H/M	L
Aging Infrastructure (water, sewer, telecom, gas (mostly updated)	Townwide/key junction points	Public/Pirvate	V	Investigate areas with aging utilities; Develop long term plan for replacement; Procure funding to replace aging utilities				M/L	O
Impassible Roads (Flooding/down trees)	Outer reaches of town	Public	V	Investigate low lying wet areas and potential impact to roadways; Develop alternatives for potential remedies; Consider preparing existing tree inventory for long term maintenance planning.				M	O
Mosquito Brook (Beaver Issues)	Townwide	Public/Pirvate	V	Develop beaver management program including beaver deceivers, beaver trapping, and increased operation and maintenance at beaver dam locations.				H	O
Sewer Pump Stations (some vulnerable - others to be eliminated)	27 Townwide	Public	V & S	Most pump stations have emergency back-up and generators are currently being upgraded; continue with securing funding to upgrade pump stations and emergency back-up generators; review possible pump station elimination locations and develop design for elimination; procure funding to construct gravity and eliminate pump stations where applicable; investigate Winter Street pump station and potential upgrade to mitigate impacts during				M	O
Wastewater Treatment Plant/GLSD	Charles Street	GLSD	V & S	Ensure NGRID maintains vegetation along electrical lines to treatment plant and pumping station. Major power outage in 2017 was caused by vegetation falling on power lines.				L	O
Shoreline Erosion on Lake Cochichewick (under study)	Great Pond Road and other areas	Public	V	Currently remedy is being designed for approximate 600 foot length; Need to procure funding for proposed remedy.				H	S
Culverts	Townwide	Public/Private	V	Develop culvert investigation program using GIS; develop program for proposed remedies and replacement; procure funding to design and construct remedies; develop long term operation and maintenance program				H	L
Riverside Pump Station - Flood Potential	Riverview Street	GLSD	V	Conduct study ofo the pumping station to determine areas of weakness associated with flooding from the adjacent Merrimack River. Consider waterproofing of the station and/or providing a portable system to build a dam around the facility. MassPort uses similar system.				L	

Culverts/Dams associated with Mills	Downtown	Public/Private	V & S	Mill has just replaced/reconstructed entire weir control system; continue to work with Mills in future coordinating dam/weir operations. Investigate ownership of weir downstream of Mills near Sutton Street and consider ownership opportunities.	M	L
Shoreline of Lake Cochichewick	Town-wide	Public/Private	V	Develop plan to investigate remaining shoreline; Prepare long term plan for repair and maintenance of shoreline.	M	L
Equipment/Manpower to remove downed trees after storm event	Town-wide	Public/Private	V	Review existing equipment for tree department; bucket truck is due to be replaced within next 5 years; consider purchase of other equipment (tree removal truck with claw/picker) to expedite down tree removal from roadways.	H/M	O
Hazardous materials on interstate roads & rail (rare occurance)	Specific parts of town	Public/Private	V	Fire Department trained on hazmat, continue	H	O
Flooding Issues	Flats Bridge, Rte 114 at Market Basket, Mass Ave. at 495	Public	V	Work with Mass DOT on issues (Rte 114, 495) Continue to investigate and fund "Flats Bridge" area improvements	M	O
Lake Cochichewick/Surface Drinking Water Supply	Town-wide	Public	V	Watershed Protection Plan (budgeted)	H	S
DPW Facility in Floodplain	Osgood Street	Public	V	Continue to study, upgrades to drainage, underground storage tanks/canopy (30 years old)	M	O
Stormwater BMPs	Townwide	Public/Private	V	Develop tracking system for annual maintenance of BMPs where privately owned (Shorterm) Identify and assess - public BMPs (Longterm)	M	L
Fiber Optic Network/Internet Connection	Specific parts of town	Public/Private	V	Engage internet proivders/companies, look at augmenting with mobile hotspots	H/M	O

