



Hazard Mitigation Plan

February 2021

Tighe&Bond
Engineers | Environmental Specialists

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Massachusetts Emergency Management Agency – Samantha Phillips, Director

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Municipal Vulnerability Preparedness and Hazard Mitigation Planning Team

	Name	Title/Department/Affiliation
MVP/HMP Core Team	Lisa Davis	Town Planner
	David Querze	Emergency Management Director
	Beverly Woods	Northern Middlesex Council of Governments (NMCOG)-Regional Planning Agency
	Brynn Montesanti	Planning
	Paula Terrasi	Conservation Agent/DPW
	Ken Kalinowski	DPW Director
	Andrew MacLean	Town Administrator
	Kalene Gendron	Health Agent
MVP/HMP Advisory Committee	Walter Richards	Resident, large employer sector
	Denise Pigeon	Superintendent of Schools
	Beverly Woods	NMCOG
	Tony Beattie	Resident, agricultural sector
	Casey Campetti	Resident, engineering sector
	Jim Scarsdale	Resident, energy/tech sector
	Kat Belliveau	Resident, environmental sector
	Tom Nephew	Resident, real estate

Section 1
Introduction

The purpose of hazard mitigation is to reduce loss from current and future natural hazards. Storms and other natural disasters such as floods, earthquakes, and hurricanes can cause loss of life, damage to buildings and infrastructure, and negatively affect a community's economic, social, and environmental well-being. The Town of Pepperell has developed this Hazard Mitigation Plan as a means to permanently reduce or alleviate the loss of life, injuries, and damage to property resulting from natural hazards, through the adoption of long-term strategies. These long-term strategies address not only municipal infrastructure but also societal, economic, and environmental assets of Pepperell, through planning, policy changes, programs, projects, educational outreach, and other activities. The desired outcome of implementing the HMP focuses on creating a more resilient community that is better prepared for future natural disasters so that it can recover more quickly should one occur.

1.1 Overview of Planning Requirements

1.1.1 Planning Requirements under the Federal Disaster Mitigation Act

The Federal Disaster Mitigation Act of 2000 requires that all municipalities adopt a local Hazard Mitigation Plan (HMP) in order to continue to be eligible to receive Federal Emergency Management Agency (FEMA) hazard mitigation grants. The Act also requires that local HMPs be updated every five years. This planning requirement does not affect federally-authorized disaster assistance funding which is exempt from this requirement.

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The Town of Pepperell received grant funding from the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) under the Municipal Vulnerability and Preparedness (MVP) Program to complete the five-year update of Pepperell's HMP. The single-jurisdiction local HMP for Pepperell produced under this grant is designed to meet the requirements of the Disaster Mitigation Act, following guidance provided in FEMA's Local Mitigation Planning Handbook (March 2013)[1] and FEMA's Local Mitigation Plan Review Guide (October 1, 2011)[2]. Where text in the Hazard Mitigation Plan meets an element identified in the Review Guide, it is called out in a blue box in the margins.

1.1.2 Municipal Vulnerability Preparedness (MVP) Program

The MVP grant program allows municipalities in the Commonwealth to begin the process of preparing for climate change resiliency. The MVP planning process engages members of the local community through participatory exercises focused on identifying community strengths and vulnerabilities, and prioritizing actions that improve resiliency to natural hazard risks including impacts of climate change. Communities that complete the MVP

[1] FEMA (2013), "Local Mitigation Planning Handbook", https://www.fema.gov/media-library/assets/documents/31598

[2] FEMA (2011), "Local Mitigation Plan Review Guide", https://www.fema.gov/media-library/assets/documents/23194

process become certified as an MVP community and are eligible for MVP Action grant funding and other opportunities.

The MVP effort supplements the HMP process by providing statewide and watershed-specific climate change data to use in the natural hazard risk assessment, and by utilizing a consistent methodology for public engagement through Community Resilience Building (CRB) workshops. **Figure 1-1** below demonstrates the overlap between the MVP and HMP development processes. The MVP places additional emphasis on future climate driven hazards and targets outreach to environmental justice (EJ) and vulnerable populations.

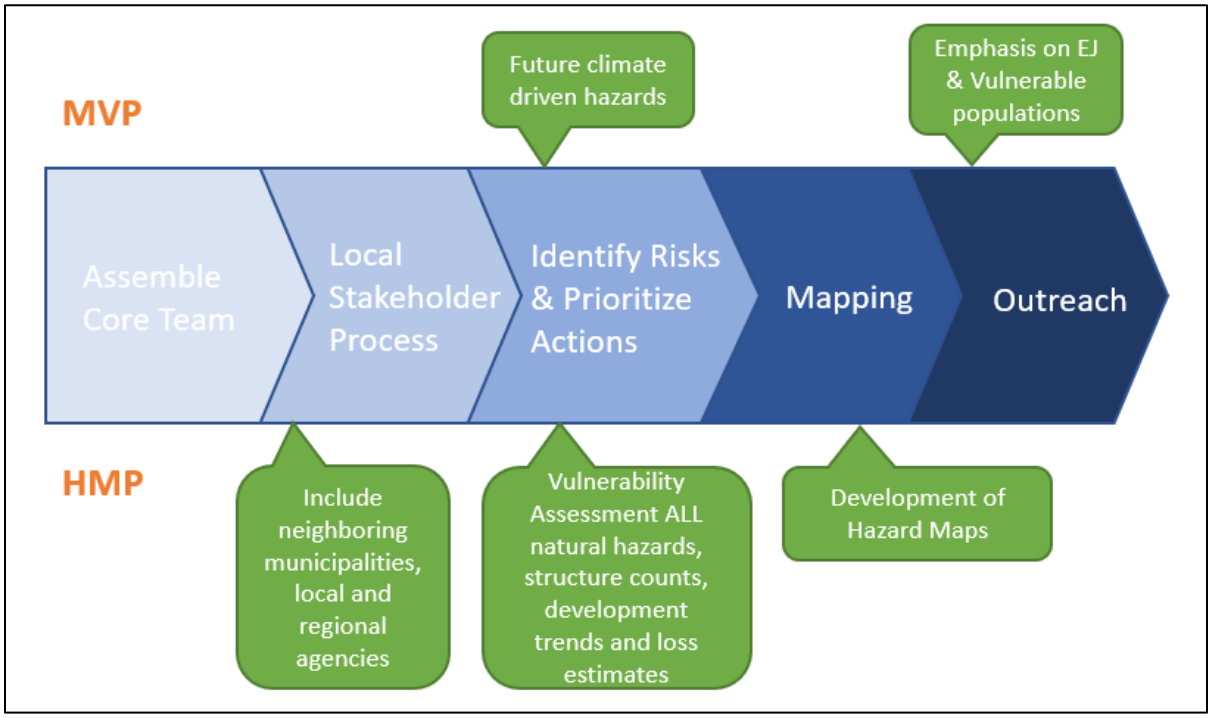


Figure 1-1 – Joint Planning of MVP Program and HMP
Source: MA Executive Office of Energy and Environmental Affairs

1.2 Community Profile

Pepperell is a small, rural town located in Middlesex County, Massachusetts. The Town is adjacent to the New Hampshire border and occupies 23.18 square miles. Pepperell is bounded on the north by Brookline and Hollis, New Hampshire; on the east by Dunstable; on the south by Groton; and on the west by Townsend. While Pepperell is not directly served by a limited access highway, it is reasonably proximate to U.S. Route 3 via Routes 111 and 113, and access to I-495 is available via State Route 119.

Pepperell residents highly value the town's rural character, agricultural landscapes, open spaces, natural resources and historic buildings. The visual character and historic heritage set Pepperell apart from other nearby communities.

Pepperell's legislative power is vested in open town meeting, while executive authority falls to its three-member Select Board. The Town of Pepperell maintains a website at https://town.pepperell.ma.us.

1.2.1 Pepperell's Demographics

Pepperell is a small sized town in Massachusetts, with an estimated 2020 population of 11,648, according to projections developed by MassDOT.[3] Over the past half century (1960 to 2010), Pepperell's population increased by 165.15%, an average of 33.03% per decade. In contrast, the regional population grew by 69.4% during the same time period, from 169,403 to 286,901, an average of 13.88% per decade. With a total area of 23.18 square miles, Pepperell's population density was approximately 496 persons per square mile in 2010.

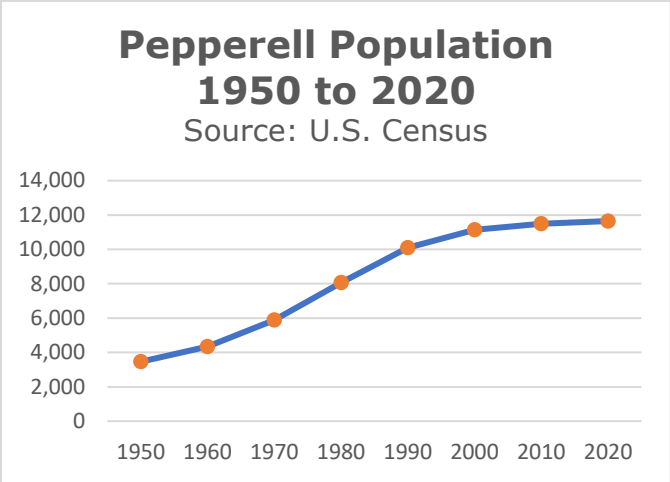


Figure 1-2: Pepperell Population

Population projections developed by MassDOT for the Town of Pepperell predict a slightly higher future growth rate for the Town through 2030, compared to the region as a whole. Between 2010 and 2020, Pepperell is expected to experience a growth rate of 1.3%, which is anticipated to increase to 2.7% in the 2020s, and to 4.9% in the 2030s, reaching a total projected population of 12,553 by 2040. The projections suggest that Pepperell's population will comprise 4.1% of the Greater Lowell region's population by 2040, compared to just above 4% today.

The largest racial group in Pepperell is white, accounting for 94.2% of the community, according to the 2013-2017 American Community Survey produced by the U.S. Census Bureau. The Asian population has grown slightly and comprises 2% of Pepperell's overall population, while the Hispanic and African American populations comprise 1.2% and 2.6%, respectively.

1.2.2 Pepperell's Economy

Pepperell's workforce is well educated and generally commutes outside of Pepperell for employment. Pepperell residents work in virtually every industry, from manufacturing and construction to public administration and the restaurant industry. There were fewer manufacturing establishments and employees in 2018 than there were just ten years ago.

The labor force includes those individuals who have jobs or are seeking jobs, are at least 16 years old, and are neither serving in the military nor are institutionalized. According to data available from the Executive Office of Labor and Workforce Development (EOLWD), Pepperell had an estimated labor force of 7,396 people in July 2018. This number represents the highest level of Pepperell residents actively participating in the labor force since 2000. Similarly, the number of people employed reached a peak of 7,138 workers in July 2018.

The growth and decline of business establishments operating in Pepperell over the past eleven years reflects the local economy. The number of establishments in Pepperell has

[33] Pepperell Master Plan, adopted October 2020, p.15

increased steadily from 230 establishments in 2008 (Q3) to 274 establishments in 2018 (Q3) or by 19.1%. The monthly employment for Pepperell businesses steadily increased from 1,473 employees in 2008 (Q3) to 1,711 employees in 2018 (Q3) or by 16.2%.

In terms of the goods-producing domain, the number of establishments in Pepperell increased from 64 in 2014 (Q3) to 80 in 2018 (Q3), or by 25%. Manufacturing establishments increased by 9.1%, which included nondurable goods manufacturing establishments increasing by 50%. Construction establishments increased by 30% from 50 establishments in 2014 (Q3) to 65 establishments in 2018 (Q3). The most significant growth in the Service-Providing Domain was in the Financial Activities sector, which grew by 60% between 2014 (Q3) and 2018 (Q3). Within that particular industry, Real Estate and Rental and Leasing establishments increased from five firms in 2014 (Q3) to eleven firms in 2018 (Q3) or by 120%. The Education and Health Services sector increased by 28.9% going from 38 establishments in 2014 (Q3) to 49 establishments in 2018 (Q3). The Information industry increased from six firms in 2014 (Q3) to seven firms in 2018, while establishments within the Leisure and Hospitality industry decreased by one firm.

1.2.3 Pepperell's Natural Environment

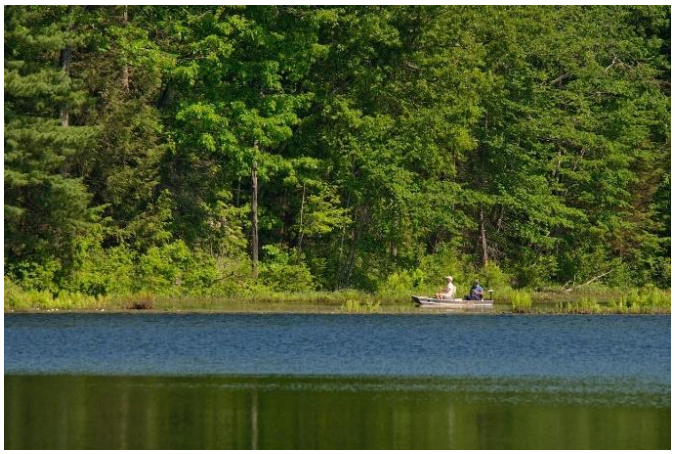


Figure 1-3: Water Resource in Pepperell, Fishing on Heald Pond

Pepperell maintains a rural character and its natural environment is a valuable asset to the community. Natural resources include land, surface water, streams, wetlands, aquifers, wildlife habitat, open space, and other ecologically sensitive areas.

Water Resources

Pepperell has an extensive hydrological system that includes groundwater, ponds, rivers, brooks, aquifers, and wetlands. Approximately 25% of the town's land area (3,760 acres) is comprised of wetlands or falls within the 100-foot buffer zone of a wetland. Many of the town's wetland areas are associated with its rivers and streams.

Pepperell is located at the confluence of the Nashua and Nissitissit Rivers. The Nashua River runs along the Town's border with Groton and Dunstable. The Nissitissit River runs through the northern portion of town before its confluence with the Nashua River. Many of Pepperell's streams are cold water fisheries that provide critical habitat for native fish, including trout.

Robinson Brook and Nutting Brook enter the Nashua River in Pepperell just north of the Groton-Pepperell town line. Robinson Brook drains the area between Groton's Throne Hill and South Street and features a small pond and waterfall in its lower reaches. Its major tributary, Bancroft Brook, begins north of Route 113, near the intersection with Route 119. Beavers have dammed Bancroft Brook at several locations. Nutting Brook begins near Mt. Lebanon and runs south parallel to Shirley Street. Greens Brook enters the Nashua River from the former mill yard near the downtown business district and drains the area between Main Street and River Road, the northern end of Wooltop, and the ponds

on both sides of Elm Street. Varnum Brook joins Greens Brook behind the Pepperell Communications Center. The area drained by Greens Brook and Varnum Brook comprises 600 acres. Gulf Brook and Sucker Brook are important tributaries of the Nissitissit River. One of the Town's drinking water wells is located on Gulf Brook, which has a 2,000-acre watershed. The Gulf Brook headwaters include Stewart Brook and Blood Brook.

Pepperell's largest water body is Pepperell Pond, an impoundment of the Nashua River located between the Pepperell Dam and Route 119, locally known as "The Moat". Other waterbodies in town include Heald Pond and Coon Tree Pond. Pepperell's abundance of natural resources in the area provide opportunities for economic development; however, the Town's proximity to these inland bodies of water increase the Town's vulnerability to natural hazards.



Figure 1-4: Flooding in Pepperell

Flood Hazard Areas

Pepperell lies entirely within the watershed of the Nashua River and has nearly 8 miles of riverfront. FEMA's Flood Hazard Zone mapping indicates flood hazards for parts of Pepperell, including along its main rivers and tributaries. Historically, flooding in Pepperell is common. The areas with the greatest risk of flooding include the segment of the Nashua River that flows through the Village of East Pepperell. Low lying areas near the confluence of the Nashua River, Nissitissit River, Robinson Brook, and Reedy Meadow Brook are also prone to flooding. Extensive flooding of Route 119 at the Groton-Pepperell line has resulted in the closure of Route 119.

Land Resources

Pepperell has set aside multiple parcels for conservation and protection. The Town maintains sixteen conservation areas and almost 20 miles of trails. These lands are an important asset to the community and provide space for hiking, fishing, picnicking, boating, camping (by permit), biking, and other activities. These open spaces also provide habitat for a wide variety of flora and fauna, including several listed rare and endangered species. The Nashoba Conservation Trust, Nissitissit River Land Trust, MA Division of Fisheries and Wildlife, and MA Department of Conservation and Recreation (DCR) own and manage conservation areas in Pepperell.

Areas of Critical Environmental Concern

Much of the eastern portion of Pepperell is part of the Petapawag Area of Critical Environmental Concern (ACEC), which is located along and to the east of the Nashua River, from the Town of Ayer north to New Hampshire. The Squannassit ACEC is located on the west side of the Nashua River adjacent to the Petapawag ACEC.

1.2.4 Pepperell's Infrastructure

Transportation Systems

As noted above, while Pepperell is not directly served by a limited access highway, it is reasonably proximate to U.S. Route 3 via Routes 111 and 113, and access to I-495 is available via State Route 119. The Town has approximately 87.39 miles of roadways, 26.03 of which are arterial roads (major conduit for travel and commerce), 2.62 miles of collector roads (low to moderate capacity roads that provide access from local roads to arterials), and 58.74 miles of local roads. These State-numbered routes and local roadways are the basis of the town's transportation infrastructure and are vital to its economic growth and prosperity. Major roads and evacuation routes in Town include Route 113, Route 119 and Route 111.

There are six bridges in Town that connect the town's roadway system and span waterways, three of which are owned by MassDOT and three are under the Town's jurisdiction. Presently, there are no structurally deficient bridges in Pepperell.[4]

Pepperell lies within the Lowell Regional Transit Authority (LRTA) service area. The LRTA is one of sixteen regional transit authorities across Massachusetts dedicated to increasing the use of mass transit. The LRTA does not currently operate fixed-route bus service in Pepperell. MBTA regional commuter rail service to and from Boston via the Lowell line is available at the Gallagher Terminal in Lowell. Private bus service (Boston Express) to Boston is available at the MassDOT park-and-ride lot located on Route 113 in Tyngsborough, just east of Route 3.[5]

Wastewater

The Sewer Division operates a Grade 6 wastewater treatment facility serving Pepperell and Groton. Designed for 1.1 million gallons per day of sewerage, approximately 550,000 gallons per day are treated at the plant and discharged as effluent to the Nashua River. The collection system transports the wastewater from individual homes and buildings to the treatment plant. The system consists of 11,600 linear feet of sewer interceptor, 13,900 linear feet of lateral sewer, 800 manholes, three siphons (Shawnee Rd. and Lowell St. in Pepperell and Broad Meadow Rd. in Groton) and two river crossings. Wastewater flows by gravity to the treatment plant via a 24-inch line.

A $4.2 million upgrade to the wastewater treatment facility, which included upgrades to staff offices, process buildings, the aeration system, Supervisory Control and Data Acquisition (SCADA) upgrades, and the implementation of chemical addition for final effluent treatment, was completed in 2020.

Water Supply

Pepperell provides public drinking water through five gravel-packed wells located at three well sites: Jersey Street, Nashua Road, and Bemis Road. One of the well heads on Jersey Street is sited within 1,000 feet of Nashua Road in Groton, while the second well head is about 2,000 feet from the Groton line within the same aquifer. Protecting these wells requires a cooperative effort between Pepperell and Groton. The well site on Bemis Road

[4] https://town.pepperell.ma.us/DocumentCenter/View/5052/Pepperell-Master-Plan_transportation-draft-chapter

[5] Ibid.

is comprised of two well heads, and most of the land to the south of the site is protected by the Pepperell Water Division, the Conservation Commission, or the Nashoba Conservation Trust. A third well site is located off Nashua Road near the Hollis, NH line. The Town has purchased property in Hollis to protect the well site.[6] The public water system has 3,200 connections and delivers 250 million gallons annually. The town is permitted by MassDEP to pump a maximum of 1.3 million gallons per day. Pepperell's water system has a storage capacity of 3 million gallons. Improvements to the drinking water system are implemented on a regular basis, including an $8M filtration plant under construction at the Bemis Well site to remove naturally occurring concentrations of iron and manganese.

Stormwater Infrastructure

Although most residents are unaware of the Town's stormwater system, the catch basins, outfalls, swales and pipes that handle falling rain and melting snow are part of the Town's overall infrastructure. Pepperell's stormwater system includes pipes, and numerous culverts, catch basins, detention ponds, and outfalls, as well as over 87 miles of public streets.

Dams

There are four dams within Pepperell. None of these dams serves a flood control purpose. According to the Department of Conservation and Recreation's Office of Dam Safety, the privately-owned Pepperell Paper Company Dam is the only dam currently classified as a significant hazard, given the downstream population. The Nashua River includes Pepperell Pond, a 300-acre impoundment created by the hydro dam at the Eagle Creek Renewable Energy Company, which was recently sold to Ontario Power. The Nashua River has been powering a hydro plant at this location for over 150 years. The hydroelectric power station is a 2,139-kilowatt hydroelectric generating station first developed in 1834. The Pepperell Paper Company built the current dam and powerhouse in 1920. Pepperell Hydro Company upgraded the turbines in 2007 and 2013, completed repairs to the face of the dam, and added downstream fish passage and a plunge pool. In 2012, the 60-year old 13' wood stave penstock was replaced with a 12' steel penstock. The increase in power generated at the site as a result of these upgrades requires that the dam operate under a Federal Energy Regulatory Commission (FERC) license.

The facility currently produces approximately 8 million kilowatt-hours of energy in a typical year from three turbines. Under a 2015 license from the Federal Energy Regulatory Commission (FERC Project No. 12721), a new 67-kW minimum flow turbine will generate an additional 300,000kilowatt hours of energy per year. Power generated is currently purchased by the Reading Municipal Light Department.[7] The FERC license requires upstream and downstream fish passage, an invasive monitoring program, and a recreational component. Canoe and kayak launch and portage areas have been added on property owned by the hydro company both upstream and downstream of the dam to meet the requirements of the recreational component of the FERC license.

[6] https://town.pepperell.ma.us/DocumentCenter/View/5048/Pepperell-Master-Plan_Natural-and-Cultural-Resources_final-chapter_revised-August-2019

[7] https://town.pepperell.ma.us/DocumentCenter/View/5048/Pepperell-Master-Plan_Natural-and-Cultural-Resources_final-chapter_revised-August-2019

1.3 Federal/State Disaster Declarations

Pepperell has experienced twenty (20) natural hazard incidents that triggered federal or state disaster declarations since 1991, listed in **Table 1-1**. Most events involved severe storms and flooding.

Table 1-1
Federal and State Disaster Declarations in Middlesex County 1991-2018

Disaster Name (Date of Event)	Type of Federal Assistance Provided	Declared Areas in Massachusetts
Hurricane Bob (August 1991)	FEMA Public Assistance Project Grants Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk Statewide Hazard Mitigation
No-Name Storm (October 1991)	FEMA Public Assistance Project Grants FEMA Individual Household Program Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk Statewide Hazard Mitigation
Nor'easter-Winter Coastal Storm (December 1992)	FEMA Public Assistance Project Grants FEMA Individual Household Program	Counties of Barnstable, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	Statewide
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	Statewide
October Flood (October 1996)	FEMA Public Assistance Project Grants FEMA Individual Household Program Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Plymouth, Norfolk, Suffolk Statewide Hazard Mitigation
June Flood (June 1998)	FEMA Individual Household Program Hazard Mitigation Grant Program Community Development Block Grant- HUD	Counties of Bristol, Essex, Middlesex, Plymouth, Norfolk, Suffolk, Worcester Statewide Hazard Mitigation
March Flood (March 2001)	FEMA Individual Household Program Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Plymouth, Norfolk, Suffolk, Worcester Statewide Hazard Mitigation
January Blizzard (January 22-23, 2005)	FEMA Public Assistance Project Grants	Statewide
May Rainstorm/Flood (May 12-23, 2006)	Hazard Mitigation Grant Program	Statewide Hazard Mitigation

Disaster Name (Date of Event)	Type of Federal Assistance Provided	Declared Areas in Massachusetts
April Nor'easter (April 15-27, 2007)	Hazard Mitigation Grant Program	Statewide Hazard Mitigation
Flooding (March 2010)	FEMA Public Assistance FEMA Individual and Household Programs SBA Loans Project Grants/Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Plymouth, Norfolk, Suffolk, Worcester Statewide Hazard Mitigation
Nor'easter (January 11-12, 2011)	FEMA Public Assistance Grants Hazard Mitigation Grant Program	Counties of Berkshire, Essex, Hampshire, Middlesex, Norfolk and Suffolk Statewide Hazard Mitigation
Tropical Storm Irene (August 27-28, 2011)	FEMA Public Assistance Grants Hazard Mitigation Grant Program	Counties of Franklin and Berkshire Statewide Hazard Mitigation
"Snowtober" October 29-30, 2011	FEMA Public Assistance Grants Hazard Mitigation Grant Program	Counties of Berkshire, Franklin, Hampshire, Hampden, Worcester and Middlesex Statewide Hazard Mitigation
Hurricane Sandy October 27- Nov 8, 2012	FEMA Public Assistance Grants /Hazard Mitigation Grant Program	Counties of Bristol, Plymouth, Barnstable, Dukes and Nantucket Statewide Hazard Mitigation
Winter Storm Nemo February 8-10, 2013	FEMA Public Assistance Grants Hazard Mitigation Grant Program	Statewide
Winter Storm Juno January 26-29, 2015	FEMA Public Assistance Grants Hazard Mitigation Grant Program	Counties of Worcester, Middlesex, Essex, Suffolk, Norfolk, Bristol, Plymouth, Barnstable, Dukes and Nantucket Statewide Hazard Mitigation
Winter Storm Riley March 2-3, 2018	FEMA Public Assistance Grants Hazard Mitigation Grant Program	Counties of, Essex, Norfolk, Bristol, Plymouth, Barnstable, and Nantucket. Statewide Hazard Mitigation
Winter Storm Skylar March 14-15, 2018	FEMA Public Assistance Grants Hazard Mitigation Grant Program	Counties of Worcester, Middlesex, Essex, Suffolk, and Norfolk, Statewide Hazard Mitigation

1.4 Available Documents

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See **Appendix A** for a list of all reports, plans, studies, and technical information used in the development of the MVP/HMP Five-Year Update. The information was used to develop key findings is cited directly in the document.

Section 2
MVP/HMP Planning Process

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To develop this combination MVP/HMP report, the Town of Pepperell followed the planning process framework consistent with FEMA's hazard mitigation planning guidance and EEA's Community Resilience Building framework, while focusing on local needs and priorities, and maintaining a regional perspective on natural hazard events. The combined process included the following primary steps:

1. **Identifying and Mapping the Hazards** – The Town used data from federal, state, and locally developed data to identify hazards that impact Pepperell. A profile of each hazard was developed including previous occurrences, magnitude and severity of the hazard, and probability for future occurrences. Maps were created to show areas affected by the identified natural hazards, and these maps were used as the basis for developing the risk assessment. The Natural Hazards Risk Assessment is included in Section 3.
2. **Assessing the Critical Community Assets and Potential Damages** – Critical community assets including municipal facilities, infrastructure, vulnerable populations, economic assets, and natural resources were located and compared with hazard data, in order to identify those that may be vulnerable to hazards. Pepperell developed estimates of the potential impacts of certain hazard events on the community, including flooding, flooding impacts due to future climate change, earthquakes, and hurricane winds. Further discussion is included in the Asset Inventory in Section 4 and the Vulnerability Assessment in Section 5.
3. **Reviewing Existing Mitigation** – Pepperell has implemented many mitigation strategies including floodplain zoning (the Master Plan identified the need for a more robust floodplain bylaw. Pepperell's current floodplain "bylaw" falls under the Code of the Town and only addresses work in the floodway), a wetland protection bylaw, and other measures, as well as enforcing the State Building Code. All current municipal mitigation measures were documented and discussed as part of the Capabilities Assessment in Section 6.
4. **Developing Mitigation Strategies** – The Town worked with a designated planning group, local stakeholders, and its consultants to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessment, and existing mitigation measures, in order to determine where additional work is needed to reduce potential future damages from hazard events. The Mitigation Strategy discussed in Section 7 includes goals and objectives, mitigation actions, and an implementation strategy.
5. **Implementing and Updating the Plan** – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a 5-year basis, making preparation for the next Plan update an important on-going activity. A schedule for implementation, Plan Evaluation and Maintenance is included in Section 8.
6. **Plan Approval and Adoption** – Once a final draft of the HMP update is complete, it is sent to MEMA for the state level review, and pending the completion of any revisions, it is sent to FEMA for approval. Once FEMA approves the Plan, FEMA issues a conditional approval pending adoption of the Plan by the Town of Pepperell. The Plan Approval Process is included in Section 9.

The steps outlined above included public participation as an important component of the process, providing critical information about the local occurrence of hazards, a discussion on regional issues, and building support for hazard mitigation activities.

Public participation was accomplished through the Community Resilience Building (CRB) Process. The Town held two public meetings that were open to the general public, to present and discuss aspects of the Hazard Mitigation Plan 5-year Update.

2.1 The Planning Team

A2 a b

The **MVP/HMP Core Team**, listed in Table 2-1, was assembled at the start of the MVP/HMP 5-year update project to solicit input from multiple staff in the Town of Pepperell. The advisory group met to kick-off the HMP planning process. The meeting was led by Lisa Davis, Town Planner, and the Town's consultant, Tighe & Bond. Presentations served to outline the MVP/HMP project, to facilitate discussion on new HMP goals, and to provide guidance for town staff on project responsibilities.

TABLE 2-1
MVP/HMP Core Team

Name	Title & Department
Lisa Davis	Town Planner
David Querze	Emergency Management Director
Beverly Woods	Northern Middlesex Council of Governments (NMCOG)-Regional Planning Agency
Brynn Montesanti	Planning
Paula Terrasi	Conservation Agent/DPW
Ken Kalinowski	DPW Director
Andrew MacLean	Town Administrator
Kalene Gendron	Health Agent

An Advisory Group, listed in Table 2-2, was assembled by the Town Administrator at the start of the project to review draft components and help guide the HMP project efforts.

TABLE 2-2
Advisory Group

Name	Affiliation
Walter Richards	Resident, large employer sector
Denise Pigeon	Superintendent of Schools
Tony Beattie	Resident, agricultural sector
Casey Campetti	Resident, engineering sector
Jim Scarsdale	Resident, energy/tech sector
Kat Belliveau	Resident, environmental sector
Tom Nephew	Resident, real estate

2.2 Outreach Strategy

A2 a c

The Town of Pepperell completed public outreach through the MVP and HMP update, and through other recent climate resiliency efforts undertaken as part of the master planning process. Outreach efforts included core team and advisory group meetings, public meetings, and multi-media outreach, including news articles and press releases.

A3 a b

Table 2-3 summarizes the meetings and public forums conducted throughout the MVP/HMP process.

TABLE 2-3
Meetings and Public Forums

Meeting Date	Topic	Audience	Purpose
July 15, 2019	MVP Kickoff Meeting	Key Town Leaders & Core Team	Identify process and plan CBR workshops
September 26, 2019	Core Team Check-In	Core Team	Asset inventory, risk review, and workshop planning
October 7, 2019	Advisory Meeting #1	Advisory Committee	Hazard list, community asset review, business engagement strategy
October 28, 2019	CRB Workshop #1	Core Team & Public	Outline community assets and vulnerabilities
November 2, 2019	CRB Workshop #2	Core Team & Public	Brainstorm actions and priority levels
January 27, 2020	Advisory Meeting #2	Advisory Committee	Status update, mitigation strategies
February 13, 2020	Core Team Check-In	Core Team	Discuss action grants, review draft deliverables and next steps
April 6, 2020	Public Meeting	Public	Review MVP and HMP planning, community asset inventory, natural hazards, climate change impacts, and mitigation strategies
May 21, 2020	Listening Session	Public	Review MVP Summary of Findings
TBD	Draft HMP Approval	Public	Approve sending draft HMP to MEMA for review

2.2.1 Community Resilience Building Workshops

Stakeholders were invited to participate in two Community Resilience Building (CRB) workshops on October 28th and November 2nd, 2019 at the Pepperell Community Center. The CRB workshop methodology is an "anywhere at any scale" format that draws on stakeholder's wealth of information and experiences to foster dialogue about the strengths and vulnerabilities within the town. Workshop participants interacted at both large and small group levels, using an iterative process to gather input, synthesize ideas across groups, and ultimately develop a set of priority resilience and adaptation actions. A

summary of findings from the workshops and the list of community stakeholders invited to the workshops is included in **Appendix E.**

2.2.2 MVP/HMP Public Meeting

A public meeting to present the draft report and review the high priority actions identified through the CRB workshops was held online as a virtual meeting on April 6, 2020. The Planning Department and the Core Team led the listening session with support from Tighe & Bond. Town staff and community members were in attendance. The listening session included a presentation that briefly reviewed the MVP process, including findings followed by a discussion period. A copy of this presentation is included in **Appendix B**.

2.2.3 Select Board Meeting to approve the Draft HMP

The Draft HMP was presented to the Pepperell Select Board on February 8, 2021, and the Select Board voted to send the draft HMP to MEMA for review on February 22, 2021.

Section 3
Natural Hazard Risks

3.1 Identification of Natural Hazards

3.1.1 State-Wide Hazards

The 2018 Massachusetts State Hazard Mitigation and Climate Action Plan (SHMCAP) provides an in-depth overview of natural hazards in Massachusetts. The SHMCAP identifies fifteen (15) natural hazards that impact or have a history of impacting communities in the Commonwealth, including the following:

Hydrologic & Geologic Flood Related Hazards-

- Inland Flooding- including Riverine Flooding, Urban Drainage Flooding, Ground Failure, Ice Jams, and Dam Overtopping
- Drought
- Landslides
- Coastal Flooding
- Coastal Erosion
- Tsunami

Atmospheric Hazards

- Extreme Temperatures
- Wildfires
- Invasive Species

Extreme Weather

- Hurricane and Tropical Storms
- Nor'easters
- Severe Winter Weather (includes snow, blizzards and ice storms)
- Tornadoes
- Other Severe Weather (includes high winds, thunderstorms)

Non-Climate Related Hazards

- Earthquake

3.1.2 Impacts from Climate Change

Changes in precipitation, temperature, sea level rise, and storm surge due to climate change are summarized in this section. Climate change projections for Pepperell were reviewed using data from the Northeast Climate Science Center (NCSC) at the University of Massachusetts Amherst developed for inclusion in the 2018 SHMCAP. The data used in

downscaled projections for Massachusetts are based on simulations from the latest generation of climate models included in the Coupled Model Intercomparison Project Phase 5, which form the basis of projections summarized in the Intergovernmental Panel on Climate Change Fifth Assessment Report (2013). To ensure consistency with the SHMCAP, Pepperell has included data from the 2018 Statewide and Major Basin Climate projections specifically developed for the Nashua River Basin.

A categorization of traditional natural hazards, within the context of climate change, was included to demonstrate the connections between traditional natural hazard analysis and climate change projections. This categorization also aligns with the four climate change categories included on the Commonwealth's Resilient MA Climate Change Clearinghouse website (http://www.resilientma.org/). Those categories are illustrated as follows:



Changes in Precipitation: Changes in the amount, frequency, and timing of precipitation—including both rainfall and snowfall—are occurring across the globe as temperatures rise and other climate patterns shift in response.



Sea Level Rise: Climate change will drive rising sea levels, and rising seas will have wide-ranging impacts on communities, natural resources, and infrastructure along the Commonwealth's 1,519 tidal shoreline miles.



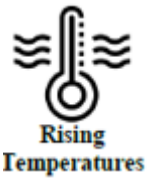
Rising Temperatures: Average global temperatures have risen steadily in the last 50 years, and scientists warn that the trend will continue unless greenhouse gas emissions are significantly reduced. The 9 warmest years on record all occurred in the last 20 years (2017, 2016, 2015, 2014, 2013, 2010, 2009, 2005, and 1998), according to the U.S. National Oceanographic and Atmospheric Administration (NOAA).



Extreme Weather: Climate change is expected to increase extreme weather events across the globe, as well as right here in Massachusetts. There is strong evidence that storms—from heavy downpours and blizzards to tropical cyclones and hurricanes—are becoming more intense and damaging and can lead to devastating impacts for residents across the state.

Table 3-1 from the 2018 SHMCAP shows the climate change and natural hazard taxonomy for the State of Massachusetts.

TABLE 3-1
Climate Change and Natural Hazard Taxonomy

Primary Climate Change Interaction	Natural Hazard	Other Climate Change Interactions	Representative Climate Change Impacts
	Inland Flooding	Extreme Weather	Flash flooding, urban flooding, drainage system impacts (natural and human-made), lack of groundwater recharge, impacts to drinking water supply, public health impacts from mold and worsened indoor air quality, vector-borne diseases from stagnant water, episodic drought, changes in snow-rain ratios, changes in extent and duration of snow cover, degradation of stream channels and wetlands
	Drought	Rising Temperatures, Extreme Weather	
	Landslide	Rising Temperatures, Extreme Weather	
	Coastal Flooding	Extreme Weather	Increase in tidal and coastal floods, storm surge, coastal erosion, marsh migration, inundation of coastal and marine ecosystems, loss and subsidence of wetlands
	Coastal Erosion	Changes in Precipitation, Extreme Precipitation	
	Tsunami	Rising Temperatures	
	Average/Extreme Temperatures	N/A	Shifting in seasons (longer summer, early spring, including earlier timing of spring peak flow), increase in length of growing season, increase of invasive species, ecosystem stress, energy brownouts from higher energy demands, more intense heat waves, public health impacts from high heat exposure and poor outdoor air quality, drying of streams and wetlands, eutrophication of lakes and ponds
	Wildfires	Changes in Precipitation	
	Invasive Species	Changes in Precipitation, Extreme Weather	
	Hurricanes/ Tropical Storms	Rising Temperatures, Changes in Precipitation	Increase in frequency and intensity of extreme weather events, resulting in greater damage to natural resources, property, and infrastructure, as well as increased potential for loss of life
	Severe Winter Storm / Nor'easter	Rising Temperatures, Changes in Precipitation	
	Tornadoes	Rising Temperatures, Changes in Precipitation	
	Other Severe Weather (including Strong Winds and Extreme Precipitation)	Rising Temperatures, Changes in Precipitation	
Non-Climate Influenced Hazards	Earthquake	Not applicable	There is no established correlation between climate change and this hazard

3.1.3 Selection of Hazards that Affect Pepperell

B1 a

As suggested under FEMA planning guidance, the Planning Team reviewed the full range of natural hazards contained in the 2018 SHMCAP and identified natural hazards that have impacted Pepperell in the past or that could impact Pepperell in the future. The hazards selection for Pepperell was made using local expertise from the Planning Team, information from the *2015 Hazard Mitigation Plan*[8] *for the Northern Middlesex Region*, the 2018 SHMCAP and other sources. Climate change impacts are integrated into the natural hazard elements where appropriate, consistent with the strategy used in the 2018 SHMCAP.

The Planning Team reviewed each natural hazard and analyzed the history of occurrence in Town, hazard probability, hazard frequency, geographic extent, and severity of impact. Each of these categories were ranked based on the Hazard Profile Definitions, displayed in **Table 3-2**.

TABLE 3-2
Hazard Profile Definitions [9]

Points	Rank	Description
Hazard Probability (Possible occurrence in the future)		
1	Unlikely	Less than a 1% probability over the next 100 years
2	Possible	1-10% probability in the next year or at least one chance in the next 100 years
3	Likely	10-100% probability in the next year or at least one chance in the next 10 years
4	Highly Likely	Near 100% probability in the next year
Hazard Frequency		
0	Very Low	Events that occur less frequently than once in 1,000 years (less than 0.1% per year)
1	Low	Events that occur from once in 100 years to once in 1,000 years (0.1% - 1% per year).
2	Medium	Events that occur from once in 10 years to once in 100 years (1% - 10% per year).
3	High	Events that occur more frequently than once in 10 years (greater than 10% per year).
Geographical Extent (Area Impacted by a Given Natural Hazard)		
1	Small	Less than 10% of the Town affected
2	Medium	10-50% of the Town affected
3	Large	More than 50% of the Town affected

[8] Hazard Mitigation Plan for the Northern Middlesex Region, 2015 Update; Northern Middlesex Council of Governments

[9] 2018 MA State Hazard Mitigation and Climate Adaption Plan (MA SHMCAP)

TABLE 3-2 (cont'd)
Hazard Profile Definitions [10]

Points	Rank	Description
Severity of Impact from Hazard		
1	Minor	Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e. one or two communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.
2	Serious	Scattered major property damage (more than 10% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services briefly interrupted up to 1 day; some minor injuries.
3	Extensive	Consistent major property damage (more than 25%); major damage public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and possible fatalities.
4	Catastrophic	Property and public infrastructure destroyed (more than 50%); essential services stopped for 30 days or more, multiple injuries and fatalities.

The Planning Team analyzed each type of hazard relative to the Town of Pepperell, as shown in **Table 3-3** on the following page. The final Hazard Risk Ranking is determined by totaling the point value for all categories for each type of hazard.

[10] 2018 MA State Hazard Mitigation and Climate Adaption Plan (MA SHMCAP)

TABLE 3-3
Relevant Natural Hazards for the Town of Pepperell

Type of Hazard	History of Occurrence (Y/N)	Hazard Probability	Hazard Frequency	Geographic Extent	Severity of Impact	Hazard Risk Ranking
Hydrological Hazards						
Inland Flooding	Yes	2	3	2	2	**9**
Coastal Flooding	No	0	0	0	0	N/A
Drought	Yes	3	2	3	2	**10**
Atmospheric Hazards						
Extreme Temperatures	Yes	4	3	3	2	**12**
Hurricanes/ Tropical Storms	Yes	2	0	3	3	**8**
Severe Weather – Strong Wind and High Precipitation	Yes	4	3	3	2	**12**
Severe Winter Storm/ Nor'easter	Yes	4	3	3	2	**12**
Tornadoes	No	1	0	1	3	**5**
Geological Hazards						
Coastal Erosion	No	0	0	0	0	N/A
Earthquake	Yes	2	1	3	4	**10**
Landslide	No	1	1	1	2	**5**
Tsunami	No	0	0	0	0	N/A
Other Hazards						
Wildfires	Yes	3	2	2	4	**11**
Invasive Species	Yes	4	3	3	1	**11**

Pepperell has elected to include twelve (12) of the fifteen (15) hazards from the SHMCAP as the basis for evaluating hazards for the Pepperell Hazard Mitigation Plan (HMP) 5-year update. Coastal natural hazards, including coastal flooding, coastal erosion and tsunamis, are not applicable for this inland community.

The Types of Hazard were then assigned a ranking of between 1 and 5, depending on its overall Hazard Risk Ranking. **Table 3-4** below demonstrates the correlation between the Hazard Risk Ranking and the Priority Hazards for the Town of Pepperell.

TABLE 3-4
Priority Hazard Ranking

Hazard Risk Ranking	Pepperell Priority Hazards Ranking	Description
12 - 11	#1	High Priority
10 - 9	#2	
8 - 7	#3	
6 - 5	#4	
4 - 3	#5	Lowest Priority

Based on the ranking scale provided in Table 3-4, the highest ranked natural hazards for Pepperell include:

- Severe Weather-Strong Winds and Extreme Precipitation
- Severe Winter Storms / Nor'easters
- Extreme Temperatures

The lowest ranked natural hazards for Pepperell include:

- Tornadoes
- Landslides

3.1.4 Pepperell Climate Change Projections

Researchers from the Northeast Climate Science Center at the University of Massachusetts Amherst prepared projections for changes in temperature, precipitation, and sea level rise for the entire state, as well as for each major watershed, in recognition that there are differences regionally. The Town of Pepperell lies entirely within the Nashua River watershed. The information presented in this section is specific to this watershed and was excerpted from Massachusetts Climate Change Projections, dated March 2018[11].

The researchers also developed downscaled projections for changes in temperature, precipitation, and sea level rise for the Commonwealth of Massachusetts. EEA has provided support for these projections to enable municipalities, industry, organizations, state government and others to utilize a standard, peer-reviewed set of climate change projections that show how the climate is likely to change in Massachusetts through the end of this century. These projections are incorporated into the 2018 SHMCAP. To ensure consistency with the SHMCAP, Pepperell has adopted data developed for the Nashua River Watershed region from the State-wide climate change projections (2018, NE CASC and EEA[12]). Climate change for each natural hazard risk is discussed within the hazard profiles below.

3.2 Hazard Profiles

Hazard profiles are provided in Sections below for each of the eleven (11) natural hazards that could impact Pepperell in the future or that have impacted the Town in the past. Each hazard profile includes a definition and description of the hazard, previous occurrence and extent, local areas of impact, and probability for future occurrence. A discussion of previous occurrences includes historic data. Evaluation of the extent or severity of the hazard includes the measuring scale for a specific hazard. Locally identified areas of impact are shown on maps for the hazard whenever possible. The probability of future occurrences is based on best available science and historic events using the hazard probability scale provided in **Table 3-3**.

B2 a b c.

[11] EEA (2017). "Statewide and Major Basins Climate Projections Final, 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan Natural Hazards Risk Assessment"

[12] Ibid.

For each natural hazard, the major vulnerability issues for four key sectors are summarized. The key sectors or categories of community assets include:

- **Societal** - Vulnerable populations and cultural assets
- **Infrastructural** - Built environment, including municipal and critical structures
- **Environmental** – Natural environmental resources
- **Economic** – Commercial and industrial entities

Resources used to develop the natural hazard profiles are referenced as footnotes throughout the section.

3.2.1 Hydrological Hazards

Flooding is not the highest rated hazard in Pepperell but may occur as the direct result of heavy rains, nor'easters, and dam failure. Coastal flooding does not impact this inland community. At the other end of the spectrum, drought impacts are included as a hydrologic hazard for Pepperell, primarily based on the negative impacts to water supplies and agriculture.

3.2.1.1 Inland Flooding

Background

Nationally, inland flooding causes more damage annually than any other severe weather event[13]. Between 2007 and 2014, the average annual cost of flood damages in Massachusetts was more than $9.1 million (NOAA, 2014). Inland flooding is the result of moderate precipitation over several days, intense precipitation over a short period, or melting snowpack. Developed, impervious areas can contribute to inland flooding. Increases in precipitation and extreme storm events will result in increased inland flooding. The most common types of inland flooding are described below.

- ***Riverine Flooding*** - Riverine flooding often occurs after heavy rain. Areas of the state with high slopes and minimal soil cover (such as found in western Massachusetts) are particularly susceptible to flash flooding caused by rapid runoff that occurs in heavy precipitation events and in combination with spring snowmelt, which can contribute to riverine flooding. Frozen ground conditions can also contribute to low rainfall infiltration and high runoff events that may result in riverine flooding. Some of the worst riverine flooding in Massachusetts' history occurred as a result of strong nor'easters and tropical storms in which snowmelt was not a factor. Tropical storms can produce very high rainfall rates and volumes of rain that can generate high runoff when soil infiltration rates are exceeded. Inland flooding in Massachusetts is forecast and classified by the National Weather Service's (NWS) Northeast River Forecast Center as minor, moderate, or severe based upon the types of impacts that occur. Minor flooding is considered a "nuisance only" degree of flooding that causes impacts such as road closures and flooding of recreational areas and farmland. Moderate flooding can involve land with structures becoming inundated. Major flooding is a widespread, life-

[13] U.S. Climate Resilience Toolkit, 2017

threatening event. River forecasts are made at many locations in the state where there are United States Geological Survey (USGS) river gauges that have established flood elevations and levels corresponding to each of the degrees of flooding.

- ***Urban Drainage Flooding*** - Urban drainage flooding entails floods caused by increased water runoff due to urban development and drainage systems that are not capable of conveying high flows. Drainage systems are designed to remove surface water from developed areas as quickly as possible, to prevent localized flooding on streets and other urban areas. Such systems make use of a closed conveyance system that channels water away from an urban area to surrounding streams, bypassing natural processes of water infiltration into the ground, groundwater storage, and evapotranspiration (water uptake and respiration by plants). Since drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding can occur more quickly and reach greater depths than if there were no urban development at all (Wright, 2008). In urban areas, basement, roadway, and infrastructure flooding can result in significant damage due to poor or insufficient stormwater drainage.
    - *Overbank Flooding* **-** Occurs when water in rivers and streams flows into the surrounding floodplain or into "any area of land susceptible to being inundated by floodwaters from any source." (FEMA, 2011b)
    - *Flash Flooding* **–** Characterized by "rapid and extreme flow of high water into a normally dry area, or a rapid rise in a stream or creek above a predetermined flood level." (FEMA, 2011b).
- ***Ground Failures -*** Flooding and flood-related erosion can result from various types of ground failures, which include mud floods and mudflows, and to a much lesser degree, subsidence, liquefaction, and fluvial erosion.
    - *Mud floods* - floods that carry large amounts of sediment, which can at times exceed 50 percent of the mass of the flood, and often occur in drainage channels and adjacent to mountainous areas.
    - *Mudflows* – a specific type of landslide that contains large amounts of water and can carry debris as large as boulders. Both mudflows and mud floods result from rain falling on exposed terrain, such as terrain impacted by wildfires or logging. Mud floods and mudflows can lead to large sediment deposits in drainage channels. In addition to causing damage, these events can exacerbate subsequent flooding by filling in rivers and streams.
    - *Subsidence* – the process where the ground surface is lowered from natural processes, such as consolidation of subsurface materials and movements in the Earth's crust, or from manmade activities, such as mining, inadequate fill after construction activity, and oil or water extraction. When ground subsides, it can lead to flooding by exposing low-lying areas to groundwater, tides, storm surges, and areas with a high likelihood of overbank flooding.
    - *Liquefaction* - when water-laden sediment behaves like a liquid during an earthquake, can result in floods of saturated soil, debris, and water if it occurs on slopes. Floods from liquefaction are especially common near very steep slopes.

- *Fluvial erosion* – the process in which the river undercuts a bank, usually on the outside bend of a meander, causing sloughing and collapse of the riverbank. Fluvial erosion can also include scouring and down-cutting of the stream bottom, which can be a problem around bridge piers and abutments. In hillier terrain where streams may lack a floodplain, fluvial erosion may cause more property damage than inundation. Furthermore, fluvial erosion can often occur in areas that are not part of the 100- or 500-year floodplain.

- ***Ice Jam –*** An ice jam is an accumulation of ice that acts as a natural dam and restricts the flow of a body of water. There are two types of ice jams: a freeze-up jam and a breakup jam. A freeze-up jam usually occurs in early winter to midwinter during extremely cold weather when super-cooled water and ice formations extend to nearly the entire depth of the river channel. This type of jam can act as a dam and begin to back up the flowing water behind it. The second type, a breakup jam, forms as a result of the breakup of the ice cover at ice-out, causing large pieces of ice to move downstream, potentially piling up at culverts, around bridge abutments, and at curves in river channels. Breakup ice jams occur when warm temperatures and heavy rains cause rapid snowmelt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to a thickness great enough to raise the water level and cause flooding upstream of the obstruction. The Ice Jam Database, maintained by the Ice Engineering Group at the U.S. Army Corps of Engineers (USACE) Cold Regions Research and Engineering Laboratory currently consists of more than 18,000 records from across the U.S.

FEMA Flood Hazard Areas

Areas at risk of flooding are mapped by FEMA as part of the National Flood Insurance Program (NFIP) established in 1968 to reduce the nation's flood losses via local floodplain management practices. A floodplain is defined by the NFIP as any land area susceptible to being inundated by floodwaters from any source[14]. FEMA's flood maps, the Flood Insurance Rate Maps (FIRM), delineate flood zones that are defined according to varying risk of, or potential for, flooding due to the land area's characteristics (proximity to a waterbody, topography/slope) and current waterbody conditions (water levels, historic storm experience).

The frequency and severity of flooding are measured based on the probability that a certain river discharge (flow) will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different flooding levels. For example, the 100-year flood has a 1-percent chance of being equaled or exceeded in any given year. The 100-year flood, or 1% chance annual flood, is **not** inherently a flood that will occur once every 100 years.

The 100-year flood is used by the NFIP to guide floodplain management and determine the need for flood insurance. The term "500-year flood" or 0.2% annual chance flood, is the flood that has a 0.2-percent chance of being equaled or exceeded each year.

[14] https://www.fema.gov/national-flood-insurance-program/definitions

In 1981, FEMA published flood maps for Pepperell showing 100-year flood zones for the Town. However, the flooding along the Nashua River, lower sections of the Reedy Meadow Brook, and the Nissitissit River, as shown on the FEMA maps, was less than the actual flooding experienced during the 1936 flood in those locations. Therefore, in November 1984, Town Meeting incorporated into the Town's Zoning Bylaws, the 1936 Nashua River flood elevations, as shown by the Raytheon Company's mapping of U.S. Army Corps of Engineers flood data. Wherever applicable, these actual flood records provide the base flood elevation for local regulatory purposes. The FEMA maps were updated again to more closely reflect the actual flooding conditions seen historically. The current effective FIRM date is 6/4/2010. FEMA maps for the Nashua River watershed have recently been updated to accurately depict floodplain elevation levels using field survey data of the Nashua and Nissitissit Rivers and other flood prone areas in Pepperell. The draft FEMA maps are expected to be available for public review in 2021 and the process of adopting the draft FEMA maps will follow.

Previous Occurrence and Extent of Inland Flooding in Pepperell

Flooding in Massachusetts is often the direct result of frequent weather events, such as coastal storms, nor'easters, tropical storms, hurricanes, heavy rains, and snowmelt. Rainfall events are the most consistently influential drivers of riverine flooding in the Commonwealth. The state receives approximately 48 inches of rain per year on average, with average monthly rainfall between 3 and 4 inches in all regions of the state. However, heavy rainfall events occur regularly. As a result, riverine flooding affects the majority of the communities in the Commonwealth, including Pepperell.

As shown in **Figure 3-1** below, Pepperell has been subject to fourteen (14) FEMA-declared flood disasters between 1954 and 2017:

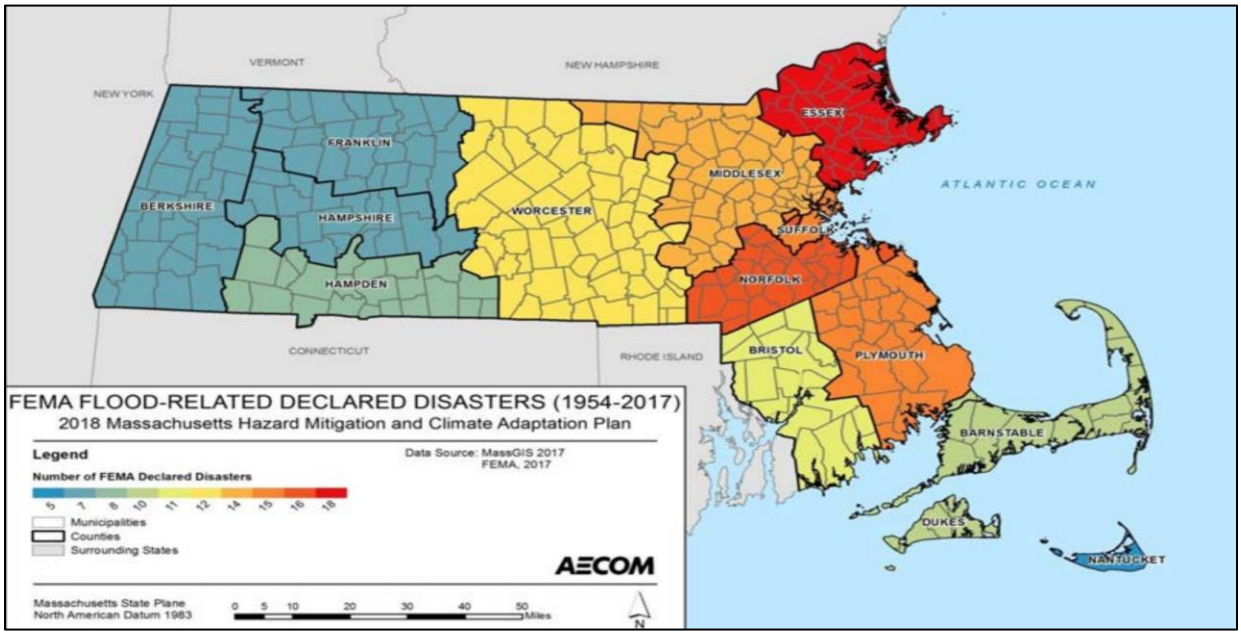


Figure 3-1 – **FEMA Flood-Related Declared Disasters (1954-2017)**

Locally Identified Areas of Impact

Pepperell lies entirely within the watershed of the north-flowing Nashua River, and has almost eight miles of riverfront. U.S. Geological Survey maintains a gauging station that shows an average flow of 546 cubic feet per second. Historically, the Nashua River has been prone to flooding. The 1936 flood destroyed the Main Street Bridge in East Pepperell. This flood resulted from a series of interrelated weather events: above average snowfall with cold temperatures and frozen ground, followed by a storm that brought warmer temperatures, snowmelt, and successive days of rain, resulting in rapid runoff and massive flooding. Roads were awash, and factories and homes were inundated. The peak flow on the Nashua River during the March 1936 flood was 20,900 cubic feet per second (compared with an average flow of 546 cfs), as measured by USGS.

In the May 2006 flood, the Nashua River crested at 9.38 feet, which is 1.38 feet over flood stage. Historically, flood damage has been concentrated in East Pepperell on the Nashua River. Since the Town's early beginnings, activity has concentrated around East Pepperell on the banks of the Nashua River, so that portions of the floodplain have been developed residentially, commercially, and industrially. Low-lying areas of Pepperell Center are subject to periodic flooding in the area near the confluence of the Nashua River, Nissitissit River, and Reedy Meadow Brook.

Pepperell has four miles of riverfront on the Nissitissit River. The Nissitissit River is protected under the Squannacook and Nissitissit Rivers Sanctuary Act (MGL Chapter 132A, section 17). Its confluence with the Nashua River is approximately one mile north of the East Pepperell Dam, near the Covered Bridge.

Varnum Brook and Greens Brook, both tributaries of the Nashua, are prone to flooding. Greens Brook joins the Nashua through the former mill yard. Just upstream, the area between Main Street and River Road is also prone to flooding. Varnum Brook joins Green's Brook further upstream behind the Communications Center. Upstream it crosses under the Route 111/113 rotary, where it collects runoff from both sides of Park Street. The combined area drained by Greens Brook and Varnum Brook is 600 acres in size.

Further downstream of the Greens Brook confluence with the Nashua, is a flood prone area on the west bank of the Nashua River, between the Nashua and the Nissitissit Rivers. The area is known as "The Land between the Rivers" and extends about one-half mile upstream from the confluence. On the opposite bank, the Nashua is joined by Reedy Meadow Brook to form a complex hydrological dynamic.

During meetings with local officials it was reported that significant flooding has occurred along Route 119 near the Nashua River, requiring closure of the roadway. The Town attributes this problem, in part, to the collection of debris on the upstream side of the Route 119 Bridge across the River. It may be possible to lessen the severity of the flooding through improved maintenance of the bridge structure by MassDOT.

There are no flood control works on the rivers and streams in the Town of Pepperell. The dam on the Nashua Rivers offers no flood protection. In 1974, Pepperell entered the NFIP, making residents eligible to buy subsidized flood insurance. As a result, a floodplain bylaw was enacted as part of the Town's General Bylaw and the draft Master Plan suggests

updating the floodplain bylaw to ensure protection of floodplain areas not just the floodway, which is currently addressed in the Code of Pepperell.

Repetitive Loss Structures

B4 a

The frequency and locations of flood hazard events in Pepperell can be estimated based on the reported loss occurrences for repetitive loss properties and from local knowledge of flood hazard areas.

As defined by the Community Rating System (CRS) of the NFIP, a repetitive loss property[15] is any property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. A severe repetitive loss property is any NFIP-insured property that has met at least one of the following paid flood loss criteria since 1978, regardless of ownership:

- Four or more separate claim payments of more than $5,000 each (including building and contents payments); or
- Two or more separate claim payments (building payments only) where the total of the payments exceeds the current value of the property.

There were 22 policies in force within Pepperell as of April 23, 2019, which included 19 residential and 3 non-residential properties.[16] There were 15 repetitive loss claims in Pepperell, according to claims data dating from July 2, 1981 to April 23, 2019[17]. Of the fifteen repetitive flood loss properties, 9 were residential and 6 were commercial. The total losses paid were $186,125.

Inland Flooding with Climate Change

Precipitation and temperature changes due to climate change are key factors that will impact inland flooding in the future. These changes have the potential to modify the current floodplain, impacting areas of Pepperell that have not flooded in the past. According to the Northeast Climate Impacts Assessment report of 2007, annual precipitation levels are expected to increase across New England by as much as fourteen percent (14%) by the end of this century, with an estimated thirty percent (30%) increase in precipitation during winter months. Changes in precipitation and extreme weather can trigger the following:

- **Changes in precipitation → more intense and frequent downpours:** More intense downpours often lead to inland flooding as soils become saturated and stop absorbing more water, river flows rise, and urban stormwater systems become overwhelmed. In inland areas, flooding may occur as a result of heavy rainfall or snowmelt.
- **Extreme weather → more frequent severe storms:** Climate change is expected to result in an increased frequency of severe storm events. This would

[15] For more information on repetitive losses see http://www.fema.gov/business/nfip/replps.shtm

[16] https://isource.fema.gov/cis/insurance.action?method=getOccupancy

[17] FEMA Region 1 and Massachusetts State Floodplain Coordinator correspondence

directly increase the frequency of flooding events and could increase the chance that subsequent precipitation will cause flooding if water levels are still elevated.

- **Changes in precipitation → episodic droughts:** Vegetated ground cover has been shown to significantly reduce runoff. If drought causes vegetation to die off, this flood-mitigating capacity is diminished.

The climate projections suggest that the frequency of high-intensity or extreme rainfall events will trend upward. As shown in **Figure 3-2**, the amount of precipitation released by storms in the northeast has increased by 71% from the baseline level (recorded 1901-1960) and present-day levels (measured 2001-2012)[18].

Overall, it is anticipated that the severity of flood-inducing weather events and storms will increase, with events that produce sufficient precipitation to present a risk of flooding likely increasing. A single intense downpour can cause flooding and widespread damage to property and critical infrastructure.

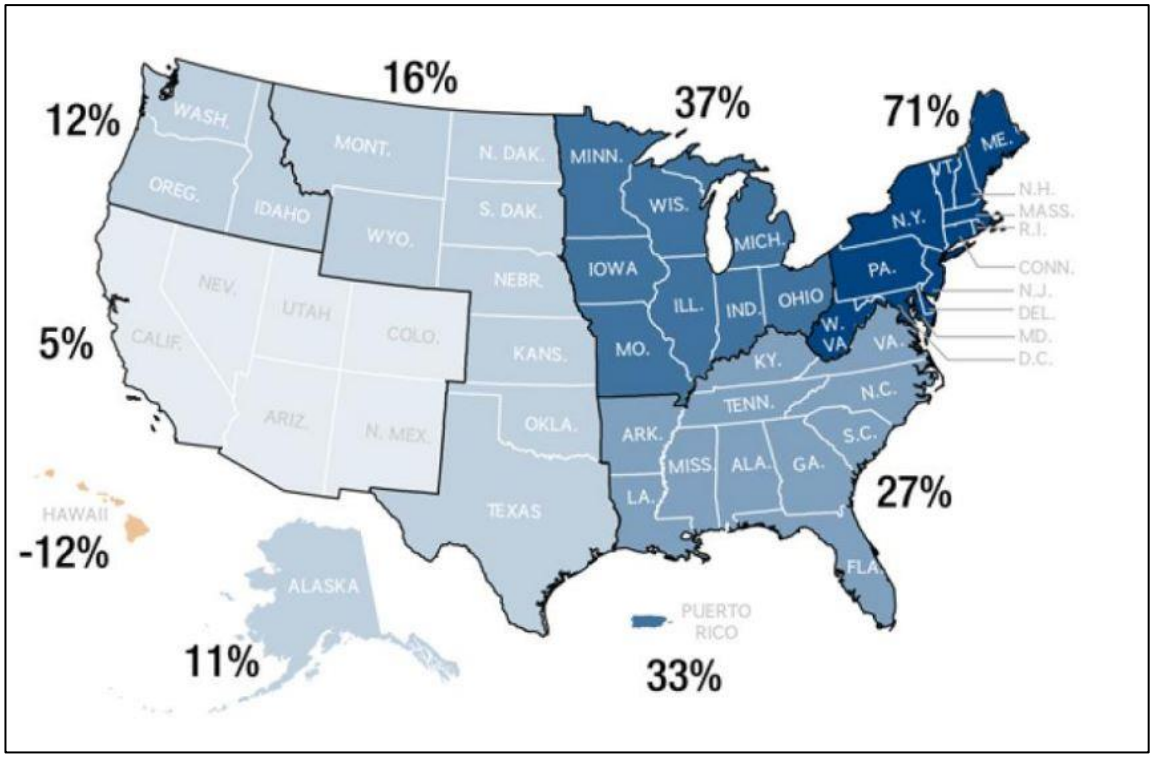


Figure 3-2 – Nationwide Comparison of Increase in Precipitation (source: NCA, 2014)

The number of days each year with extreme precipitation over one inch are variable for the Nashua River Basin, fluctuating between loss and gain of days (**Table 3-5**). Seasonally, winter season is expected to see the highest projected increase of 0-1 days by mid-century and 0-2 days by the end of century.

[18] 2018 MA SHMCAP

Table 3-5
Projected Annual Frequency of Future Extreme Precipitation Events in the Nashua River Basin[19]

Average Annual Number of Days	Projected Change 2030s	Projected Change 2050	Projected Change 2070	Projected Change 2100
7.34 Days >1" precipitation	-0.25 – 1.96	0.54 – 3.32	1.14 – 3.09	1.05 – 4.00
0.7 Days >2" precipitation	-0.05 – 0.30	-0.01 –0.34	-0.02 – 0.38	0.03– 0.42
0.02 Days >4" precipitation	-0.01 – 0.03	-0.01 – 0.04	-0.01 – 0.03	-0.02 – 0.05

Probability of Future Occurrence

The potential effects of climate change significantly impact inland flooding due to the increased frequency of severe storm events including nor'easters and hurricanes. Global climate change models suggest that Middlesex County may experience additional inland flooding as precipitation increases by 2100[20]. The Planning Team has determined that it is **LIKELY** that flooding will impact the Town of Pepperell in the future. The Town has implemented both structural and non-structural measures to withstand floods from heavy rain, and dam/culvert failure. The Town is enforcing the State Code in flood prone areas (100-year floodplain as shown on the FIRM)

In spite of these best efforts, a storm with sufficient magnitude could result in damages far greater than any the community has known, impacting the economy, natural resources, cultural and historic assets, and buildings and structures. Therefore, it is in the best interest of the Town and residents to understand how climate change may influence flooding and begin proactive planning to adapt or mitigate these impacts.

Extreme Precipitation Impact on Engineering Design

Estimating changes in the expected intensity of future rainfall events is constantly evolving, with technological advancements, increases in available precipitation records, and climate change models. Utilizing rainfall values that reflect the changing climate are important in engineering design. Accounting for extreme precipitation is necessary to design adequate capacity in drainage system and provide sufficient structural elevation to avoid flooding.

There are a variety of opinions on the definition of "extreme precipitation", and which precipitation metric to use for comparison over time. Rainfall can be compared using statistical thresholds (e.g. 95th percentile), absolute thresholds (e.g. greater than 1 inch)

[19] NECSC, 2017

[20] 2018 MA SHMCAP

and return intervals (e.g. 100-year storm), all of which can be applied over a range of time scales from minutes to years.[21]

The "design storm" approach is a practical way to compare extreme precipitation amounts that is consistent with values used for engineering design. Rainfall amounts are compared over time intervals based on storms of similar size and duration called recurrence intervals or "return period," typically ranging from a 2-year to 100-year storm event. For example, a 2-year storm event has a 1 in 2 chance of occurring in a given year, or a 50% probability. A 100-year storm event has a 1 in 100 chance of occurrence in a given year, or a 1% probability. A "design storm" is based on the historical precipitation records for a particular return interval and duration of the storm event, such as a 2-year, 24-hour storm.

To assist the Town in planning for climate change, methods to calculate future design storm events for a variety of recurrence intervals were reviewed. Available data included a review of data from the National Oceanic and Atmosphere Administration (NOAA) Atlas 14, Northeast Regional Climate Center (NRCC) data and the 2017 NCSC state-wide precipitation climate change data.

The National Oceanic and Atmosphere Administration (NOAA) Atlas 14 has been used for a number of years as an improved source of extreme precipitation. The Atlas was completed in 2016 and is the most current rainfall intensity dataset in Massachusetts. The NRCC or Cornell data is a second commonly used source for extreme precipitation. **Table 3-6** shows the 24-hour rainfall depths for Pepperell, Massachusetts using both NOAA Atlas 14 and NRCC data, choosing the higher value for each recurrence interval shown.

TABLE 3-6
Pepperell, MA 24-hour Rainfall Depth Estimates[22]

Recurrence Interval Storm Event	NOAA 24-hour Rainfall Depth (inch)
2 year	3.15
10 year	4.75
25 year	6.00
50 year	7.17
100 year	8.57

Implications for Inland Flooding with Climate Change

Rainfall is expected to increase in spring and winter months particularly in Massachusetts, with increasing consecutive dry days in summer and fall. More total rainfall can have an impact on the frequency of minor but disruptive flooding events, especially in areas where storm water infrastructure has not been adequately sized to accommodate higher levels.

[21] Boston Research Advisory Group, "Climate Ready Boston Climate Change and Sea Level Rise Projections for Boston", June 2016

[22] Northeast Regional Climate Center (http://precip.eas.cornell.edu/data.php?1587585113182)

More intense downpours often lead to inland flooding as soils become saturated and stop absorbing more water, river flows rise, and the capacity of storm water systems is exceeded. Flooding may occur as a result of heavy rainfall, snowmelt, ice or dam failure, but precipitation is the strongest driver of flooding in Massachusetts. Winter flooding is also common in the state, particularly when the ground is frozen. Pepperell experienced 14 flood-related disaster declarations from 1954-2017 with many of these occurring in winter, or early spring.

Pepperell's current FEMA Flood Insurance Maps provide an important baseline for gaging the extent of future flood condition; however, it is important to note that FEMA defined floodplain areas are based on historic and existing conditions; but do not include future or projected climate conditions. The floodplain will expand in the future as extreme precipitation impacts inland flood levels.

Flooding Impacts on Pepperell's Four Key Sectors

Major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how flooding will impact them, as shown in **Table 3-7** below.

TABLE 3-7
Inland Flooding Exposure and Vulnerability by Key Sector[23]

Sector	Vulnerability
Infrastructural	Flooding can wash out sections of roadways and bridges as well as cause extensive damage to public utilities and disruptions to delivery services.
Environmental	Severe floods cause a wide range of environmental impacts. Animals can lose their habitats if habitat elements are swept away or destroyed. Riverbank and soil erosion transform existing habitats and deposit sediment to downstream areas. If high levels of nutrients are present in the soil, this can lead to eutrophication in downstream ecosystems.
Economic	Economic losses due to a flooding include, but are not limited to, damages to buildings (and their contents) and infrastructure, agricultural loses, business interruption (including loss of wages), impacts on tourism, and tax base.
Societal	Populations that are particularly vulnerable to this hazard include the Economically disadvantaged, who may face greater difficulty in evacuating, and individuals with medical needs who may not have been able to receive required medical care either during evacuation or if isolated by flooded infrastructure.

Dam Failure

A dam is an artificial barrier that has the ability to impound water for the purpose of storage or control of water. Dam failure is a catastrophic type of failure characterized by a sudden, rapid, and uncontrolled release of impounded water. Dam failure can occur as a result of structural failure, independent of a hazard event, or as the result of the impacts

[23] 2018 MA SHMCAP

of a hazard event such as flooding associated with storms or an earthquake. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters. Dam failure in general is infrequent but has the potential for severe impacts. An issue for dams in Massachusetts is that many were built in the 19th century without the benefits of modern engineering or construction oversight.

The Massachusetts DCR has three hazard classifications for dams:

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

In general, DCR requires that dams rated as low hazard be inspected every ten years, while dams that are rated as significant hazards must be inspected every five years. High hazard dams must be inspected every two years. Owners of dams are responsible for having their dam inspected. MGL Chapter 253 and 302 CMR 10.00 requires that dam owners prepare, maintain and update Emergency Action Plans for all High Hazard Potential dams and certain Significant Hazard Potential dams.

Non-jurisdictional dams are not regulated by the Office of Dam Safety or under their jurisdiction. Typically, these dams are under 6 feet in height and/or under 15 acre-feet in storage and do not have an assigned 'Hazard Code'. Dams owned and regulated by the Federal Government are also typically non- jurisdictional but do have an assigned Hazard Code.

Culvert Failure

A culvert is defined as a structural opening under a roadway that allows water to pass from one side of a roadway to the other. A culvert can impound water similar to a dam under certain flood conditions, and if conditions are extreme, culverts can fail, causing road and property damage. A culvert can fail under the following conditions:

- clogged with debris and sediment, invasive species and other vegetation;
- buildup of flood water or on the upstream side of the culvert exceeding the capacity of the culvert;
- loss of structural integrity;
- culvert and road are washed out during a heavy rain or from snowmelt; or
- soil around the culvert erodes, and without support, the culvert will buckle or sag and the culvert will collapse.

Previous Occurrence and Extent

Historically, dam failure occurrence has been rare in the Middlesex Region. However, many of the dams within the Region are more than 100 years old, and some are even older, meaning the possibility of dam failure is not inconceivable. There have been several culverts that have been washed out due to flooding in the past.

Locally Identified Areas of Impact

There is one significant dam in Pepperell. The Main Street or Pepperell Pond Dam is located on the Nashua River. The Turner Dam was removed in 2015 through a MA Division of Ecological Restoration Priority Project. **Table 3-8** lists all remaining Pepperell Dams and their Hazard Classifications.

Table 3-8:
Hazard Classification of Pepperell Dams

Dam Name	Impoundment Name	Hazard Class
Pork Barrel Dam	Pork Barrel Pond	Non-jurisdictional
Nashua River Dam/ Pepperell Paper Co. Dam (Also known as the Nashua River Dam)	Nashua River	Significant
Heald Pond Dam	Heald Pond	Low

Many areas in Pepperell are impacted by poorly functioning culverts. A marshy basin bounded by East Street and Lowell Road receives runoff from more than 300 acres. Two culverts through the railroad embankment channel the flow toward the Nashua River. At flood stage the River backs up through one of the culverts, exacerbating flooding in this area. In recent years, beaver activity has caused extensive impoundment of water, flooding buried sewer lines and street storm drains. Attempts by the Town and the Massachusetts Department of Conservation and Recreation to manage the beaver population have resulted in some improvement. This past year, DCR repaired one of the culverts located under the railroad embankment in response to flooding on the Shawnee Road. The roots of a large 90' white pine tree directly above the culvert has caused the granite blocks to collapse inside of the culvert, further restricting the flow. Now that the culvert has been repaired and a beaver deceiver has been installed by DCR, flooding has been addressed. The second culvert operates properly but the culvert upstream of it, under Shawnee Road, is occasionally the site of beaver activity. Monitoring the beaver activity at both culverts is constant. The flooding of Lawrence Street, just north of the confluence of Gulf and Stewart Brooks at two undersized 48" side-by-side culverts, has occurred twice within the past year. The CMP culverts recently failed, causing the road to collapse. An emergency in-kind repair of the culverts was completed by the Pepperell Highway Division, and the site has been evaluated and a Reconnaissance Study is currently being drafted by Stantec Engineering to identify the appropriate replacement structures.

During meetings with local officials it was reported that significant flooding has occurred along Route 119 near the Nashua River, requiring closure of the roadway. The Town

attributes this problem, in part, to the collection of debris on the upstream side of the Route 119 Bridge across the River. It may be possible to lessen the severity of the flooding through improved maintenance of the bridge structure by MassDOT.

Probability of Future Occurrence

Climate change is likely to increase the severity of extreme precipitation events, increasing the probability that dams and culverts will exceed their capacity. The Core Team determined that based on past history of culvert failure events it is **LIKELY** that this natural hazard risk will impact the planning area in the future.

Dam/Culvert Failure Impacts on Pepperell's Key Sectors

Major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine the impact of dam and culvert failure as shown in **Table 3-9** below.

TABLE 3-9
Dam and Culvert Failure Exposure and Vulnerability by Key Sector[24]

Sector	Vulnerability
Infrastructural	Flood waters from dam and culvert failure may potentially cut off evacuation routes, limit emergency access, and create isolation issues. Utilities such as overhead power lines, cable and phone lines in the inundation zone are also vulnerable.
Environmental	Following a dam failure, the impounded reservoir would experience a reduction in water levels, displacing aquatic organisms and exposing the benthic community to air. Downstream, habitat impacts would likely include direct mortality of flora and fauna, toppling of trees and removal of soil and inhibition of plant respiration in areas that remain flooded for long periods of time.
Economic	In addition to buildings and infrastructure in the inundation area, any habitat or agricultural operations in the area would also be exposed to this hazard, which could cause extensive economic damage if crops were ruined.
Societal	Given the relatively short warning time associated with dam failure, culvert or tide gate failure, any population that is exposed to inundation and cannot rapidly evacuate would be considered vulnerable. This population includes households without vehicles, the elderly, and young children who may be unable to get themselves out of the inundation area.

3.2.1.2 Drought

Background

Drought is a period characterized by long durations of below normal precipitation.[25] Drought conditions typically last a season or more and result in water shortages, causing

[24] 2018 MA SHMCAP
[25] NOAA May 2008, Drought Public Fact Sheet (http://www.nws.noaa.gov/om/brochures/climate/DroughtPublic2.pdf)

adverse impacts on vegetation, animals, and people. A drought may also increase the probability of a wildfire occurring.

Drought characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that area. Drought is a temporary aberration, and is different from aridity, which is a permanent feature of climate in areas where low precipitation is normal, such as in a desert.

Previous Occurrence and Extent of Drought in Pepperell

The entire planning area can be affected by drought, impacting local water resources and often requiring voluntary or required water-use restrictions. In Massachusetts, drought is defined based on a combination of several indices, as defined by the Massachusetts Drought Management Plan (EEA and MEMA, 2019)[26]. These indices are:

1. Precipitation
2. Streamflow
3. Groundwater Levels
4. Lakes and impoundments
5. Fire danger (Keetch-Byram Drought Index, KBDI)
6. Evapotranspiration (Crop-Moisture Index, CMI)

The indices are analyzed on a monthly basis to generate a hydrological conditions report and used to determine the onset, severity and end of droughts. Five levels of increasing drought severity are defined in the Plan – Normal, Mild Drought, Significant Drought, Critical Drought and Emergency. The drought levels are associated with state actions as outlined in the Plan. Recommendations of drought levels are made by the Drought Management Task Force (DMTF) to the Secretary of EEA who declares the drought level for each region of the state. Current drought status and indices data can be viewed through the Northeast Drought Early Warning System dashboard.[27]

While drought does involve multiple indices, historic multi-year droughts were identified by the USGS by analyzing annual and cumulative departures from long-term average streamflow at gauging stations across Massachusetts. Streamflow deficits were analyzed, and recurrence intervals computed for selected droughts. The droughts of 1929-32, 1939-44, 1961-69, and 1980-83 stand out as particularly significant because of their severity and areal extent. The most severe drought on record in the Northeastern United States was from 1961 through 1969. Water supplies and agriculture were affected because of the severity and long duration of the drought.[28]

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[26] EEA and MEMA (2019), "Massachusetts Drought Management Plan," https://www.mass.gov/doc/massachusetts-drought-management-plan/download

[27] http://nedews.nrcc.cornell.edu

[28] U.S. Geological Survey Water-Supply Paper 2375 National Water Summary 1988-89--Floods and Droughts: Massachusetts Floods and Droughts

More recently drought periods include 10 months of drought in 2002 and 10 months of drought from June 2017 through March 2017[29]. **Figure 3-3** shows areas within the Commonwealth that are prone to Severe Drought, while **Figure 3-4** shows the areas with prone to Extreme Drought from 2011 to 2017, according the U.S. Drought Monitor. Pepperell is among the communities that experienced the most severe and extreme drought conditions during this period.

Figure 3-3 – Severe Drought across Massachusetts (2001-2017)

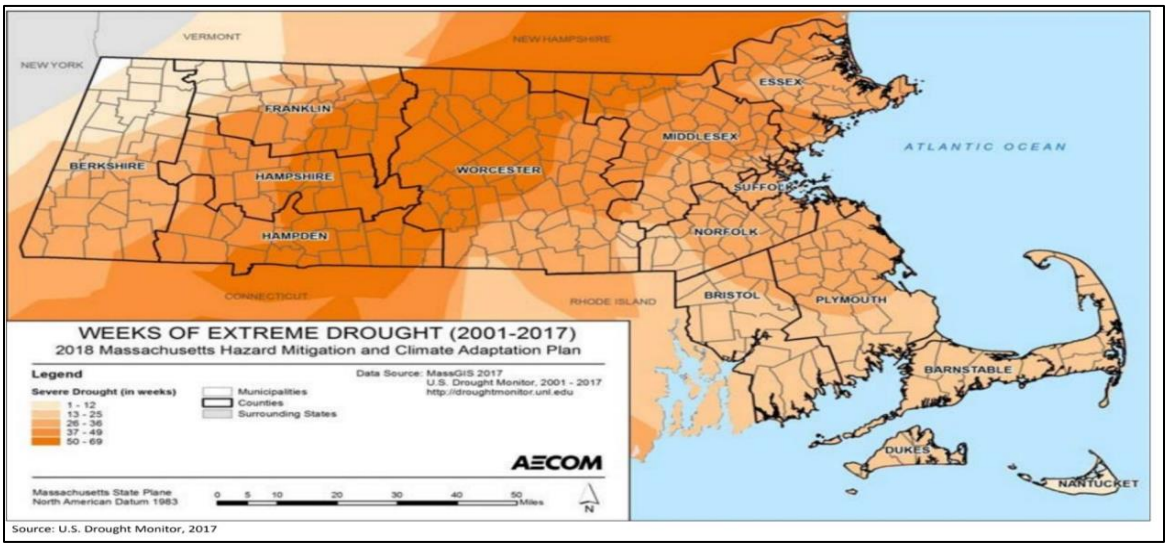
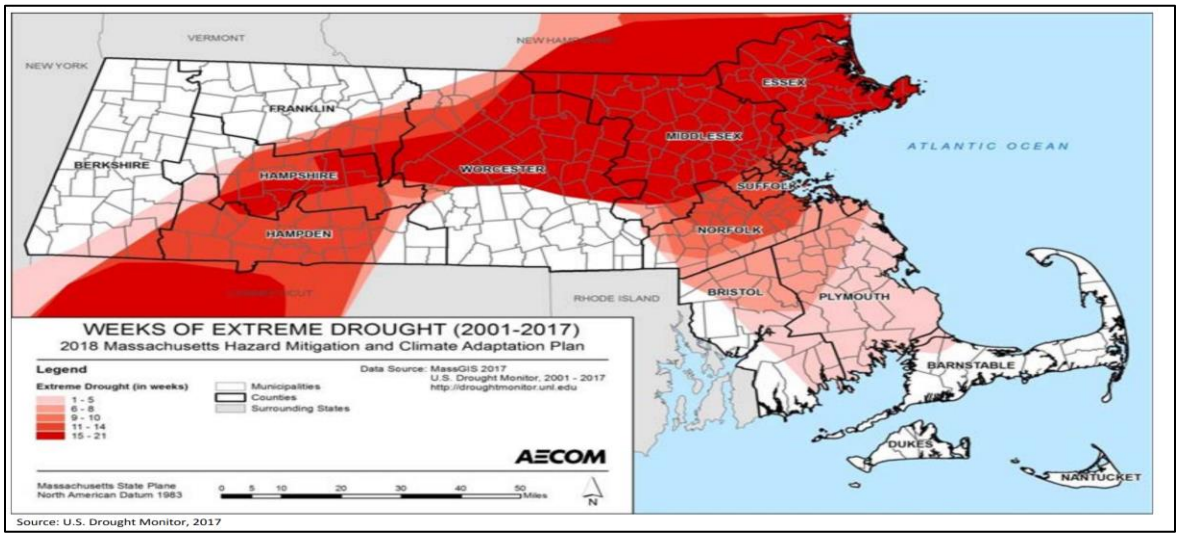


Figure 3-4 – Extreme Drought across Massachusetts (2001-2017)



[29] http://www.mass.gov/eea/wrc/droughtplan.pdf

Droughts will create challenges for local water supply by reducing surface water storage and the recharge of groundwater supplies, including private wells. More frequent droughts could exacerbate the impacts of flood events by damaging vegetation that could otherwise help mitigate flooding impacts. Droughts may also weaken tree root systems, making them more susceptible to toppling during high wind events.

Locally Identified Areas of Impact

The entire planning area can be affected by drought, impacting local water resources and often requiring voluntary or required restrictions on water use. Pepperell obtains 100% of its water supply from groundwater, including private and public water supply wells. The Massachusetts office of the USGS provides local data on streamflow and drought conditions across Massachusetts on its Water Watch website,[30] and the DCR Water Resource Commission issues monthly reports of hydrologic conditions.[31]

Probability of Future Occurrence

The Drought Management Plan conducted an extensive review of precipitation indices since the beginning of data collection in 1850. The probability of each drought level occurrence in a given month, as identified in the Plan, is shown in **Table 3-10.**

TABLE 3-10
Frequency and Probability of Drought Events

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

Source: EEA and MEMA 2013

Drought with Climate Change

Although research suggests that the overall amount of precipitation is likely to increase due to climate change, the length of time between rain events is also expected to increase. Prolonged dry periods increase the probability of drought conditions occurring.

Table 3-11 on the following page indicates the extent to which the durations of dry days are likely to increase, according to the "high" and "low" limits of the NECSC data for the Nashua Basin. This data suggests that the average time between rain events is likely to remain fairly constant; however, individual drought events could still increase in frequency and severity.

[30] http://newengland.water.usgs.gov/drought/index.html
[31] https://www.mass.gov/drought-management

TABLE 3-11[32]
Consecutive Dry Days by Planning Year

Planning Year	2030	2050	2070	2100*
Projected Range of Consecutive Dry Days	12.5 - 20.6	12.2 - 19.1	11.0 - 19.8	12.3 – 21.7

*Because the study generated 5-year averages for future conditions, "2100" values from this study are derived from the period centered around 2095, the further year available. This practice is generally considered to provide a useful approximation for conditions this far in the future.

The occurrence of drought due to rising temperatures and changes in precipitation is outlined below.

- **Rising temperatures and changes in precipitation → prolonged drought:** The frequency and intensity of droughts is projected to increase during summer and fall in the Northeast, as higher temperatures lead to greater evaporation and earlier winter and spring snowmelt, and precipitation patterns become more variable and extreme.
- **Rising temperatures and changes in precipitation → reduced snowpack:** Due to climate change, the proportion of precipitation falling as snow and the extent of time snowpack remains are both expected to decrease. This reduces the period during which snowmelt can recharge groundwater supplies, bolster streamflow, and provide water for the growing period.

The Planning Team determined that based on past history of drought events and climate change data provided by the NECSC, it is **LIKELY** that drought will impact the planning area in the future.

Drought Impacts on Pepperell's Key Sectors

Major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how drought will impact them as shown in **Table 3-12** on the following page.

[32] NECSC, 2017

TABLE 3-12
Drought Exposure and Vulnerability by Key Sector[33]

Sector	Vulnerability
Infrastructural	Drought impacts on elements of the built environment are limited, except to the extent that drought conditions increase the risk of wildfires.
Environmental	Prolonged droughts can have severe impacts on ecosystems and natural resources, as most organisms require water throughout their lifecycle. Forests managed for timber or other economic uses could experience reduced growth rates or mortality during periods of drought.
Economic	The economic impacts of drought can be significant in the agriculture, recreation, forestry, and energy sectors. Crop failure can also result in an increase in food prices, placing economic stress on a broader portion of the economy.
Societal	Residents with a private water well are more vulnerable to drought than those who receive water through a public provider. Drought can also increase the concentration of airborne pollutants, presenting a health hazard for those with respiratory health conditions like asthma.

3.2.2 Atmospheric Hazards

Atmospheric Hazards covered in this section include extreme temperature, hurricanes and tropical storms, severe weather, severe winter storms and nor'easters, and tornadoes.

3.2.2.1 Extreme Temperature

Extreme temperatures are defined as temperatures that are far outside the normal ranges for the season in a specific area. Extreme cold events are characterized in a temperate zone by the air temperature dropping to approximately 0 ºF or below. A heat wave is defined as 3 or more days of temperatures of 90°F or above. A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population.

Extreme Cold

The extent (severity or magnitude) of extreme cold temperatures can be measured through the Wind Chill Temperature Index (**Figure 3-5**). Wind Chill Temperature is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body loses heat at a faster rate, causing the skin's temperature to drop.