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Features	Location	Ownership	V or S	Top Priority Hazards: Severe Winter Storms/Nor'easters; Inland Flooding; Extreme Temperatures; Drought — Actions	Priority H-M-L	Time Short Long Ongoing
Society						
Seniors - accessibility to critical needs/tranportation	Townwide	Public and Private	V	1) Increase promotion of SMART 911 2) Identify vulnerable: names, location, language requirements, medical. Maintain aforementioned in an accessible anywhere format for public safety officials (eg, database, wifi with emergency power supply for storage location). 3) Keep data up-to-date, need data collectors that have the necessary language capability, need technology infrastructure for the data storage & access, staff need skills to use the technology. 4) Work with local organizations (like a faith-based one) to gather the data. ADDITIONAL REQUIREMENT when non-govt organizations involved: need legal status/protection around security, privacy of data during & after the data collection process. Food, medicine, transportation can only be provided if the data is known ahead of time and resources lined up. Scheduling of delivery is another axis on a planning chart.	H	O
Access to internet/wifi	Townwide	Public and Private	V	1) Identify ways to increase coverage for long term (eg, a internet company "wires"a neighborhood) because that helps when an event occurs. 2)In the meantime, identify ways to quickly bring coverage when there is not time for infrastructure build-out. For instance, during pandemic, COMCAST is brings a van that is a mobile hotspot and parks in a neighorhood.	H/M	O
High School Emergency Shelter Capacity	430 Osgood Street	Public	S	1)Identify what, how to support people in a shelter for more than a few days. Examples from Columbia Gas experience: story times, activities for children. Public access ccomputer room setup (like a library) so people can check email, accounts, etc when they do not have or couldn't bring laptops, tablets, etc. Identify Town Dept, staff that can help with these supplemental needs. Libraries provide the most public computer access today so librarians could be assigned to provide computer assistance as well as do a story time, for instance. 2)Assess logistics for food, bedding, sanitation	L M	O S
Lack of Multi-lingual tools for increasingly diverse populations	Townwide (esp. schools)	Public	V	1) Provide important announcements in multiple languages (H) 2) Identify outside organizations for languages support, eg, translation services. Language learning software/tools. CHALLENGES: Time-critical, real-time need vs a "passive" need - get a sign, poster, letter, etc translated. 3)Identify need for various languages (including sign language)	M	O
Police/fire/emergency management/DPW are critical for emergency response	Townwide	Public	S	Strength is our response time & skill training (safety, fire, etc.) Town is proactive already working to increase mental health recognition skills, awareness of unconscious bias - not always black, could be hispanic, "foreign," gender). CHALLENGE: see #12 multi-lingual: languages skills for the first responders.	M	O
Emergency Shelter (Field House) does not have AC/subject to Rte 125 Power Outages	430 Osgood Street	Public	V	1)Consider Library building could as a cooling center, but has limitations. It does not have emergency backup power (this has been considered but not an "easy" change), there are no food, shower, or sleeping arrangements, so could offer limited time periods with people having to be able to leave for things like food, or overnight. Investment in another building's AC likely to be a better solution for long-term events support. 2)Evaluate cost and determine if grants/funding is available	L	O

Senior Housing - Does not lend itself to one backup power solution - required to evacuate if temps drop	Townwide	Public	V	1)Develop contingency plan for emergencies 2) Backup Power to Community Areas in process	H/M	O
Requirement for Mutual Aid in non-hydrant district (25% of town)	Sharpners Pond Rd, Boxford St., Outcountry	Public	V	Extend water mains. Continue with mutual aid in interim. Continue cross training with mutual aid depts.	H	L
Homebound Senior Population (single family homes)	Townwide	Private	V	1)Use town census to identify population 2)Conduct survey of homebound Seniors to determine vulnerability and need	M	O
Availability of fresh food (in emergency situations)	Townwide	Public/Private	V	1)Individuals and companies like Market Basket have been so generous, but this is all response to appeal. A formal plan with partnerships in place should be developed to move from "appeal & response" to guarantee you get the items needed, not what people think to donate from their cupboads. 2)Assess School System capability to distribute food 3)Partner with non-profit/civic organization	H	O
Smart 911 Profile (needs to be completed for many properties)	Townwide	Public/Private	V & S	1) Begin outreach campain/Include information in quarterly newsletter, etc. 2) Regularly scheduled project/program to get updated data. Identify catalyst for changes and have that catalyst initiate a signal to update out of schedule. For instance, Building Dept issues permits to start construction and occupancy permits. These could be signals for the data maintaining group to go to that building now, instead of waiting for the planned review.	M	O
Lack of transportation capacity in natural disasters for vulnerable populations	Townwide	Public	V	Add another category to emergency for PANDEMIC, when transportation becomes even more problematic: the 10-person van can only carry 1 person, or the "family" group. And, the vehicle must be santizied between trips. Explore opportunity to introduce car sharing, Commuter Rail Station	L	O
Town Government works well in disaster management	Townwide	Public	S	Continue training: Shelter training, NIMS training, ALICE training	H	O
Disabled Populations (identify who may need help)	Townwide	Public/Private	V	1) Outreach campaign/Include information in quarterly newsletter 2) Identify vulnerable: names, location, language requirements, medical. Maintain aforementioned in accessible-anywhere records (eg, wifi, database, with emergency power supply). Keep data up-to-date, data collectors have the necessary language capability, technology infrastructure for the data storage & access. Work with local organizations (like a faith-based one) to gather the data. Need legal status/protection (memorandum of understanding?) around security, privacy of data during & after the data collection process. 3)Develop list of vulnerable parties and interested Care Partners to make contact with during emergencies	M	O

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Features	Location	Ownership	V or S	Top Priority Hazards: Severe Winter Storms/Nor'easters; Inland Flooding; Extreme Temperatures; Drought — Actions	Priority H-M-L	Time Short Long Ongoing
Environment						
Mosquito Control District	Townwide	Public	S	1)Identify areas susceptible to flooding for mosquito breeding habitat 2)Research incentives for residents/businesses to eliminate standing water sites through installation of rain gardens and other nature-based solutions to improve groundwater recharge, reduce mosquito habitat, and bring back mosquito predators (birds); 3)Consider other opportunities which can actually decrease risk of vector-born diseases and reduces the Town's authority to utilize nature-based solutions.	M/L	O
Water Treatment Plant	Townwide	Public	S	Continue educating citizens on importance of municipal water supply.	H	O
Drinking Water Supply - Lake Cochechewick	Townwide	Public	V	1) Update watershed plan 2) Prioritize land acquisition and obtaining CR's in the watershed. 3) Continue with drafting regulations around dog walking and docks to maximize protection.	H	S/O
Water Quality affected by run-off and infiltration	Townwide	Public/Private	V	1) Update watershed vulnerability to include private property issues; educate property owners about their impact 2) Identify and catalogue areas that could benefit from LID or other retrofit to increase infiltration and WQ treatment (public parking areas, town owned properties) 3) Conduct a thorough audit of the local zoning and land use regulations to benefit from Green Infrastructure and Low Impact Development (LID) utilizing Mass Audubon's Bylaw Review Tool; 4) Training seminars and public outreach to help residents understand how water conservation and limiting use helps preserve water quality; 5) Expand participation in/optimize use of the Greenscapes North Shore Coalition, the Parker-Ipswich-Essex Rivers Partnership (PIE-Rivers) water conservation Task Force to increase municipal capacity to manage water neutral growth programs and initiatives.	H	S
Beaver Management	Townwide	Public/Private	V & S	1) Educate residents on the role beavers play, humane methods for managing their activity. 2) Identify vulnerable areas that cannot accomodate beaver damming activity and formalize management plan for same. 3) Continue advocacy for additional solutions for beaver management; monitor trouble spots	H	S/O
Mitigation Options for Increased Stormwater (quantity & quality)	Townwide	Public	V	1) Public projects should evaluate options for LID, reducing impervious surfaces, increased planted buffers, upgrade/retrofit existing stormwater BMP's 2) Identify approaches for stormwater mitigation in open spaces 3) Continue water conservation incentive programs. Consider residential and commercial water audits, rebates for fixture upgrades. Continue rain barrel program and other measures that help capture and utilize rainwater on-site and limit runoff. 4) Promote Greenscapes lawn alternatives to increse native groundcover, which is better at absorbing and utilizing rainwater than grass lawns	H L	S O
Trees (damaged/dangerous - long list)	Townwide	Public	V	1) Perform comphrehensive evaluation of existing trees, prioritze removal of hazardous trees with replanting of appropriate species tolerant to roadside conditions 2) Promote tree planting initiative - involve private property owners (subsidize)	M	S