[33] 2018 MA SHMCAP

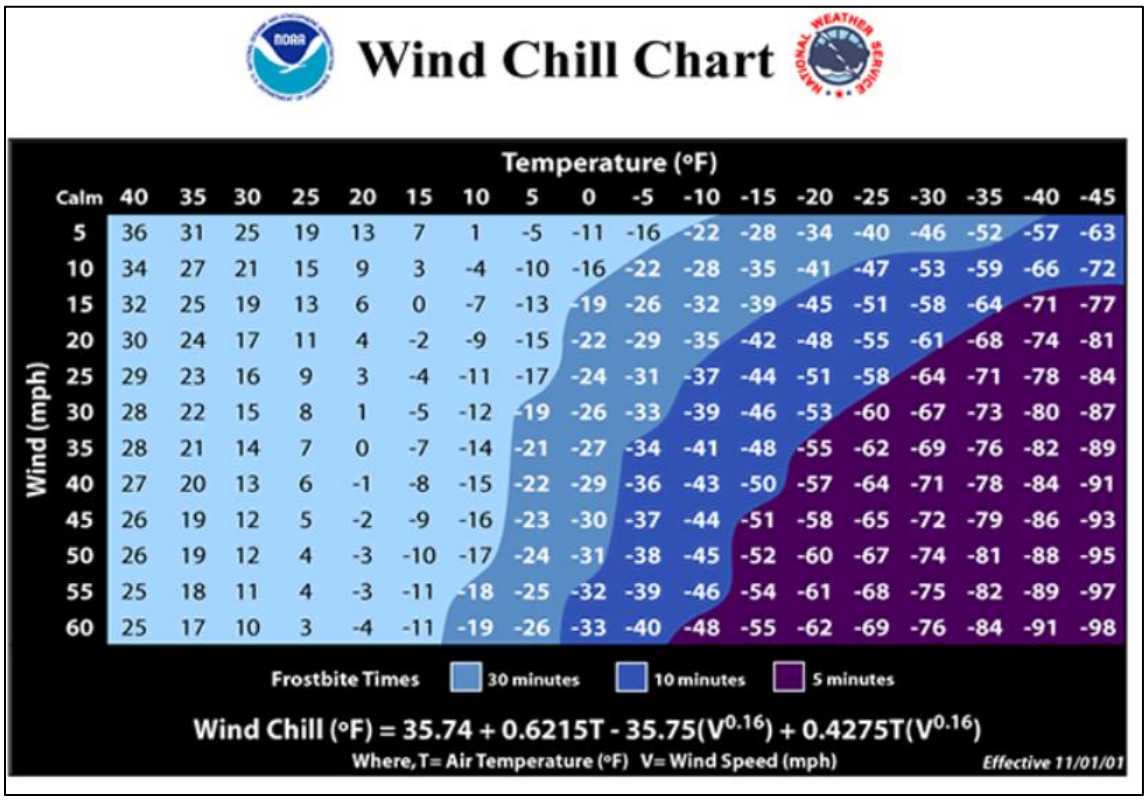


Figure 3-5 – NOAA Wind Chill Index (Source: www.nws.noaa.gov)

When winter temperatures drop significantly below normal, staying warm and safe can become a challenge. Extremely cold temperatures often accompany a winter storm, which may also cause power failures, icy roads and freezing ice in rivers, streams and lakes.

Cold weather also can present hazards indoors. Many homes will be too cold, either due to a power failure or because the heating system is not adequate for the weather. Exposure to cold temperatures, whether indoors or outside, can cause serious or life-threatening health problems. The use of space heaters and fireplaces to stay warm, and/or the use of generators and candles in power outages, increases the risk of residential fires and carbon monoxide poisoning.

Extreme Heat

The extent of extreme heat is documented by the National Weather Service (NWS) Heat Index. The NWS issues a Heat Advisory when the Heat Index is forecast to reach 100-104°F for 2 or more hours. The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105+ °F for 2 or more hours. The Heat Index describes a temperature that the body feels, and is based both on temperature and relative humidity (**Figure 3-6**).

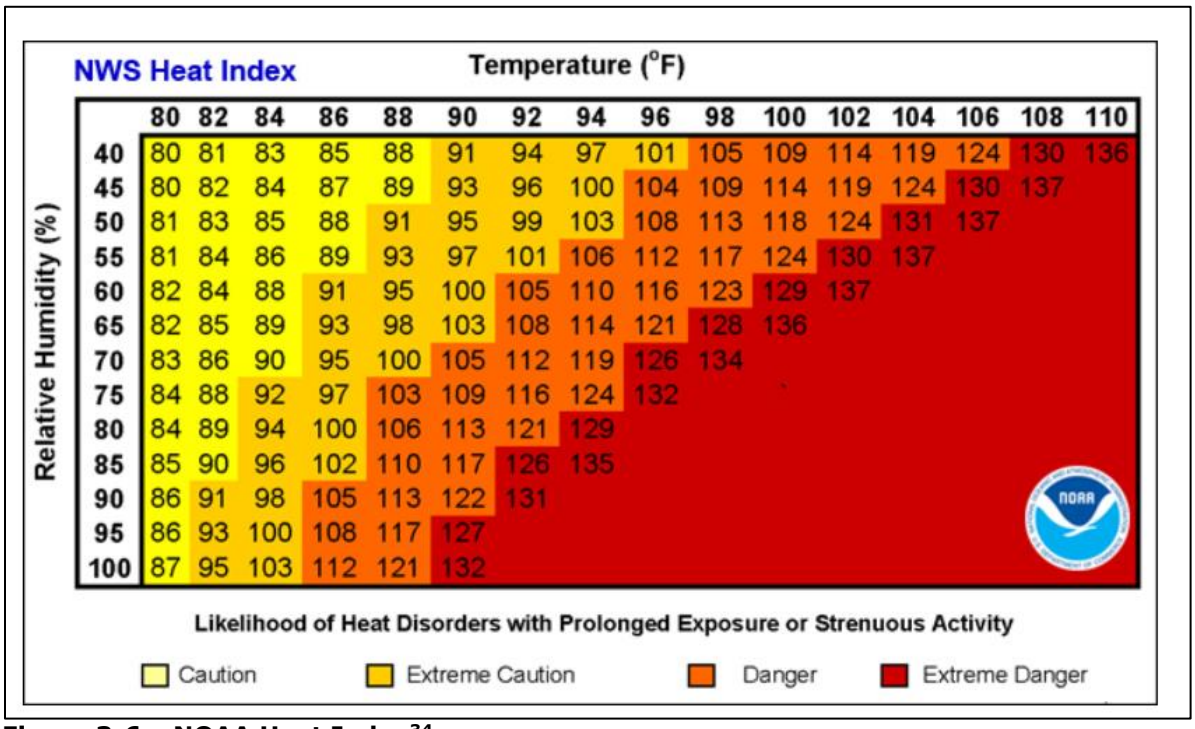


Figure 3-6 – NOAA Heat Index[34]

Extreme heat is currently the leading weather-related cause of death in the United States.[35] Prolonged exposure to high temperatures can cause heat-related illnesses, such as heat cramps, heat syncope, heat exhaustion, heat stroke, and death. Heat exhaustion is the most common heat-related illness and if untreated, it may progress to heat stroke. Additionally, heat is expected to contribute to the exacerbation of chronic health conditions.[36] In particular, hyperthermia—elevated body temperature due to failed thermoregulation - can be caused by heat stroke and is a contributing factor to cardiovascular, metabolic, and other causes of death.[37]

Those at particularly high risk of adverse health effects from extreme heat exposure are older adults, children, those living alone and/or with chronic illnesses, urban residents, minorities, lower income families, people with less education, and people without access to air conditioning. In addition, people with chronic mental disorders or pre-existing medical conditions (e.g., cardiovascular disease, obesity, diabetes, neurologic or psychiatric disease), and those participating in outdoor manual labor or sports in hot

[34] NOAA Heat Index: http://www.nws.noaa.gov/om/heat/heat_index.shtml
[35] Luber, G., & McGeehin, M. (2008b). Climate change and extreme heat events. American Journal of Preventive Medicine, 35(5), 429–435. http://doi.org/10.1016/j.amepre.2008.08.021
[36] Kravchenko, J., Abernethy, A. P., Fawzy, M., & Lyerly, H. K. (2013). Minimization of heat wave morbidity and mortality. American Journal of Preventive Medicine, 44(3), 274–282. http://doi.org/10.1016/j.amepre.2012.11.015
[37] O'Neill, M. S., & Ebi, K. L. (2009). Temperature Extremes and Health: Impacts of Climate Variability and Change in the United States. Journal of Occupational and Environmental Medicine, 51(1), 13–25. http://doi.org/10.1097/JOM.0b013e318173et22

weather are also at increased risk for heat-related illness.[38] Extreme heat adversely impacts utility companies that may struggle to meet the elevated demand created by operation of air conditioners. Brown outs may result in secondary impacts to vulnerable populations.

Previous Occurrence and Extent of Extreme Temperatures

According to NOAA NCDC data, the entire area is vulnerable to extreme temperatures. For the past decade, Massachusetts has reported temperatures 2 to 4ºF warmer than the 20th Century average.[39] **Figure 3-7** depicts the trend for maximum high summer temperatures and minimum low winter temperatures from 1895 to 2015.

According to the Northeast Regional Climate Center at Cornell University, 2012 was the warmest year in the U.S. to date, and had the third hottest summer. Extreme heat for Pepperell is most common in July, with the record high of 105ºF set in 1948. Extreme cold temperatures are most common in January-February with the lowest recorded temperatures being –29ºF in 1957.

Locally Identified Areas of Impact

The entire planning area is at risk for impacts due to extreme temperatures.

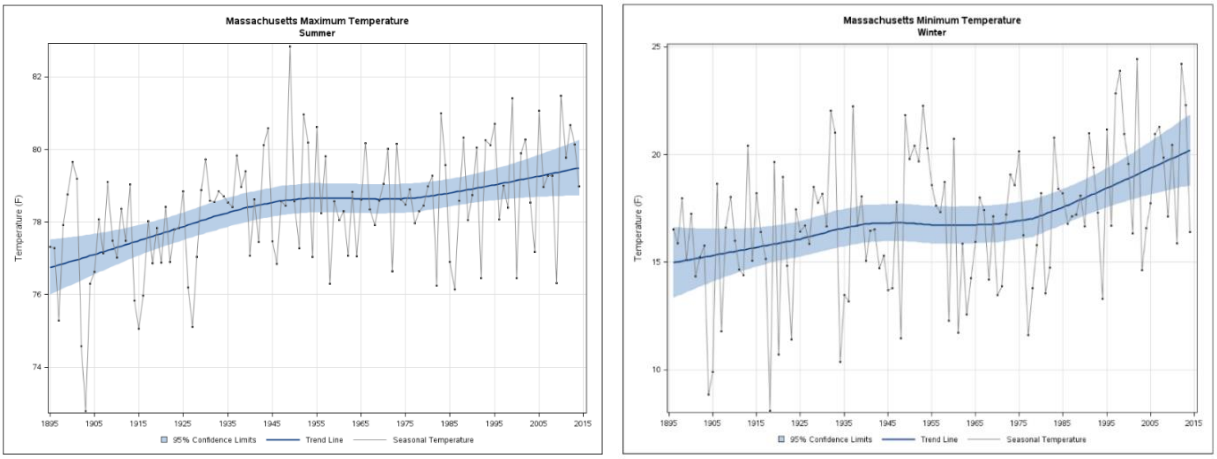


Figure 3-7: **Maximum Summer (left) and Minimum Winter (right) Monthly Temperatures in Massachusetts (1895-2016)**

Probability of Future Occurrence of Extreme Temperatures in Pepperell

The Intergovernmental Panel on Climate Change (IPCC) forecasts state that temperatures are continuing to increase worldwide during the 21st century due to the ongoing GHG emission trajectory. The latest scenarios from the 2015 United Nations Paris Climate Summit for average temperature changes across all greenhouse gas emissions modeling scenarios show a continuation of increased global temperatures. The average temperature

[38] Holstein, J., Canouï-Poitrine, F., Neumann, A., Lepage, E., & Spira, A. (2005). Were less disabled patients the most affected by 2003 heat wave in nursing homes in Paris, France? Journal of Public Health (Oxford, England), 27(4), 359–365.
[39] https://www.ncdc.noaa.gov/temp-and-precip/state-temps/

in Massachusetts between 1961 and 1990 has been approximately 46.4 degrees Fahrenheit (°F). By mid-century this is anticipated to increase by approximately 3.6 to 5.4°F. By the latter part of the 21st century average temperatures are expected to increase by 5.4 to 9°F.

Recent Massachusetts Statewide Climate Projections (NESCE 2017) shown in **Table 3-13** estimate that Pepperell is expected to experience increased average temperatures throughout the 21st century. Maximum and minimum temperatures are also expected to increase throughout the end of the century. These increased temperature trends are expected for annual and seasonal projections.

Table 3-13
Seasonal and Annual Temperature Projections for Nashua River Basin Region[40]

Nashua Basin		Observed Baseline 1971-2000 (°F)	Projected Change in 2030s (°F)			Mid-Century Projected Change in 2050s (°F)			Projected Change in 2070s (°F)			End of Century Projected Change in 2090s (°F)		
Average Temperature	**Annual**	46.78	+2.20	to	+4.44	+2.99	to	+6.39	+3.54	to	+9.02	+3.90	to	+10.95
	Winter	25.2	+2.20	to	+5.10	+2.81	to	+7.60	+3.65	to	+9.22	+3.94	to	+10.58
	Spring	44.94	+1.64	to	+3.47	+2.51	to	+5.53	+2.72	to	+7.71	+3.25	to	+9.45
	Summer	67.56	+2.24	to	+4.55	+3.14	to	+7.02	+3.53	to	+10.13	+3.98	to	+12.60
	Fall	49.01	+2.18	to	+5.10	+3.71	to	+6.64	+3.58	to	+9.54	+4.05	to	+11.79
Maximum Temperature	**Annual**	57.77	+2.06	to	+4.26	+2.73	to	+6.47	+3.23	to	+9.09	+3.55	to	+10.95
	Winter	35.13	+1.84	to	+4.62	+2.44	to	+7.05	+3.02	to	+8.41	+3.43	to	+9.60
	Spring	56.16	+1.52	to	+3.43	+2.35	to	+5.51	+2.67	to	+7.91	+3.25	to	+9.55
	Summer	79.16	+1.97	to	+4.68	+2.98	to	+7.23	+3.42	to	+10.45	+3.87	to	+12.93
	Fall	60.19	+2.34	to	+4.92	+3.56	to	+6.97	+3.45	to	+9.79	+3.96	to	+12.25
Minimum Temperature	**Annual**	35.78	+2.33	to	+4.78	+3.26	to	+6.47	+3.80	to	+8.94	+4.24	to	+11.00
	Winter	15.26	+2.49	to	+5.62	+3.27	to	+8.10	+4.23	to	+10.02	+4.41	to	+11.40
	Spring	33.72	+1.77	to	+3.82	+2.66	to	+5.92	+2.83	to	+7.51	+3.25	to	+9.31
	Summer	55.97	+2.46	to	+4.60	+3.23	to	+7.16	+3.65	to	+9.81	+4.12	to	+12.27
	Fall	37.83	+1.99	to	+5.23	+3.62	to	+6.59	+3.68	to	+9.27	+4.11	to	+11.62

Seasonally, maximum summer and fall temperatures are expected to see the highest projected increase throughout the 21st century, including:

- Summer mid-century increase of 3 **°**F to 7.2 **°**F (4-9% increase); end of century increase of 3.9 **°**F to 12.9 **°**F (5-16% increase).
- Fall mid-century increase of 3.6 **°**F to 7 **°**F (6-12% increase); end of century increase by and 4 **°**F to 12.3 **°**F (7-20% increase).

Seasonally, minimum winter and fall temperatures are expected to increase throughout the 21st century, including:

[40] NECSC, 2017

- Winter mid-century increase of 3.3 °F to 8.1 °F (21-53% increase); end of century increase of 4.4 °F to 11.4 °F (29-75% increase).
- Fall mid-century increase of 3.6 °F to 6.6 °F (10-17% increase); end of century increase of 4.1°F to 11.6 °F (11-31% increase).[41]

Based on historic data and local projections, the Planning Team determined that it is **HIGHLY LIKELY** that extreme temperatures will impact the planning area.

Impacts on Pepperell's Key Sectors

Major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how extreme temperatures will impact them, as shown in **Table 3-14** below.

TABLE 3-14
Extreme Temperature Exposure and Vulnerability by Key Sector[42]

Sector	Vulnerability
Infrastructural	Extreme heat events can sometimes cause short periods of utility failure due to increased usage of air conditioners and other appliances. Heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption. Backup power is recommended for critical facilities and infrastructure.
Environmental	Because the species that exist in a given area are designed to survive within a specific temperature range, extreme temperatures events can place significant stress both on individual species and ecosystems. Warming temperatures across the globe force species poleward, or upward in elevation, while species that cannot relocate fast enough face local extinction.
Economic	Extreme temperature events can have significant economic impacts, including loss of business function and damage/loss of inventory. The agricultural industry is most at risk in terms of economic impact and damage, due to extreme temperature and drought events.
Societal	Populations that are most at risk to extreme cold and heat events include individuals over age 65, infants and young children, individuals who are physically ill, low-income individuals who cannot afford proper heating and cooling, and those whose jobs involve exposure to extreme temperature events.

3.2.2.2 Severe Weather Wind Related Hazards

Severe weather wind-related hazards include hurricanes, tropical storms, and tornadoes, as well as high winds during severe rainstorms and thunderstorms. The typical wind speed in Pepperell ranges from 3-10 miles per hour over the course of the year, with peak gusts over 50 mph.[43] The prevailing wind direction is west, and the highest wind speeds occur

[41] NECSC, 2017
[42] 2018 MA SHMCAP
[43] NOAA Climatic Wind Data for the United States 1930-1996- Data for Boston

January through March. **Figure 3-8** shows the average monthly wind speed for the contiguous U.S. for March based on wind conditions in the lower troposphere.[44] The Northeast United States, including Middlesex County, has some of the highest average wind speeds in the contiguous U.S.

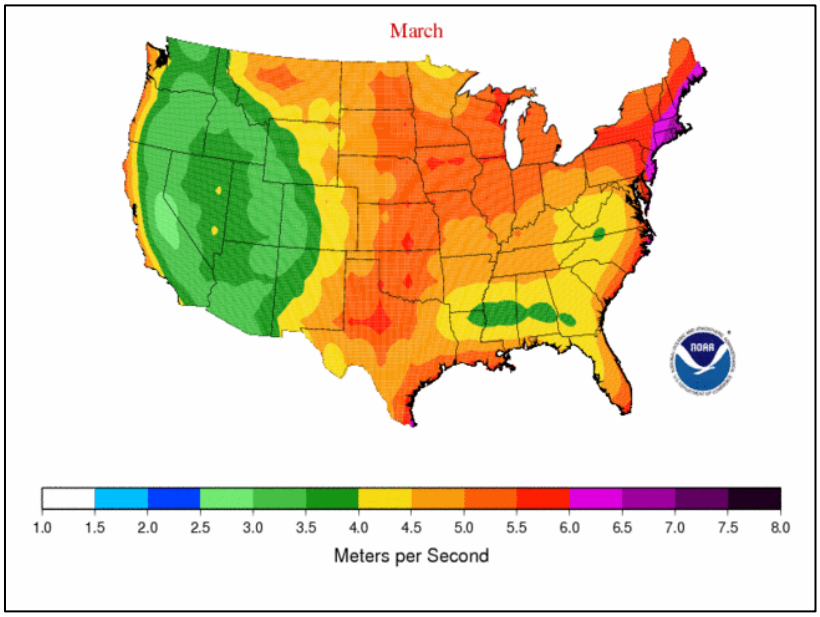


Figure 3-8 – March Average Wind Speeds in the Lower Troposphere (1971-2000)

High winds can occur as an isolated event or can accompany other weather events such as:

- Before and after frontal systems
- Hurricanes and tropical storms
- Severe thunderstorms
- Tornadoes
- Nor'easters

National wind zone designations were developed by FEMA based on 40 years of tornado history and 100 years of hurricane history. As shown in **Figure 3-9**, Middlesex County lies within Zone II, with maximum winds of 160 mph. Pepperell is also within the Hurricane-Susceptible Region, along with the entire East Coast and Gulf of Mexico.[45]

[44] https://www.ncdc.noaa.gov/societal-impacts/wind/w-mean/201603
[45] FEMA Taking Shelter from the Storm: Building a Safe Room Inside Your House. https://www.fema.gov/pdf/library/ism2_s1.pdf

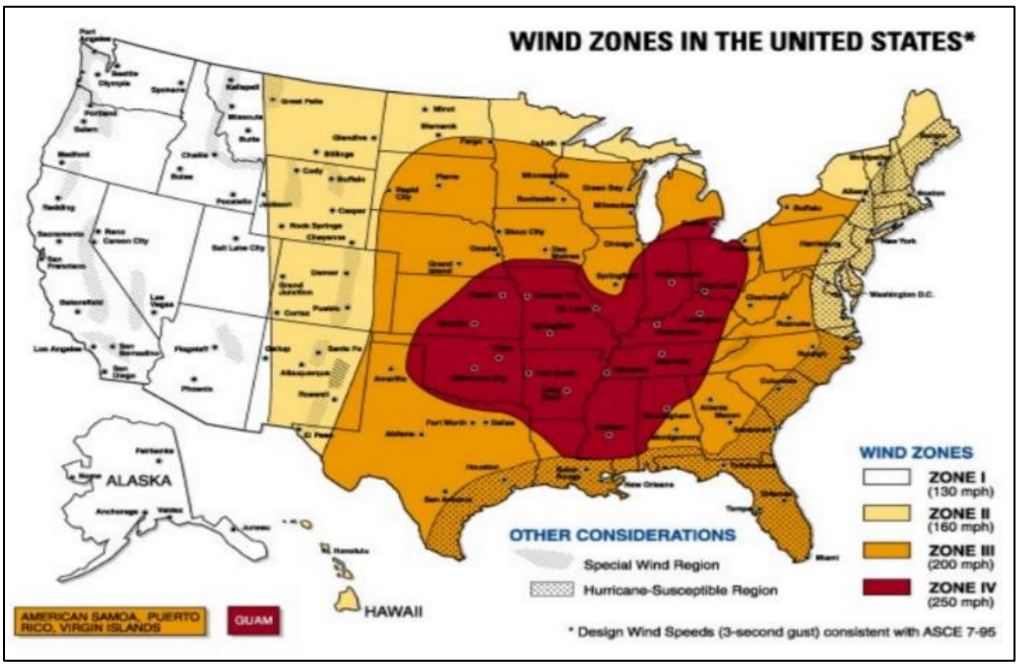


Figure 3-9 – **Wind Zones in the United States**

Table 3-15 includes the high wind warning categories issued by the NWS for both non-tropical and tropical events. Winds measuring under 30 mph are not considered to be hazardous under most conditions.[46]

TABLE 3-15
NWS High Wind Warning

Type of Warning	Wind Speeds
Non-tropical event over land:	
Wind Advisory	Sustained winds of 31-39 mph for at least 1 hour, or any gust 46 to 57 mph
High Wind Warning	Sustained winds 40+ mph or any gust 58+ mph
Non-tropical event over water:	
Small Craft Advisory	Sustained winds 25-33 knots
Gale Warning	Sustained winds 34-47 knots
Storm Warning	Sustained winds 48 to 63 knots
Hurricane Force Winds	Sustained winds 64+ knots
Tropical storm events (inland or coastal):	
Tropical Storm Warning	Sustained winds 39 to 73 mph
Hurricane warning	Sustained winds of 74+ mph

[46] 2018 MA SHMCAP

Effects from high winds can include downed trees and/or power lines, damage to structures, etc. This is especially true after periods of heavy snow, rain or prolonged drought, due to the weakening of tree branches and roots. High winds can cause scattered power outages and are a hazard for the boating, shipping, and aviation industry sectors. More specific discussion on severe weather high wind events impacting Pepperell follows.

3.2.2.3 Hurricanes/Tropical Storms

A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originate over tropical or subtropical water. The four types of tropical cyclones are classified as follows:

- **Tropical Depression:** A tropical cyclone with maximum sustained winds of 38 mph (33 knots) or less.
- **Tropical Storm:** A tropical cyclone with maximum sustained winds of 39 to 73 mph (34 to 63 knots).
- **Hurricane:** A tropical cyclone with maximum sustained winds of 74 mph (64 knots) or higher.
- **Major Hurricane:** A tropical cyclone with maximum sustained winds of 111 mph (96 knots) or higher, corresponding to a Category 3, 4 or 5 on the Saffir-Simpson Hurricane Wind Scale.

Hurricanes are characterized by high winds and extratropical moisture resulting in torrential rainfall, especially if the storm is slow moving. The rotational nature of hurricanes often results in winds changing direction as the storm passes, altering wave generation and surge setup. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as storms hit the land. In the Atlantic Basin, the hurricane season runs from June 1 to November 30 with peak activity occurring in early to mid-September.[47]

Hurricanes are classified by the Saffir-Simson Scale, which categorizes intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. **Table 3-16** shows the wind speeds, surges, and range of damage caused by different hurricane categories.

[47] National Hurricane Center Educational Resources

TABLE 3-16
Saffir/Simson Scale to Measure Hurricane Intensity

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

Previous Occurrence and Extent

The National Oceanic and Atmospheric Administration (NOAA) has been keeping records of hurricanes since 1858. Within the last 25 years, hurricanes and tropical storms that have impacted Massachusetts include Hurricane Gloria (1985), Irene (Category 2, 2011), Earl (Category 4, 2010), and Bob (Category 2, 1991); and Tropical Storms Sandy (2012), Bill (2009), Hanna (2008), and Beryl (2006).[48] Historically, the 1938 Hurricane known as the Great New England Hurricane, a Category 3 hurricane, was the most severe to impact Pepperell, with high winds and record rainfall.

While historic records include 28 tropical storms and hurricanes for New England, only 2 events have resulted in FEMA hurricane-related disasters for Middlesex County, as listed in **Table 3-17**.

TABLE 3-17
FEMA Hurricane-Related Declared Disasters Impacting Middlesex County[49]

FEMA Disaster #	Name	Date	Category
DR-751	Hurricane Gloria	9/27/1985	Category 2
DR-914	Hurricane Bob	8/19/1991	Category 2

Locally Identified Areas of Impact

Based on past history, the Planning Team determined the entire planning area is at risk for impacts due to hurricanes and tropical storms.

Probability of Future Occurrence

According to the 2018 MA SHMCAP and NOAA Hurricane Research Division, the Commonwealth has a 6 to 30 percent chance of a tropical storm or hurricane affecting the area each year. The probability increases moving from the northwest corner of the state to the southeast, with the highest probability along the coast, specifically Cape Cod and

[48] 2018 MA SMCAP

[49] https://www.fema.gov/disasters

the Islands. New England averages about one hurricane per decade, but there is some evidence that more and stronger hurricanes occur when Atlantic Sea-Surface-Temperatures are warm. While the science of global warming and hurricanes is evolving, present research calls for slightly stronger and wetter storms, but changes in frequency are unknown. Based on the past regional and local history of tropical cyclones, the Planning Team determined that it is **POSSIBLE** that a hurricane or tropical storm will impact the area in the future**.**

Impacts on Pepperell's Key Sectors

As previously outlined, major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how hurricanes will impact them, as shown in **Table 3-18** below.

TABLE 3-18
Hurricane Exposure and Vulnerability by Key Sector[50]

Sector	Vulnerability
Infrastructural	Hurricane flooding can wash out sections of roadways and bridges, as well as cause extensive damage to public utilities and disruptions to the delivery of services. Hurricane wind can down trees and power lines and damage buildings.
Environmental	As the storm is occurring, flooding, or wind – or water-borne detritus can cause mortality to animals if it strikes them or transports them to a non-suitable habitat. In the longer term, environmental impacts can occur as a result of riverbed scour, fallen trees, or contamination of ecosystems by transported pollutants.
Economic	Hurricanes and severe winter storms, can greatly impact the economy, including loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage losses, road repair, and rental loss due to the repair/replacement of buildings.
Societal	Of the population exposed, the most vulnerable include the economically disadvantaged and population over age 65. Economically disadvantaged populations are more likely to weigh the economic impact of evacuating, and individuals over 65 are more likely to face physical challenges in evacuating or to require medical care while evacuated.

Thunderstorms

A thunderstorm is a storm with lightning and thunder produced by a cumulonimbus cloud, usually producing gusty winds, heavy rain, and sometimes hail. The NWS classifies a thunderstorm as 'severe' when it produces damaging wind gusts in excess of 58 mph (50 knots), hail that is 1-inch in diameter or larger (quarter size), or a tornado (NWS, 2013).

[50] 2018 MA SHMCAP

Three basic ingredients are required for a thunderstorm to form:[51]

- moisture to form clouds and rain;
- rising unstable warm air that can rise rapidly; and
- lift caused by cold or warm fronts, sea breezes, mountains, or the sun's heat.

While less severe than other types of storms, a thunderstorm can lead to localized damage and represents a hazard risk for all communities in Massachusetts. An average thunderstorm is 15 miles across and lasts 30 minutes; severe thunderstorms can be much larger and longer. Southern New England typically experiences 10 to 15 days per year with severe thunderstorms (**Figure 3-10**).

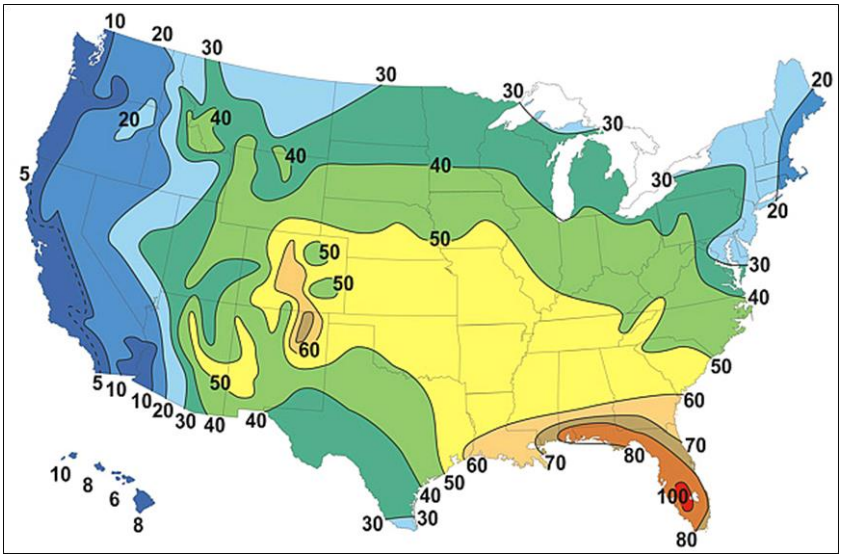


Figure 3-10–Annual Average Number of Thunderstorm Days in the U.S. (*Source: NOAA NWS*)

Thunderstorms have masses of air, an updraft (rising air), and a downdraft (sinking air). A strong downdraft, also known as a downburst, can cause tremendous wind damage similar to a tornado. Damages from hail and lightning are secondary impacts to thunderstorms. Hail can cause damage to vehicles and crops, especially when the hail stones are large in diameter.

Previous Occurrence and Extent of Thunderstorms in Pepperell

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 Suffolk, Essex, Middlesex, Norfolk and Bristol received a Presidential Disaster Declaration for the

[51] Thunderstorms, Tornadoes, Lightning: Nature's Past Violent Storms, A Preparedness Guide, US Department of Commerce, NOAA, and the National Weather Service

Individual Household Program (Individual Assistance) on June 23, 1998. Each community in the Northern Middlesex region is at equal risk of being impacted by a severe thunderstorm and it is not possible to predict where damage from such a storm might occur.

On May 22, 2006 a severe thunderstorm toppled trees in several Middlesex County towns and left 5,000 residents without power. Wind gusts reached 45 mph.

On May 15, 2020, a strong thunderstorm containing a microburst with 100 mph winds caused considerable damage in Pepperell. Several large trees were uprooted near Brookline Street and Cheyenne Road, some onto houses, and trees were snapped about 2 to 3 feet from their bases farther down on Cheyenne Road near Algonquin Road, and on Gosselin Drive and Seminoles Drive. The total path of the microburst in Pepperell was 0.3 miles. Severe wind damage from the same storm also occurred in Groton and Westford.



May 15, 2020 Microburst Damage in Pepperell, photo by David Querze, Town of Pepperell Emergency Management

According to the NOAA National Climatic Data Center (NCDC)[52], Middlesex County experienced the following events between January 1, 1950 and January 1, 2020:

[52] https://www.ncdc.noaa.gov/

- 17 days with reported Tornado (EF1-F3 magnitude, 1 death and 6 injuries, $4.9M property damage)
- 49 days with reported Lightning (1 death, 30 injuries, $2.9M property damage)
- 79 days with reported Hail (0-2.25-inch diameter, $75.3K property damage)
- 110 days of reported High/Strong Wind (up to 50 knots, 3 injuries, $764.7K property damage)
- 177 days of reported Thunderstorm Wind (up to 80 knots, $3.9M property damage

Probability of Future Occurrence

Based on the past regional and local history of severe weather wind events, the Planning Team determined that it is **HIGHLY LIKELY** that a wind-related weather event, including lightning, hail, strong winds, and thunderstorms will impact the area in the future**.** The planning team thinks that it is **LIKELY** that an impactful weather event due to tornadoes will impact the area in the future.

3.2.2.4 Severe Winter Storm/Nor'easter

Winter Storms

Hazards associated with Heavy Snow, Nor'easters, Blizzards, and Ice Storms can be similar in many ways, and therefore have been categorized under Winter Storms, although each of these hazard events is separately distinguished under Probability of Future Events.

Nor'easters

Nor'easters are ferocious northeastern coastal storms that typically occur in the winter months. The storm's name refers to the continuous strong northeasterly winds blowing in a large counter-clockwise circulation pattern around a low-pressure center, resulting in heavy snow and rain, gale force winds, rough seas, and coastal flooding that often causes shoreline erosion. The radius of these storms can extend up to 1,000 miles.[53] Impacts along the coast are typically worse than inland locations due to the additional moisture picked up from the ocean. Nor'easters may be especially damaging because they can sit stationary for several days, affecting multiple tidal cycles and producing extended periods of heavy precipitation, resulting in increased flooding, shoreline erosion, and damage to coastal infrastructure.

There is no widely used scale to classify nor'easters, but a combination of scales including the Beaufort Scale for wind speed, Regional Snowfall Index for snowfall, and precipitation associated with a historic recurrence interval (i.e. 100-year rainfall) can be combined to evaluate the magnitude of the storm. For Pepperell, precipitation amounts of 7.8 inches are associated with a 100-year storm event (1% chance of occurring in any one year). Winter and spring flooding from nor'easters may be exacerbated due to snow melt and

[53] 2018 MA SHMCAP

frozen ground conditions. Depending on the metric used to measure the storm, assigned severity may also take into account the storm's societal and economic impacts.

The level of damage in a hurricane is often more severe than a nor'easter, but historically Massachusetts has suffered more damage from nor'easters because of the greater frequency of these coastal storms (1 to 2 per year). As another comparison, the duration of high surge and winds in a hurricane is 6 to 12 hours while a nor'easter can last from 12 hours to 3 days.

Nor'easters are not typically named the way that hurricanes are by the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service (NWS), though locally coined names have been used. For example, Winter Storm Juno and Winter Storm Nemo were named by the Weather Channel in 2014 and 2015.[54] The unofficial storm naming is controversial with meteorologists because winter storms can re-form more than once, making naming difficult and redundant. On the other hand, naming a storm may bring more attention to the event and help people with advance emergency preparations.

Previous Occurrence and Extent

There have been 12 winter storm related federally declared disasters from 1996 through 2018 (**Table 3-19**), which include nor'easters.

Table 3-19
FEMA Nor'easter and Winter Storm Related Disaster Declarations (1996-2018) Impacting Pepperell[55]

Disaster #	Date(s)	Unofficial Storm Name	Impact
DR-4379	March 13-13, 2018	Winter Storm Reilly	Severe winter storm, snowstorm, flooding- Nor'easter
DR-4214	January 26-29,2015	"Winter Storm Juno"	Severe winter storm, snowstorm, flooding- Nor'easter
DR-4110	February 8-10, 2013	"Winter Storm Nemo"	Severe winter storm, snowstorm and flooding
DR-4051/ EM-3343	October 29-30, 2011	"Snowtober"	Severe Storm
DR-1959	January 11-12, 2011		Severe winter storm and record snow storm
DR-1895	March 12, 2010		Severe weather, record breaking rain and flooding
DR-1813/ EM3296	December 11, 2008	December Ice Storm	Severe winter and ice storm
DR-1614	October 7-16, 2005	Nor'easter	Severe Storms and Flooding
EM-3191	December 3, 2003	December Blizzard	Severe winter storm, snowstorm
EM-3175	Feb 17, 2003	February Blizzard	Severe winter storm, snowstorm

[54] https://en.wikipedia.org/wiki/Winter_storm_naming_in_the_United_States

[55] Fema.gov/disasters

Disaster #	Date(s)	Unofficial Storm Name	Impact
EM-3165	March 5-7, 2001	February Blizzard	Severe winter storm, snowstorm
DR-1090	January, 1996	January Blizzard	Severe winter storm, snowstorm

Locally Identified Areas of Impact

The entire planning area is at risk for impacts due to nor'easters. Pepperell's overall vulnerability for nor'easters is similar to that for severe winter weather and flooding.

Probability of Future Occurrence

Nor'easters may occur at any time of the year, however, they are most common from September to April. Based on historical records of the top winter storm events from 1953 to 2015, nor'easters have an average frequency of 1 or 2 per year. Nor'easters are likely to become more intense in the future due to potential effects of climate change, including increased snowfall, sea level rise, storm surge and a concentration of storm events in the coldest winter months. Nor'easters along the coast, coinciding with astronomical high tides, will result in increased flooding and more significant structural damages as sea level continue to rise.

Increased sea surface temperature in the Atlantic Ocean will cause air moving north over the ocean waters to hold more moisture. As a result, when these fronts meet cold air systems moving from the north, an even greater amount of rain and snow than normal can be anticipated. Although no one storm can be linked directly to climate change, the severity of rain and snow events has increased dramatically in recent years.

Based on the historic record of nor'easters impacting Pepperrell and the future predictions for increased severity and intensity of nor'easters, the Planning Team determined that is **HIGHLY LIKELY** that a nor'easter will impact the planning area in the future.

Impacts on Pepperell's Key Sectors

As previously outlined, major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how nor'easters will impact them as shown in **Table 3-20** on the following page.

TABLE 3-20
Nor'easter Exposure and Vulnerability by Key Sector[56]

Sector	Vulnerability
Infrastructural	Flooding can wash out sections of roadways and bridges, and cause extensive damage to public utilities and disruptions to delivery of services. Wind can take down power lines, disrupt power service, and damage buildings.
Environmental	The environmental impacts of nor'easters are similar to hurricanes and winter storms, resulting in flooding and wind damage, causing mortality to individuals, and transforming habitats.
Economic	Nor'easter events can greatly impact the economy, causing loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage losses, road repair, and rental loss due to the repair/replacement of buildings.
Societal	The most vulnerable populations include economically disadvantaged individuals and those over age 65. Economically disadvantaged populations are more likely to weigh the economic impacts of evacuating, and individuals over 65 are more likely to face physical challenges or require medical care while evacuated.

Severe Winter Storms: Snow storm and Blizzard

Severe Winter Weather includes snow storms, blizzards, and ice storms. A winter storm occurs when there is significant precipitation during periods of low temperatures. Winter storms are a combination of hazards because they often involve wind, ice, and heavy snow fall. Winter storms can occur from early autumn to late spring and include any of the following events:[57]

- Blizzards
- Blowing Snow
- Snow Squalls
- Snow Showers
- Snow Flurries
- Ice pellets and sleet
- Icing
- Coastal flooding
- Ice jams and flow
- Snow melt

Impacts from winter weather – in addition resulting in non-passable streets and sidewalks – include downed power lines causing loss of electric power service, catch basins being buried and sometimes clogged, water service pipes bursting and shut-off valves being buried (more common when cold and windy), fire hydrants being buried by snow, older water mains bursting, and dangerous icicles forming on buildings. Snow can also block building ventilation, increasing the risk of indoor carbon monoxide poisoning and deep snow can place a heavy load on roofs.

[56] 2018 MA SHMCAP
[57] http://www.nws.noaa.gov/om/winter/index.shtml

Previous Occurrence and Extent of Snow and Blizzards on Pepperell

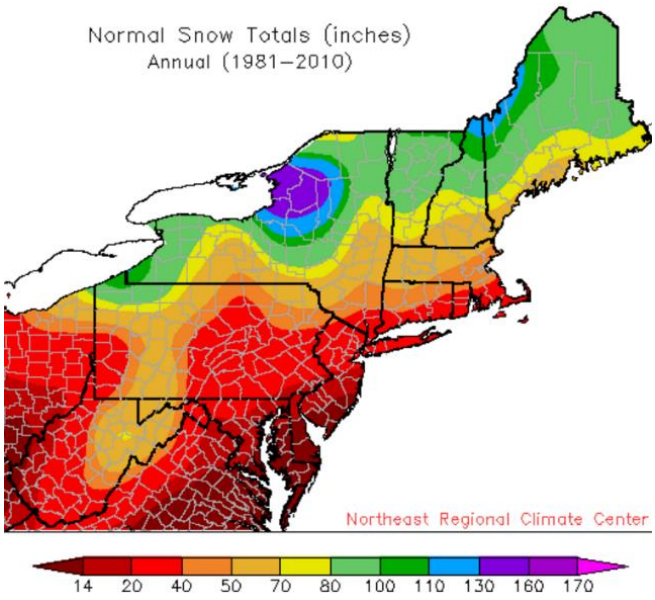


Figure 3-11: Annual Snow Totals

Snow and other forms of winter precipitation occur frequently in Pepperell, with a normal 30-year average between 50-70 inches per year, as shown in **Figure 3-11**. [58]

The one-day record snowfall of 29.0 inches was recorded for Middlesex County at the Natick Weather Station on April 1, 1997. This winter storm is known as the "April Fool's Day Storm" and dropped a record amount of snow in Middlesex County and throughout the State, leaving thousands without power. This storm was particularly impactful, as it came after plows had been put away and people were preparing for spring. A state of emergency was declared in Massachusetts and it became difficult for road crews to keep up with the snowfall. Additionally, portions of Interstate 95 and Route 128 were shut down due to the snow.

Although there is significant inter-annual variability in the frequency and severity of winter storms, this hazard should be expected to occur every winter. [59]

Locally Identified Areas of Impact

The entire planning area is at risk for severe winter weather. During these events, higher elevation areas may experience higher snow accumulations and higher winds compared to other areas at lower elevations.

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

Probability of Future Occurrence

Based on the record of previous occurrences, winter storm events in Pepperell are high frequency events as defined by the 2018 SHMCAP. This hazard may occur more frequently than once in five years (greater than 20% per year). Climate change impacts are predicted to increase the severity of winter storms because changing circulation patterns and

[58] http://www.nrcc.cornell.edu/regional/climatenorms/climatenorms.html
[59] 2018 MA SHMCAP

warming ocean water allow additional moisture to fuel the storm to greater intensity. Based on the past record, the Planning Team concludes that it is **HIGHLY LIKELY** that severe winter weather will impact Pepperell in the future.

Impacts of Pepperell's Key Sectors

As previous outlined, major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how Severe Winter Storms will impact them, as shown in **Table 3-21** below.

TABLE 3-21
Severe Winter Storm Exposure and Vulnerability by Key Sector[60]

Sector	Vulnerability
Infrastructural	All elements of the built environment in Pepperell are exposed to the severe winter weather hazard.
Environmental	Winter storms are a natural part of the Massachusetts climate, and native ecosystems and species are well-adapted to these events. However, more extreme winter storms can result in direct mortality, habitat modification, and flooding when snow and ice melt, especially in areas with high road salt applications.
Economic	Potential impacts from winter storms include loss of utilities, interruption of transportation corridors, loss of business function and loss of income during business closures. The cost of snow and ice removal and repair of roads from the freeze/thaw process can also strain local financial resources.
Societal	Populations over 65 are considered most susceptible due to their increased risk of injury and death from falls and overexertion and/or hypothermia from attempts to clear snow and ice or from related to power failures. Residents with low incomes may not have access to housing or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply).

3.2.2.5 Tornadoes, High Winds and Thunderstorms

A tornado is a violently rotating column of air extending from a cumuliform cloud, such as a thunderstorm, to the ground. Tornadoes are not always visible as funnel clouds because they may appear nearly transparent until they pick up dust and debris. The average tornado moves from southwest to northeast, but they can move in any direction and can suddenly change direction. The average forward speed of a tornado is 30 mph, but they can be stationary or move as fast as 70 mph. The strongest tornadoes have rotating winds of more than 200 mph.[61] **Table 3-22** shows the Enhanced Fujita Tornado Damage Scale developed by T. Theodore Fujita.[62]

[60] 2018 MA SHMCAP
[61] Thunderstorms, Tornadoes, Lightning: Nature's Past Violent Storms, A Preparedness Guide, US Department of Commerce, NOAA, and the National Weather Service
[62] http://www.spc.noaa.gov/efscale/

Table 3-22
Enhanced Fujita Scale Levels and Description of Damage

EF-Scale Number	Intensity Phrase	3-Second Gust (MPH)	Type of Damage Done
EF0	Gale	65-85	Some damage to chimneys; breaks branches off trees; shallow rooted trees pushed over; sign boards damaged
EF1	Moderate	86-110	Peels surfaces off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
EF2	Significant	111-135	Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.

Previous Occurrence and Extent of Tornadoes in Pepperell

On average, six tornadoes per year touch down somewhere in New England. Those at risk include people in automobiles, anyone not in a secure structure, and those residing in mobile homes. Since 1951, there have been 156 tornadoes in Massachusetts, which resulted in 105 fatalities and 1,559 injuries. Within the Northern Middlesex region, there have been 17 tornadoes since 1950. No tornadoes have been reported to have touched down in Pepperell since 1974.

Locally Identified Areas of Impact

Those at risk include people in automobiles, anyone not in a secure structure, and those residing in mobile homes. While tornadoes are unpredictable, Pepperell does have a number of residents residing in mobile homes who would be potentially at risk should a tornado touch down in the community.

Probability of Future Occurrence

The Disaster Center[63] 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. The Tornado density for Northern Middlesex County is 32-46 per 20 square miles. Based on the past record, the Planning Team concludes that it is **UNLIKELY** that tornadoes will impact Pepperell in the future.