Loss of Trees on private property resulting in negative impacts to env. (esp. Lake Coch.)	Townwide	Private	V	1) Undertake comphrehensive campaign to educate landowners in watershed regarding this issue; keep tabs on changes in ownership and contact new owners regarding same. 2) Strengthen Watershed Permit to include fines and required meaningful restoration. 3) Subsidize replacement trees on private property	M/H	O
Watershed & Conservation Bylaws (native species/LID)	Townwide	Public	S	1) Public projects should evaluate options for LID, reducing impervious surfaces, increased planted buffers, upgrade/retrofit existing stormwater BMP's 2) Update Wetlands Bylaw to address climate change specifically. 3) Provide applicants with Con Com and PB approved native plant lists. 4) Update Wetlands Bylaw and Watershed Permit process to require LID techniques 5) Consider Water Neutral Growth Bylaw or Ordinance that requires new development and re-development projects to offset their projected additional water demand to the extent feasible and offset the rest. 6) Draft a custom Bylaw using the Alliance for Water Efficiency Water Neutral Growth Tool. 7) Conduct a Water Use Profile analysis of all water customers to inform water conservation & mitigation strategies utilizing the Greenscapes coalition as a resource. Based on the profile: a) Conduct customer-specific water conservation outreach on the top 10% of commercial customers and conduct water audits on the highest users. b) Implement DEP's Healthy Lawn, Happy Summer Toolkit with the top 15% of residential water customers. 8) Promote/conduct lawn use trainings to emphasize importance of Greenscapes that require minimal watering, restore native plants and wildlife, and reduce mosquito populations 9) Review watershed/conservation bylaws for protections, fairness and practicality	1. H 2. H 3. L/M 4. H 5. L 6. L 7&8. L 9. M	1&2 &4 S O
Unprotected farmland vulnerable to development	Townwide	Private	V	1) Prioritize acquisition of these lands, obtain CR's, partner with ECGA, TTOR 2) Work with town government for incentives for farmland owners to preserve the land	H	O
Privately owned undeveloped land in Water Supply	Townwide	Private	V	1) Identify private property available in the watershed for purchase; idenify funding source for purchases 2) Educate landowners about stewardship and conservation/CR/easement options and tax benefits thereof 3) Examine the Net-Zero Water Use Toolkit for a number of measures to limit risks to the Town from privately owned undeveloped land, including: a) Monitor the Town's Residential Gallons uses Per Capita Per Day (RGPCD) to ensure that it is a steady declining trajectory until it reaches and sustains a level of 42 or less; b) Prohibit the installation of new underground irrigations systems and offer a generous rebate program for the decommissioning of existing underground irrigation systems; and c) Implement a private well bylaw based on the model recently adopted by the Town of Ipswich so that private withdrawals are subject to the same rules as the public water supply.	1. H 2. M/H 3. L	S O O
Invasive Species (need management)	Townwide	Public/Private	V	1) Engage college interns to peform assesments/inventory of invasives on Town property. From there develop priorities and strategies for management. 2) Survey exent of invasive species problem; develop eradication plan	M/L	O
Dark Impervious Sufaces, lack of trees create heat islands (limit walkability/accessibility)	Townwide	Public/Private	V	1) Identify locations where trees/foliage could mitigate heat islands 2) Adopt LID measures and plan for moving from mostly impervious to mostly permeable surfaces for roads and walkways particularly in concentrated areas, as well as native tree plantings for shade cover and habitat.	M/H	S/O
Connected Open Space & Trails/habitat connectivity	Townwide	Public	V	1) Work with town groups to develop a town'wide trails network and implementation plan 2) Work with neighboring communities in the PIE-Rivers Region to increase connectivity, including Middleton which identified several trail projects in their MVP planning process and is interested in collaborating with neighboring towns.	M	O