Impact on Pepperell's Key Sectors

As previous outlined, major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how Tornadoes will impact them, as shown in **Table 3-23** on the following page.

[63] http://www.disastercenter.com/mass/mass.htm

TABLE 3-23
Tornado Exposure and Vulnerability by Key Sector[64]

Sector	Vulnerability
Infrastructural	All elements of the built environment in Pepperell are exposed to tornadoes.
Environmental	Direct impacts may occur to flora and fauna small enough to be transported by the tornado. Even if the winds are not sufficient to transport trees and other large plants, the wind may still uproot them. Material transported by tornados can also cause environmental havoc in surrounding areas, particularly if contaminating materials are introduced into the atmosphere or local water supplies.
Economic	Tornado events are typically localized; however, in those areas, economic impacts can be significant. Types of impact may include loss of business function, water supply system damage, damage to inventory, relocation costs, wage losses, and rental loss due to the repair/replacement of buildings. Recovery and clean-up can also be costly.
Societal	Vulnerable populations include all those who may have difficulty evacuating, including car-free households, individuals over 65, and households with young children. Individuals with limited internet or phone access may not be aware of impending tornado warnings. The potential insufficiency of older or less stable housing to offer adequate shelter from tornadoes is also a concern.

3.2.3 Geologic Hazards

3.2.3.1 Earthquake

An earthquake is the movement or trembling of the ground produced by a sudden displacement of rock in the Earth's crust. The theory of plate tectonics is commonly used to explain much of the earthquake activity in the world. The plates over the Earth are in constant slow motion and this movement can cause earthquakes, most frequently at the boundary of the plates.[65]

In general, magnitude measures the size of an earthquake, while intensity measures the effects, which vary according to how far you are from the earthquake and the soils you are on.[4] Two different scales are frequently used to measure earthquakes: Richter Scale measures the amount of energy released by an earthquake, or its magnitude. The Richter Scale ranges from 3.5 to 8.0, where 3.4 may be felt but doesn't cause damage, to an 8 which includes Great Earthquakes, and serious damage over extremely large areas. The Modified Mercalli Intensity Scale measures the intensity or impact of an earthquake on people and the built environment, and the Scale ranges from a Level 1, where the earthquake is not felt except by very few under especially favorable circumstances to a X11, with total damage: where all works of construction are damaged or destroyed, lines of sight and level are distorted, and objects are thrown into the air.[4]

[64] 2018 MA SHMCAP
[65] Earthquake Causes and Characteristics, FEMA Emergency Management Institute Training Guide, https://training.fema.gov/emiweb/is/is8a/is8a-unit3.pdf

Earthquake hazards have multiple impacts beyond the obvious building collapse. Buildings may suffer structural damage that may or may not be readily apparent. Earthquakes can cause major damage to roadways, making emergency response difficult. Water lines and gas lines can break, causing flooding and fires. Another potential vulnerability is equipment within structures. For example, a hospital may be structurally engineered to withstand an earthquake, but if the equipment inside the building is not properly secured, the operations at the hospital could be severely impacted during an earthquake. Earthquakes can also trigger landslides.

Previous Occurrence and Extent

According to the State Hazard Mitigation Plan, New England experiences an average of 5 earthquakes per year. Between 1627 and 2008, 366 earthquakes were recorded in Massachusetts. Most earthquakes in the northeast region tend to be small in magnitude and cause little damage; however, between 1924 and 2012 there have been 104 earthquakes measured at a magnitude of 4.5 or greater on the Richter Scale. Due to the geologic composition and rock structure in the Northeast, seismic shaking for many of these larger earthquakes were felt throughout all of New England. Most of the earthquakes originated from the La Malbaie fault in Quebec or from the Cape Ann fault located off the coast of Rockport. The list below includes earthquakes that affected eastern Massachusetts:

- August 8, 1847: No data available on the extent of hazard.
- November 27, 1852: No data available on the extent of hazard.
- December 10, 1854: No data available on the extent of hazard.
- September 21, 1876: No data available on the extent of hazard.
- May 21, 1880: No data available on the extent of hazard.
- January 21, 1903: No data available on the extent of hazard.
- April 24, 1903: No data available on the extent of hazard.
- October 15, 1907: No data available on the extent of hazard.
- April 24, 1925: No data available on the extent of hazard.
- January 28, 1940: No data available on the extent of hazard.
- January 7, 1952: Earthquake occurred off of Cape Ann and the reported felt area extended from Providence, RI to Kennebunk, ME.
- October 16, 1963: Intensity VI, caused plaster to fall in a house, crack walls, dishes and windows.
- October 30, 1963: No data available on the extent of hazard.
- October 24, 1965: Slight damage to homes on Nantucket, house timbers creaked, doors, windows and dishes rattled.
- April 2012: A swarm of 12 or more earthquakes occurred off of the New England coast about 250 miles east of Boston. The largest of these earthquakes measured a magnitude of 4.4 on the Richter Scale. This swarm of earthquakes was of

particular concern because of the major earthquake on the continental shelf further north in 1929 that produced a deadly and damaging tsunami in Nova Scotia.

- December 30, 2012: Magnitude 1.2 earthquake about 7 miles south of Gardner, MA. No extent data available.

There have been no declared earthquake disasters for Massachusetts. There have been no recorded earthquake epicenters within Pepperell and there have been no historical recorded effects on the Town associated with earthquake impacts originating from outside of Pepperell. FEMA has published maps with seismic design categories (SDCs) for building design and construction professionals. Most of New England is classified as SDC "B," as areas that could experience shaking of moderate intensity.[66]

Locally Identified Areas of Impact

Based on mapping by FEMA, the entire planning area is at risk from impacts due to earthquakes**.**

Probability of Future Occurrence

Earthquakes cannot be predicted and may occur at any time of the day and any time of the year. However, for the purpose of this Plan, the USGS 2014 Seismic Hazard Map was used to review the probability of future occurrence as shown in **Figure 3-12**.[67]

The data is derived from seismic hazard curves and depicts probabilistic ground motions with a 2 percent probability of exceedance in 50 years. For Pepperell, moderate peak gravity acceleration from 20 to 30 percent is predicted.

[66] https://www.fema.gov/earthquake-hazard-maps
[67] https://earthquake.usgs.gov/hazards/hazmaps/conterminous/index.php#2016

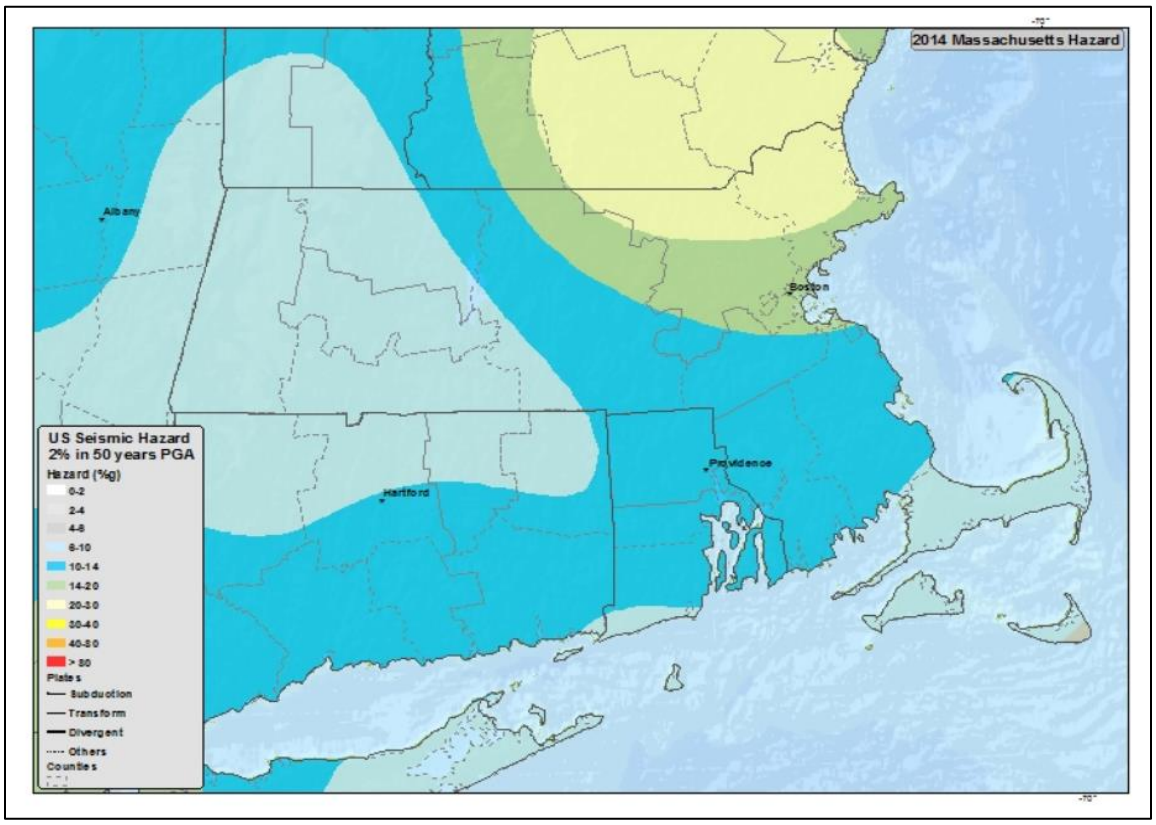


Figure 3-12 – **Seismic Hazard Map of New England**

Pepperell is similar to many communities in Massachusetts and may not be prepared for earthquakes. Although new construction under the most recent building codes will be built to seismic standards, much of the development in the Town predates the most recent building code.

The Planning Team determined that it is **POSSIBLE** that an earthquake will impact Pepperell in the future and therefore are including it in the Multi-Hazard Mitigation Plan.

Impact on Pepperell's Key Sectors

As previous outlined, major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how Earthquakes will impact them, as shown in **Table 3-24** on the following page.

TABLE 3-24
Earthquake Exposure and Vulnerability by Key Sector[68]

Sector	Vulnerability
Infrastructural	In addition to direct impacts, earthquakes also present a risk associated with hazardous materials releases, which have the potential to impact a production or storage facility during transportation, or that result from pipeline damage. These events could cause widespread interruption of services, as well as air and water contamination.
Environmental	If strong shaking occurs in a forest, trees may fall – resulting not only in environmental impacts but also potential impact to any industries relying on that forest. Disrupting the physical foundation of the ecosystem can cause species displacement and modify the species balance in that ecosystem and leave the area more vulnerable to the spread of invasive species.
Economic	Earthquake losses can include structural and non-structural damage to buildings (which could include damage to architectural components like ceilings and lights, or power systems), loss of business function, damage to inventory, relocation costs, wage losses, and rental losses due to the repair/replacement of buildings.
Societal	Socially vulnerable populations are the most likely groups to be affected by this hazard based on a number of factors, including their physical and financial ability to react or respond during a hazard, the location and construction quality of their housing, and the ability to be self-sustaining after an incident due to limited ability to stockpile supplies.

3.2.3.2 Landslide

Landslides encompass a wide variety of ground movements under the effect of gravity including rock falls, slope failures, and shallow debris flows. In the Commonwealth of Massachusetts, landslides are primarily caused by slope saturation by water, which increases the weight on the slope, as well as the pore pressure.[69] Increasing the pore pressure will decrease the cohesiveness of the soil, making the land more vulnerable to outside pressures (i.e. gravity). In Massachusetts, landslides are often caused by construction-related failures, undercut slopes, and water saturation as outlined below.

- Construction-related failures are caused by construction activities that weaken the slope by increasing the steepness of the bank and decreasing supporting material along the bank.
- Undercut slopes occur when streams, tides, or other water movement cut into the toe of the slope, eventually undermining.
- Slope saturation occurs after high precipitation events and drastic water level changes that augments the weight on the slope and diminishes the slope's cohesiveness.

[68] 2018 MA SHMCAP
[69] 2018 MA SHMCAP

Landslide incidence is the number of landslides that have occurred in a given geographic area. High incidence means greater than 15 percent of a given area has been involved in landslides, medium incidence means 1.5 to 15 percent of an area has been involved, and low-incidence means that less than 1.5 percent of an area has been involved. Pepperell has a low incidence of landslides.

Previous Occurrence and Extent

Landslides tend to coincide with other natural disasters such as earthquakes and floods that exacerbate relief and reconstruction efforts. As a result, landslide frequency is related to the frequency of other hazards. There have been zero federally declared landslide disasters from 1954 to 2012.[70] According to the 2018 State Hazard Mitigation Plan, there are roughly 1 to 3 landslides events each year. There is no specific data on events in Pepperell. Town officials did not identify any problems with areas of geologic instability such as sinkholes or subsidence, or any past occurrences with landslides, sinkholes or subsidence.

Locally Identified Areas of Impact

The entire planning area is identified as low risk for landslides.

Probability of Future Occurrence

Due to the low incidences of historic landslides, the Planning Team determined that it is **UNLIKELY** that landslides will impact Pepperell in the future. Potential effects of climate change could increase the likelihood of landslides due to slope saturation with more frequent and intense storms, and reduced vegetation cover due to the increased frequency of drought events or increased urbanization.

Impact on Pepperell's Key Sectors

As previous outlined, major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how Landslides will impact them, as shown in **Table 3-25** on the following page.

[70] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan

TABLE 3-25
Landslide Exposure and Vulnerability by Key Sector[71]

Sector	Vulnerability
Infrastructural	Landslides can cause damage to elements of the built environment and can interfere with travel if large enough to block or damage roads. Critical facilities in Pepperell are located within unstable areas.
Environmental	Landslides can affect many facets of the environment, including the landscape itself, water quality, and habitat health. Transported soil may harm aquatic habitats, and mass movement of sediment may result in stripping of forests and other vegetated systems.
Economic	Direct costs include the actual damage sustained by buildings, property, and infrastructure. Indirect costs from a large landslide event could include clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity.
Societal	Populations who rely on potentially impacted roads for vital transportation needs are considered to be particularly vulnerable to this hazard.

3.2.3.3 Tsunami

Based on the Massachusetts State Hazard Mitigation and Climate Adaption Plan of 2018, Tsunamis do not post a significant threat to Massachusetts, or more specifically Northern Middlesex County. Therefore, Tsunamis will not be discussed in this report.

3.2.4 Other Hazards

Other hazards discussed in this section include wildfires and invasive species.

3.2.4.1 Wildfires

Fire needs the right combination of heat source, fuel, and oxygen in order to ignite and thrive. Availability of fuel, weather conditions, and terrain all dictate how a fire will behave. Fires are classified as disasters when they affect people or developed areas. Fires can start from a variety of natural or anthropogenic causes. Urban fires occur in developed landscapes, where a fire has the potential to spread from one structure to another.

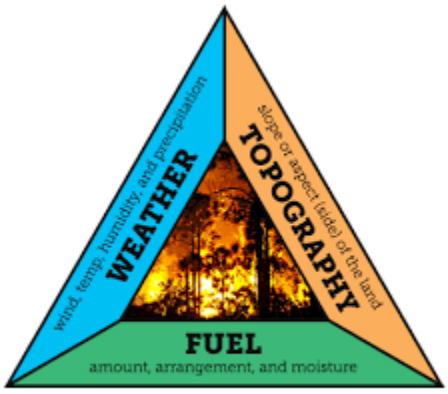
A wildfire is any non-structural fire that occurs in the vegetative wildlands. The 3 major classes of wildfires are surface, ground, and crown fires. A surface fire creeps slowly on the forest floor, while killing or damaging trees. Often occurring during droughts, ground fires burn organic ground cover below the forest floor. Rapidly spreading due to wind, crown fires quickly jump along the treetops.

Major urban and wildfires often result from other hazards, such as storms, earthquakes, gas leaks, transportation accidents, hazardous material spills, criminal activity, or terrorism. In contrast, small structural fires occur frequently from mundane events.

[71] 2018 MA SHMCAP

Fire Ecology and Wildfire Behavior

The "wildfire behavior triangle" reflects how three primary factors influence wildfire behavior: fuel, topography, and weather. Each side of the triangle represents one of the three factors, and the points represent the interplay between the factors. For example, drier and warmer weather with low relative humidity combined with dense fuel loads and steeper slopes can result in dangerous to extreme fire behavior.



Fire Behavior Triangle

How a fire behaves primarily depends on available fuel, weather conditions, and terrain, as described below.

Fuel:

- Lighter fuels such as grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs, and trunks take longer to warm and ignite.
- Snags and hazard trees, especially those that are diseased or dying, become receptive to ignition when influenced by environmental factors such as drought, low humidity, and warm temperatures.

Weather:

- Strong winds, especially wind events that persist for long periods or those with significant sustained wind speeds, can exacerbate extreme fire conditions or accelerate the spread of wildfire.
- Dry spring and summer conditions, or drought at any point of the year, increases fire risk. Similarly, the passage of a dry, cold front through the region can result in sudden wind speed increases and changes in wind direction.
- Thunderstorms in Massachusetts are usually accompanied by rainfall; however, during periods of drought, lightning from thunderstorm cells can result in fire ignition. Thunderstorms with little or no rainfall are rare in New England but have occurred.

Terrain:

- Topography of a region or a local area influences the amount and moisture of fuel.

- Barriers, such as highways and lakes, can affect the spread of fire.
- Elevation and slope of landforms can influence fire behavior because fire spreads more easily uphill compared to downhill.

The wildland-urban interface is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. There are a number of reasons that the wildland-urban interface experiences an increased risk of wildfire damage. Access and fire suppression issues on private property in the wildland-urban interface can make protecting structures from wildfires difficult. This zone also faces increased risk because structures are built in densely wooded areas, so fires started on someone's property are more easily spread to the surrounding forest.

Fire is used extensively as a land management tool to replicate natural fire cycles, and it has been used to accomplish both fire-dependent ecosystem restoration and hazard fuel mitigation objectives on federal, state, municipal, and private lands in Massachusetts since the 1980s. Between 2009 and 2012, more than 1,300 acres of state and private partnership lands in the southeastern Massachusetts pitch pine and scrub oak forests were treated with prescribed fire. This project was designed to mitigate high-hazard fuel-loading in and around wildland-urban interface zones. Controlled burns continue to be conducted throughout the Commonwealth. For example, Westover Air Reserve Base uses this technique on several hundred acres each year to maintain healthy grasslands, reduce fuel for future fires, and remove weeds and invasive vegetation.

Previous Occurrence and Extent

The wildfire season in Massachusetts typically begins in late March and usually culminates in early June, following the driest live fuel moisture periods of the year. Historically, April has the highest wildfire danger.[72] Pepperell responded to 106 brush/ wildfires between 2002 and 2010 according to the 2015 HMP. Pepperell's forested areas are primarily composed of pitch/white pine, mixed conifer, oak, and oak mixed, which are considered by the State fire officials to be the forest types at highest risk for wildfires.

Locally Identified Areas of Impact

The Northeast Wildfire Risk Assessment Geospatial Work Group determined the wildfire risk based from fuels, wildland-urban interface and topography, as shown in **Figure 3-13.**[73] Pepperell includes mainly areas of **high** risk. Based on this mapping, the planning area is at risk for wildfires.

[72] 2018 MA SHMCAP
[73] 2018 MA SHMCAP

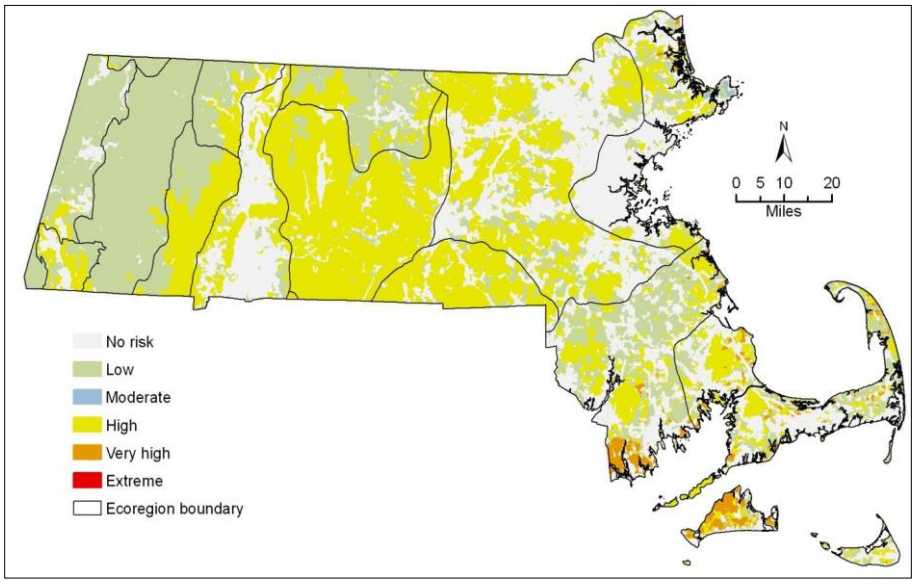


Figure 3-13 – Wildfire Risk in Massachusetts

Probability of Future Occurrence

It is difficult to predict the likelihood of wildfires given the complexity of predicting the factors leading to fires. Fires will continue to present a risk, and that risk is likely to increase with the potential drought impacts of climate change. Periods of hot, dry weather and more frequent lighting strikes may increase wildfires. Research has found that the frequency of lightning strikes could increase by approximately 12 percent for every degree Celsius of warming. The Planning Team determined that it is **POSSIBLE** that a wildfire will impact the planning area based on the large amount of forested land in Pepperell and past history of fires.

Impact on Pepperell's Key Sectors

Fires impact humans and climate in return. Beyond the immediate loss of life and property, smoke is a serious health hazard when small soot particles enter the lungs. Long-term exposure has been linked to higher rates of respiratory and heart problems. Smoke plumes can travel for thousands of miles affecting air quality for people far downwind of the original fire. Fires also pose a threat to local water quality, and the loss of vegetation can lead to erosion and mudslides.

As previous outlined, major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how Wildfires will impact them, as outlined on the following page in **Table 3-26.**

TABLE 3-26
Wildfire Exposure and Vulnerability by Key Sector[74]

Sector	Vulnerability
Infrastructural	Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. They can also damage infrastructure elements such as power and communication lines.
Environmental	Fire serves important ecological purposes; however, it can also cause environmental impacts. In addition to direct mortality, wildfires and the ash they generate can distort the flow of nutrients through an ecosystem, reducing the biodiversity that can be supported.
Economic	Wildfire events can have major economic impacts on a community, both from the initial loss of structures and the subsequent loss of revenue from destroyed homes, businesses and decreases in tourism. Additionally, wildfires can require thousands of taxpayer dollars for fire response efforts.
Societal	All residents whose homes are located in wildfire hazard areas are vulnerable to this hazard. Smoke and air pollution from the wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly, and those with respiratory and cardiovascular diseases.

3.2.4.2 Invasive Species

The Massachusetts Invasive Plant Advisory Group (MIPAG) defines invasive plants as "non-native species that have spread into native or minimally managed plant systems in Massachusetts, causing economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems." [75] These species have biological traits that provide them with competitive advantages over native species, particularly because they are not restricted by the biological controls of their native habitat in their new habitat. As a result, these invasive species can monopolize natural communities, displacing many native species and causing widespread economic and environmental damage.

The Massachusetts Invasive Plant Advisory Group (MIPAG) recognizes 69 species as "Invasive," "Likely Invasive," or "Potentially Invasive." In order to be considered "invasive," a plant species must meet the following criteria[76]:

- Be nonindigenous to Massachusetts;
- Have the biologic potential for rapid and widespread dispersion and establishment in minimally managed habitats;
- Have the biologic potential for dispersing over spatial gaps away from site of introduction;

[74] 2018 MA SHMCAP
[75] https://www.massnrc.org/mipag/
[76] https://massnrc.org/mipag/docs/MIPAG_FINDINGS_FINAL_042005.pdf#page=6

- Have the biologic potential for existing in high numbers away from intensively managed artificial habitats;
- Be naturalized in Massachusetts (persists without cultivation in Massachusetts);
- Be widespread in Massachusetts, or at least common in a region or habitat type(s) in the state;
- Have many occurrences of numerous individuals in Massachusetts that have high numbers of individuals forming dense stands in minimally managed habitats;
- Be able to out-compete other species in the same natural plant community; and
- Have the potential for rapid growth, high seed or propagule production and dissemination, and establishment in natural plant communities.

The damage rendered by invasive species is significant. The 2018 State Hazard Mitigation Plan estimates that about 3 million acres within the United States (an area twice the size of Delaware) are lost each year to invasive plants. The massive scope of this hazard means that the entire Commonwealth experiences impacts from these species. Furthermore, the ability of invasive species to travel far distances (either via natural mechanisms or accidental human interference) allows these species to propagate rapidly over a large geographic area.[77]

Regulations on Invasive Species

Massachusetts has a variety of laws and regulations in place that attempt to mitigate the impacts of these species. The Department of Agricultural Resources (DAR) has added the plant species described to a list of noxious weeds regulated with prohibitions on importation, propagation, purchase and sale in the Commonwealth. Additionally, the Massachusetts Wetlands Protection Act (310 CMR 10.00) includes language requiring all activities covered by the Act to account for, and take steps to prevent, the introduction or propagation of invasive species.

In 2000, Massachusetts passed an Aquatic Invasive Species Management Plan, making the Commonwealth eligible for federal funds to support and implement the plan through the federal Aquatic Nuisance Prevention and Control Act. The Commonwealth also has several resources pertaining to terrestrial invasive species, such as the Massachusetts Introduced Pest Outreach Project, although a strategic management plan has not yet been prepared for these species. More specific regulations are discussed below.

330 CMR 6.0(d) requires any seed mix containing restricted noxious weeds to specify the name and number per pound on the seed label. 339 CMR 9.0 restricts the transport of currant or gooseberry species in an attempt to prevent the spread of white pine blister rust.

There are also a number of state laws pertaining to invasive species. Chapters 128, 130, and 132 of Part I of the General Laws of the state include language addressing water

[77] 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan

chestnuts, green crabs, the Asian longhorn beetle and a number of other species. These laws also include language allowing orchards and gardens to be surveyed for invasive species, and for quarantines to be put into effect, at any time.

Locally Identified Areas of Impact-Flora

The 35 plant species listed on the MIPAG website as "Invasive" (last updated April 2016) are listed in **Table 3-27**.

TABLE 3-27
Invasive Species (Flora) in Massachusetts

Acer platanoides	Norway maple
Acer pseudoplatanus	Sycamore maple
Aegopodium podagraria	Bishop's goutweed, bishop's weed; goutweed
Ailanthus altissima	Tree of heaven
Alliaria petiolate	Garlic mustard
Berberis thunbergii	Japanese barberry
Cabomba caroliniana	Carolina fanwort; fanwort
Celastrus orbiculatus	Oriental bittersweet; Asian or Asiatic bittersweet
Cynanchum louiseae	Black swallow-wort; Louise's swallow-wort
Elaeagnus umbellate	Autumn olive
Euonymus alatus	Winged euonymus, burning bush
Euphorbia esula	Leafy spurge; wolf's milk
Frangula alnus	European buckthorn, glossy buckthorn
Glaucium flavum	Sea or horned poppy, yellow hornpoppy
Hesperis matronalis	Dame's rocket
Iris pseudacorus	Yellow iris
Lepidium latifolium	Broad-leaved pepperweed, tall pepperweed
Lonicera japonica	Japanese honeysuckle
Lonicera morrowii	Morrow's honeysuckle
Lonicera x bella [morrowii x tatarica]	Bell's honeysuckle
Lysimachia nummularia	Creeping jenny, moneywort
Lythrum salicaria	Purple loosestrife
Myriophyllum heterophyllum	Variable water-milfoil; two-leaved water-milfoil
Myriophyllum spicatum	Eurasian or European water-milfoil; spike water- milfoil
Phalaris arundinacea	Reed canary-grass
Phragmites australis	Common reed
Polygonum cuspidatum / Fallopia japonica	Japanese knotweed; Japanese or Mexican bamboo
Polygonum perfoliatum	Mile-a-minute vine or weed; Asiatic tearthumb
Potamogeton crispus	Crisped pondweed, curly pondweed

Ranunculus ficaria	Lesser celandine; fig buttercup
Rhamnus cathartica	Common buckthorn
Robinia pseudoacacia	Black locust
Rosa multiflora	Multiflora rose
Salix atrocinerea/Salix cinerea	Rusty Willow/Large Gray Willow complex
Trapa natans	Water chestnut

Massachusetts has implemented biological control programs aimed at controlling the invasive species purple loosestrife (*Lythrum salicaria*), mile-a-minute vine (*Persicaria perfoliata*), hemlock woolly adelgid (*Adelges tsugae*), and winter moth (*Operophtera brumata*). For the past four years, the Town of Pepperell has received funding under the MA Department of Conservation and Recreation's (DCR) Matching Funds Program to treat the water chestnuts present in the Nashua River in Pepperell and Groton. The Town of Pepperell is a partner in the Nashua River Regional Aquatic Invasives Committee. More than 130 acres of plants have formed a thick, almost unpassable barrier to those using boats, canoes, and kayaks on the River. Recreational opportunities in the areas where plants are present were impacted and water quality was impaired. While the treatment is currently focused on water chestnuts, other submerged aquatic invasives remain and will require treatment, which can be costly. The costs to treat the water chestnuts in the Nashua River is approaching $600,000, between earlier treatments in 2008 and current treatments, which are ongoing.

Locally Identified Areas of Impact-Fauna

According to the 2018 State Hazard Mitigation Plan, there are a number of animals that have disrupted natural systems and inflicted economic damage on the Commonwealth, as described in **Table 3-28**. Because of the rapidly evolving nature of the invasive species hazard, this list is subject to modification.

TABLE 3-28
Invasive Species (Fauna) in Massachusetts

Lymantria dispar	Gypsy moth (insect)
Ophiostoma ulmi, Ophiostoma himal-ulmi, Ophiostoma novo-ulmi	Dutch elm disease (fungus)
Adelges tsugae	Hemlock woolly adelgid (insect)
Cryphonectria parasitica	Chestnut blight (fungus)
Anoplophora glabripennis	Asian long-horned beetle
Cronartium ribicola	White pine blister rust (fungus)
Carcinus maenus	European green crab (crab)
Hemigrapsis sanguineus	Asian shore crab
Membranipora mambranacea	Lace Bryozoan
Codium fragile ssp. fragile	Codium
Didemnum vexillum	Tunicate
Palaemon elegans	European Shrimp
Dreissena polymorpha	Zebra mussel

Probability of Future Occurrence

Because the presence of invasive species is ongoing, rather than a series of discrete events, it is difficult to quantify the frequency of these occurrences. However, increased rates of global trade and travel have created many new pathways for the dispersion of exotic species. A warming climate may place stress on colder-weather species, while allowing non-native species accustomed to warmer climates to spread northwards. Elevated atmospheric CO_2 concentrations could reduce the ability of ecosystems to recover after a major disturbance, such as flood or fire. As a result, invasive species, which are often able to establish more rapidly following a disturbance, could have an increased probability of successful establishment or expansion. The Planning Team determined that it is **LIKELY** that invasive species will continue to impact the planning area in the future.

Impacts on Pepperell's Key Sectors

As previous outlined, major vulnerability issues for each of the four major sectors (Infrastructural, Economic, Societal, and Environmental) were assessed to determine how Invasive Species will impact them, as shown in **Table 3-29** below.

TABLE 3-29
Invasive Species Exposure and Vulnerability by Key Sector[78]

Sector	Vulnerability
Infrastructural	As described above, water bodies such as reservoirs, could be exposed to the zebra mussel if it is introduced.
Environmental	Invasive species present a significant threat to the environment and natural resources present in Pepperell. Research has found that competition or predation by alien species is the second most significant threat to biodiversity, only surpassed by direct habitat destruction or degradation.
Economic	Invasive species are widely considered to be one of the most costly natural hazards in the United States, as invasive control efforts can be quite extensive and these species can damage crops, recreational amenities, and impact water quality.
Societal	Individuals who are particularly vulnerable to the economic impacts of this hazard would include all groups who depend on existing ecosystems for their economic success and wellbeing.

[78] 2018 MA SHMCAP

Section 4
Community Asset Inventory

Section 4 provides an inventory of the community assets that are important to the Town of Pepperell. The Section is broken up into three parts: a discussion of current and future land use trends, a description of the community assets categories used in the Town's MVP/HMP, and the results of the Pepperell Community Assets Inventory organized by FEMA's community asset categories. Identifying the community assets allows the Town to investigate how it will be impacted by the different natural hazards.

4.1 Inventory Overview

FEMA defines a community asset as anything that is important to the character and function of a community. Community assets can be split up into four different categories: People, Economy, Built Environment, and Natural Environment. The People category includes populations that are more vulnerable to disaster (e.g., elderly, children, visiting populations), densely populated areas, and societal assets such as cultural and historical resources. Economy is included because economic drivers are a major part of disaster recovery. Community assets in the Economy category can include major employers, commercial centers, and locations providing food, medical supplies and building materials. The Built Environment is the largest category and includes existing structures, infrastructure (transportation and utilities), and critical facilities important for disaster response and evacuation (e.g., police station, fire stations and medical facilities). The Natural Environment category is meant to capture any natural resources important to the community's character, economy (tourism, recreation, and the protection of clean air and water), and ecosystem services (e.g., wetlands providing flood storage and erosion control as a first line of defense from storms).

Table 4-1 summarizes the community asset categories included in FEMA guidelines, relevant critical sectors within each category, and the general characteristics that describe why these assets are important to include in a hazard mitigation plan.

Table 4-1
FEMA Community Asset Categories

FEMA Community Asset Categories	Critical Sectors	Characteristics of Community Assets
People- Societal Assets	Schools, Vulnerable Populations, Cultural and Historical Facilities	Areas of greater population density, or population with unique vulnerabilities or those less able to respond and recover during a disaster.
Built Environment- Infrastructural Assets	Critical Municipal Facilities, Water, Wastewater, Energy, Stormwater, Transportation	Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or for critical facilities to operate.
Economic Assets	Seaport, Business District, Food and Medical Supplies, Building Supplies	Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.
Environmental Assets	Natural Resources	Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.

Maps included in **Appendix C** show the location of all selected community assets. The tables below list the assets. Section 5, the vulnerability risk assessment, provides a discussion on natural hazards that may impact the community assets and their vulnerability.

4.1.1 Built Environment

Table 4-2 below displays the notable infrastructure found in the Town of Pepperell along with the site elevation.

ID	Category	Name	Address	Elevation (ft)
In1	Bridge	State Highway Agency Rural Minor Arterial	South St	200
In2	Bridge	State Highway Agency Urban Arterial	Hollis St	187
In3	Bridge	State Highway Urban Arterial	Main St	180
In4	Bridge	Town Agency Local Road, BIN 7Q3	Sartelle St	258
In5	Bridge	Town Agency Urban Local	Prescott St	203
In6	Bridge	Town Agency Urban Minor Arterial	Mill St	178
In7	Bridge	Town Agency Urban Minor Arterial	Groton St	169
In8	Cemetery Dept.	Woodlawn Cemetery/Garage	40 Heald St	296
In9	Communication Tower	Bemis St Well Communication Tower	Bemis St Well	224
In10	Communication Tower	Fire Station Communication Tower	35 Park St	300
In11	Communication Tower	Heald St Communication Tower	Heald St	438
In12	Communication Tower	Highway Department Communication Tower	45 Lowell Rd	207
In13	Communication Tower	Indian Head Communication Tower	Dow St	316
In14	Communication Tower	Jersey St Well Communication Tower	Jersey St Well	207
In15	Communication Tower	Lomar Park Drive Communication Tower	2 Lomar Park Dr	182
In16	Communication Tower	Powhattan Road Communication Tower	South Rd & Powhattan Rd	292
In17	Communication Tower	Town Hall Communication Tower	1 Main St	300
In18	Communication Tower	Townsend Street Water Tank Repeater	104A Townsend St	402
In19	Communications Facility	Verizon	20 High St	247
In20	Dam	Burkinshaw Dam	Sheffield St	278
In21	Dam	Guarnottas Dam (breached)	Prescott St	204
In22	Dam	Pepperell Paper Co. Dam	Main St	183
In23	Dam	Pork Barrel Dam	Prescott St	253
In24	DPW	Highway Department	45 Lowell Rd	205
In25	DPW	Maintenance Garage	End of Tucker St	282
In26	DPW	Transfer Station	66 Boynton St	267
In27	DPW	Water Department	46 Chestnut St	206
In28	DPW	Water Department Garage	46 Chestnut St	355
In29	Fire	Station 2	38 Park St	300
In30	Fire	Station 3	47 Lowell Rd	211
In31	GW Well	Bemis Rd Gravel Packed Well #1	Bemis Rd. Well	225

ID	Category	Name	Address	Elevation (ft)
In32	GW Well	N0. 1 Jersey St Gravel Packed Well	Jersey St	205
In33	GW Well	Nashua Rd Gravel Packed Well #1	Nashua Rd	207
In34	GW Well	No. 2 Bemis Rd Gravel Packed Well	Bemis Rd Well	223
In35	GW Well	No. 2 Jersey Street Gravel Packed Well	Jersey St	207
In36	GW Well	Wellhead	Nashua River	210
In37	Municipal Offices	Pepperell Town Hall	One Main St	307
In38	Police	Pepperell PD & EOC	59 Main St	233
In39	Power Plant	Pepperell Hydro (Swift River Hydro)	128.5 Main St	189
In40	Power Substation	Mass Electric/National Grid	37 Groton St	186
In41	Sewer	Adams St Sewer Pumping Station	4 Adams St	194
In42	Sewer	Brookline St Sewer Pumping Station	112 Brookline St	238
In43	Sewer	Heald St Sewer Pumping Station	Heald St	312
In44	Sewer	Park St Sewer Pumping Station	38 Park St	297
In45	Sewer	Sheffield St Sewer Pumping Station	18 Sheffield St	279
In46	Transport	Groton Public School Bus Lot	South Rd (Rt119)	202
In47	Wastewater	Wastewater Treatment Plant	47 Nashua Rd	190
In48	Water Pumping	Mason Street Water Pump	Mason St	386
In49	Water Storage	Heald Street Water Storage	88 Heald St	446
In50	Water Storage	Mason Street Water Tank	Mason St	402
In51	Water Storage	Townsend Street Water Tank	104 A Townsend St	496
In52	Water Supply	Bemis Rd Wellfield and Pumping Station	Bemis Rd	223
In53	Water Supply	Jersey St Wellfield and Pumping Station	Jersey St	206
In54	Water Supply	Pumping Station	Nashua Rd	208

4.1.2 People

Table 4-3 displays the societal assets in the Town of Pepperell along with the site elevation.

ID	Category	Name	Address	Elevation (ft)
Soc1	Accountant	Pepperell Accountant	1 Main St	306
Soc2	Animal Shelter	Pepperell Veterinary Hospital	110 River Rd	213
Soc3	Animal Shelter	Preventive Veterinary Medicine Clinic In	23 Maple St	393
Soc4	Cemetery	Pepperell Cemetery Association	3 Park Street	306
Soc5	Cemetery	St. Joseph's Cemetery	Jersey St	206
Soc6	Cemetery	Walton Cemetery	1 Park St	298
Soc7	Cemetery	Woodlawn Cemetery	40-42 Heald St	294
Soc8	Child Care	The Family Tree Child Care Center	26 Hollis St	226
Soc9	Church	Church of the Holy Spirit	1 Tucker St	233

ID	Category	Name	Address	Elevation (ft)
Soc10	Church	Community Church of Pepperell	3 Townsend St	312
Soc11	Church	Faith Worship Ctr	2 Lomar Park	189
Soc12	Church	Grace Baptist Church	42 River Rd	229
Soc13	Church	Kingdom Hall of Jehovah's Witnesses	141 South Rd	322
Soc14	Church	Our Lady of Grace (St. Joseph's) Catholic Church	28 Tarbell St	213
Soc15	Church	Pepperell Christian Fellowship	17 Main St	305
Soc16	Church	St David's Episcopal Church	180 South Rd	348
Soc17	Church	United Methodist Church	1 Chapel Pl	234
Soc18	Community Center	Pepperell Community Center	4 Hollis St	236
Soc19	Community Center	Pepperell Senior Center/Albert Harris Center	37 Nashua Rd	191
Soc20	Elderly Housing	12 Hollis St Senior Housing	12 Hollis St	242
Soc21	Elderly Housing	68 Groton St Senior Housing	68 Groton St	222
Soc22	Elderly Housing	Babbitassit Village	8 Foster St	215
Soc23	Elderly Housing	Independent Living Facility	PO Box 1264	242
Soc24	Elderly Housing	Lodging Care	1 Chestnut St	414
Soc25	Elderly Housing	Pepperell Housing Authority/Babatassitt Village	4 Foster St	214
Soc26	Elderly Housing	Pepperell Meadows	18 River Rd	232
Soc27	Elderly Housing	Tarbell Townhouses	36 Tarbell St	206
Soc28	Elderly Housing	Trailer Park +55	6 Mason St	391
Soc29	Food Pantry	PACH Outreach	66 Hollis St	222
Soc30	Fraternal Org/ Community Ctrs	VFW	55-59 Leighton	206
Soc31	Funeral Home	Marchand Funeral Home	16 Pleasant St	229
Soc32	Funeral Home	McGaffigan Funeral Home	37 Main St	280
Soc33	Historic District	Pepperell Center Historic District		312
Soc34	Historic Structure	Col. William Prescott House	78-88 Prescott St	311
Soc35	Historic Structure	Covered Bridge	Groton St	172
Soc36	Historic Structure	Historic Turner's Dam Site	56 Hollis St	197
Soc37	Historic Structure	Pepperell District Schoolhouse #3	50 Shattuck St	381
Soc38	Historic Structure	Zachariah Fitch Tavern	70-78 South Rd	243
Soc39	Library	Lawrence Library (Public)	15 Main St	298
Soc40	School	Apple Seeds Preschool	45 Main St	226
Soc41	School	Maple Dene and Moppet School	83 Hollis St	225
Soc42	School	Nissitissit Middle School	33 Chase Ave	274
Soc43	School	Pepperell Christian Academy	42 River Rd	235
Soc44	School	Peter Fitzpatrick School (former)	45 Main St	255
Soc45	School	Varnum Brook Elementary	10 Hollis St	260

4.1.3 Economy

Table 4-4 below displays economic assets in the Town of Pepperell along with the site elevation.

ID	Category	Company Name	Address	Elevation (ft)
Eco1	Banks	Lowell Five Cent Savings Bank	65 Groton St	221
Eco2	Banks	Main Street Bank	80 Main St	230
Eco3	Construction or Building Contractor	5S Store	86 Townsend St	427
Eco4	Construction or Building Contractor	Babin Landscaping	PO Box 587	228
Eco5	Construction or Building Contractor	Brick Pond Handworks	110 Shirley St	223
Eco6	Construction or Building Contractor	Buckley Plumbing & Heating	4 Haskell Rd	211
Eco7	Construction or Building Contractor	Burnham Construction	62 West St	471
Eco8	Construction or Building Contractor	Burt Ilsley Construction	140 Brookline St	217
Eco9	Construction or Building Contractor	CBM Forms	38 Blood St	340
Eco10	Construction or Building Contractor	CJ Fei Landscape Design Corp	6 Brick Pond Way	234
Eco11	Construction or Building Contractor	Crestar Properties	25 Dow St	251
Eco12	Construction or Building Contractor	Cutting Edge Remodeling LLC	6 Juniper Rd	303
Eco13	Construction or Building Contractor	D H Nelson Construction	4 Cross St	237
Eco14	Construction or Building Contractor	Davolio Landscaping	41 Lakin St	310
Eco15	Construction or Building Contractor	DH Duncan Carpentry	44 Shattuck St	382
Eco16	Construction or Building Contractor	Douglas Eugene B Plbg & Htg	97 Chestnut St	320
Eco17	Construction or Building Contractor	E Scapes Corp	51 South Rd	235
Eco18	Construction or Building Contractor	East Coast Metals Inc	91 Chestnut St	316
Eco19	Construction or Building Contractor	Gath Electric	16 Independence Rd	248
Eco20	Construction or Building Contractor	Hickory Ridge Landscaping	PO Box 649	232
Eco21	Construction or Building Contractor	Hills Brothers Construction	94 Groton St	240
Eco22	Construction or Building Contractor	Homestead Design Corp	93 Jewett St	399
Eco23	Construction or Building Contractor	Jeff & Sons Carpentry	7 Powhatan Rd	283
Eco24	Construction or Building Contractor	Jmd Electric	111 Groton St	227
Eco25	Construction or Building Contractor	K & K Plumbing & Heating	55 Harbor St	416
Eco26	Construction or Building Contractor	Karl Pokraka	29 Nashua Rd	193
Eco27	Construction or Building Contractor	Kazanjian Horticultural Svc	5 East St	232
Eco28	Construction or Building Contractor	Kemco Construction Inc	7 Lomar Park # 4	182

ID	Category	Company Name	Address	Elevation (ft)
Eco29	Construction or Building Contractor	L L & S Development	PO Box 180	214
Eco30	Construction or Building Contractor	Landscapes Unlimited	92 Groton St	233
Eco31	Construction or Building Contractor	Larose & Sons Construction	103 Chestnut St	311
Eco32	Construction or Building Contractor	M C Contracting	24 Lomar Park # A	229
Eco33	Construction or Building Contractor	M J R Handyman Svc	14 Lomar Park	201
Eco34	Construction or Building Contractor	Macdonald Carpentry & Remodeling	152 South Rd	371
Eco35	Construction or Building Contractor	Matley Plumbing & Heating Co	1 Tucker St # B	229
Eco36	Construction or Building Contractor	MKM Construction Co	PO Box 864	299
Eco37	Construction or Building Contractor	Niklaus Painting	PO Box 223	240
Eco38	Construction or Building Contractor	Nissitissit HVAC	78 Prescott St	313
Eco39	Construction or Building Contractor	P & G Construction	26 High St	260
Eco40	Construction or Building Contractor	P J Joyce Excavating	69a South Rd	259
Eco41	Construction or Building Contractor	Patriot Painting	4 Hog Hill Rd	433
Eco42	Construction or Building Contractor	Pepperell Concrete Cutting	41 Lowell Rd	205
Eco43	Construction or Building Contractor	Pete Antosh Excavating	PO Box 807	182
Eco44	Construction or Building Contractor	R A Mechanical Inc	16 Lomar Park # 1	208
Eco45	Construction or Building Contractor	Richard Egan Construction	12 Blood St	308
Eco46	Construction or Building Contractor	Sargent Electric	94 River Rd	210
Eco47	Construction or Building Contractor	Shattuck Trucking Inc	PO Box 435	317
Eco48	Construction or Building Contractor	Townline HVAC Inc	82 Hollis St	227
Eco49	Construction or Building Contractor	Vieira Plumbing	PO Box 1354	207
Eco50	Construction or Building Contractor	W B Design & Landscape	PO Box 777	283
Eco51	Construction or Building Contractor	Winnett Electric	121 Nashua Rd	224
Eco52	Convenience Stores	Cumberland Farms	121 Main St	219
Eco53	Convenience Stores (Closed)	Energy North Citgo	49 Main St	241
Eco54	Electric Equipment & Supplies-Retail	Sentry Electronics Products	143 Townsend St	346
Eco55	Farm - Agriculture	Arpin	101 Nashua Rd	
Eco56	Farm - Agriculture	Beattie	40 Oak Hill St	
Eco57	Farm - Agriculture	Blood	27 Shirley St	
Eco58	Farm - Agriculture	Blood Land	13 Mason St	
Eco59	Farm - Agriculture	Boettcher	90 Hollis St	
Eco60	Farm - Agriculture	Delker	201 South Rd	

ID	Category	Company Name	Address	Elevation (ft)
Eco61	Farm - Agriculture	Friend	11 Dow Street	
Eco62	Farm - Agriculture	Gardner	63 River Rd	
Eco63	Farm - Agriculture	Gardner	67 River Rd	
Eco64	Farm - Agriculture	Gardner	65 River Rd	
Eco65	Farm - Agriculture	Gardner	64 90 River Rd	
Eco66	Farm - Agriculture	Graves	78 Prescott St	
Eco67	Farm - Agriculture	Graves	162 Hollis St	
Eco68	Farm - Agriculture	Graves	75 Prescott St	
Eco69	Farm - Agriculture	Hayes	70 South Rd	
Eco70	Farm - Agriculture	Hills/Kimball's	182 Hollis St	
Eco71	Farm - Agriculture	Holmes	41 Elliott St	
Eco72	Farm - Agriculture	Kaiser Twin Valley Farm	49 Brookline St	
Eco73	Farm - Agriculture	Laddager	75 South Rd	
Eco74	Farm - Agriculture	Lavender	141 Hollis St	
Eco75	Farm - Agriculture	Malouin	128 Hollis St	
Eco76	Farm - Agriculture	McGovern	48 North St	
Eco77	Farm - Agriculture	Murphy	41 North St	
Eco78	Farm - Agriculture	Nichols	183 Holli St	
Eco79	Farm - Agriculture	Ratta	96 Mt. Lebanon St	
Eco80	Farm - Agriculture	Town of Pepperell Select Board	20 Groton St	
Eco81	Farm - Agriculture	West	14 Prescott St	
Eco82	Farm - Agriculture	Wilkins	18 South Rd	
Eco83	Farm - Cows/Hay	Russell	76 Heald St	
Eco84	Farm - Cows/Pig/Milk	Duke	67 85 Jewett St	
Eco85	Farm - Goat Products	Lucille McKain	16B Brookline St	
Eco86	Farm - Hay	Red Tail/Carter	40 Elliott St	
Eco87	Farm - Hay/Sheep	Tolman	12 Harbor St	
Eco88	Farm - Horses	Bourque Tyler/Touch of Magic	2 Old Farm Lane	
Eco89	Farm - Horses	Bourque Tyler/Touch of Magic	4 Old Farm Lane	
Eco90	Farm - Horses	Haney/Oak Hill Farms	34 Elm St	
Eco91	Farm - Horses	Kinney	5 Prescott St	
Eco92	Farm - Horses	Maker Farm	12 Bancroft St	
Eco93	Farm - Horses	Rose/Autumn Hill Farm	39 Jewett St	
Eco94	Farm - Horses	Solka	95 Hollis St	
Eco95	Farm - Horses	Tyler	34 Jewett St	
Eco96	Farm - Maple Syrup	Ritchie	18 Shattuck St	
Eco97	Grocery	Donelan's Supermarket	75 Main St	234
Eco98	Grocery	Walgreens	60-62 Groton St	217
Eco99	Landscaper	Ream Design	156 Heald St	438

ID	Category	Company Name	Address	Elevation (ft)
Eco100	Pharmacy	Pepperell Family Pharmacy	PO Box 1547	221
Eco101	Pharmacy	Walgreens	60 Groton St # 62	217
Eco102	Telecommunications Services	Charter Communications	7 Lomar Park # 7	183
Eco103	Telecommunications Services	Pepperell Community Media	6 Cottage St	225
Eco104	Tree Service	Mead Tree & Landscape Svc	73 Groton St	219
Eco105	Trucking	Buxton Co	PO Box 499	317
Eco106	Trucking	Reese Enterprises	10 Lomar Park # 10	184
Eco107	Trucking	Shattuck Trucking Inc	5 Heald St	309
Eco108	Variety Stores	7-Eleven	2 Tarbell St # 2	213

4.1.4 Natural Environment

Table 4-5 below displays natural environment assets in the Town of Pepperell along with the site elevation.

Category	Name	Address
Protected Open Space	9 Harvard Lane	9 Harvard Lane
Protected Open Space	Anderson	115A Groton
Protected Open Space	Anderson Lot	83 Elm St
Protected Open Space	Anderson Lot	89 Elm St
Protected Open Space	B & M R.O.W.	21 South Rd
Protected Open Space	Babin	56 Hollis
Protected Open Space	Babin/Abele	34 Lawrence st
Protected Open Space	Babin/Abele	38 Lawrence St
Protected Open Space	Babin/Abele	40 Lawrence St
River	Bancroft Brook	
River	Beaver Brook	
Protected Open Space	Beaver Creek	Beaver Creek
Protected Open Space	Bemis Road Sand Pit	Off Bemis Rd
Protected Open Space	Bemis Road Well	Bemis Rd
Protected Open Space	Bemis Road Well	Blood Lot
Protected Open Space	Bemis Road Well	Rich Tree Farm
Protected Open Space	Bisson	120A Heald
River	Blood Brook	
Chapter 61, 61A or 61B		13 Mason St
Chapter 61, 61A or 61B		18 Mason St
Chapter 61, 61A or 61B		20 Mt Lebanon St
Chapter 61, 61A or 61B		24 Shirley St
Chapter 61, 61A or 61B		27 Shirley St

Category	Name	Address
Chapter 61, 61A or 61B		65 Elm St
Protected Open Space	Bon	67 Shirley
Protected Open Space	Boy Scout Parcels	172 A Lowell Rd; access from Pine Street Extension
Protected Open Space	Boy Scout Parcels	Off June St; access from Pine St Extension
Protected Open Space	Burnham Lot	43B Oak Hill St
Protected Open Space	Burnham Lot	56 - 62 Boynton St
Chapter 61, 61A or 61B		67 Jewett St
Chapter 61, 61A or 61B		84 Jewett St
Protected Open Space	Countryside	23 Countryside Rd
Protected Open Space	Countryside	24 Countryside Rd
Protected Open Space	Countryside	25 Countryside Rd
Protected Open Space	Cranberry St.	Lot 12/Cranberry Woods
Protected Open Space	Cranberry Woods	Off Cranberry Street, bog
Protected Open Space	Darling	63 Wheeler
Protected Open Space	DF & W	0 Brookline St
Protected Open Space	DF & W	142 Brookline St
Protected Open Space	DF & W	169 -175 Brookline St
Protected Open Space	DF & W	2 - 8 South Rd/Rt. 119
Protected Open Space	DF & W	2 Lowell St
Protected Open Space	DF & W	20 1/2 Groton St
Protected Open Space	DF & W	25 Boynton St
Protected Open Space	DF & W	4 - 14 North St
Protected Open Space	DF & W	40 Mill St
Protected Open Space	DF & W	49 Hollis St
Protected Open Space	DF & W	6 - 8 Groton St
Protected Open Space	DF & W	9 Nashua Rd
Protected Open Space	DF & W	Accessed from Brookline St
Protected Open Space	DF & W	Nissitissit River WMA Brookline, Prescott, North Sts
Protected Open Space	DF & W	Off Groton St
Protected Open Space	DF & W	Off Hollis St
Protected Open Space	DF & W	off Shawnee Rd
Protected Open Space	DF & W	47 Brookline St
Protected Open Space	Eaton Lot	Off Brookline St
Protected Open Space	Egan Lot	Off Plainfield Rd
Protected Open Space	Emerson Village	30 Emerson Circle

Category	Name	Address
Protected Open Space	Ferrero	146 South Rd
Protected Open Space	Ferrero	148 South Rd
Protected Open Space	Foley Lot	Off Harbor St
Protected Open Space	DF & W	Off South Rd
Chapter 61, 61A or 61B		63 River Rd
Protected Open Space	Gardner Farm	64 to 90 River Rd
River	Greens Brook	
Protected Open Space	Griffis	58 60 Prescott
Protected Open Space	Griffis	58A Prescott
Protected Open Space/River	Gulf Brook	81 - 99 Oak Hill St
Protected Open Space	Gulf Brook - Stewart Brook	Bayberry Rd/Lawrence St/Cranberry St
Protected Open Space	Heald Pond	Heald St/Jewett St
Protected Open Space	Heald Street Orchard	11A Heald Street; east side of Heald Pond
Protected Open Space	Heald Street Orchard	88 - 180 Heald St; east side of Heald Pond
Protected Open Space	Holmes Donation	48 Elliott St
Protected Open Space	Holmes Donation	50 Elliott St
Protected Open Space	Homoleski	off Lawrence St
Protected Open Space	Hopkins Donation	130 Shirley St
Protected Open Space	Independence Rd. Trust	Independence Rd
Protected Open Space	J. Harry Rich State Forest	130 River Rd
Protected Open Space	Jersey Street Well	Off Jersey St
Protected Open Space	Kemp Donation	4 Yale
Protected Open Space	Kemp Donation	7 Harvard
Protected Open Space	Kemp Race Track CR	15' Access from River Road; 100' buffer zone along Nashua River
Protected Open Space	Kemp Race Track OSRD	116 River Rd
Protected Open Space	Keyes Farm	33 39 Canal
Protected Open Space	Keyes Farm	28 32 Canal St
Protected Open Space	Keyes Farm	35 53 River Rd
Protected Open Space	Keyes Farm	44 River Rd
Protected Open Space	Keyes Farm	52 Elm
Protected Open Space	Keyes Farm Ext.	off River Rd
Protected Open Space	Kimball Fruit Farm	171 Hollis St
Protected Open Space	Kirin Krossing	Off Kirin Krossing
Protected Open Space	Land beside Covered Bridge	0 Mill St

Category	Name	Address
Protected Open Space	Levi Backland	Wheeler
Protected Open Space	Levi Lot	55 - 61 Wheeler Rd
Protected Open Space	Linkel	Elm St
Protected Open Space	Lorden	0 East St
Protected Open Space	Lorden	Off Crawford Way
Protected Open Space	Mention's Pond	Lawrence St
Protected Open Space	Merrill Lot	66 - 72 Oak Hill St
Protected Open Space	Merrimac	Riverside Dev.
Protected Open Space/River	Mine Brook	
Protected Open Space	Mount Lebanon	32 - 34 Mt. Lebanon St
Protected Open Space	Mount Lebanon	46 Mt. Lebanon St
Protected Open Space	Mount Lebanon	48 Mt. Lebanon St
Protected Open Space	Mount Lebanon	55 Mt. Lebanon St
Protected Open Space	Mount Lebanon	58 Mt. Lebanon St
Protected Open Space/River	Nashua River	MA81-06/MA81-07
Protected Open Space	Nashua River shoreline	Rail Trail frontage at Groton line
Chapter 61, 61A or 61B		95 Hollis St
Chapter 61, 61A or 61B		96 Hollis St
Protected Open Space	Nissitissit Meadows	Prescott St
Protected Open Space/River	Nissitissit River	Off Brookline St; Carter Parcel
Protected Open Space	Nissitissit River Land Trust	Off Brookline St
Protected Open Space	Nursery	10 Nursery
Protected Open Space	Nursery	7 Nursery
Protected Open Space/River	Nutting Brook	
Protected Open Space/River	Nutting Stream	
Protected Open Space	Old Rail Corridor	0 South Rd
Protected Open Space	Parker Donation	Off Brookline St
Protected Open Space	Parker Lot	172 River Rd
Protected Open Space	Pepperell Pond; Nashua River	9 Yale Rd
Protected Open Space	Pepperell Pond; Nashua River	Pepperell Pond Off River Rd
Protected Open Space	Pepperell Springs	29 41 Bayberry
Protected Open Space	Pepperell Springs	43-53 Bayberry
Protected Open Space	Pepperell Springs	74 80 Chestnut
Protected Open Space	Pepperell Springs	Maple St
Protected Open Space	Pepperell Springs	Oak Hill Rd
Protected Open Space	Rail Trail	Groton St to Lowell Rd
Protected Open Space	Rail Trail	Lowell Rd north to Dunstable along east side of Nashua River downstream from Main Street dam

Category	Name	Address
Protected Open Space	Rail Trail	Town of Groton boundary north to Groton St
Chapter 61, 61A or 61B		51 Mt Lebanon St
Protected Open Space/River	Robinson Brook	
Protected Open Space	Seminatore Lot	59 A Park St
Protected Open Space	Senior Ctr. Land Between the Rivers	20 Groton St
Protected Open Space	Senior Ctr. Land Between the Rivers	20A Groton St
Protected Open Space	Senior Ctr. Land Between the Rivers	35 Nashua Rd
Protected Open Space	Shattuck	109 Nashua Rd
Protected Open Space	Shattuck Estates Donation	11 Longmeadow Lane
Protected Open Space	Shattuck Estates Donation	24 Ridge Rd
Protected Open Space	Shattuck Estates Donation	9 Longmeadow Lane
Protected Open Space	Shattuck Estates Donation	9-23 Ridge Rd
Protected Open Space	Shattuck Estates Donation	Discontinued road, Longmeadow to Brookdale
Protected Open Space/River	Stewart Brook	Lawrence St
Protected Open Space	Storage Tanks	Heald St; 1 million gals
Protected Open Space	Storage Tanks	Off Mason St
Protected Open Space	Storage Tanks	Off Mt. Lebanon St
Protected Open Space	Storage Tanks	Off Townsend St
Protected Open Space	Stromsted	42 Mt. Lebanon
Protected Open Space	Stromsted	55 Mt. Lebanon St
Protected Open Space/River	Sucker Brook	Off Brookline St/Oak Hill St
Protected Open Space	Sue's Ramble	138 Jewett St
Protected Open Space	Susan Smith Lot	21A Main (behind Lawrence Library)
Protected Open Space	Susan Smith Lot	2A Sartelle St
Protected Open Space	Town Forest	Between Elm Street and River Rd
Protected Open Space	Town Forest	Off Heald St,"Old Poor Farm"
Protected Open Space	DF & W	148 Lowell Rd
Protected Open Space	Tully	97A Off East St
Protected Open Space	Twin Valley Farm	49 Brookline St
Protected Open Space	Twin Valley Farm	50 Brookline St
Protected Open Space	Twin Valley Farm	74 Brookline St
Protected Open Space	Twohig	36 Oak Hill
Protected Open Space	Unkety Brook Watershed	137A Lowell Rd
Protected Open Space	Unkety Brook Watershed	148 Lowell Rd
Protected Open Space/River	Varnum Brook	
Protected Open Space	VCR (Visniewski)	106 Shirley

Category	Name	Address
Protected Open Space	Village Rd.	47 49 Park St
Protected Open Space	Village Rd.	Off Village Rd
Protected Open Space	Walent	146 River
Protected Open Space	Wooltop	0 Independence
Protected Open Space	Yapp	South Rd/Rt. 119
Chapter 61, 61A or 61B		101 Hollis St
Chapter 61, 61A or 61B		11 Dow St
Chapter 61, 61A or 61B		11 Harbor St
Chapter 61, 61A or 61B		11 Powhatan Rd
Chapter 61, 61A or 61B		112 Hollis St
Chapter 61, 61A or 61B		117 Chestnut St
Chapter 61, 61A or 61B		12 Harbor St
Chapter 61, 61A or 61B		121 Elm St
Chapter 61, 61A or 61B		127 Shirley St
Chapter 61, 61A or 61B		128 Hollis St
Chapter 61, 61A or 61B		133 Hollis St
Chapter 61, 61A or 61B		137 Hollis St
Chapter 61, 61A or 61B		14 Prescott St
Chapter 61, 61A or 61B		141 Hollis St
Chapter 61, 61A or 61B		143 River Rd
Chapter 61, 61A or 61B		143 South Rd
Chapter 61, 61A or 61B		148 River Rd
Chapter 61, 61A or 61B		150 Nashua Rd
Chapter 61, 61A or 61B		162 Hollis St
Chapter 61, 61A or 61B		163 Hollis St
Chapter 61, 61A or 61B		169 Hollis St
Chapter 61, 61A or 61B		17 Lawrence St
Chapter 61, 61A or 61B		17 Powhatan Rd
Chapter 61, 61A or 61B		18 Boynton St
Chapter 61, 61A or 61B		18 Shattuck St
Chapter 61, 61A or 61B		19 Harbor St
Chapter 61, 61A or 61B		2 Blue Herons Wy
Chapter 61, 61A or 61B		20 South Rd
Chapter 61, 61A or 61B		201 South Rd
Chapter 61, 61A or 61B		22 Sheffield St
Chapter 61, 61A or 61B		26 Lakin St
Chapter 61, 61A or 61B		26 Prescott St
Chapter 61, 61A or 61B		26 Sartelle St
Chapter 61, 61A or 61B		27 Sartelle St
Chapter 61, 61A or 61B		32 Elliott St

Category	Name	Address
Chapter 61, 61A or 61B		32 Shirley St
Chapter 61, 61A or 61B		33 North St
Chapter 61, 61A or 61B		34 Elm St
Chapter 61, 61A or 61B		4 Sirius Ln
Chapter 61, 61A or 61B		40 Elliott St
Chapter 61, 61A or 61B		40 Oak Hill St
Chapter 61, 61A or 61B		41 Elliott St
Chapter 61, 61A or 61B		41 North St
Chapter 61, 61A or 61B		41 Shattuck St
Chapter 61, 61A or 61B		46 Bancroft St
Chapter 61, 61A or 61B		46 Blood St
Chapter 61, 61A or 61B		48 North St
Chapter 61, 61A or 61B		51 Elm St
Chapter 61, 61A or 61B		52 Elliott St
Chapter 61, 61A or 61B		54 Elm St
Chapter 61, 61A or 61B		6 Ames St
Chapter 61, 61A or 61B		64 Harbor St
Chapter 61, 61A or 61B		67 River Rd
Chapter 61, 61A or 61B		68 Prescott St
Chapter 61, 61A or 61B		7 Lakin St
Chapter 61, 61A or 61B		70 South Rd
Chapter 61, 61A or 61B		74 Nashua Rd
Chapter 61, 61A or 61B		75 Prescott St
Chapter 61, 61A or 61B		75 South Rd
Chapter 61, 61A or 61B		76 Heald St
Chapter 61, 61A or 61B		76 Prescott St
Chapter 61, 61A or 61B		78 Prescott St
Chapter 61, 61A or 61B		83 South Rd
Chapter 61, 61A or 61B		87 Elm St
Chapter 61, 61A or 61B		87 Lawrence St
Chapter 61, 61A or 61B		9 Maple St
Chapter 61, 61A or 61B		90 Hollis St
Chapter 61, 61A or 61B		93 Groton St
Chapter 61, 61A or 61B		96 Mt. Lebanon St
Chapter 61, 61A or 61B		99 Nashua Rd
Chapter 61, 61A or 61B		Off Dow St
Chapter 61, 61A or 61B		Off Jewett St
Chapter 61, 61A or 61B		off Lowell Rd
Chapter 61, 61A or 61B		Off North St
Chapter 61, 61A or 61B		Off South Rd

Category	Name	Address
Chapter 61, 61A or 61B		Sartelle St
Protected Open Space	DF & W	13 Theodore Ln
Protected Open Space		29 Wheeler St
Protected Open Space		32 Shirley St/Easement
Protected Open Space	DF & W	78 Hollis St
Protected Open Space	DF & W	80 Hollis St
Protected Open Space		Behind 27 Wheeler St

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4.2 Land Use and Development Trends

Information contained in the Town's 2020 Master Plan update provides an excellent summary of land use and development trends. This information is summarized in this section of the HMP.

4.2.1 Overview of Historical Development Pattern

The Town of Pepperell was originally settled with the establishment of farms and river crossings along the Nashua River in the 1720s and 1730s. Industrial and commercial activities thrived between the early 18th and 19th centuries, taking advantage of water power provided by the Nashua River.

After construction of the Worcester & Nashua Railroad in 1848, commercial establishments grew around the railroad depot. More recent development generally followed earlier established settlement patterns.

4.2.2 Land Use and Population Trends

As shown in **Table 4-5,** land use development patterns have significantly changed over the past fifty years as residential and commercial development replaced farmland and forest. Between 1971 and 2016, acreage classified as residential grew by 246%, while agricultural land decreased by 42%. Overall, developed acreage grew by 204%, while the total acreage of undeveloped land decreased by 23%.

Table 4-5:
Land Use Development Patterns in Pepperell: 1971 to 2016

Land Use	1971	1985	1999	2016	Percent Change 1971 -2016	Percent of Total 2016
Residential	1,163	2,125	3,386	4,022	245.86%	27.11%
Commercial	50	61	67	59	17.99%	0.40%
Industrial	103	225	178	188	82.26%	1.27%
Government/Institutional	126	211	96	113	-10.56%	0.76%
Developed	**1,443**	**2,622**	**3,726**	**4,383**	**203.74%**	**29.54%**
Agricultural	2,673	2,488	2,069	1,560	-41.66%	10.51%
Other Undeveloped	10,344	9,352	8,643	8,496	-17.87%	57.26%
Undeveloped	**13,018**	**11,839**	**10,712**	**10,055**	**-22.76%**	**67.77%**
Water	378	378	400	400	5.95%	2.70%
Total	14,838	14,838	14,838	14,838	**N/A**	**100%**

Source: University of Massachusetts, MacConnell Land Use Data; 2016 land use data was updated from 1999 MacConnell land use data using 2016 aerial imagery

During approximately the same period, Pepperell's population grew from 5,887 in 1970 to 11,497 in 2010[79]. With a total area of 23.18 square miles, Pepperell's population density was approximately 496 persons per square mile in 2010.

4.2.3 Current Land Use

Table **4-6** summarizes parcel-based land use statistics from the Tax Assessor's database as of January 2018.

Table 4-6:
Current Use of Parcels in Pepperell (2018)

Land Use	No. of Parcels	Total Acres	% of Land Area
Residential - Single Family Dwellings	3,138	6,554.14	46.89%
Residential - Two Family Dwellings	207	323.66	2.32%
Residential - Multi-Family Dwellings	374	167.69	1.20%
Residential - Mobile homes	23	147.49	1.06%
Residential - Accessory Land	13	52.74	0.38%
Mixed Residential and Agricultural	24	580.40	4.15%
Mixed Residential and Commercial	40	158.41	1.13%
Commercial	58	169.27	1.21%
Manufacturing and R&D	95	71.76	0.51%
Public Utilities	9	20.23	0.14%
Institutional	20	18.67	0.13%
Agricultural	29	811.02	5.80%
Cemetery	5	42.10	0.30%
Municipal Land (excluding conservation)	83	776.66	5.56%
Conservation: State, Municipal, and Private	93	1,473.62	10.54%
Limited Protection Conservation/Open Space	40	949.64	6.79%
Vacant	384	1,658.91	11.87%
Total	**4,635**	**13,976.41**	**100.00%**

Source: Pepperell Assessor's Parcel Data and Land Use Codes, January 2018

Ninety-three (93) open space and conservation parcels are owned by the Commonwealth of Massachusetts, the Town of Pepperell, Nashoba Conservation Trust, and other private organizations, as are identified by the Assessor's database. Combined, these parcels account for 1,473.6 acres, or 10.5% of the town's land area, and are afforded some level of protection from development.

The Assessor's database also identifies forty (40) parcels as classified under Chapter 61 forestry, Chapter 61B recreation, or as parcels with a mix of residential and Chapters 61 or 61B. Combined, these 40 parcels constitute 949.6 acres, or 6.8% of the Town's total land area. While such programs offer tax benefits to keep forest and recreation land undeveloped, they do not provide permanent protection from future development.

There are three hundred eighty-four (384) parcels classified as undeveloped or vacant in the Assessor's database. Combined, these undeveloped parcels total 1,658.9 acres, or

[79] US Census Bureau

11.9% of Pepperell's total land area. The parcels include 549.6 acres of developable residential land and 121.1 acres of developable industrial land. In addition, 736.8 acres are classified as undevelopable, while 251.4 acres are classified as potentially developable.

Based on a review conducted by town staff of projects constructed since approval of the previous HMP in 2015, the Town has not approved any development projects in hazard prone areas and has acquired considerable land for permanent protection. Much of Pepperell's protected open space surrounds the Nashua and Nissitissit Rivers and their tributaries, is clustered in the northwest and north central sections of town, and coincides with the Water Resources Protection Overlay District (WRPOD). Pepperell's land acquisition initiatives focus on connecting parcels that further the establishment of an open space network, protecting water quality, addressing vulnerability and resiliency related to flooding and climate change, and creating wildlife corridors.

4.2.4 Potential Future Development

Population projections for the Town of Pepperell, as outlined in **Table 4-7**, predict a slightly higher future growth rate for the Town compared to the region as a whole. Between 2010 and 2020, Pepperell is expected to experience a growth rate of 1.3%, which is anticipated to increase to 2.7% in the 2020s, and to 4.9% in the 2030s, reaching a total projected population of 12,553 by 2040. The projections suggest that Pepperell's population will comprise 4.1% of the Greater Lowell region's total population by 2040, just slightly higher than today.

Table 4-7:
Actual and Projected Population: 2010-2040

Year	Population	Growth Rate	Greater Lowell Region	Regional Growth Rate	Pepperell as a Percentage of Region
2010	11,497	3.2%	286,901	2.0%	4.0%
2020	11,648	1.3%	291,101	1.5%	4.0%
2030	11,962	2.7%	295,370	1.5%	4.0%
2040	12,553	4.9%	306,913	3.9%	4.1%

Sources: U.S. Census Bureau; Projections developed by MassDOT in consultation with NMCOG

Pepperell's Growth and Development

There are several areas and sites in Pepperell that offer potential for future economic development, including:

- **Railroad Square** - Railroad Square has been the subject of many economic development and transportation studies over the past 10-15 years. Railroad Square should be promoted as a vibrant, pedestrian-oriented commercial center to help attract businesses and shoppers, including those enjoying the DCR Rail Trail and access to the Nashua River.
- **Route 113 Corridor** - The Route 113 Corridor offers extensive opportunities for commercial development. This area should continue to serve as a home to small businesses, professional offices and commercial enterprises located in buildings that contribute to its New England village character and traditional development pattern.

- **Former Pepperell Paper Mill Site** - The former Pepperell Paper Mill site offers a development opportunity. Currently owned by A1 Auto, the project has sat idle for 2-3 years.
- **Peter Fitzpatrick School** – The reuse of this facility is being analyzed. The redevelopment of the school will add greatly to the properties along the Route 113 Corridor.
- **Lomar Industrial Park** – This industrial property could be used as a potential Food Hub in the future. As the only industrial park in Pepperell, it may offer an opportunity for industrial investors to move to Pepperell.
- **Route 119 Corridor** - There are some underutilized parcels along the Route 119 Corridor that could be redeveloped. The reuse of these parcels should not impact the wetlands but should primarily consist of agricultural uses.

Section 5
Multi-Hazard Vulnerability Assessment

5.1 Overview

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The purpose of the vulnerability assessment is to estimate the extent or magnitude of potential damages from natural hazards of varying types and intensities. Section 5 ties together the hazards identified in Section 3 and the community assets identified in Section 4 to estimate the potential losses that Pepperell could experience during a natural hazard event. There are four assessments included in **Section 5** of the this HMP Update:

1. **HAZUS-Multi Hazards (MH) Assessment:** HAZUS is a standardized hazard assessment methodology created by FEMA. This vulnerability assessment includes estimation of damages for hurricanes and earthquakes using HAZUS-MH software and is described in **Section 5.2**.
2. **Exposure Assessment of Parcels and Building Flood Risk**: This assessment was completed using GIS analysis for existing flooding using assessor's data, and current FEMA FIRMs. This assessment is described in **Section 5.3.1**.
3. **Vulnerability Assessment for Future Development:** This assessment was completed for areas slated for future development, identifying natural hazard risk from hurricanes, earthquakes, and flooding, and is further described in **Section 5.3.2.**
4. **Vulnerability of Community Assets**: This assessment was completed to determine whether critical facilities and other identified community assets could be exposed to flooding, surge, sea level rise and coastal erosion. The assessment looks at existing flood conditions based on approved FEMA FIRMS with 2017 and 2018 map revisions and future flood conditions due to climate change, based on data from the Massachusetts Climate Change Warehouse. This assessment is described in **Section 5.4**.

5.2 HAZUS-MH for Hurricanes and Earthquakes

Methodology

HAZUS-MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. For the purposes of this Plan, HAZUS-MH was used to estimate losses due to hurricane winds and earthquakes. The following overview of HAZUS-MH is taken from the FEMA website:

Hazus is a nationally applicable standardized methodology that estimates potential losses from earthquakes, hurricane winds, and floods. FEMA developed Hazus under contract with the National Institute of Building Sciences (NIBS).

Hazus uses state-of-the-art GIS software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of earthquakes, hurricane winds, and floods on populations.

Estimating losses is essential to decision-making at all levels of government, providing a basis for developing mitigation plans and policies, emergency preparedness and response, and recovery planning." [80]

There are three modules included with the HAZUS-MH software: hurricane wind, flooding, and earthquakes. There are also three levels at which HAZUS-MH can be run. Level 1 uses national baseline data and is the quickest way to begin the risk assessment process. The analysis in this Plan was completed using Level 1 data.

Level 1 relies upon default data on building types, utilities, transportation, etc. from national databases as well as census data. While the databases include a wealth of information on the community, it does not capture all relevant information. In fact, the HAZUS training manual notes that the default data is "subject to a great deal of uncertainty."

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

Results - Hurricanes

For the purposes of this Plan, a Category 2 and a Category 4 storm were chosen to illustrate damages. The reason is to present more of a "worst case scenario" that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms. **Table 5-1** below presents estimated damages from hurricanes.

Table 5-1
Estimated Damages from Hurricanes

	Category 2 (Carol peak gust 100mph)	**Category 4 (Donna peak gust 152mph)**
Building Characteristics		
Estimated total number of buildings	4,167	**4,167**
Estimated total building replacement value (Year 2002 $) (Millions of Dollars)	$1,656	**$1,656**
Building Damages		
# of buildings sustaining minor damage	7	**15**
# of buildings sustaining moderate damage	0	**1**
# of buildings sustaining severe damage	0	**0**
# of buildings destroyed	0	**0**
Population Needs		
# of households displaced	0	**0**
# of people seeking short-term public shelter	0	**0**

[80] For more information on the HAZUS-MH software, go to https://www.fema.gov/hazus.

	Category 2 (Carol peak gust 100mph)	Category 4 (Donna peak gust 152mph)
Debris		
Building debris generated (tons)	25	**78**
Tree debris generated (tons)	1,441	**2,138**
Value of Damages (Thousands of dollars)		
Total economic losses from property damage	**$2,284**	**$3,999**

*No Category 4 or 5 hurricanes have been recorded in New England. However, a Category 4 hurricane was included to help the community understand the impacts of a hurricane beyond what has historically occurred in New England.

Results – Earthquakes

The HAZUS earthquake module allows users to define a number of different types of earthquakes and to input a number of different parameters. The module is more useful where there is a great deal of data available on earthquakes. In New England, defining the parameters of a potential earthquake is much more difficult because there is little historical data. The earthquake module does offer the user the opportunity to select a number of historical earthquakes that occurred in Massachusetts. For the purposes of this Plan, two earthquakes were selected: an earthquake with a 5.1 magnitude and 10 fault depth and a 5.8 with 10 fault depth. Table 5-2 below presents estimated damages from earthquakes.

Table 5-2
Estimated Damages from Earthquakes

	Magnitude 5.1	Magnitude 5.8
Building Characteristics		
Estimated total number of buildings	4,167	**4,167**
Estimated total building replacement value (Year 2002 $ Millions of dollars)	$1,656	**$1,656**
Building Damages		
# of buildings with no damage	1,925	**739**
# of buildings sustaining slight damage	1,257	**1,272**
# of buildings sustaining moderate damage	710	**1,232**
# of buildings sustaining extensive damage	214	**494**
# of buildings completely damaged	61	**430**
Population Needs		
# of households displaced	139	**521**
# of people seeking short-term public shelter	70	**264**
Debris		
Debris generated (tons)	36	**122**
Value of Damages (Millions of dollars)		
Total property economic loss	**$217.7**	**$621.8**

(42.667599, -71.598099) epicenter location.

5.3 Exposure Assessment of Parcel and Building Flooding Risk

An exposure assessment was used to estimate losses due to flooding. An exposure assessment is a geospatial evaluation where geographic areas and hazards are mapped together to show the physical relationship of one to the other. The geospatial relationship can be used to quantify the number and value of parcels and structures within the hazard area, in order to estimate losses. A GIS-based exposure analysis was used to identify potential flood losses for developed properties that fall within Pepperell's 100-year and 500-year flood zones, as defined on page 3-10.

The analysis for current conditions was based on Pepperell's 2017 Assessor's data and the most recent FEMA-approved flood zones (6/15/1983). Future potential flooding with climate change was evaluated using the extent of the 500-year flood zone.

5.3.1 Existing Flood Vulnerability Assessment Methodology

The vulnerability assessment identifies locations that are at risk from flooding inundation based on current and historic flooding extent as defined by the FEMA 100-year flood plain, and predicts future flooding extent using the 500-year flood. The following assumptions were used in the methodology.

Risk of Current Flooding- FEMA Analysis for Developed Parcels and Community Assets

Current risk of flooding is evaluated based on the most recent approved FEMA flood zones (dated 6/15/1983)

- Developed properties and Community Assets currently within the FEMA-mapped A and AE zones were identified, including areas with defined base flood elevations or inundation depth.
- Determination of risk was based on whether a mapped building is within the flood zone, not based on whether the parcel boundary alone is within the zone.
- The total building value for A-zone parcels is included in Table 5-3. Individual properties and land use classifications were not identified due to privacy concerns.
- Community Assets located within FEMA flood zones were also identified

Risk of Future Flooding- FEMA Analysis for Developed Parcels

- Developed properties currently within the FEMA-mapped X500 zones were identified following the same selection criteria as described above for A-zone analysis.

Proposed Disclaimers

- The information in this plan related to the potential extent of current inundation and future inundation due to climate change is based on publicly available data (see Bibliography) and is subject to change as new data become available.
- Information is provided to help understand extent of possible current and future risk, and not for the purposes of construction regulations, flood insurance, or other insurance requirements.

5.3.2 Results

Of the 4,309 developed parcels in Pepperell, about 15% (416) are located in the FEMA 100-year flood plain.

Based on the building value of the developed property, estimated potential losses for inland areas are summarized in **Table 5-3**.

Table 5-3
Present and Historic Flood Risk 1% Annual Chance

FEMA 100-year Flood Zone	Number of Developed Parcels within the Zone	Building Value
A/AE	416	$89,681,900

In Pepperell, 221 developed parcels are located within inland or riverine 500-year flood hazard areas. Of the 4,309 developed parcels in Pepperell, about 5% are located in the FEMA 500-year flood plain. Based on the building value of these developed properties, estimated potential losses for inland areas are summarized in **Table 5-4**.

Table 5-4
Future Flood Risk

FEMA 500-year Flood Zone	Number of Developed Parcels within the Zone	Building Value
X500	221	$53,421,600

The total value of properties located within flood zones is $143,103,500.

5.3.3 Community Assets within Flooding Zones

A total of 134 community assets are located within the 100-year flood zone:

- Economic - 61
- Infrastructure - 39
- Societal - 34

5.4 Future Development in Hazard Areas

The Town of Pepperell has identified parcels where development has been proposed, is underway or is expected to occur in the future. **Table 5-4** shows the relationship of these parcels to three of the mapped hazards. This information is provided so that planners can ensure that development proposals meet all floodplain regulations and that careful attention is paid to drainage issues and appropriate mitigation.

Table 5-4
Natural Hazard Risk in Areas with Future Development Potential Over the Next 10 Years

Area of Future Development	Earthquakes	Hurricanes	Flood Zone
Railroad Square	Yes	Yes	Yes
Route 113 Corridor	Yes	Yes	Yes
Former Pepperell Paper Mill Site	Yes	Yes	Yes
Peter Fitzpatrick School	Yes	Yes	No
Lomar Industrial Park	Yes	Yes	No
Route 119 Corridor	Yes	Yes	Yes

Section 6
Capabilities Assessment

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The capability assessment identifies the Town's strengths and weaknesses for mitigating the risks identified in the Hazard Mitigation Plan. The assessment examines the Town's current capabilities and includes changes since completion of the 2015 Hazard Mitigation Plan. The assessment is useful in developing an effective hazard mitigation strategy in that it ensures that the goals and strategies articulated throughout the Plan are realistic and achievable, based on the Town's governmental and staffing structure, and recognizing the extent of resources and tools available to the community.

FEMA defines four types of capabilities that should be considered within the Hazard Mitigation planning process:

1. **Planning and Regulatory Capabilities** based on the jurisdiction's implementation of ordinances/bylaws, policies, local laws, State statutes, plans and programs that relate to guiding and managing growth and development;
2. **Administrative and Technical Capabilities** associated with the jurisdiction's staff and their skills and tools that can be used for mitigation planning and implementation;
3. **Financial Capabilities** which include the fiscal resources to which the Town has access, as well as funding sources eligible for use in funding mitigation actions; and
4. **Education and Outreach** programs and methods already in place that could be used to implement mitigation activities and to communicate hazard-related information.

Each of these capabilities is discussed in detail in the following narrative. FEMA capability assessment worksheets are included in **Appendix D**.

6.1 Planning and Regulatory

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Planning and regulatory capabilities are the plans, policies, codes, and bylaws that prevent and reduce the impacts of hazards. Pepperell regulates development through zoning, subdivision control, health regulations, and wetlands regulations. In 1974, Pepperell entered the National Flood Insurance Program, making residents eligible to buy subsidized flood insurance. As a result, a **floodway regulation** was enacted as part of the Town Code (Chapter 95), rather than through the Zoning Bylaw. This regulation addresses encroachment, including fill, new construction, and substantial improvements to existing structures. It also prohibits building in the floodway unless certification by a registered professional civil engineer is provided to the Building Inspector by the applicant, demonstrating that such encroachment will not result in any increase in flood levels within the community.

Pepperell has enacted a local **Wetlands Protection Bylaw** requiring that a 50-foot wide undisturbed, vegetated strip of naturally occurring plant species be maintained from a certified vernal pool or wetland resource area. The requirements of the bylaw go beyond what is outlined the state's Wetland Protection Act. The State's Rivers Protection Act also preserves the town's riverine areas, by protecting a 200-foot wide Riverfront area, as

measured along each side of a river from the mean annual high water line outward horizontally and parallel to the river.

The Massachusetts Natural Heritage and Endangered Species Program (NHESP) has certified 45 vernal pools in Pepperell. An additional 132 potential vernal pools have been identified that have yet to be certified. These pools are critical habitat for amphibians and invertebrate animals that use them to breed. They typically hold water in the winter and spring due to rising groundwater and rainfall, remain wet through the spring and into the summer, and dry out completely by mid- to late summer. The NHESP reports that Pepperell is home to sixteen (16) animal species listed as endangered, threatened or of special concern.

Much of the eastern portion of Pepperell is part of the Petapawag Area of Critical Environmental Concern (ACEC), which is located along and to the east of the Nashua River, from the Town of Ayer north to New Hampshire. The Squannassit ACEC is located on the west side of the Nashua River adjacent to the Petapawag ACEC. Projects within an ACEC that are subject to state agency jurisdiction or regulation (particularly those that are initiated by an agency, require a state permit, or are funded by a state agency) are reviewed with closer scrutiny to avoid or minimize adverse environmental impacts. The designations provide a framework for the Town and state agencies to work together to ensure long-term preservation and management of these areas.

The Town's Zoning Bylaw addresses erosion control and requires that site design, materials, and construction processes be employed to avoid erosion damage, sedimentation, or uncontrolled surface water runoff. The Water Resource Protection Overlay District outlined within the Zoning Bylaw consists of three zones: Water Source Protection Zone (Zone I); Well Protection Zone (Zone II) and an Aquifer-Watershed Protection Zone (Zone III). Allowed activities within each of these zones are regulated to protect groundwater from degradation. In addition to each zone's individual land use restrictions, the WRPOD has general performance standards and construction standards that apply to all development in the three WRPOD zones.

The Town of Pepperell has established an **Open Space and Residential Development Bylaw** in order to:

- Allow for flexibility in design and minimize land disturbance;
- Encourage the protection of open space, natural and cultural resources, agricultural land, and the town's water supply;
- Enhance community character; and
- Provide affordable housing to persons of low and moderate income.

Pepperell's Open Space Residential Development (OSRD) regulation allows for the issuance of a Special Permit for flexible site design with reduced lots sizes and dimensional requirements. An OSRD must set aside at least 40% of the total tract area as permanently protected open space.

Pepperell's **Subdivision Regulations** require that surface water drainage be designed to accommodate a twenty-five-year storm, and that culverts be designed to handle a fifty-year storm, with consideration given to avoidance of damage for a one-hundred year storm. The regulations also require that stormwater management systems be designed in accordance with Massachusetts Department of Environmental Protection's (DEP) Stormwater Manual.

Pepperell requires **Site Plan Review** for nearly all development projects other than single and two-family dwellings. In approving or disapproving a site plan, the following issues are considered: landscaping, open space, signage, parking, utilities, outdoor lighting, screening, and overall compliance with the standards set forth in the zoning bylaw. Site plan approval lapses after one year from the approval date, if substantial use has not commenced, except for good cause.

In 2016, EPA and DEP issued a new MS4 Stormwater Permit for Massachusetts that went into effect on July 1, 2018. This permit requires the operators of a regulated small municipal separate storm sewer system (MS4), including Pepperell, to obtain National Pollutant Discharge Elimination System (NPDES) permit coverage. Under the permit, Pepperell will be required to develop and implement a **stormwater management program** that includes six minimum control measures, and there are water quality testing, monitoring, mapping, maintenance and reporting requirements contained within the permit as well. Pepperell submitted its Notice of Intent (NOI) to EPA and MassDEP on October 1, 2018 outlining the BMPs that the Town planned to include in their stormwater management program in order to comply with the terms of the General Permit. The Town of Pepperell has established a **Storm Water Enterprise Fund**, which will function as a stormwater utility. Fees are assessed quarterly on each tax parcel.

The 2016 Pepperell Open Space and Recreation Plan Update stressed the importance of preserving open space, natural resources and outdoor recreational opportunities. Protecting farmland has been the focus of many land protection projects within Pepperell and will continue into the future. Pepperell has continued to protect open space by working with state and non-profit partners and landowners. Over the past fifteen years, an additional sixty-one parcels totaling almost 985 acres have been protected, bringing the Town's total acreage of protected open space to over 3,074 acres, accounting for approximately 20% of the town's land area. Permanently protected lands include state lands and municipal properties subject to Article 97, a conservation restriction or other deed restriction, as well as private properties subject to a conservation restriction, agricultural preservation restriction, or a deed restriction.

As a result of a two-year planning process, Pepperell approved a new Master Plan in October 2020. The Master Plan recognizes that climate change planning in Pepperell has been undertaken through multiple projects, including the recent preparation of the town's Municipal Vulnerability Preparedness Plan, the updating of the Hazard Mitigation Plan, completion of the most recent Open Space and Recreation Plan, and the town's Green Community activities. The Master Plan builds upon many of the recommendations and initiatives put forth as part of these programs. The document contains many strategies that are predicated on recognition of the fact that the climate change will continue to occur, and that municipal staff and boards, businesses, and residents will make major decisions today and in the future that will influence the town's vulnerabilities.