Increase Riparian/Wetland buffers (including ponds)	Townwide	Public/Private	V	1) Look for opportunities to add buffers 2) Consider updating the Wetland Bylaw and Watershed Bylaw to require larger No Disturb Zones on newly created lots/subdivsions 3) Work with other communities throughout the PIE-Rivers Region to improve watershed-wide conservation of Riparian/Wetland buffers and educate landowners about the importance of increasing these areas	L	L

Appendix E
Plan Approval Documents

CERTIFICATE OF ADOPTION

Town of North Andover, Massachusetts

A RESOLUTION ADOPTING NORTH ANDOVER MULTI-HAZARD MITIGATION AND MUNICIPAL VULNERABILITY PLAN SEPTEMBER 2021

WHEREAS, the **Town of North Andover** established a local planning team to work with and assist the Merrimack Valley Planning Commission in the preparation of the ***Town of North Andover Multi Hazard Mitigation and Municipal Vulnerability Plan 2021*** (hereinafter, "North Andover HMP/MVP"); and

WHEREAS, the North Andover HMP/MVP identifies potential future activities and projects aimed at mitigating potential adverse impacts from floods, winter storms, and other natural hazards in the Town of North Andover; and

WHEREAS, duly noticed workshops and public meetings were held by the Town of North Andover on May 14, 19, 21 and June 1, 2020 (workshops) and on April 5, 2021 and September 13, 2021 (Listening Sessions) as part of the process of updating the Hazard Mitigation Plan; and

WHEREAS, the Town of North Andover, acting through its various municipal departments, boards, and commissions is committed to implementing these potential mitigation activities and projects as future town funding and personnel resources permit; and

WHEREAS, adoption of this Hazard Mitigation Plan makes the Town of North Andover eligible for funding to alleviate the impacts of future hazards.

NOW, THEREFORE BE IT RESOLVED that the Town of North Andover Select Board adopts the ***Town of North Andover Multi Hazard Mitigation and Municipal Vulnerability Plan 2021*** in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of North Andover.

ADOPTED AND SIGNED this day, the 13th of September, 2021

By: Laura M Bates

Name: Laura M. Bates
Title: Select Board Chair

U.S. Department of Homeland Security
FEMA Region I
99 High Street, Sixth Floor
Boston, MA 02110-2132

FEMA

September 23, 2021

Samantha C. Phillips, Director
Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, Massachusetts 01702-5399

Dear Director Phillips:

The U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA) Region I Mitigation Division has approved the Town of North Andover Multi-Hazard Mitigation and Municipal Vulnerability Plan 2021 effective **September 22, 2021** through **September 21, 2026** in accordance with the planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, the National Flood Insurance Act of 1968, as amended, and Title 44 Code of Federal Regulations (CFR) Part 201.

With this plan approval, the jurisdiction is eligible to apply to the Massachusetts Emergency Management Agency for mitigation grants administered by FEMA. Requests for funding will be evaluated according to the eligibility requirements identified for each of these programs. A specific mitigation activity or project identified in this community's plan may not meet the eligibility requirements for FEMA funding; even eligible mitigation activities or projects are not automatically approved.

The plan must be updated and resubmitted to the FEMA Region I Mitigation Division for approval every five years to remain eligible for FEMA mitigation grant funding.

Thank you for your continued commitment and dedication to risk reduction demonstrated by preparing and adopting a strategy for reducing future disaster losses. Should you have any questions, please contact Brigitte Ndikum-Nyada at (617) 378-7951 or brigitte.ndikum-nyada@fema.dhs.gov.

Sincerely,

Paul F. Ford
Acting Regional Administrator
DHS, FEMA Region I

PFF:bnn

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