Building community resilience will require significant town government policy adjustments to address the root causes of climate change, as well as measures that increase social cohesion, localize food and energy systems, and advance public education and participation. Resilience requires that both the public and private sectors make structural shifts and capacity investments that support assessing and addressing the complex challenges of climate disruption.

Climate change and greenhouse gas emission reductions are addressed by recommendations throughout the Master Plan, rather than in a single section, and are summarized in the Implementation Chapter matrix of recommendations. The matrix specifically denotes those recommendations that will have a climate benefit for the community. Mixed-use, compact development that encourages walking and biking, use of alternative transportation modes, improved development practices, use of renewable energy systems, environmentally-friendly design guidelines, preservation of open space, water conservation measures, and enhanced stormwater management efforts are some of the strategies that help reduce greenhouse gas emissions, mitigate the impacts of climate change, mitigate natural hazards and reduce overall energy usage.

6.1.1 Existing Planning Mechanisms

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The Planning Team updated information regarding existing planning mechanisms to mitigate natural hazards in the Town of Pepperell**. Table 6-1** summarizes current local planning efforts that include hazard mitigation elements.

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Table 6-1
Summary of Current Planning Efforts related to Hazard Mitigation

Date of Plan	Status	Plan Name	Department Responsible for Update or Implementation
2020	Implementation of Master Plan adopted in October 2020	Master Plan	Planning Board
July 2019	Complete	2020-2040 Northern Middlesex Regional Transportation Plan	NA – Regional Plan
2019	Ongoing updates	Stormwater Management Plan	Engineering/DPW
June 2020	Completed/ Approved	Municipal Vulnerability Preparedness (MVP) Summary of Findings	Planning
2016	Approved by State/ DCS	Open Space and Recreation Plan Update	Conservation
2005	Being revised to address MS4 Permit Requirements	Rules and Regulations Governing the Subdivision of Land	Planning Board/DPW
2010	Current	Planning Board Rules and Regulations for Special Permits and Site Plan Reviews	Planning Board
2014	Revisions proposed as outlined in the Master Plan	Zoning Bylaw	Planning Board/DPW

The Town of Pepperell has taken steps to implement findings from the 2015 Hazard Mitigation Plan into the following policy, programmatic areas and plans: the 2016 Open Space and Recreation Plan, the 2019 Stormwater Management Plan, the 2020 Pepperell Master Plan, a Complete Streets Plan, and the 2020 Municipal Vulnerability Preparedness (MVP) Plan. In addition, the Town received state and federal funding to remove the Turner Dam on the Nissitissit River, and to address undersized and failing culverts. The Town also appropriated funding to acquire open space lands, including some located in flood zones, in order to protect these areas from future development and to provide resiliency from the impacts of climate change.

6.2 Administrative and Technical

The Town has multiple staff members and volunteer boards that assist with planning, development, and implementation of hazard mitigation. The roles are further described below.

The Town Administrator oversees and coordinates Pepperell's day-to-day operations with the assistance of the Town Accountant, Tax Collector/Treasurer, and Assessor. Their work is supported and guided by several elected and appointed boards, including the Select Board, the Finance Committee, and the Board of Assessors. Each of these entities has a specialized and statutory role in financial and administrative policy.

The Town Accountant is appointed by the Select Board. It is the legal obligation of the Town Accountant to oversee all the financial activity of the Town, maintain all financial records, and review all bills, including payrolls, to ensure that they are within the budget and are not fraudulent or unlawful. The Town Accountant retains custody of all municipal contracts and prepares the financial reports for the municipality. Primarily working directly with other town departments, the accounting office has limited contact with the public. The Town Accountant also serves as an advisor to the Finance Committee.

In Pepperell, the duties of the treasurer and tax collector are combined into one office: **Treasurer/Tax Collector**. The Treasurer is responsible for the receipt, posting, classifying, depositing and investment of all money belonging to the Town. The Treasurer is also responsible for the administration of tax title and foreclosure accounts, debt service, trust funds, investments and bank account reconciliation. Using guidelines established by the Department of Revenue, the Tax Collector is responsible for the collection of all taxes, liens and fees associated with real and personal property, as well as other funds owed to the town, such as fees for permits, licenses, utilities, and services.

The Finance Committee consists of five members appointed by the Select Board for a three-year term. The Finance Committee reviews and analyzes the overall budget and forecasts the Town's financial position for the future fiscal year based on prior trends. The Committee also identifies and recommends funding sources for proposed capital items, and reviews and makes recommendations on warrant articles. All Town Meeting articles that call for the expenditure of funds must be referred to the Finance Committee for its consideration. Each year the Finance Committee must review previous year expenditures and estimate budgetary requirements for the upcoming year and provide appropriation recommendations to Town Meeting.

The Pepperell Fire Department is a combination department with five full-time personnel and approximately 25 volunteers and paid-on-call firefighters. Twenty of these personnel are also emergency medical technicians. From 6 AM until 6 PM there is one firefighter/paramedic on duty as well as the chief. The Pepperell Department focuses on fire suppression, fire prevention, public education and emergency medical services. In addition to responding to fire and emergency medical calls, the fire department is also tasked with responding to other emergencies, such as a motor vehicle crash, building collapse, water and ice rescue, mass casualty incident, weather related emergency, or natural disasters. In addition, permits and inspections are issued or performed by the department. The Pepperell Fire Prevention program provides educational programs for children in pre-K to 8th grade.

The Pepperell Fire Department participates in an active mutual aid response system for fire, hazardous materials, and EMS operations. The Department is a member of Massachusetts Mutual Aid Fire District 6, as well as Border Area Mutual Aid (BAMA), a group of 30 Massachusetts and New Hampshire Fire Departments. Fire District 6 coordinates the mutual aid response of Massachusetts fire departments in the Greater Lowell area. The following services are available through these organizations:

- Centralized communications control center for mutual aid activities;
- Operation of multi-channel radio system for dispatch and coordination of firefighting apparatus and emergency medical units;
- Mobile command and communications vehicle for complex operations;
- Ten alarm running card system for coordination and deployment of apparatus, personnel and other resources;
- Regional hazardous materials response team (funded by the Massachusetts Department of Fire Services);
- Mobile air supply unit for refilling self-contained breathing apparatus at incidents;
- Evacuation and rehabilitation buses;
- Fire safety house trailer for fire prevention and training purposes; and
- Critical incident debriefing team.

The mission of the **Pepperell Police Department** is to: "Provide the highest level of protection and service to the citizens, businesses, and visitors of Pepperell. Members of the Pepperell Police Department shall provide safety and security for the community by enforcing the bylaws of the Town of Pepperell, the laws of the Commonwealth of Massachusetts, and the Constitution of the United States of America. Members of the Pepperell Police Department shall be dedicated to provide the highest quality of public service with honesty, respect, and fairness." The Police Department goals are to do the following:

- "identify criminal activity, pursue and apprehend criminal offenders and proceed in the prosecution of known offenders,
- maintain a proactive patrol and investigation force and thus reduce the opportunity to commit crime;
- facilitate the safe movement of people and vehicles through analysis and commitment of selective traffic enforcement resources;

- perpetuate a sound managerial environment that focuses upon department goals and provides for career development; and
- instill public confidence in the agency by maintaining a high degree of professionalism, dedication and expertise in police service."

When fully staffed, the Police Department consists of 18 full-time sworn law enforcement personnel, an administrative assistant and a civilian clerk.

The Pepperell Police Department is a member of the North Eastern Massachusetts Law Enforcement Council (NEMLEC), a non-profit corporation and law enforcement council composed of a consortium of 60+ police and sheriff departments in Middlesex and Essex Counties. Member agencies operate pursuant to an interagency mutual aid and assistance agreement. NEMLEC is a professional organization focused on member needs and priorities and governed by an elected Board. Member police chiefs actively participate in its operation by serving in leadership roles on operational units and committees. NEMLEC manages all aspects of the organization through member meetings, open processes and a comprehensive intranet system.

NEMLEC units are composed of highly trained and skilled officers from member agencies under the command of a police chief. They are a primary source of assistance and support and are available to member police chiefs who activate them in accordance with written protocol. The available units include the following:

- Motorcycle Unit (MCU);
- Incident Management Assistance Team (IMAT);
- Regional Communications (RC);
- Regional Response Team (RRT);
- School Threat Assessment/Response System (STARS); and
- Special Weapons and Tactics (SWAT).

In Pepperell, the emergency communications center is operated as a separate department, rather than being tied to the police or fire departments. The **Communications Department** is responsible for the following tasks:

- Emergency and routine dispatching of Pepperell police, fire, ambulance, highway, water and sewer departments;
- Answering 911 calls and business calls for the above entities;
- Performing medical dispatch services;
- Operation of the National Crime Information Center (NCIC)/Law Enforcement Alerting Portal (LEAPS) computer to retrieve driver and criminal history through a national database;
- Chronologically documenting all incidents and calls;
- Coordinating civil defense personnel during times of emergency or disaster; and
- Using the Code Red notification system to alert the public.

The Communications Center is staffed with four full-time and two part-time dispatchers. Both the Director and Assistant Director are responsible for filling a shift in addition to

their other duties. During the week, seven of the 21 shifts are staffed with two personnel, while on dispatcher is on duty during the remaining shifts. Groton serves as the alternate Public Safety Answering Point (PSAP) and as the back-up for Pepperell. Currently, the town is studying the possibility of regionalizing 911 dispatch services in partnership with the towns of Ashby and Townsend.

The primary function of the **Animal Control Officer** is to enforce local by-laws and the Massachusetts General Laws as they relate to animal issues. In Pepperell, the Animal Control officer performs the following functions under the direction of the Board of Health:

- Maintains a record of complaints and investigates complaints;
- Educates the public relative to animal control regulations;
- Picks up, transports and holds lost, injured or dangerous animals;
- Seeks to return animals to their rightful owners;
- Responds to emergency calls;
- Destroys rabid animals;
- Removes dead animals from public ways with the assistance of the Highway Department;
- Investigates animal cruelty and neglect allegations;
- Investigates dog and cat bites; and
- Serves criminal or civil notices relative to the enforcement of animal control laws and bylaws.

State law requires that all animal control officers receive formal training. Training enables the officers to be more effective at protecting themselves, the animals, and the public.

Pepperell also has an Animal Inspector whose primary duty involves rabies control in the domestic animal population. The Animal Inspector works under the supervision of the Select Board and is also responsible for barn inspections. The inspector may also be called upon to assist with domestic animal quarantines in the event of a disease outbreak

Pepperell's Emergency Management Director (EMD) and Emergency Management program ensure that effective emergency services are in place during large-scale emergencies or disasters as outlined within the Town's Comprehensive Emergency Management Plan (CEMP). The CEMP is developed by the Local Emergency Planning Committee (LEPC), which is chaired by the EMD, and approved by the Town Administrator and Select Board. The EMD is responsible for maintaining the CEMP and for activating and managing the Emergency Operations Center. The LEPC meets quarterly to discuss public safety issues. There are also twenty-seven volunteers that support emergency services.

On a day-to-day basis, the EMD works with the heads of Police, Fire, Emergency Medical Services, Communications, Board of Health, DPW and Council on Aging to coordinate major emergency event planning for the Town. This effort includes public awareness and education, community outreach, resource management, manpower deployment, mutual aid agreements and coordination with the Massachusetts Emergency Management Agency (MEMA), the American Red Cross and other statewide resources. MEMA coordinates state level emergency operations and can assist the Town in the event of a disaster. MEMA also

serves as a conduit for resources from other jurisdictions and the Federal Emergency Management Agency (FEMA).

Pepperell's Emergency Management director also oversees four other programs:

- Emergency Shelter Operations;
- The Auxiliary Police;
- The Community Emergency Response Team (CERT); and
- The Radio Amateur Civil Emergency Services (RACES)

The Inspection Department enforces State and local laws, by-laws, and regulations. The Department issues permits for all types of construction, including all public and private buildings. It also issues permits for additions and alterations of buildings, installation of pools, sheds, and garages, and other improvements to properties. The Building Inspector is required to perform periodic inspections for businesses and buildings that must obtain a Certificate of Inspection. The Plumbing and Wiring Inspectors also work out of this department.

The Department of Public Works (DPW) consists of the Highway Division, Sewer Division, Water Division, Parks & Cemeteries, and Transfer Station. The Pepperell Director of Public Works also serves as the Town Engineer. The Department provides technical and engineering services on matters related to municipal operations and land use, including assistance to town departments, boards and committees. The Town Engineer reviews subdivision plans and participates on the Signs and Safety Committee.

The Highway Division maintains and repairs the town's roadways, street signs, sidewalks and subsurface drainage systems to provide for safe vehicle and pedestrian travel. It removes snow, salts and sands, re-seeds grass in the roadway rights-of-way, and trims and removes trees. In addition, it also maintains the municipal drainage facilities, as well as all DPW vehicles and equipment in-house.

The Sewer Division is responsible for operating and maintaining the wastewater treatment facility that serves the towns of Pepperell and Groton. The Sewer Division employs six licensed operators who regularly inspect the plant and eight pumping stations. Seasonal inspections and monitoring of the collection system and its infrastructure is an ongoing process. Inspections are performed utilizing the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) guidelines.

The Water Division operates and maintains the public drinking water system for Pepperell in accordance with the Federal Safe Water Drinking Act and Massachusetts Department of Environmental Protection (MassDEP) regulations.

The Planning Board, Zoning Board of Appeals, Conservation Commission, Board of Health and Historical Commission carry out community planning and development review in Pepperell with the assistance and support of Town staff.

The Planning Board consists of five elected members and one appointed associate member and is responsible for reviewing proposed subdivisions and site plans and issuing special permits. All zoning bylaw revisions must go through the Planning Board. The duties and powers of the Planning Board are outlined in Chapters 40A and 40 of the

Massachusetts General Laws. The Planning Board is supported and advised by a part-time professional planning consultant.

The Zoning Board of Appeals is appointed by the Select Board, serves as the special permit granting authority for some special permits, exercises statutory jurisdiction over variances and comprehensive permits, and hears appeals on the decisions of the Building Inspector. The Board consists of three members and two alternates. The Zoning Board of Appeals is authorized under Chapters 40A and 40B of the General Laws of the Commonwealth of Massachusetts as well as the Pepperell Zoning Bylaw.

The Conservation Commission, which is comprised of seven appointed Commissioners, administers the Massachusetts Wetlands Protection Act, MGL c.131 § 40 and the Pepperell Wetlands Protection Bylaw, has responsibility for protecting natural resources, and purchasing and managing the Town's conservation properties. Each building permit application is reviewed by the Conservation Commission to determine whether a project falls under its jurisdiction. The Commission has partnered with the Nashua River Watershed Association to address the control of aquatic invasive plants on the Nashua River via the implementation of a five-year treatment plan. The Commission also coordinates volunteer activities for trail monitoring, cleanup and maintenance. The Conservation Commission is supported by the town's Conservation Agent.

The Pepperell Board of Health is composed of three elected members; its mission is to protect public health through the enforcement of health codes and regulations and promote a healthy community. The Board adopts and modifies regulations to address various public health issues, such as the sale of tobacco and fill importation. Through assistance from the Nashoba Associated Boards of Health, the Board provides inspection services regarding food safety, safe and sanitary housing, and Title V, and conducts nuisance complaint investigations. The Nashoba Associated Boards of Health also provides community nursing services, such as immunizations, chronic disease management, and health screenings for Pepperell residents.

The Pepperell Historical Commission is charged with "the preservation and development of the historical and archaeological assets" of the town, in accordance with MGL Chapter 40, section 8D, and seeks to identify and promote the town's historical resources. The five members of the Commission are appointed by the Select Board for three-year terms.

The Historical Commission researches places of historic or archeological value, cooperates with the state archaeologist in conducting research, and may advertise, prepare, print and distribute books, maps, charts, plans and pamphlets which it deems necessary for its work. For the purpose of protecting and preserving historic resources, the Commission may make recommendations to the selectmen and to the Massachusetts Historical Commission that locations be certified as historical or archeological landmarks, and that procedures be implemented that preserve historic resources in town. The Commission is required to report to the State Archaeologist the existence of any archaeological, paleontological or historical site or object discovered.

The Affordable Housing Committee consists of seven members: three residents at large plus one representative each from the Planning Board, Zoning Board of Appeals, Select Board, and Finance Committee. The Committee is appointed by the Select Board to oversee the development of the Housing Production Plan (HPP) and to promote affordable housing opportunities. The HPP remains in effect for five years and serves as a "blueprint"

for the community in developing affordable housing units to address the 10% affordable housing goal established by the state's Department of Housing and Community Development (DHCD). The Affordable Housing Committee helps implement the HPP by promoting affordable housing projects that address the housing needs of the community, while meeting the community standards.

The Pepperell Council on Aging (COA) supplies or coordinates most of the services that directly benefit senior citizens. The COA staff relies on volunteers to assist in providing support services, information, and referrals relative to housing, fuel and food assistance, home care, guidance on Social Security, insurance counseling, lending of medical equipment, grief support, home visits, wellness checks, tax preparation services, Meals on Wheels, and transportation services. In addition, the Senior Center offers a number of educational programs, fitness classes, entertainment, and social opportunities. The Center also provides a daily lunch for approximately 180 people each week.

The Town's **Veterans Agent** helps veterans and their dependents with financial, medical or burial benefits. Pepperell has a part-time Veteran's Services Officer who has office hours at Town Hall each Wednesday afternoon. The Department of Veterans' Services oversees a state assistance program based on need, which provides financial, medical, educational and service benefits to veterans and their dependents. The Veteran's Services Officer administers the Program's main financial and medical assistance components, and offers assistance and referrals in the areas of federal compensation and pensions, fuel assistance, state and federal educational benefits, tax exemptions, annuities, home loans, counseling and job training. Approximately 300 Pepperell veterans are served annually.

The Pepperell Housing Authority Board consists of four members elected by Pepperell voters plus a fifth member appointed by the Governor. The Housing Authority manages low- and moderate-income public housing units. Currently, Pepperell has 70 units: 57 one-bedroom apartments for senior or disabled citizens; six units are bedrooms within congregate apartment housing for mentally challenged elderly or disabled citizens, and are staffed 24 hours/day; seven units are for families and of these, six are two-bedroom apartments and one is a 3-bedroom unit.

Table 6-2
Hazard Mitigation Staffing

Staff	Hazard Mitigation Role
Building Department	Enforces State Building Code, Pepperell Municipal Code, and maintains all critical building facilities
Director of Public Works/Town Engineer/Highway Division/DPW	Maintains the infrastructure necessary to protect the Town from flooding, implements mitigation projects
Floodplain Administrator	Reviews projects for NIFP compliance and ensures compliance with the NFIP requirements

Emergency Management Director	Implements the Comprehensive Emergency Management Plan and provides education on community preparedness. The Emergency Management Director works closely with the Pepperell Police, Fire and Emergency Medical Services, Board of Health and Council on Aging to coordinate emergency event planning for the Town.
Town Planner	Maintains and updates HMP plan with the Town Engineer, incorporates HMP goals into other Town plans, serves as the lead on resiliency planning efforts
Conservation	Administers the Massachusetts Wetlands Protection Act, MGL c.131 § 40 and the Pepperell Wetlands Protection Bylaw; has responsibility for protecting natural resources.

Pepperell Regulations and Ordinances

A summary of Town bylaws and State and Federal regulations that provide flood mitigation benefits is provided in Table 6-2 below.

Table 6-2
Regulations, Bylaws and Policies that Provide Flood Mitigation

Regulatory Category	Applicable Section	Flood Mitigation Benefit
Zoning Bylaw Special Districts	Flood Plain District	Overlay district for most vulnerable sections of Town, includes FEMA flood zones. Development must meet State Building Codes, Title V, and Wetlands Protection Regulations. The ordinance defines its Flood Plain District as special flood hazard areas as the 100-year floodplain shown on Flood Insurance Rate Map (FIRM) dated June 15, 1983. The FIRM was updated 6/4/2010.
Zoning Bylaw Procedures	Section V-Development Review Requirements, Section B- Site Plan Review and Approval --- Section VI. C. Low Impact Development Standard	Site plans must include information on surface and ground water drainage and erosion control.
Community Preservation Committee	General Bylaws, Article XIX, part B (2)	Community Preservation Committee duties include making recommendations to Town Meeting for acquisition, creation and preservation of open space
State Regulations	DCR Dam Safety Regulations	The State has enacted dam safety regulations mandating inspections and emergency action plans. All new dams are subject to state permitting.

100-Year Flood Zone	Federal Regulations	FEMA regulations require elevation above 100-year flood level for new and substantially improved residential structures located in the floodplain.
Local Wetlands Bylaw	Town regulation	In addition to the requirements of the state's Wetlands Protection Act, the local bylaw states that a 50-foor wide undisturbed, vegetated strip of naturally occurring plant species must be maintained between a certified vernal pool or wetland resource area.
Zoning Bylaw Special District	Water Resource Protection Overlay Bylaw	The Water Resource Protection Overlay District consists of three zones: Water Source Protection Zone (Zone I); Well Protection Zone (Zone II) and an Aquifer-Watershed Protection Zone (Zone III). Activities within each of these zones are regulated to protect groundwater from degradation.

6.3 Financial

Pepperell has multiple funding mechanisms in place or planned to help fund mitigation projects. Financial resources available to the Town for funding mitigation activities are the town's general fund, enterprise funds, free cash, stabilization, and retained earnings accounts. The Town's FY2021 revenues totaled $30,332,554, with 63% of the Town's FY2021 budget dedicated to educational expenses and 37% to town services. The Town also supports four Enterprise funds for Water, Wastewater, Solid Waste, and Storm Water Management. The Storm Water Fund is new, with collections only starting in FY2019. The Enterprise funds collectively generate revenue of $4,796,432 annually including $249,000 in the Storm Water Management Enterprise fund.

Moody's bond rating for Pepperell is Aa3, consistent with similar communities in Massachusetts. The Town's stabilization funds, total $2,111,746, including $1,336,415 in Free Cash. In May of 2019, the Town passed a permanent $1,400,000 tax override, correcting a structural deficit and providing funding for capital improvements. Current revenue projections show the Town General Fund will increase to $35,183,231 by FY2026. The Enterprise Funds also have Retained Earnings, collectively $3,102, 920, of which $243,291 is in the Storm Water Management account.

Pepperell's property taxes are 19% lower and State aid is 61% lower than in similar communities in Massachusetts[81]. Pepperell received $1,807,117 in State Aid in FY 2021, and relies heavily on local property taxes to meet its needs.

The Town of Pepperell has successfully leveraged state and federal grants for projects that benefit natural hazard mitigation, and it is expected that the Town will continue to apply for competitive grants through the Green Communities program, the Hazard Mitigation grant program, the Federal BRIC grant, the MA DER Culvert Replacement Municipal Assistance Grant Program, MA DER Priority Projects Program, and other available state and federal grant programs.

Pepperell has received $622,014 in Green Community grants since 2018. Working with funding and technical support from State Agencies and local partners such as the Squan-A-Tissit Chapter of Trout Unlimited, grant funding and donations covered the more than $400,000 cost for the removal of the high-hazard Turner Dam on Hollis Street. Most recently, the Massachusetts Division of Ecological Restoration selected the removal of a dam and the replacement of a culvert on Sucker Brook as a Priority Project, which includes project oversight, engineering, and permitting. The Town was also awarded grants totaling $113,000 for field data collection, engineering and design, and permitting for a failing culvert on Sucker Brook on Heald Street.

The Town has partnered with a number of non-profit and community organizations to leverage the resources needed to successfully complete many projects. For example, the Town worked with the Squan-A-Tissit Chapter of Trout Unlimited and the MA Division of Fisheries and Wildlife to install three-sided or bottomless culverts and on the removal of the Turner Dam on Hollis Street. Much of the land along the Nissitissit River has been protected by the MA Division of Fish and Wildlife, working with the Nissitissit River Land Trust, the Nashoba Conservation Trust, the Nashua River Watershed Association, and the Town of Pepperell Conservation Commission. The federal designation of the Nashua, Squannacook, and Nissitissit Rivers as Wild & Scenic in March of 2019, and Pepperell's representation in the Stewardship Council provides opportunities for funding and regional oversight and support for projects within the Nashua River watershed. The Town will continue to foster and grow these partnerships in the implementation of the recommendations outlined in the Hazard Mitigation Plan.

Pepperell has authority to levy taxes for specific purposes, but so far this method has not been used for mitigation actions. Pepperell does not charge impact fees for new development, as development impact fees are not legal in Massachusetts, and Pepperell has not utilized the Community Development Block Grant Program.

6.4 Education and Outreach

Pepperell uses the CodeRED emergency notification service to reach residents and businesses by telephone, mobile phone, text message, or email regarding time-sensitive emergencies. The Town also distributes information via the town website and through Pepperell Community Media, the local cable access channel. Pepperell Community Media, Inc. produces public access programming and cablecasting for cable customers over three

81 https://cleargov.com/massachusetts/middlesex/town/pepperell/2019/revenue?breakdowntype=object&objectid=857660

channels: 191, 192, and 194. Programming includes educational and government programs for the Town, as well as an extensive video library available on *Video On Demand.* Community events, municipal meetings, and all types of local video content are available to view online. with new videos added regularly.

The Pepperell Fire Prevention program provides educational programs on fire prevention and safety for children in pre-K to 8th grade. The Water Division, Sewer Division and Conservation Commission provide educational materials to homeowners and businesses on conservation, pollution prevention, best management practices and changes in regulations.

Under its MS4 permit, the Town is required to broadly distribute educational materials on stormwater within the community, as part of a formal public education program for specific target audiences.

Section 7
Mitigation Strategies and Targeted Adaptation Strategies

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7.1 Mitigation Goals and Objectives

The Core Team and Advisory Committee reviewed and updated the mitigation goals present in the *2015 Hazard Mitigation Plan for the Northern Middlesex Region*. This Hazard Mitigation Plan Update includes specific plan goals and objectives, and addresses additional community assets including the environment, economy and cultural facilities.

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7.1.1 2020 Town of Pepperell Hazard Mitigation Goals

In updating this Plan, the Core Team and the Advisory Committee reviewed the hazard identification and analysis, the vulnerability assessment, and the existing protection matrix and measures. The goals in the 2015 Plan were reviewed.

The following goals were considered (note that goals are presented in no particular order);

- Increase coordination between the Federal, State, regional and local levels of government;
- Discourage future development in hazard prone areas, such as flood plains;
- 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;
- Encourage alternative drinking water supplies in the event of contamination or disruption from a natural hazard;
- Increase awareness and support for natural hazard mitigation among the municipality, private organizations, businesses, and area residents through outreach and education;
- Implement a broad range of mitigation measures that protect the Town's vulnerable population and infrastructure;
- Protect critical public facilities and services from damage due to natural hazards;
- Develop a mitigation strategy that considers area businesses and protects the economic vitality of the Town;
- Update and maintain the Plan as resources permit;
- Organize information concerning hazard mitigation funding opportunities;
- Increase the community's capability for responding to a natural hazard event by promoting the adequate provision of emergency service capabilities; and
- Implement adaptation strategies and modify local emergency plans to protect critical infrastructure and property from the impacts of climate change.

No goals were added. A few goals were adjusted to reflect that this HMP Update is a Pepperell-specific plan, not a regional Plan.

7.2 Mitigation Actions

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What is Hazard Mitigation?

Hazard mitigation means to permanently reduce or alleviate loss of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects, and other activities.

The following categorizes mitigation actions that will serve to minimize risks or reduce losses from natural hazards. The actions have been organized into the following categories, as recommended in the FEMA Local Multi-Hazard Mitigation Planning Guide (7/1/08) and the Multi-Jurisdictional Mitigation Planning Guide (August 2006), and FEMA's Local Multi-Hazard Mitigation Planning Guidance:

- Prevention: Prevention actions are intended to address future development and guide development away from natural hazards. Many of the hazards that impact the town can be reduced by addressing them upfront through code enforcement and regulatory measures. Prevention activities include planning, zoning, building ordinances/regulations, subdivision regulations, and requirements to bury utilities;
- Property Protection: Property protection actions address individual buildings and reduce risk through modification. Activities include acquisition, building relocation, building elevation, retrofitting, barriers, flood-proofing, utility relocation/flood-proofing, and insurance;
- Public Education and Awareness: Public education and awareness actions will inform and remind the public about natural hazards and actions that can be taken to avoid potential damage and injury resulting from a hazard. Activities include providing informational mailings or workshops, community outreach, real estate disclosure of hazards, environmental education, and technical assistance provided on disaster management issues;
- Natural Resource Protection**:** Natural resource protection reduces the intensity of hazard effects and improves the quality of the environment. Activities include preservation or restoration of natural systems, open space preservation, state and local floodplain and wetland regulations, stormwater management, watershed protection measures and best management practices, and soil erosion and sediment control;
- Structural Projects: Structural projects are actions that control the hazard and directly protect people and property. Such activities include construction and maintenance of berms, dams, floodwalls, channel improvements, drainage improvements, and detention/retention basins; and
- Emergency Services Protection: Emergency services protection actions are aimed at protecting emergency services before, during and immediately after an occurrence. Activities include hazard recognition, emergency warning systems, emergency response training, evacuation planning, protection of critical facilities, protection of public facilities, and health and safety maintenance.

These 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. The actions have been further categorized by timeframe into on-going, immediate, short-term projects and long-term measures.

Funding to implement hazard mitigation projects may come from a variety of federal, state, and local sources. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Building Resilience Infrastructure and Communities program (BRIC), and the Flood Mitigation Assistance (FMA) program. The three links below provide additional information on these programs.

- HMGP: https://www.fema.gov/grants/mitigation/hazard-mitigation
- BRIC: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities
- FMA: https://www.fema.gov/grants/mitigation/floods

Other potential funding sources include the Municipal Vulnerability and Preparedness Action Grant Program through the Massachusetts Executive Office of Energy and Environmental Affairs, Massachusetts State Revolving Funds, U.S. Army Corps of Engineers, and the Small Business Administration.

7.2.1 Progress on Prior Actions

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Since completion of the 2015 Regional HMP, the Town of Pepperell has made significant progress in implementing additional measures to mitigate natural hazards. The Planning Team reviewed the 2015 Mitigation Actions to outline the progress that has been made towards implementation. Table 7-1 provides an update on the mitigation actions described in the 2015 Regional HMP, including the action description, responsible department, and implementation status. Action items from the 2015 not listed in the table were incorporated within this plan update.

Table 7-1
Review of 2015 Mitigation Actions

Hazard to Mitigate	Description of Action	Responsible Department	Status	Explanation of Status as of 2020
Flooding, hurricanes, climate change	Replace undersized culvert under Hollis Street to mitigate flooding problem at the intersection of Main, River and Hollis Streets.	Town DPW, MassDOT.	Completed	Rebuilt headwall on upstream side, and cleaned out culvert. Work was completed approximately three years ago.
Flooding, hurricane	Work with MassDOT to improve debris removal at the Route 119 bridge over the Nashua River.	Town DPW and MassDOT. (MassDOT owns this bridge.)	Ongoing	Town staff call MassDOT to address the problem as needed. This is ongoing effort.

Earthquake, flooding	Work with MassDOT to replace/rehabilitate any structurally deficient bridges identified in the future.	Town, MassDOT.	Ongoing	Since the completion of the 2006 Plan, the Covered Bridge on Groton Street and the Mill Street Bridge have been rebuilt Recently, the upper section of the Hollis Street bridge was rehabilitated. The State inspects bridges classified on the National Bridge Inventory (NBI) every two years and provides reports to Town staff.
Earthquake, flooding	Work with DCR Office of Dam Safety to ensure that the inspections of all dams are current.	Town Engineer, Highway Superintendent, Conservation, DCR Office of Dam Safety, dam owners	Ongoing	Heald Street dam is the Town's responsibility. The Town is required to complete an inspection and update the Emergency Response Plan (ERP) every 10 years. DCR is responsible for enforcing dam regulations and ensuring timely inspections of all dams.
Flooding	Modify local wetlands bylaw to better address Hazard mitigation.	Town Conservation Commission	Deferred	The wetlands bylaw was most recently updated in 2002. Bylaw updates to manage runoff will be completed as required by MS4 permit implementation and will require coordination with changes to the State's stormwater handbook and wetlands standards.
Flooding, hurricane	Undertake an assessment of measures needed to eliminate the flooding problem at Canal Street.	Town Engineer and MassDOT. MassDOT owns the bridge and adjoining road on Main Street at the Nashua River. No work has commenced to date.	Ongoing	Main Street Bridge is a specific concern. MassDOT continues to maintain ownership of the bridge. In May 2010, flooding was as high as bottom of covered bridge at bottom of Groton Street and within one travel lane. Canal Street has not been completely closed in a long time.
Wildfire	Participate in DCR's Fire Wise Program for the forested sections of town.	Fire Department and DCR	Deleted	Town Forest Committee did expend funds putting a fire road through Town forest in 2011. Conservation maintains the cutting plans for the forest.

Extreme Temperatures	Increase public awareness of the dangers of extreme temperatures and outline locations where vulnerable populations (elderly, homeless, and those with health issues) can access air conditioning or shelter from the cold.	Town Emergency Manager	Ongoing/in progress	Over the last two years, the Emergency Manager has made an annual presentation to the public on severe weather and preparedness. The intention is to continue this initiative annually. A brochure was also created and distributed, and will be made available on the town's website. The town can send out Code Red if shelters are open.
Winter storms– snow storms, blizzards, ice storms	Distribute educational information to residents and businesses on protecting life and property from severe winter storm events	Emergency Manager	This is ongoing and in progress	See row above
Tornado	Ensure that administrators of schools, businesses, medical facilities, and the mobile home park have a shelter plan in the event of a tornado warning	Emergency Manager and public safety	Deferred	Not yet initiated.
All Hazards	Study regional consolidation of 911 dispatch services by establishing a regional emergency communications center (RECC)	Town public safety officials, NMCOG, and the State 911 Department and the municipalities	Ongoing	In January 2020, Town staff met with neighboring communities to discuss the RECC. Hope to authorize for FY21 and open as soon as possible in FY21. This will improve operations for Pepperell, by having additional operators on each shift. Added cost is being offset by state funding through the State 911 Department.
Flooding, hurricanes	Develop a mitigation plan for protecting properties on Yale Road from repetitive flooding.	Town Emergency Manager, town engineer, Conservation Commission and area homeowners	Deferred	FEMA's floodplain map updates will affect this area. There is language in both the OSRP about buying these properties through FEMA's program to purchase properties. These parcels have been raised, including septic systems, but during a flood event River Road is impassible. Flood plain bylaw updates should include language addressing this area.

All hazards	Incorporate hazard mitigation into the town's Master Plan and Open Space Plan updates.	Planning Board and Conservation Commission.	Complete and ongoing	The Master Plan was updated as of FY20 and includes hazard mitigation and resiliency language. The Open Space and Recreation Plan was last prepared in 2016, and will be updated in 2022. At that time, additional language about hazard mitigation and resiliency will be incorporated.
Winter storm	Delineate the limits of the ROW on Brookline Street and Lowell Road and develop a plan to remove pine trees that shade the road to decrease icing problems in the winter.	Town DPW	Delete	Handle on case-by-case basis. There may be other places that have issues.
All Hazards	Study the establishment of a mutual aid agreement with neighboring communities to administer NFIP following a major storm event.	Town Emergency Manager and building inspector	Complete	Town is now part of statewide mutual aid agreement (joined in 2017). This benefits rapid response for Police, Fire, DPW, etc.
Flooding	Revise subdivision regulations and erosion control regulations to improve floodplain management as needed.	Town Planning Board and Conservation Commission.	Update pending	Sedimentation and erosion control bylaw is part of MS4 stormwater requirements and will be developed. MS4 also requires updated post-construction stormwater management which will also control runoff following construction.
Severe winter storm/ snowstorm, blizzard	Inspect public buildings to evaluate the capacity to withstand snow loads and prevent roof collapse. Develop plans to clear roofs of excessive snow accumulations to prevent collapse.	Building inspector and Emergency Manager	In progress. This is being combined with the following two rows.	Insurance agency completes roof inspections biannually and will provide input. Engineering firm completed four recent roof inspections. Town is planning to complete full building evaluations at these sites, as a whole asset approach is better over the long term for infrastructure upgrades.
Hurricane, tornado, blizzard	Evaluate public buildings and critical facilities for the potential to withstand high winds	Building inspector and emergency manager	See above	Town insurance completes extensive review of town buildings to reduce risks. See above.
Earthquake	Develop an inventory of public buildings that do not currently meet seismic standards	Building inspector and emergency manager	See above	Town insurance completes extensive review of town buildings to reduce risks. See above.

Severe winter storm/ snowstorm, blizzard	Identify locations for snow storage farms for utilization in severe winters with heavy snowfall	Highway Department	Complete	One location is available at the school by the soccer fields. Have used this site once in last five years. MassDEP guidance on snow disposal is followed.
Structure fire/ wildfire	Assess bridges and roadways to ascertain their capability to support fire apparatus and develop alternative routing plans where deficiencies are noted	Fire Department and Highway Department	Delete	No longer have any posted bridges in Town.
Drought, Brush fire/ wildfire	Provide information to homeowners on how to protect their property from brush fire or wildfire during times of drought	Fire Department	Ongoing	Information available online.

7.2.2 Current Mitigation Action and Adaptation Strategy

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The Planning Team developed a revised Mitigation Action Plan for the 2020 HMP Update. The revised plan includes 12 projects carried over from the 2015 Plan, and 17 new projects identified by the Planning Team and the Community Resilience Building Workshops. The completed list of 29 projects was reviewed and refined by members of Town staff who would lead in implementing the action items.

The goal of the Plan is to reduce Pepperell's vulnerability to hazards, and by selecting and implementing the most costs effective mitigation actions the Town will be well positioned to achieve that goal. The Planning Team completed a Risk and Benefit Assessment to prioritize the most cost-effective mitigation actions, as described in **Section 7.2.3**.

7.2.3 Cost Benefit Review Methodology

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The cost benefit review is the first step in completing the prioritization of mitigation projects. FEMA does not dictate how the cost benefit review is completed; however it is a required element for the plan. For the Pepperell HMP, the prioritization of projects was based on a benefit cost review using the FEMA STAPLEE method. STAPLEE is a cost/benefit analysis tool that includes consideration of **S**ocial, **T**echnical, **A**dministrative, **P**olitical, **L**egal, **E**nvironmental and **E**conomic issues.

In its simplest application, the STAPLEE method consists of a table where actions (and mitigation options) are shown along the vertical axis and the STAPLEE categories are listed along the horizontal axis (see inset on the following page). Each action is analyzed per the categories in STAPLEE and a mark is placed in each category that the action affects in a positive way. The action with the most marks achieves a higher priority.

For Pepperell's HMP, the basic STAPLEE method was modified to allow for a more detailed evaluation, accounting for both **benefits** and **costs** and reflecting the types of mitigation actions being considered for the Town. For many of the criterion values, a range of scores were assigned. **Table 7-2** includes the values that were considered for each STAPLEE criteria and potential scores. A final score for each mitigation action was tabulated as the sum of the cost score and the benefit score.

Table 7-2
STAPLEE Benefit Cost Review: Criteria, Considered Values and Rating Scores

	COSTS		BENEFITS	
	Cost Values	**Cost Rating Scores**	**Benefit Values**	**Benefit Rating Scores**
Social	Adversely Affects Segment of the Population or Community Values	-3=yes -2=maybe -1=no	Benefits a Large Segment of the Population	3=large 2=med 1=small
Technical	Number of Years to Actually Complete Project	-1= 1 year -2= 2-3 years -3= 4 or more	Easy to Implement with Local Resources	3=yes 2=maybe 1=no
Administrative	Operations and Maintenance $$ Required	-3=high -2=med -1=low or none	Sufficient Staffing Available	3=yes 2=maybe 1=no
Political	Public Opposition	-3=high -2=med -1=low	Local Champion-Politically Acceptable	3=yes 2=maybe 1=no
Legal	Action Potentially Subject to Legal Challenge	-1 Not expected -2 Maybe -3 Subject to legal challenge	Existing Local Authority to Implement	3= state or local authority (yes) 2 = maybe 1 = no
Economic	Approximate Cost	-1 =$0-$100,000 -2 = $100,001-$500,000 = -3 = $500,001-$1,000,000 -4 = >$1,000,001	Funding Available	3=yes 2=maybe 1=no
Environmental	Adverse Environmental Impacts	-3=high -2=med -1=low	Other Community Goals Achieved	3=yes 2=maybe 1=no

Once a total cost benefit rating score was calculated for each mitigation action, all of the mitigation actions were ranked as high, medium and low priority for implementation by hazard category based on the range of scores for each hazard.

Table 7-3 includes the list of 29 future mitigation actions sorted by type of hazard, including the total benefit cost rating score and final overall ranking.

TABLE 7-3

Mitigation Action Plan

Hazard Addressed	Mitigation Action #	Description of Action	Implementation Responsibility and Status	Additional Funding Sources	Approximate Cost	Timeframe when action would begin	Consistency with Mitigation Goals	Consistency with Other Town Plans	Benefit Cost Review Rating	Priority Ranking
All Hazards	1	Conduct an agreement with a private vendor regarding gas/oil supplies for the highway department in the event of an emergency	DPW/Emergency Manager		$	Short-term	Increase community's capability for responding to a natural hazard event by promoting the adequate provision of emergency service capabilities	CEMP	13.19	High
All Hazards	2	Incorporate hazard mitigation into the town's Open Space Plan updates.	Planning Board and Conservation Commission		$	Ongoing	Develop programs and measures that protect residences and other structures from natural hazards	Master Plan	12.00	High
All Hazards	3	Evaluate and identify backups for the existing communications system, define alternative communications and improve redundancy	Communications Director/Police and Fire	State 911 Department grants	$	Short-term	Increase community's capability for responding to a natural hazard event by promoting the adequate provision of emergency service capabilities; Protect critical public facilities and services from damage due to natural hazards	CEMP	11.40	High
Flooding, Hurricane	4	Work with MassDOT to improve debris removal at the Route 119 bridge over the Nashua River.	Town DPW and MassDOT. MassDOT owns this bridge.	MassDOT maintenance funds	$	Ongoing	Increase coordination between the Federal, State, regional and local levels of government	Master Plan	11.00	High
All Hazards	5	Develop an evacuation plan for elderly housing and other facilities that house vulnerable populations	Emergency Manager, Council on Aging		$	Short-term	Implement a broad range of mitigation measures that protect the Town's vulnerable population and infrastructure	CEMP	10.65	High
All Hazards	6	Study, inventory and conduct an evaluation on emergency generator readiness in regard to private entities	Building Department		$	Long-term	Develop a mitigation strategy that considers area businesses and protects the economic vitality of the Town		10.37	High
All Hazards	7	Develop/reactivate the Regional Emergency Planning Committee (REPC)	Emergency Services		$	Ongoing	Increase coordination between the Federal, State, regional and local levels of government	CEMP	10.22	High
All Hazards	8	Add a shower at Senior Center to allow the facility to serve as the primary shelter	Emergency Manager/ Council on Aging		$	Short-term	Implement adaptation strategies and modify local emergency plans to protect critical infrastructure and property from the impacts of climate change	CEMP, Master Plan	10.14	High
All Hazards	9	Study regional consolidation of 911 dispatch services by establishing a regional emergency communications center (RECC)	Town public safety officials, the State 911 Department and other participating municipalities	State 911 Department grants	$$$	Ongoing	Increase community's capability for responding to a natural hazard event by promoting the adequate provision of emergency service capabilities	CEMP	10.00	High

TABLE 7-3
Mitigation Action Plan

Hazard Addressed	Mitigation Action #	Description of Action	Implementation Responsibility and Status	Additional Funding Sources	Approximate Cost	Timeframe when action would begin	Consistency with Mitigation Goals	Consistency with Other Town Plans	Benefit Cost Review Rating	Priority Ranking
Flooding, Severe Storms, Climate Change	10	Conduct a town-wide watershed/stormwater assessment (modeling, culvert assessments), including capacity planning for culverts, to analyze design, permit, and construct culvert projects	Conservation Commission/ Town Engineer/DPW	MVP Action Grant, MassDEP Asset Management Grant, Division of Ecological Restoration grants	$	Ongoing	Ensure that critical infrastructure is protected from natural hazards	Stormwater Master Plan, Pepperell Master Plan	9.78	High
Flooding	11	Conduct a floodplain impact evaluation for the Wastewater Treatment Facility and collection system	DPW/Conservation	MVP Action Grant	$	Short-term	Ensure that critical infrastructure is protected from natural hazards		8.40	Medium
Flooding, Climate Change	12	Update Town floodplain, zoning, and stormwater bylaws	Planning Board/Conservation Commission		$	Short-term	Discourage future development in hazard prone areas, such as flood plains		8.32	Medium
Flooding, Climate Change	13	Conduct a watershed evaluation study for stormwater retrofits	Conservation Commission/DPW		$$	Short-term	Develop programs and measures that protect residences and other structures from natural hazards	SWMP	8.20	Medium
Climate Change	14	Develop a wildlife (beavers, mosquitos, etc.) management plan for major wetlands and waterbodies	Board of Health/Conservation		$	Short-term	Develop programs and measures that protect residences and other structures from natural hazards		8.03	Medium
Earthquake, Flooding	15	Work with DCR Office of Dam Safety to ensure that the inspections of all dams are current.	Town Engineer, Highway Superintendent, Conservation, DCR Office of Dam Safety, dam owners		$	Ongoing	Protect critical public facilities and services from damage due to natural hazards		8.00	Medium
Extreme Temperature	16	Increase public awareness of the dangers of extreme temperatures and outline locations where vulnerable populations (elderly, homeless and those with health issues) can access air conditioning or shelter from the cold	Emergency Manager		$	Ongoing/short-term	Increase awareness and support for natural hazard mitigation among municipality, private organizations, businesses, and area residents through outreach and education		7.00	Medium
Winter Storms, Snow Storms, Blizzards, Ice Storms	17	Distribute educational information to residents and businesses on protecting life and property from severe winter storm events	Emergency Manager		$	Ongoing/short-term	Increase awareness and support for natural hazard mitigation among residents and businesses through outreach and education		7.00	Medium

TABLE 7-3
Mitigation Action Plan

Hazard Addressed	Mitigation Action #	Description of Action	Implementation Responsibility and Status	Additional Funding Sources	Approximate Cost	Timeframe when action would begin	Consistency with Mitigation Goals	Consistency with Other Town Plans	Benefit Cost Review Rating	Priority Ranking
All Hazards	18	Evaluate the design and construction for a new Public Safety Complex	Building Committee		$$	Short-term	Increase community's capability for responding to a natural hazard event by promoting the adequate provision of emergency service capabilities	Master Plan	6.32	Medium
Drought, Brush Fire, Wildfire	19	Provide information to homeowners on how to protect their property from brush fire or wildfire during times of drought	Fire Department		$	Short-term	Increase awareness and support for natural hazard mitigation among municipality, private organizations, businesses, and area residents through outreach and education		5.00	Low
Flooding, Hurricanes, Climate Change	20	Acquire and protect land including forests, agriculture, floodplains, and other local priorities	Planning Board/Conservation Commission		$$$	Ongoing	Discourage future development in hazard prone areas, such as flood plains	Open Space Plan, Master Plan	4.57	Low
Flooding	21	Revise subdivision regulations, and erosion control regulations to improve floodplain management as needed.	Planning Board, and Conservation Commission		$	Short-term	Discourage future development in hazard prone areas, such as flood plains	Open Space, Stormwater Management Plan, Master Plan	4.00	Low
Flooding	22	Modify local wetlands bylaw to better address hazard mitigation.	Conservation Commission		$	Deferred	Discourage future development in hazard prone areas, such as flood plains	Master Plan	3.00	Low
Flooding, Severe Storms	23	Address repetitive flood issues on Route 119	Town DPW, MassDOT, Conservation Commission		$$	Ongoing	Increase coordination between the Federal, State, regional and local levels of government	Master Plan	2.08	Low
Earthquake, Flooding	24	Work with MassDOT to replace/rehabilitate any structurally deficient bridges identified in the future.	Town, MassDOT		$$$$	Ongoing	Increase coordination between the Federal, State, regional and local levels of government	Northern Middlesex Regional Transportation Plan	2.00	Low
Severe Storms, Climate Change	25	Conduct a feasibility study and cost/benefit analysis for developing microgrids	Select Board		$$	Long-term	Protect electric power delivery infrastructure from natural hazards		1.02	Low

TABLE 7-3 continued								
Sever Winter Storm/ Snowstorm, Blizzards, Hurricane, Tornado, Earthquake	26	Inspect public buildings to evaluate the capacity to withstand snow loads and prevent roof collapse. Develop plans to clear roofs of excessive snow accumulations to prevent collapse. Evaluate public buildings and critical facilities for the potential to withstand high winds. Develop an inventory of public buildings that do not currently meet seismic standards.	Building inspector and Emergency Manager (confirm)	$$	Short-term	Protect critical public facilities and services from damage due to natural hazards	1.00	Low
Flooding, Hurricane	27	Undertake an assessment of what is needed to eliminate the flooding problem at Canal Street.	Town Engineer and MassDOT	$$	Ongoing	Increase coordination between the Federal, State, regional and local levels of government	-7.00	Low

7.2.4 2020 Mitigation Action Plan

This Mitigation Action Plan is an update of the 2015 Action Plan. The matrices note whether each particular action was included in the 2015 Regional HMP. Many of the actions contained in the 2015 Regional HMP remain in the updated plan and are still a priority for Pepperell. The actions delineated in this Plan will be implemented as resources are made available.

7.2.4.1 Timeline for Implementation

Table 7-3 includes 11 projects ranked with a high priority, 9 with a medium priority and 9 with a lower priority for all hazard categories. Although all projects are important to the Town, the high priority projects are summarized below relative to recommended timing of the individual mitigation actions. The Town has identified its Capital Improvement Planning, Stormwater Management Plan, Master Plan, and Open Space and Recreation Plan, and Comprehensive Emergency Management Plan as mechanisms to integrate mitigation actions over the next five years.

2 high priority mitigation actions are identified as ongoing with a year or less to complete:

- Work with MassDOT to improve debris removal at the Route 119 bridge over the Nashua River.
- Study regional consolidation of 911 dispatch services by establishing a regional emergency communications center (RECC)

1 high priority mitigation action is identified as short-term with a year or less to complete:

- Conduct an agreement with a private vendor regarding gas/oil supplies for the highway department in the event of an emergency

4 high priority mitigation actions are ongoing with two to three years to complete:

- Incorporate hazard mitigation into the town's Open Space Plan updates.
- Develop a Reactive Regional Emergency Planning Committee (REPC)
- Conduct a town wide watershed/stormwater assessment (modeling, culvert assessments)
- Develop a large/dead tree management plan and conduct tree trimming

3 high priority mitigation actions are identified as short term and require two to three years to complete:

- Evaluate and identify backups for the existing communications system and define alternative communications and improve redundancy
- Develop an evacuation plan for nursing homes, elderly housing, and other facilities that house vulnerable populations
- Add a shower at Senior Center to allow the facility to serve as the primary shelter

1 high priority mitigation actions are identified as long term and require two to three years to complete:

- Study inventory and conduct an evaluation on emergency generator readiness in regard to private entities

7.2.4.2 Continued Compliance with 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, in order 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 (Section 3107), which is implemented at the local level by municipal building inspectors. In Massachusetts, 344 out of 351, or 98%, of Massachusetts municipalities participate in the NFIP.

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The Town continues to enforce required elements of the NFIP so that they may continue to participate in the program including:

- Issuing or denying floodplain development/ building permits
- Inspecting all development to assure compliance with the local floodplain zoning by-law
- Maintaining records of floodplain development
- Assisting in the preparation and revision of floodplain maps
- Helping residents obtain information on flood hazards, floodplain map data, flood insurance and proper construction measures.

The Town periodically reviews the zoning by-law for consistency and uses the most recent FIRM data to determine base flood elevation or the best available scientific data for determinations of base flood elevation if no FIRM data is available to achieve a reasonable measure of flood protection.

Section 8
Plan Evaluation and Maintenance

8.1 Who is Involved?

The implementation of this Hazard Mitigation Plan will take place at the State, Regional and local levels of government. Local governments play a pivotal role in hazard mitigation, particularly in floodplain management. The municipal Planning Boards, Conservation Commissions, and Boards of Health have legal responsibilities to implement local floodplain bylaws, floodplain guidelines incorporated into the Wetlands Protection Act, the Rivers Protection Act and Title 5 of the State Environmental Code (wastewater disposal). Local Building Departments enforce the National Flood Insurance Program (NFIP) construction standards incorporated into the Massachusetts State Building Code. Local public works and highway departments are responsible for local roadways, and municipal drainage, sewer and stormwater management systems. Each municipality has an emergency manager who is responsible for local preparedness, mitigation response and recovery for natural and manmade hazards. Table 8.1 below provides a summary of local boards and departments and their corresponding roles in implementing the action items contained in the Regional and Pepperrell Mitigation Plan.

Table 8.1: Role of Local Boards, Departments and Committees in Plan Implementation

Department, Board or Committee	Function	Role in Hazard Mitigation Implementation
Building Department/Inspector	The building inspector enforces the Massachusetts State Building Code that incorporates NFIP construction standards. The building inspector also enforces locally adopted bylaws. The state building code contains sections on wind, snow, structural loads and seismic retrofitting.	Insures that NFIP standards and other mitigation standards are uniformly applied
Public Works Department/Town Engineer	The DPW/engineer is primarily responsible for municipal drainage and stormwater management issues, taking the lead in insuring compliance with EPA MS4 Stormwater Regulations. DPW also maintains the roadway network.	Ongoing maintenance and upgrading of local stormwater systems is crucial to reducing and managing flood risks. Roadway system must remain open for evacuation and for emergency response.

Table 8-1 (Cont'd): Role of Local Boards, Departments and Committees in Plan Implementation

Department, Board or Committee	Function	Role in Hazard Mitigation Implementation
Conservation Commission	The Conservation Commission is responsible for implementing the Rivers Protection Act (MGL Chapter 258, 310 CMR 10.58), and the Wetlands Protection At (MGL Chapter 131, Section 40, 310 CMR 10.00). 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.	These regulations contain performance standards which address flooding, protection of natural resources, stormwater management, and storm damage prevention.
Planning Board and Planning Department	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".	The Planning Department coordinates the hazard mitigation planning and municipal vulnerability planning processes, and the implementation of the hazard mitigation plan.
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.	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	The three-member Select Board serves as the chief elected officials in Pepperell.	The Board must adopt the local Hazard Mitigation Plan. In addition, their approval is necessary for hazard mitigation grant applications and potential projects.
Emergency Management Department	The emergency manager is responsible for local response and recovery planning, as well as mutual aid.	Emergency managers play a primary role in the development of the Comprehensive Emergency Management Plan (CEMP), as well as in other plans required by MEMA and FEMA.

Each department identified in the Pepperell Hazard Mitigation Plan is responsible for implementing specific mitigation actions detailed in the Mitigation Actions section of the plan (**Section 7**). Every proposed action listed in the Future Mitigation Action section is

A6 d

assigned to a specific "lead" department as a way to assign responsibility and accountability and increase the likelihood of subsequent implementation. Annual review will enable specific actions to be modified, if needed, rather than wait until the 5-year update, allowing mitigation projects to evolve in a timely manner as circumstances dictate. Pepperell's Planning Department will be responsible for ensuring that the Plan is monitored, evaluated, and updated throughout the next five years.

The incorporation of the hazard mitigation actions outlined in this Plan Update within other local and regional planning documents and procedures is highly encouraged. Such documents include community master plans, capital improvement plans, Open Space and Recreation Plans, stormwater plans and regulations, emergency management plans, zoning bylaws, subdivision regulations, and local wetland bylaws and ordinances. Elected officials should be directly involved in the implementation of the updated Plan, as they set policy and can provide direction in establishing timeframes, assigning implementation responsibility, and providing implementation funding.

8.2 How will the Plan be Maintained?

The following activities describe how the plan will be maintained and updated over the next five years:

A6 ad

Plan Monitoring

Members of the Planning Team will communicate annually to report on the implementation status of each Mitigation Action identified in **Section 7**, noting accomplishments, challenges, and recommended modifications to identified actions. The Planning Team will also describe and document any new hazard data that can be incorporated in the Hazard Profile section of the Plan, noting any new hazard, and its location, extent, and impact.

At least once per year, the Planning Team will update the implementation status of Mitigation Actions and evaluate the appropriateness of the actions, noting any changes warranted. The public will be invited to this meeting and their input will be sought on the progress of implementation and the possible need for updates.

Plan Evaluation

A6 bd

The Planning Team will communicate annually to evaluate the purpose and goals of the Hazard Mitigation Plan, to ensure the Plan continues to serve its purpose. The annual review will include the following activities:

- Submit a survey to all members of the implementation group and other interested local stakeholders. The survey will poll the members on any changes or revisions to the plan that may be needed, progress and accomplishments for implementation, and any new hazards or problem areas that have been identified.
- Review survey results and make recommendations relative to any changes to the plan that are needed.
- Review the Mitigation Goals in the Hazard Mitigation Plan.
- Discuss recent activities undertaken to reduce loss of life and property, such as grants received/applied for and any completed Mitigation Actions.

- Discuss ongoing or recent planning efforts that are consistent with the Mitigation Goals and Actions of the Hazard Mitigation Plan.

Plan Update

A6 cd

This Hazard Mitigation Plan will be reviewed and updated every five years to ensure there is no lapse in Plan coverage. The Plan update process will be scheduled 12 to 18 months before the Plan is set to expire.

8.3 When Will the Plan be Maintained?

A start date and time periods were assigned to each Mitigation Action in Section 7 which will used to assess whether actions are being implemented in a timely fashion. Also, the Planning Team will communicate annually to discuss progress on Mitigation Actions.

Following a disaster declaration, this Hazard Mitigation Plan will be revised as necessary to reflect lessons learned, or to address specific issues and circumstances arising from the event. It will be the responsibility of the Town Planner to coordinate with the Planning Team and ensure that appropriate stakeholders are invited to participate in the plan revision and the update process following a declared disaster event.

A5 a

8.4 Incorporation with Other Plans

Upon approval of the Pepperell Hazard Mitigation Plan by FEMA, the Planning Team will provide all interested parties and implementing departments with access to a copy of the Plan and will initiate a discussion regarding how the Plan can be integrated into that department's ongoing work, including the preparation of town policy plans, regulations, financial plans, and budgets. At a minimum, the Plan will be shared with the following departments, commissions, and boards:

C6 e

- Select Board
- Fire Department
- Emergency Management Staff
- Police
- Planning Board
- Conservation Commission
- Health Department
- Public Works Department.

The Plan will also be posted on the Town's website. The posting of the Plan on the website will include a mechanism for public feedback, such as an e-mail address for submitting comments.

Section 9 Plan Adoption

Once the draft of the Pepperell Hazard Plan is reviewed by the Planning Team, stakeholders, Select Board and the general public, it is reviewed by MEMA and FEMA. Once the Plan is approved by MEMA and FEMA, the Select Board can officially adopt the document. Once the Plan is approved, it enters the five-year "maintenance" phase. This Section describes the timeline for plan adoption and includes documentation of the Plan adoption by the Select Board.

9.1 Timeline for Plan Adoption

The timeline for Plan Adoption is as follows:

The Pepperell Select Board, at its February 22, 2021 meeting, voted to submit the Pepperell Hazard Mitigation Plan to MEMA.

MEMA will review the Plan and return it to the Town should it require edits. The Pepperell Hazard Mitigation Plan will then be submitted to FEMA for final review.

_____: FEMA issued an Approved Pending Adoption status on _____.

_____: The Pepperell Select Board officially adopted the Hazard Mitigation Plan on _____. during a regularly scheduled meeting.

9.2 Plan Adoption

The Certificate of Adoption will be provided in this section.

TO BE PUT ON
SELECT BOARD
LETTERHEAD
DATE

TOWN OF PEPPERELL
CERTIFICATE OF ADOPTION

A RESOLUTION ADOPTING THE TOWN OF PEPPERELL
HAZARD MITIGATION PLAN

WHEREAS the Town of Pepperell established a Committee to prepare the *Hazard Mitigation Plan*; and

WHEREAS the *Hazard Mitigation Plan* contains many potential future projects to mitigate potential impacts from natural hazards in the Town of Pepperell, and

WHEREAS a duly-noticed public meeting was held by the Select Board on _____

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

NOW, THEREFORE BE IT RESOLVED that the Town of Pepperell formally approves and adopts the *Hazard Mitigation Plan* in accordance with M.G.L. 40 §4 or the charter or the bylaws of the Town of Pepperell.

ADOPTED AND SIGNED ON [Month___Day___, 20__]

[INCLUDE SIGNATURE BLOCKS HERE]

Appendix A

Resources

Reference List

Boston Research Advisory Group (June 2016) Climate Ready Boston Climate Change and Sea Level Rise Projections for Boston, Final, Report.

Cornell (Ongoing) Northeast Regional Climate Center, http://www.nrcc.cornell.edu/regional/climatenorms/climatenorms.html, Database.

EEA (2017) Statewide and Major Basins Climate Projections , Final, Report.

FEMA. Earthquake Causes and Characteristics, FEMA Emergency Management Institute Training Guide, https://training.fema.gov/emiweb/is/is8a/is8a-unit3.pdf, Report.

FEMA (2017) Taking Shelter from the Storm: Building a Safe Room Inside Your House, https://www.fema.gov/pdf/library/ism2_s1.pdfWebsite.

FEMA (2020) National Flood Insurance Program Definitions, https://www.fema.gov/national-flood-insurance-program/definitionsWebsite.

FEMA (April 28, 2020) HAZUS, https://www.fema.gov/hazus.

FEMA (March 2013) Local Mitigation Planning Handbook, Report.

FEMA (October 1, 2011) Local Mitigation Plan Review Guide, Report.

Holstein, J., Canoui-Poitrine, F., Neumann, A., Lepage, E., & Spira, A. (2005) Were less disabled patients that most affected by 2003 heat wave in nursing homes in Paris, France?, Journal of Public HealthJournal.

Kravchenko, J., Abernethy, A.P., Fawzy, M, & Lyerly, H.K. (2013) Minimization of heat wave morbidity and mortality, American Journal of Preventive Medicine, Journal.

Luber, G., & McGeehin, M. (2008) Climate change and extreme heat events, American Journal of Preventive Medicine, Journal.

Massachusetts Invasive Plant Advisory Group (MIPAG) (April 1, 2005) Non-Native Plant Species for Invasiveness in Massachusetts, https://massnrc.org/mipag/docs/MIPAG_FINDINGS_FINAL_042005.pdf#page=6, Report.

NMCOG (July 2019) Northern Middlesex Regional Transportation Plan, 2020-2040, Final, Report.

NMCOG (2015) Northern Middlesex Regional Transportation Plan, Final, Report.

NOAA. National Hurricane Center Educational Resources, Website.

NOAA (May 2008) Drought Public Fact Sheet, http://www.nws.noaa.gov/om/brochures/climate/DroughtPublic2.pdf, Website.

O'Neill, M.S., & Ebi, K.L. (2009) Temperature Extremes and Health: Impacts of Climate Variability and Change in the United States, Journal of Occupational and Environmental Medicine, Journal.

SHMCAP Project Management Team (September 2018) Massachusetts State Hazard Mitigation and Climate Adaptation Plan, Final. Report.

Town of Pepperell (Ongoing) Town of Pepperell Master Plan, Draft , Report.

US Department of Commerce, NOAA, and the Natural Weather Service (2010) Thunderstorms, Tornadoes, Lightning: Nature's Past Violent Storms, A Preparedness Guide, Report.

USGS (1988-89) National Water Summary, Massachusetts Floods and Droughts, Report.

USGS New England Water Science Center, https://www.usgs.gov/centers/new-england-water, Website.

Appendix B

HMP Public Meeting

Planning Board
Meeting Agenda

Time: 7:00 PM
Date: Monday, April 6, 2020
Location: Remote Meeting

Please join the meeting from your computer, tablet or smartphone.

https://global.gotomeeting.com/join/273692965

You can also dial in using your phone.

United States: +1 (872) 240-3412

Access Code: 273-692-965

1. Call To Order
2. 7:00 PM - MVP Public Meeting - Presentation By Tighe And Bond Of Draft MVP Report
3. 7:30PM - Continuation Of Public Hearing - 12 Bancroft Street - Special Permit Application To Operate A Recreational Camp
4. Reports/Correspondence/Discussion
   (Matters may arise that the chair didn't reasonably anticipate)
   a. Complete Streets Update
   b. Master Plan Update
   c. NMCOG Update
5. Future Meeting





PEPPERELL'S HAZARD MITIGATION AND MUNICIPAL VULNERABILITY PREPAREDNESS PLANNING

Public Meeting

April 6, 2020

Tighe&Bond

WELCOME



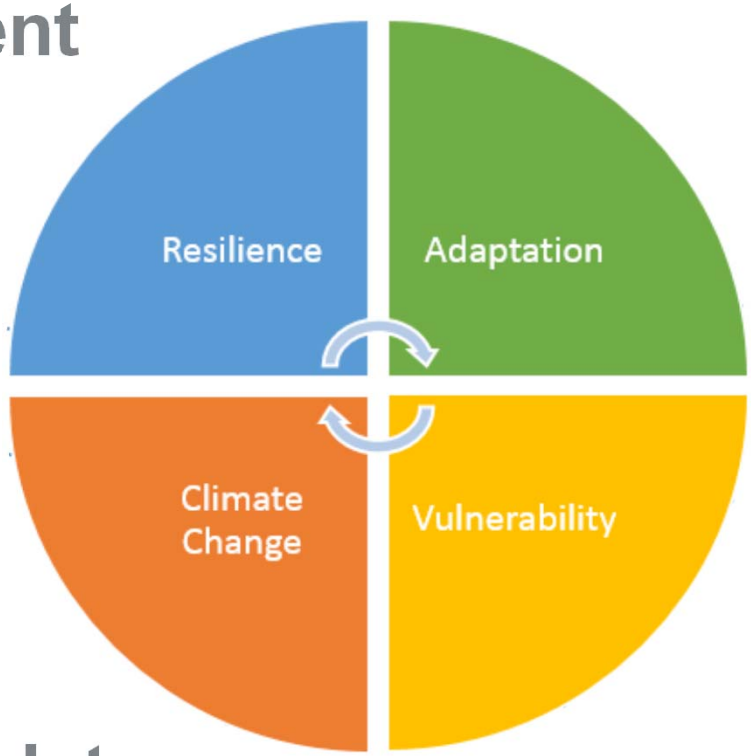
Pepperell awarded $37.5K grant for

- Municipal Vulnerability Preparedness (MVP) Community Resilience Building (CRB) Workshop Process; and
- Draft Hazard Mitigation Plan (HMP) Update

First step in unlocking additional funding opportunities for Pepperell from FEMA/MEMA and Commonwealth of Massachusetts

MVP/HMP GRANT AND CRB PROCESS

1. Establish Core Team
2. Complete Evaluation/Assessment
   - Natural Hazard Risks
   - Community Assets
   - Multi-Hazard Vulnerability Assessment
   - Capabilities Assessment
   - Mitigation Strategies



3. Hold two workshops
4. Draft MVP Report
5. Hold Public Meeting
6. Draft Hazard Mitigation Plan Update
7. Hold Listening Session
8. Final MVP Report

PURPOSE OF PUBLIC MEETING

- **Required** to comply with Federal HMP guidance and contract with EEA
- **Introduce Hazard Mitigation and Municipal Vulnerability Planning** and **provide an update** on work completed to date
- Provide opportunity for **Q&A**

A BRIEF THANKS TO PEPPERELL'S HAZARD MITIGATION PLAN AND MVP CORE TEAM AND ADVISORY GROUP

CORE TEAM

- Lisa Davis*
- David Querze
- Beverly Woods*
- Brynn Montesanti
- Paula Terrasi*
- Ken Kalinowski
- Andrew MacLean
- Kalene Gendron*



ADVISORY GROUP

- Walter Richards
- Denise Pigeon
- Tony Beattie
- Casey Competti
- Kalene Gendron
- Jim Scarsdale
- David Querze
- Kat Belliveau

*Also a member of the Advisory Group

BACKGROUND ON MVP PROGRAM

EXECUTIVE ORDER 569 9.16.16

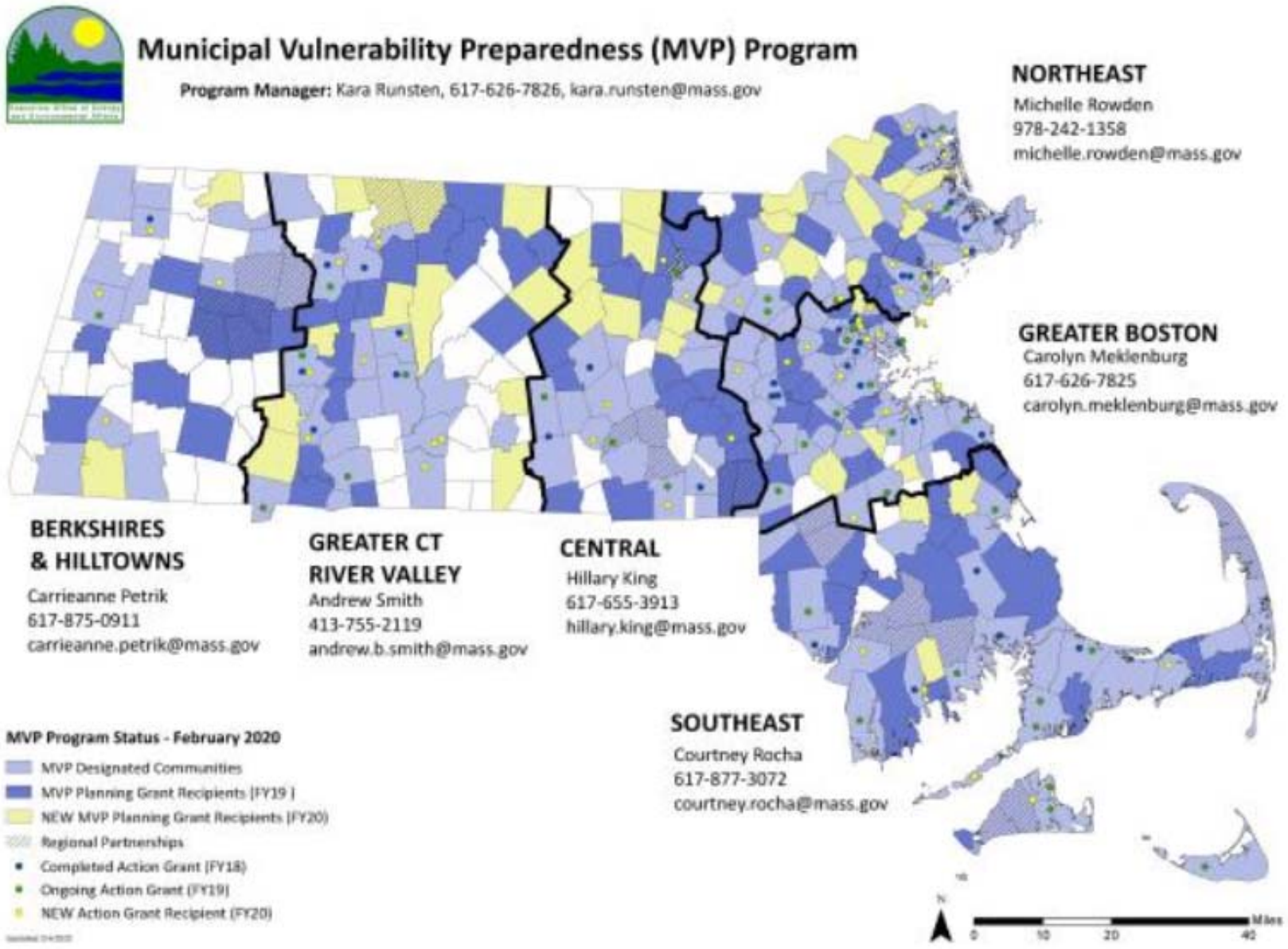


ENVIRONMENTAL BOND BILL 8.21.18



- $2.4 billion bond bill with focus on climate change resiliency
- Over $500 million authorized for climate change adaptation
- **Codifies EO 569, including the MVP Program**

WHO HAS PARTICIPATED IN MVP PROGRAM?

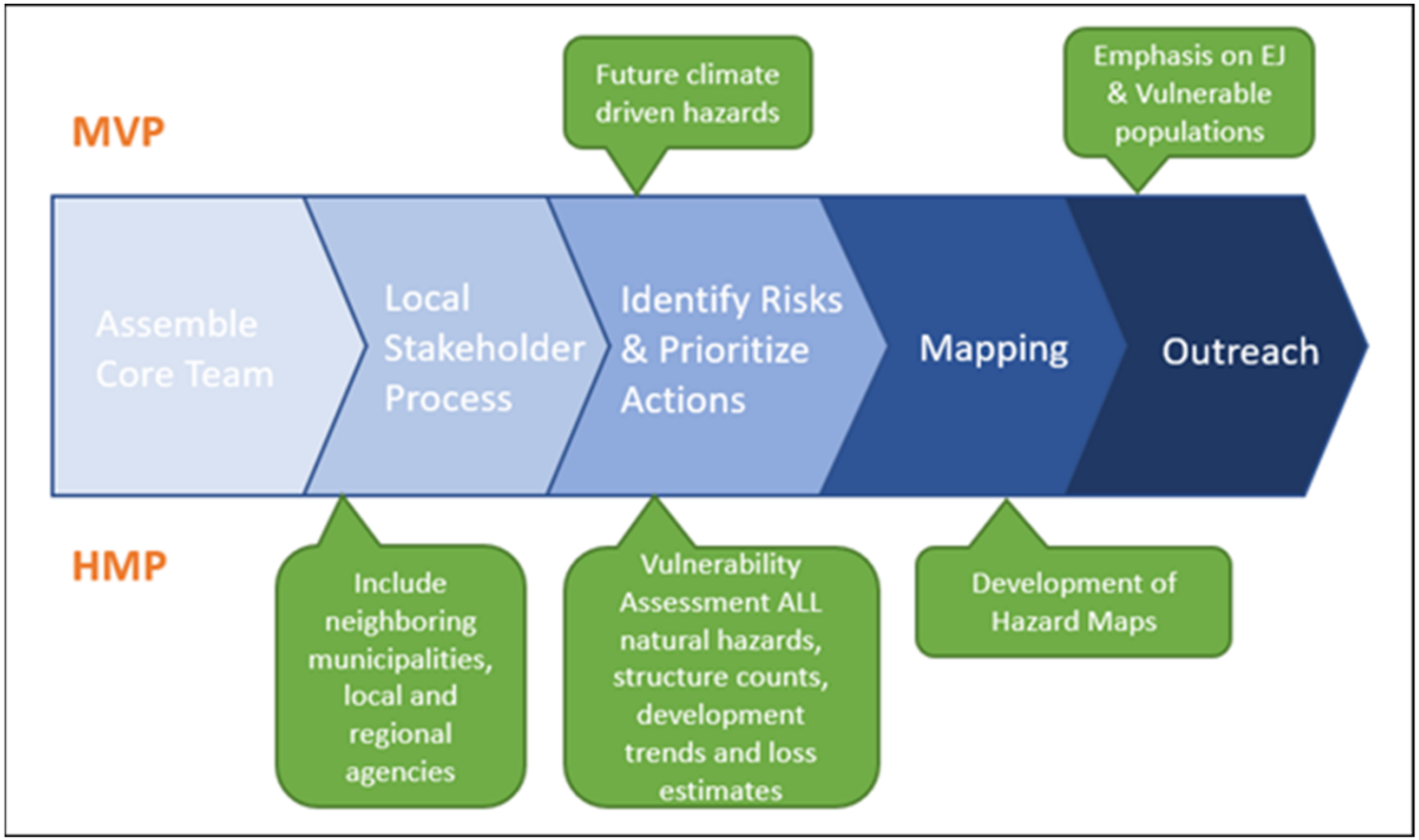


BACKGROUND ON HAZARD MITIGATION PLANNING

- **FEMA Requirements:**
  - Disaster Mitigation Act of 2000, 44 CRF Part 201.6
  - *FEMA Local Mitigation Plan Review Guidance, October 2011*
  - *FEMA Local Mitigation Planning Handbook, March 2013*
- **Pepperell included in Northern Middlesex Regional Hazard Mitigation Plan, approved August 2015.**
  http://www.nmcog.org/Websites/nmcog/images/Hazard_Mitigation_Plan_FEMA_approved_8_15.pdf
- **To maintain eligibility for FEMA/MEMA funding, must update plan every 5 years**
- **Commonwealth of Massachusetts State Hazard Mitigation & Climate Adaptation Plan 2018 must be considered in update**

HOW DO THE MVP AND HMP PROCESSES OVERLAP?

The MVP effort supplements the HMP process by providing a statewide and major watershed specific climate change data to use in the natural hazard risk assessment and a consistent methodology for public engagement through the Community Resilience Building (CRB) workshops.



Tighe&Bond

WHY DO THIS PLANNING?

Help Pepperell Build Resilience and Preparedness:

Climate change is a challenge that will affect every government agency and every community across the Commonwealth, and our coordination in addressing this challenge will help protect Massachusetts residents, infrastructure and natural resources while improving quality of life year-round

Governor Charlie Baker

WHY DO THIS PLANNING?

Help Pepperell Build Resilience and Preparedness:

- Build on the Town's existing emergency management capabilities
- Plan for more frequent and intense weather events that are linked to climate change
- Engage multiple stakeholders in the planning process
- Improve access to funding for mitigation and adaptation





COMMUNITY ASSET INVENTORY

Tighe&Bond

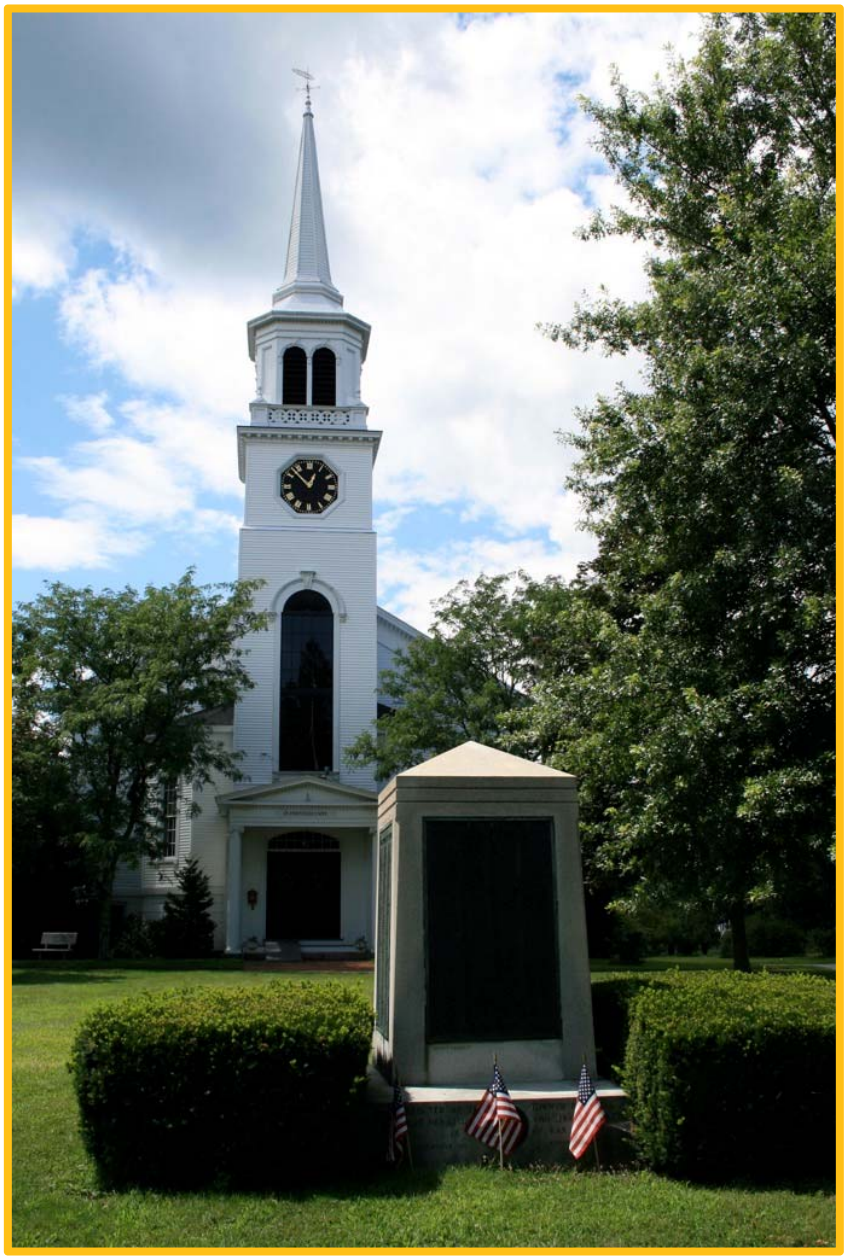
COMMUNITY ASSET CATEGORIES

FEMA defines a community asset as anything that is important to the character and function of a community.

FEMA Community Asset Categories	Critical Sectors	Characteristics of Community Assets
People	Schools, Vulnerable Populations, Cultural Facilities	Areas of greater population density, or population with unique vulnerabilities or less able to respond and recover during a disaster.
Built Environment	Critical Municipal Facilities, Water, Wastewater, Energy, Stormwater, Transportation, Cultural Resources	Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or needed for critical facilities to operate.
Economy	Marinas, Business and Industry	Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.
Natural Environment	Natural Resources	Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.

PEOPLE – SOCIETAL ASSETS

- Child Care on Hollis Street
- Churches
- Emergency shelters
- Food Pantry
- Historical Places
- Nursing Homes/elderly housing
- Pepperell Airport
- PACH outreach
- Senior Center
- RV/Trailers
- SNMC
- Schools
- Town Library
- Veterinary hospitals



BUILT ENVIRONMENT – INFRASTRUCTURE ASSETS

- Bridges (Main Street, Route 119, Route 113, Groton Street, Hollis Street, Mill Street)
- Culverts (town-wide)
- Department of Public Works facilities
- Fire and Police facilities
- Main Street Dam (private)
- Major traffic arteries
- Power grid
- Private medical center on Main Street
- Public safety communications
- Public wells and water facilities
- Schools/town shelters
- Wastewater treatment plant and pump stations



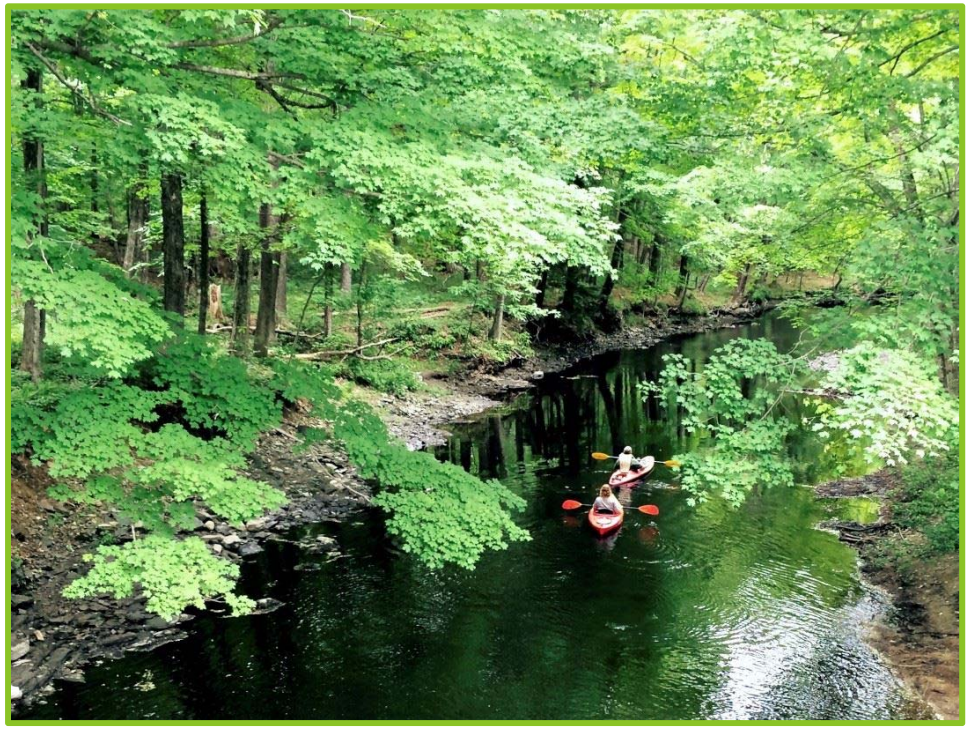
ECONOMIC ASSETS

- Banks
- Donelan's Supermarket (Main Street)
- Farms
- Funeral Homes (Main Street, Pleasant Street)
- Gas Heating Oil Company
- Gas Stations
- Hardware Store (Main Street)
- Industrial Park (Lomar Park)
- Kimball Fruit Farm (Hollis Street)
- Main Street Businesses
- Medical Center (Main Street)
- Oil Delivery (Groton Street, Hollis Street)
- Pharmacies
- Railroad Square (East Main Street)
- Recreational Areas
- Skydiving Park (Nashua Road)
- Tree removal services
- Veterinary Hospital (River Road)



ENVIRONMENTAL ASSETS

- Conservation lands and open space
- Major Wetlands and Waterbodies (e.g., Nashua and Nissitissit Rivers, Gulf Brook)
- Habitat (including vernal pools)
- Trails (Nashua River Trail)
- Well contribution areas





NATURAL HAZARD RISK AND VULNERABILITY ASSESSMENT

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WHAT ARE NATURAL HAZARDS?


Inland Flooding


Tsunami


Severe Winter Storm

Blizzards
Snow
Ice Storms


Drought


Average/Extreme Temperatures


Tornadoes


Landslide


Wildfires


Other Severe Weather

Nor'easters
High Wind
Heavy Precipitation
Microbursts


Hurricanes/Tropical Storms


Invasive Species


Earthquake

HISTORICAL EVENTS IN PEPPERELL

- **August 1948 Highest Temperature Recorded**
  Temperature of 105 degrees recorded in Pepperell
- **January 1957 Lowest Temperature Recorded**
  Temperature of -29 degrees recorded in Pepperell
- **March 1968 Ice Jam**
  Ice jam on the Nashua River
- **1987 Major Flooding of Nashua River**
  Road closures, school closed
- **July 2002 Thunderstorm Wind**
  Winds recorded over 70 mph
- **March 2010 Nashua River Flooding**
  Flooding of the Nashua River leads to closure of Route 111 and Route 119
- **August 2011 Hurricane Irene**
  Devastating flooding, wind damage
- **October 2011 Halloween Storm**
  Power out for seven days
- **March 2018 Nor'easter**
  Pepperell received 20 inches of snow from a winter nor'easter

NATURAL HAZARD RISK INDEX

Type of Natural Hazard	History of Occurrence in Pepperell	Hazard Probability	Hazard Frequency	Geographic Extent	Severity of Impact	Hazard Risk Ranking
Inland Flooding	Yes	3	3	2	3	11
Severe Winter-Storm/Nor'easter	Yes	3	3	3	2	11
Drought	Yes	3	3	2	2	10
Extreme Temperature	Yes	3	3	3	1	10
Tropical Storms/ Hurricanes	Yes	3	2	3	2	10
Severe Weather-Strong Wind and High Precipitation	Yes	3	3	3	1	10
Invasive Species	Yes	4	3	2	1	10
Microburst	Yes	3	3	1	1	8
Earthquake	Yes	1	0	3	3	7
Wildfires	Yes	3	1	1	1	6
Tornadoes	No	1	0	1	3	5
Landslide	No	1	0	1	1	3

PEPPERELL'S TOP NATURAL HAZARDS



Inland Flooding



Severe Winter Storm



Other Severe Weather



Drought



Average/Extreme Temperatures



CLIMATE CHANGE





CLIMATE CHANGE

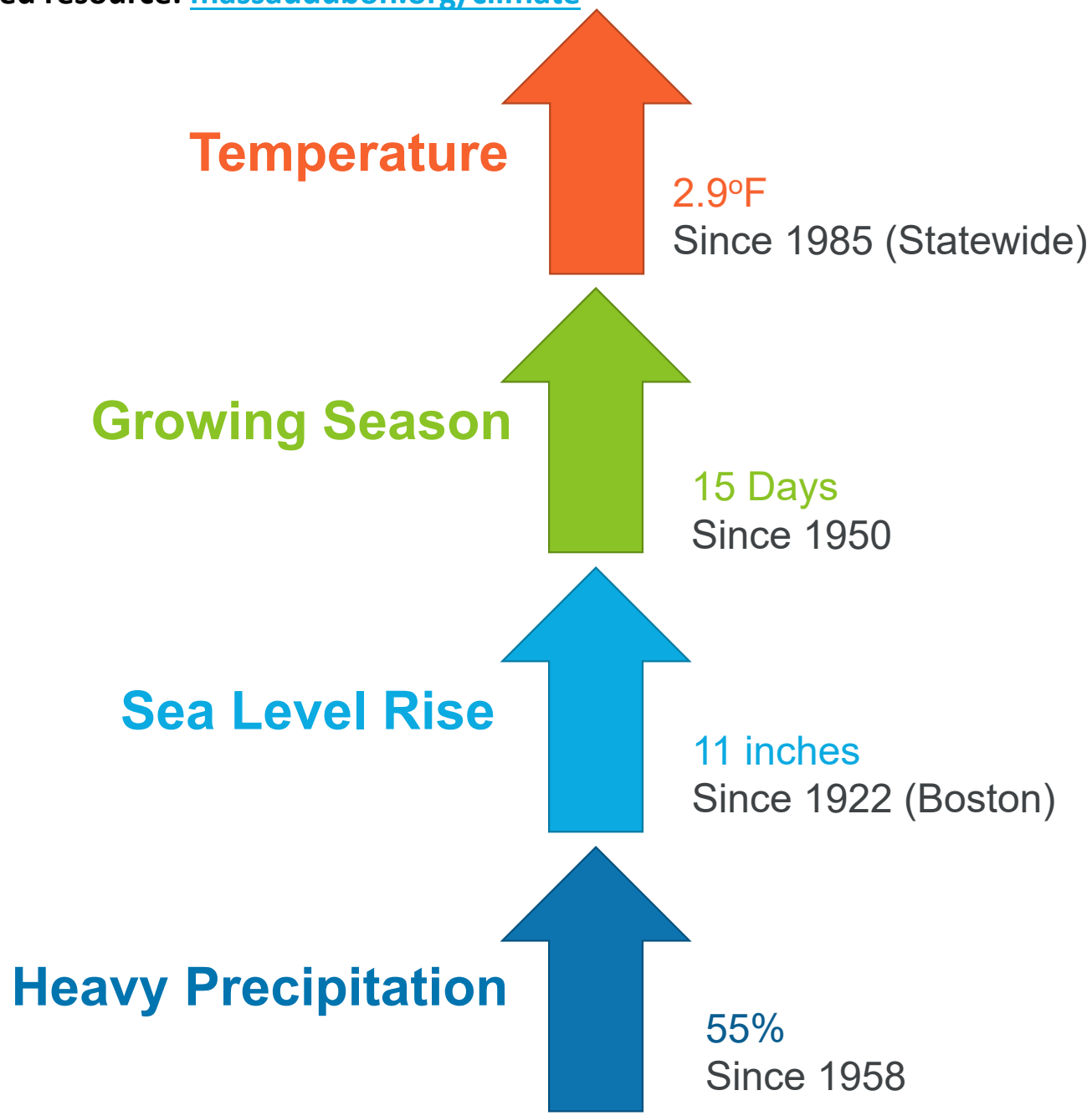
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CLIMATE CHANGE REFERENCES FOR MVP PROCESS

- **Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan, September 2018**
  - https://www.mass.gov/service-details/massachusetts-integrated-state-hazard-mitigation-and-climate-adaptation-plan
- **Massachusetts Climate Clearinghouse**
  - https://resilientma.org/
- **Statewide and Major Watershed (Basin) Climate Change Projections**
  - https://www.mass.gov/files/ma-statewide-and-majorbasins-climate-projections-final.pdf

MASSACHUSETTS OBSERVED CLIMATE CHANGES

Recommended resource: massaudubon.org/climate



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MASSACHUSETTS CLIMATE PROJECTIONS

By end of century:

Changes in precipitation

- 18% increase in consecutive dry days
- 57% increase in days with > 1 in. rainfall
- 7.3 inches additional annual rainfall

Rising temperatures

- 10.8°F increase in average annual temperature
- 42% decrease in days/year with min. temperatures < 32* F
- 1,280% increase in 90-degree days/year

Sea level rise

- 4-10.5 feet along the MA coast

Extreme weather

- Increase in frequency and magnitude



CLIMATE CHANGE THREATENS PUBLIC HEALTH



CHANGES IN PRECIPITATION

Nashua Basin		Observed Baseline 1971-2000 (Inches)	Projected Change in 2030s (Inches)	Mid-Century Projected Change in 2050s (Inches)	Projected Change in 2070s (Inches)	End of Century Projected Change in 2090s (Inches)
Total Precipitation	Annual	45.9	+0.4 to +4.9	+1.2 to +6.3	+2.3 to +7.9	+1.3 to +8.4
	Winter	11.0	-0.3 to +1.9	+0.2 to +2.5	+0.4 to +3.3	+0.6 to +4.3
	Spring	11.8	-0.0 to +2.2	+0.1 to +2.0	+0.5 to +3.0	+0.1 to +2.9
	Summer	11.3	-0.3 to +1.5	-0.3 to +2.2	-0.6 to +2.2	-1.1 to +2.2
	Fall	11.8	-1.1 to +1.1	-1.2 to +1.8	-1.6 to +1.7	-1.4 to +1.5

IMPACTS OF CHANGING PRECIPITATION

- Episodic droughts
- Concerns over food production and drinking water supply
- Stress on ecosystems
- Flooding

EXTREME STORMS

Blizzards

- There have been more than 5 in Massachusetts since 2011

Nor'easters and Hurricanes

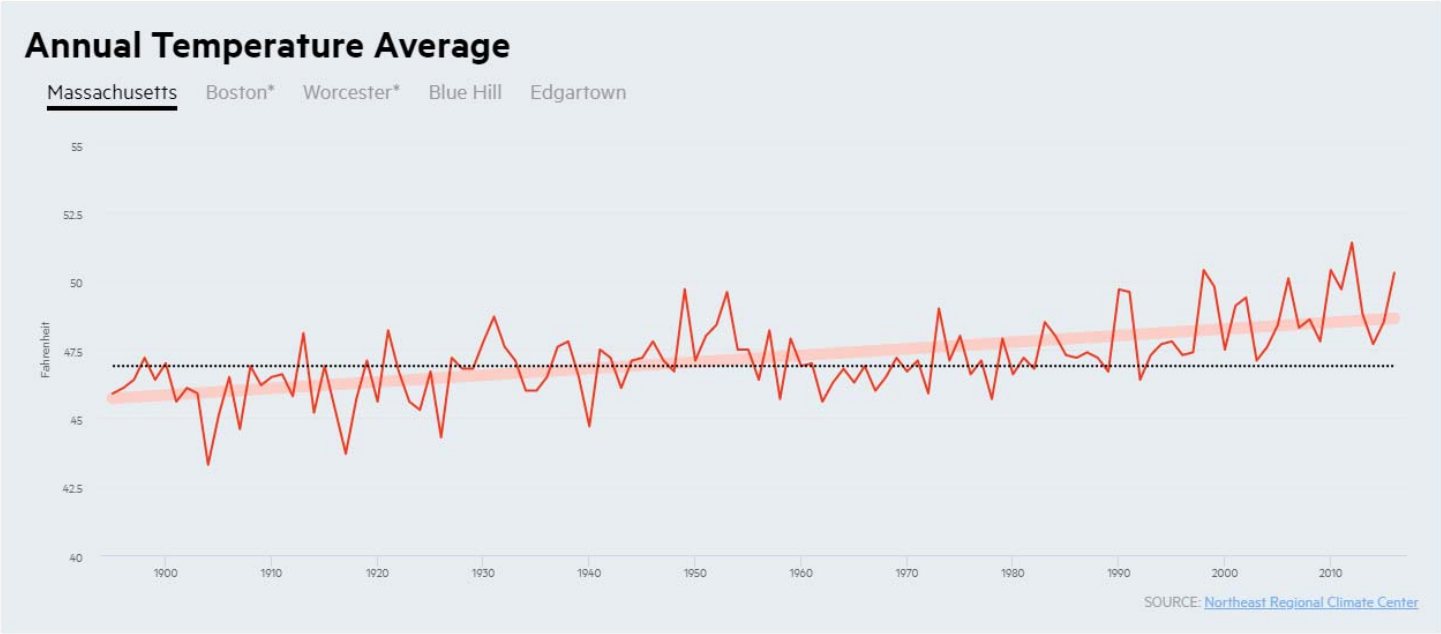
- Upward trend since the 1970s



IMPACTS OF EXTREME STORMS:

- **Public safety concerns, including increased injuries and mortality**
- **Economic damages and business disruption**
- **Property and infrastructure damage**
- **Natural resources**

RISING TEMPERATURE



IMPACTS OF RISING TEMPERATURE:

- Heat-related illnesses
- Vector borne-diseases
- Health of plants, animals, ecosystems
- Reduced crop production
- Larger energy demand
- Droughts and wildfires

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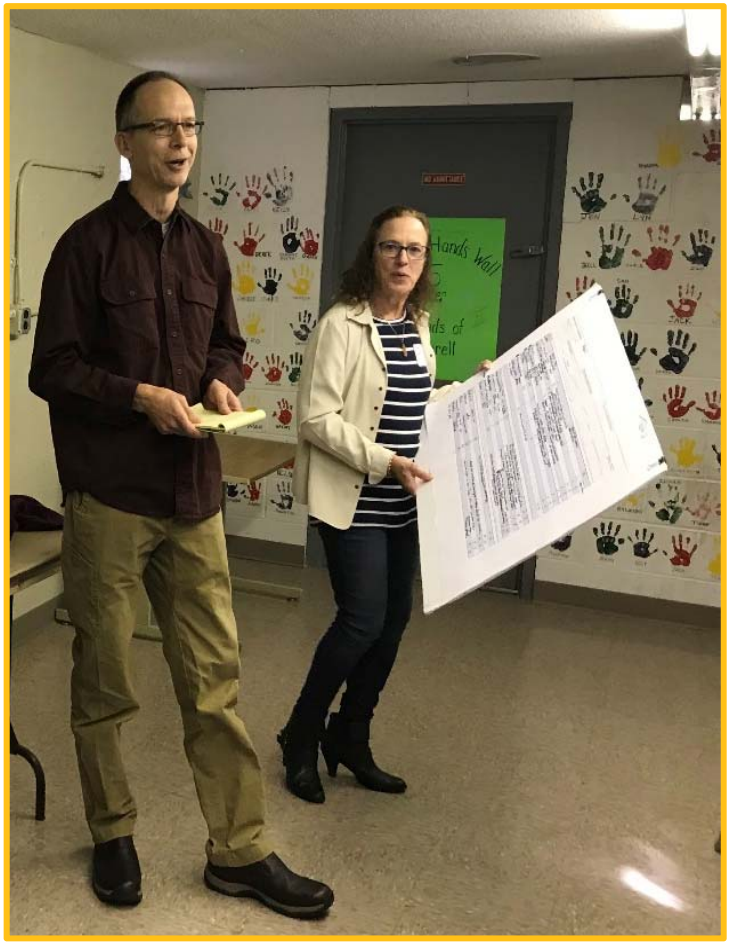


MVP WORKSHOPS

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WORKSHOP OBJECTIVES

- Hear from stakeholders who can help evaluate our community's strengths and vulnerabilities of residents, infrastructure, and natural resources
- Understand connections between natural hazards and local planning/mitigation efforts
- Develop and prioritize resiliency actions for the municipality, organizations, businesses, neighborhoods, and community groups
- Identify opportunities to advance actions that reduce the impact of hazards and increase resiliency in the community



Overview of the Process (Steps & Tasks)

DURING WORKSHOP

A Prepare for the Workshop
1. Establish a core team with goals.
2. Engage stakeholders.
3. Prepare materials for workshop.
4. Decide on participant arrangements.

B Characterize Hazards
1. Identify past, current, and future impacts.
2. Determine the highest-priority hazards.

C Identify Community Vulnerabilities and Strengths
1. Identify infrastructural vulnerabilities and strengths.
2. Identify societal vulnerabilities and strengths.
3. Identify environmental vulnerabilities and strengths.

D Identify and Prioritize Community Actions
1. Identify and prioritize infrastructural actions.
2. Identify and prioritize societal actions.
3. Identify and prioritize environmental actions.

E Determine the Overall Priority Actions
1. Identify highest-priority actions.
2. Further define urgency and timing.

F Put It All Together
1. Generate final workshop products.

G Move Forward
1. Continue community outreach and engagement.
2. Secure additional data and information.
3. Inform existing planning and project activities.

Community Components



Infrastructural



Societal



Environmental

https://www.communityresiliencebuilding.com/

CRB RISK MATRIX

- **Series of small and large group discussions to fill out CRB Risk Matrix:**
  1. Identify important community assets and the vulnerability to top hazards
  2. Determine mitigation actions to address vulnerabilities and protect strengths
  3. Prioritize and schedule mitigation actions

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

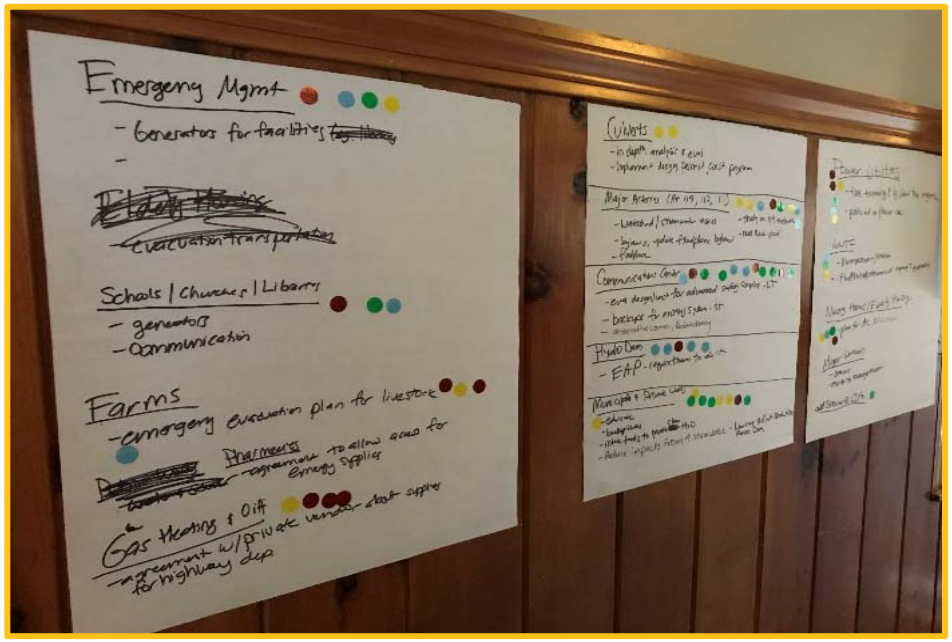
H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Societal									
Environmental									
Economy									

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WORKSHOP RESULTS

- Groups reported top risks and strengths and mitigation actions based on prioritization and scheduling
- Mitigation actions then reviewed by Core Team
- MVP Findings Report Draft has been developed







MITIGATION STRATEGIES

TYPES OF MITIGATION ACTIONS

1. Prevention
2. Property Protection
3. Public Education and Awareness
4. Natural Resource Protection and Green Infrastructure
5. Structural Projects
6. Emergency Services Protection

EXAMPLE MITIGATION ACTIONS IN PEPPERELL

- **Prevention**
  - Update Town floodplain, zoning, and stormwater bylaws
- **Natural Resource Protection**
  - Conduct a town-wide watershed/stormwater assessment
- **Structural Projects**
  - Conduct a capacity planning study for culverts to analyze design, permit, and construction
- **Emergency Services Protection**
  - Evaluate and identify backups for the existing communications system and define alternative communications
  - Study inventory and conduct an evaluation on emergency generators
  - Conduct an agreement with a private vendor regarding gas/oil supplies for the highway department in the event of an emergency

Full list available in draft MVP Report on website



WHAT'S NEXT?

NEXT STEPS BEFORE JUNE 30, 2020

- Complete draft Hazard Mitigation Plan for Town staff and public review
- Hold listening session
- Selectmen vote to submit Hazard Mitigation Plan to FEMA
- Submit documents to EEA and FEMA



MVP ACTION GRANT OPPORTUNITIES

MVP ACTION GRANTS

- Detailed Vulnerability and Risk Assessment*
- Community Outreach and Education
- Local Bylaws, Ordinances, Plans, and Other Management Measures**
- Redesigns and Retrofits***
- Nature-Based Flood Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques
- Nature-Based, Infrastructure and Technology Solutions to Reduce Vulnerability to Extreme Heat and Poor Air Quality



* Most common project type

** Second-most common project type

***Third-most common project type

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MVP ACTION GRANTS (CONT)



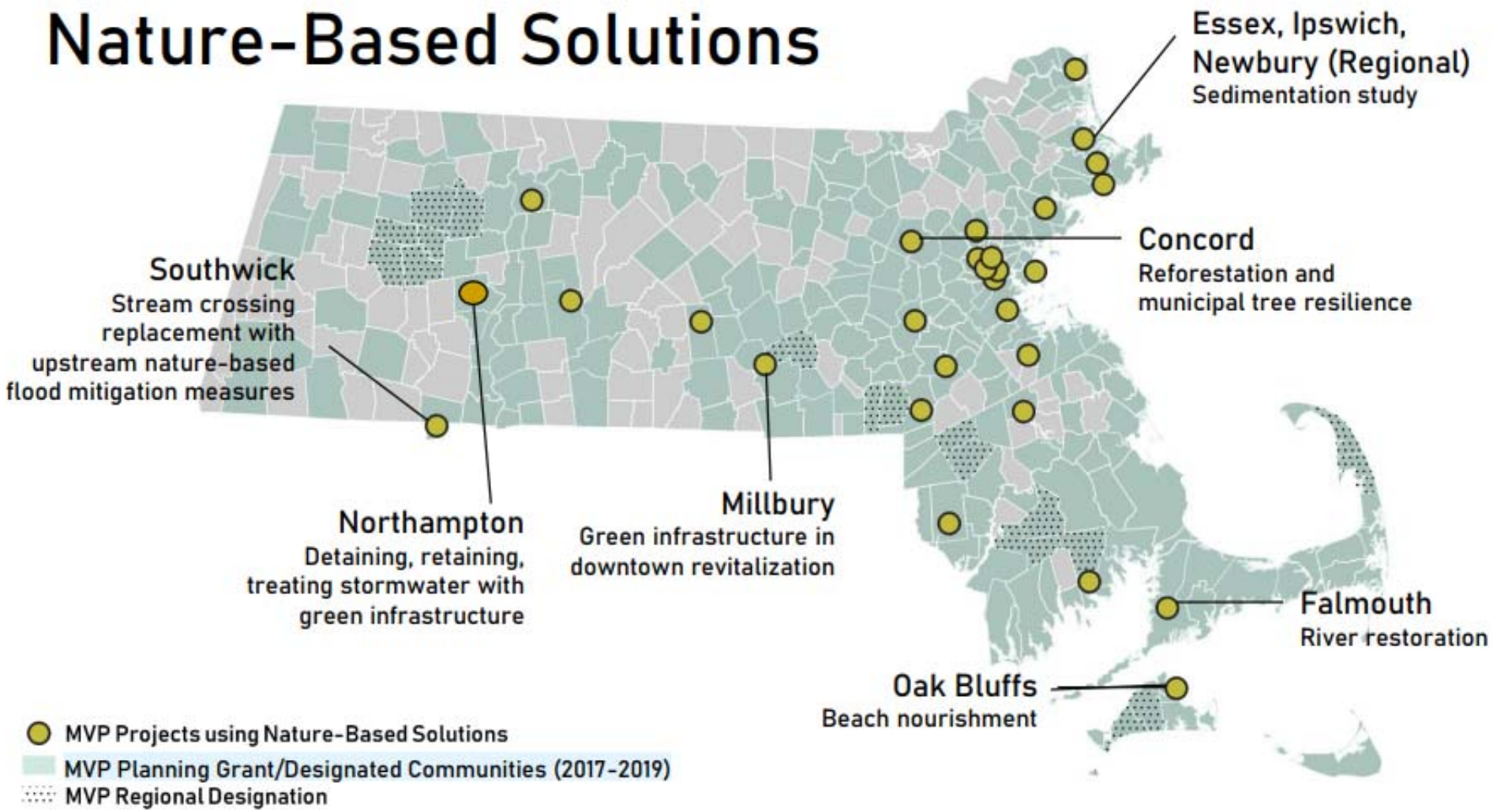
- Nature-Based Solutions to Reduce Vulnerability to other Climate Change Impacts
- Ecological Restoration and Habitat Management to Increase Resiliency

NEW IN 2019

- Energy Resilience
- Chemical Safety
- Land Acquisition for Resilience
- Subsidized Low-Income Housing Resilience Strategies

\+ Expanded eligibility of project location

Nature-Based Solutions



Tighe&Bond

OPEN DISCUSSION & QUESTIONS

Contact Information:



- **Lisa Davis, AICP**
  - LDavis@town.pepperell.ma.us
- **Janet Moonan, PE, Project Manager**
  - JSMoonan@tighebond.com
  - (781) 708-9826

Information on Town's website at:

- **https://town.pepperell.ma.us/668/MVP-Grant-Information**

HMP/MVP Public Meeting
Town of Pepperell Planning Board Meeting

ATTENDEES:	Richard McHugh	Charles Walkovich
	Paul Lonergan	Albert Patenaude
	Case Campetti	
	Janet Moonan, Tighe & Bond	
DATE:	April 6, 2020	

On April 6, 2020 the HMP/MVP Process was discussed at the Town of Pepperell Planning Board Meeting. The meeting was held virtually due to COVID-19 restrictions.

Meeting Summary

Janet Moonan, PE from Tighe & Bond gave a 20 minute presentation on the HMP/MVP Process and opened the floor to discussion afterwards. Presentation is included as an attachment.

Discussion items included:

- Obligations of the Town given commitments made in the HMP/MVP Report.
- Clarification by local project manager and supporting MVP Provider that there is no obligation, but these are important projects recommended by the group.
- Where/how to review background materials and the final reports.
- Review of projects eligible under the MVP grant.

Appendix C

Community Assessment Inventory Maps

Figure 3
Societal Assets

- Animal Shelter
- Cemetery
- Child Care
- Church
- Community Center; Community Center; Special Popul
- Elderly Housing
- Food Pantry
- Funeral Home
- Historic Site
- Library
- Shelter
- School
- Waterbody
- Parcel Boundary

LOCUS MAP



0 1,250 2,500
Feet

1:15,600

NOTES

Data source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology

Community Assets
Municipal Vulnerability Preparedness (MVP)
Planning Grant
Pepperell, Massachusetts

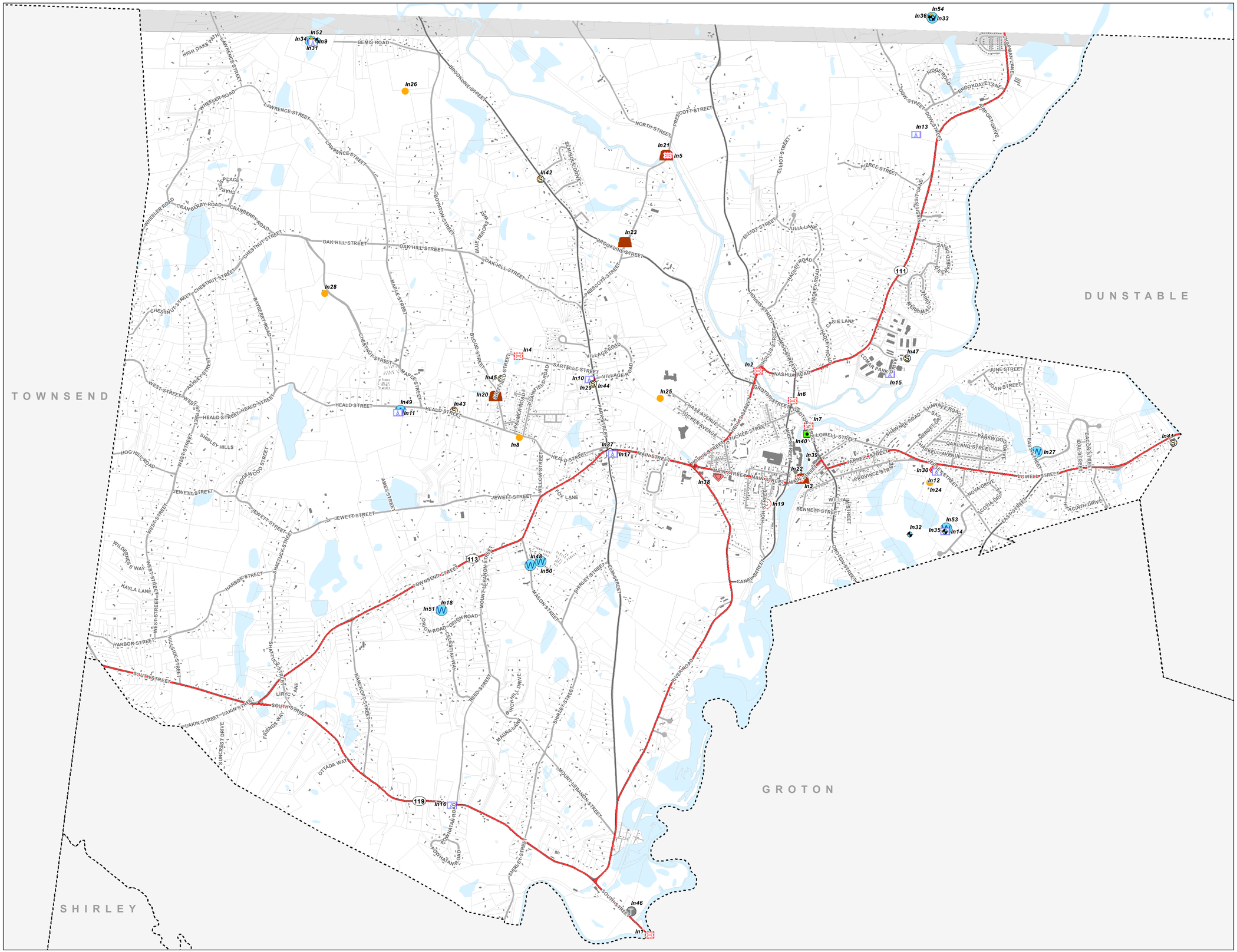
February 23, 2021

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Figure 1
Built Environment



LOCUS MAP



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Feet

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NOTES

Data source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology

Community Assets
Municipal Vulnerability Preparedness (MVP)
Planning Grant
Pepperell, Massachusetts

February 23, 2021

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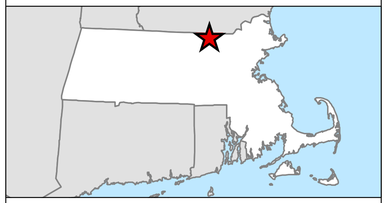
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Figure 2
Economic Assets

- Banks
- Construction or Building Contractor
- Electric Equipment & Supplies-Retail
- Trucking
- Tree Service
- Grocery
- Pharmacy
- Convenience Stores
- Variety Stores
- Telecommunications Services
- Farms
- Waterbody
- Parcel Boundary

LOCUS MAP



0 1,250 2,500
Feet

1:15,600

NOTES

Data source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology

Community Assets
Municipal Vulnerability Preparedness (MVP)
Planning Grant
Pepperell, Massachusetts

February 23, 2021

Tighe&Bond
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P-0671 Rev. NMCOG

Appendix D

FEMA Capability Assessment Worksheets

EXISTING CAPABILITIES OF PEPPERELL TO ADDRESS NATURAL HAZARDS

Local mitigation capabilities are existing authorities, policies, programs, and resources that reduce hazard impacts or that could be used to implement hazard mitigation activities.

Please review the list below- taken from the 2015 Adopted HMP. Provide any comment you would like to see in the updated plan, or update as indicated (highlighted items). Comments might include specific improvements since the last plan, or identified weakness based on experience over the last 5 years. Please add any new Implementation Elements as appropriate.

Existing Flood Hazard Mitigation Resources					
Implementation Element	*Lead Agency*	***Area Covered***	**Effectiveness/ Enforcement**	**2015 Adopted HMP Recommended these Improvements/ Changes**	**Is this Element still effective? If not, what changes are needed for 2020 HMP Update?**
National Flood Insurance Program (NFIP) – Pepperell participates in the National Flood Insurance Program. NFIP provides flood insurance to property owners in exchange for compliance with floodplain management.	*Planning Board*	FEMA 100-year flood zones	Effective	None.	Effective, no changes are needed.
Local Wetlands Protection Bylaw – In addition to the requirements of the state's Wetlands Protection Act, the local bylaw states that a 50-foor wide undisturbed, vegetated strip of naturally occurring plant species must be maintained between a certified vernal pool or wetland resource area.	*Conservation Commission*	Town-wide	Moderately effective	Bylaw should be reviewed and modifications considered.	Effective, no changes have been made, but modifications are needed.
Zoning bylaw addresses erosion control. The Town's zoning bylaw states that site design, materials, and construction processes shall be employed to avoid erosion damage, sedimentation, or uncontrolled surface water runoff.	*Planning Board*	Town-wide	Effective	None.	Effective.
Zoning bylaw contains a Water Resource Protection Overlay District. The Water Resource Protection Overlay District consists of three zones: Water Source Protection Zone (Zone I); Well Protection Zone (Zone II) and an Aquifer-Watershed Protection Zone (Zone III). Activities within each of these zones are regulated to protect groundwater from degradation.	*Planning Board/ Water Division*	Town-wide	Effective	None.	Effective.
Local Flood Control Bylaw (Chapter 95) – The Town bylaws contain a local floodplain bylaw consistent with the requirements of the National Flood Insurance Program.	*Conservation Commission*	Town-wide	Effective	None.	Flood control is effective, but bylaw should be updated and integrated into zoning bylaw rather than through town code.
Subdivision Regulations	*Planning Board*	Town-wide	Moderately effective	N/A	New element. Current requirements require drainage to be designed to handle a 25-year storm and culverts handle a 50-year storm. Should be updated to reflect the new MS4 permit and consistent with OSRD special permit which encourages LID.
Stormwater Regulations	*To be determined*	Town-wide	Moderately effective	N/A	New element. Town needs to develop, by 2021, to meet MS4 permit.

Capability Assessment Worksheet

Local mitigation capabilities are existing authorities, policies, programs, and resources that reduce hazard impacts or that could be used to implement hazard mitigation activities. Please complete the tables and questions in the worksheet as completely as possible. Complete one worksheet for each jurisdiction.

Planning and Regulatory

Planning and regulatory capabilities are the plans, policies, codes, and ordinances that prevent and reduce the impacts of hazards. Please indicate which of the following your jurisdiction has in place.

Plans	Yes/No Year	Does the plan address hazards? Does the plan identify projects to include in the mitigation strategy? Can the plan be used to implement mitigation actions?
Comprehensive/Master Plan	Yes	Update is in Process. Yes, plan identifies hazards and mitigation strategies.
Capital Improvements Plan	Yes	Capital Planning Committee is in the process of updating the CIP to improve it further.
Economic Development Plan	No	
Local Emergency Operations Plan	Yes	Plan identifies assets that are at risk
Continuity of Operations Plan	Yes	Does not really address hazards, but deals with backup and redundancy
Transportation Plan	Yes	NMCOG Regional Transportation Plan
Stormwater Management Plan	Yes	Written Stormwater Management Plan prepared to address compliance with EPA's MS4 General Permit
Community Wildfire Protection Plan	No	
Other special plans (e.g., brownfields redevelopment, disaster recovery, coastal zone management, climate change adaptation)	No	

Building Code, Permitting, and Inspections	Yes/No	Are codes adequately enforced?
Building Code	State	Version/Year: IBC 2015
Building Code Effectiveness Grading Schedule (BCEGS) Score	No	
Fire department ISO rating		
Site plan review requirements	Yes	Yes, site plan approval requires commercial projects greater than 3,000 square feet
Land Use Planning and Ordinances	**Yes/No**	**Is the ordinance an effective measure for reducing hazard impacts?** **Is the ordinance adequately administered and enforced?**
Zoning ordinance	Yes	Yes, the bylaw is effective but should be modified to encourage Low Impact Development (LID)
Subdivision ordinance	Yes	Subdivision bylaw needs to be revised to be consistent with the Open Space Residential Development Bylaw, which encourages LID, whereas subdivision bylaw does not. Bylaws can be updated to better reduce hazard impacts and to promote mitigation.
Floodplain ordinance	Yes	Not adequate and not adequately administered.
Natural hazard specific ordinance (stormwater, steep slope, wildfire)	No	Included in zoning bylaws
Flood insurance rate maps	Yes	Updated in 2010
Acquisition of land for open space and public recreation uses	Yes	Seven-year action plan included in Open Space and Recreation Plan, 2017
Other		

How can these capabilities be expanded and improved to reduce risk?

Administrative and Technical

Identify whether your community has the following administrative and technical capabilities. These include staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. For smaller jurisdictions without local staff resources, if there are public resources at the next higher level government that can provide technical assistance, indicate so in your comments.

Administration	**Yes/No**	**Describe capability** **Is coordination effective?**
Planning Board	Yes	
Mitigation Planning Committee	No	Pepperell has a Local Emergency Planning Committee
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems)	Yes	DPW responsible for clearing drainage; Highway Superintendent responsible for tree trimming.
Mutual aid agreements	Yes	
Staff	**Yes/No** **FT/PT[1]**	**Is staffing adequate to enforce regulations?** **Is staff trained on hazards and mitigation?** **Is coordination between agencies and staff effective?**
Chief Building Official	Yes, FT	Staffing is adequate. Staff are not trained.
Floodplain Administrator	No	Conservation Agent administers floodplain.
Emergency Manager	Yes, PT	Volunteer position with small stipend
Community Planner	Yes, PT	Staffing generally adequate Staff is trained
Civil Engineer	Yes, FT	Town Engineer is also head of DPW
GIS Coordinator	No	Town relies on regional agency (NMCOG) for GIS
Other Conservation Agent	Yes, PT	Yes, adequacy to enforce regulations.

1 Full-time (F) or part-time (PT) position

Worksheet 4.1
Capability Assessment Worksheet

Technical	Yes/No	Describe capability Has capability been used to assess/mitigate risk in the past?
Warning systems/services (Reverse 911, outdoor warning signals)	Yes	CodeRed, reverse 911, outdoor warning signals
Hazard data and information	Yes	Hazard mitigation plan, Pepperell Emergency Services Inventory does have some data on hazards
Grant writing	Yes	East department is responsible for grant writing.
Hazus analysis	No	
Other		

How can these capabilities be expanded and improved to reduce risk?

Financial

Identify whether your jurisdiction has access to or is eligible to use the following funding resources for hazard mitigation.

Funding Resource	Access/ Eligibility (Yes/No)	Has the funding resource been used in past and for what type of activities? Could the resource be used to fund future mitigation actions?
Capital improvements project funding	No	In process
Authority to levy taxes for specific purposes	Yes	Has not been used for mitigation
Fees for water, sewer, gas, or electric services	Yes	Used to expand services
Impact fees for new development	No	
Storm water utility fee	Yes	Yes, fee adopted.
Incur debt through general obligation bonds and/or special tax bonds	Yes	Could be used to fund routine mitigation.
Incur debt through private activities	No	
Community Development Block Grant	No	
Other federal funding programs	Yes	Received funds from FEMA for Halloween Storm (2011), Irene (2012), and Juno (January 2015), and Storm in 2018
State funding programs	Yes	Received grants from MEMA in past.
Other		

How can these capabilities be expanded and improved to reduce risk?

Education and Outreach

Identify education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information.

Program/Organization	Yes/No	Describe program/organization and how relates to disaster resilience and mitigation. Could the program/organization help implement future mitigation activities?
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	Yes	Town has a climate change and Resiliency Working Group
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Yes	Emergency Response Program includes an educational component.
Natural disaster or safety related school programs	No	
StormReady certification	No	
Firewise Communities certification	No	
Public-private partnership initiatives addressing disaster-related issues	No	
Other		

How can these capabilities be expanded and improved to reduce risk?

Appendix E

MVP Summary of Findings Report

Tighe&Bond
Engineers | Environmental Specialists

COMMUNITY RESILENCE BUILDING WORKSHOPS- SUMMARY OF FINDINGS

TOWN OF PEPPERELL
MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) PROGRAM



Source: *https://www.town.pepperell.ma.us/*

SUBMITTED TO

Town of Pepperell

June 18, 2020

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Photo 2: Group from Workshop #1
Photo 3: Group from Workshop #2
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Photo 5: Results of collective voting from workshop #1

Appendices

A Core Team and Advisory Group Meeting Materials
B MVP Workshop Materials and Documentation
C Completed Capabilities Assessment Worksheet
D Compiled Community Resilience Building Matrix
E Listening Session Materials

Section 1
Community Resilience Building Workshops

1.1 Overview



FIGURE 1: 2010 Roadway flooding along Route 119 in Pepperell

The Town of Pepperell, like other communities in the Commonwealth of Massachusetts, is already feeling the impacts of climate change. In particular, the community has experienced severe weather related to inland flooding and extreme winter events. There have been 20 natural hazard incidents that triggered federal or state disaster declarations since 1991 that have affected Pepperell. The Town has had to manage extreme storm events such as the back to back Winter Storms Riley and Skylar in March 2018, where over 20 inches of snow was recorded by the end of the second storm. Pepperell experienced a drought that lasted from June 2016 through May 2017 and impacted the public water supply, businesses, and the public. The October 2011 "Halloween Storm" caused power outages for seven days in Town. Tropical Storm Irene in August 2011 caused devastating flooding and wind damage. The March 2010 storm caused the Nashua River to experience its worst flood in 23 years, resulting in substantial impacts in Pepperell including closure of Routes 119 and 111. In the future, the Town anticipates more severe and commonly occurring weather events due to climate change, such as increased flooding from large rain events, more substantial winter storms, and a greater likelihood of drought, including increased extreme heat days and heat waves. These extreme weather events will test Pepperell's ability to prepare for and respond to emergencies.

In 2017, the Commonwealth of Massachusetts inaugurated the Municipal Vulnerability Preparedness (MVP) program to assist municipalities in planning for and implementing strategies to adapt to predicted changes in our warming climate. The Executive Office of Energy and Environmental Affairs (EEA) oversees and implements the MVP program. Funds are awarded to municipalities under two categories of work: planning grants and action grants.

To proactively prepare for climate resiliency and begin to consider adaptation strategies, Pepperell applied for an MVP Planning Grant that also includes funding to prepare a Town-specific update of the 2015 Regional Hazard Mitigation Plan (HMP) prior to expiration of the Regional HMP.

1.1.1 How does the MVP Planning Process Augment the HMP?

The Federal Disaster Mitigation Act, adopted in 2000, requires that after November 1, 2004, all municipalities that wish to continue to be eligible to receive Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant funding for hazard mitigation activities adopt a local Hazard Mitigation Plan (HMP) and update the plan every five years.

Note that this planning requirement does not affect federally authorized disaster assistance funding which is exempt from the HMP requirement.

Currently, Pepperell is included in the "Hazard Mitigation Plan for the Northern Middlesex Region", which was approved by FEMA in August 2015. This plan covers Billerica, Chelmsford, Dracut, Dunstable, Lowell, Pepperell, Tewksbury, Tyngsborough, and Westford and was prepared under the overall direction of the Northern Middlesex Council of Governments (NMCOG). This plan will expire in August 2020.

The MVP effort supplements the HMP process by providing a statewide and major basin-specific climate change data to use in the natural hazard risk assessment and a consistent methodology for public engagement through the Community Resilience Building (CRB) process. Figure 2 demonstrates the overlap between the MVP and HMP development.

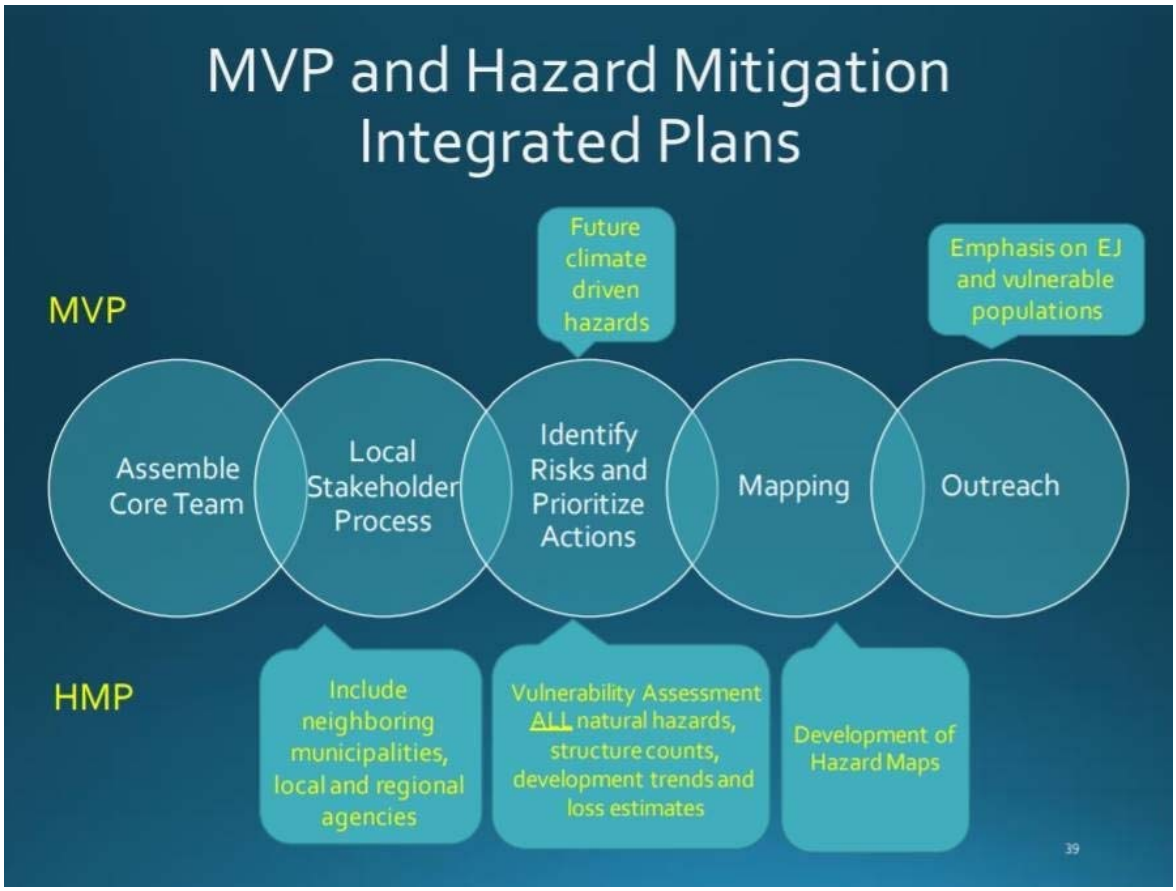


FIGURE 2: Overlap between MVP and HMP Development

1.1.2 Overview of the Community Resilience Building (CRB) Process

The CRB methodology is an "anywhere at any scale" format that draws on stakeholders' wealth of information and experiences to foster a collaborative dialogue about the strengths and vulnerabilities within a community, identify potential resiliency actions, and advance the education, planning, and ultimately implementation of priority actions. Figure 3 provides an overview of this process from the CRB Workshop Guide, which is available online at: https://www.communityresiliencebuilding.com/

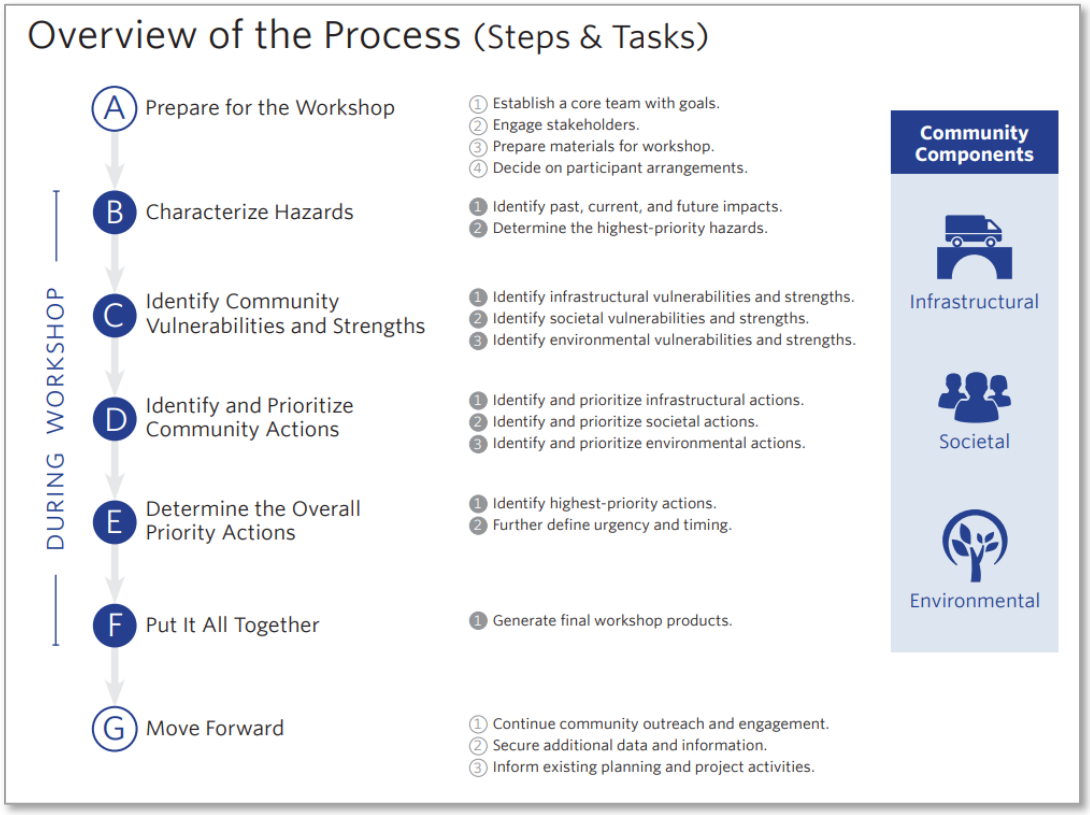


FIGURE 3: Overview of the CRB Process

During the workshops, participants interact at both small and large group levels, using an iterative process to gather input, synthesize ideas across groups, and ultimately develop a set of priority resilience and adaptation actions. Each workshop's central objectives are to:

- Define the top local natural and climate-related hazards of concern;
- Identify existing and future strengths and vulnerabilities of the Community;
- Develop prioritized actions for the Community; and
- Identify immediate opportunities to collaboratively advance actions to increase resilience.

1.2 Pepperell's CRB Planning Activities

Lisa Davis, Planning Board Advisor, served as the Local Project Manager for undertaking the integrated MVP and HMP planning process. The Town partnered with Tighe & Bond, a state-certified MVP Provider, to complete the town-specific HMP Update and undertake the CRB process, including holding the CRB workshops.

To complete Step A of the CRB Guide, the Town of Pepperell drew from multiple departments, boards, and commissions to form the Core Team for the MVP. In addition, Pepperell formed an Advisory Group to create a knowledge base among citizens for a longer-term commitment on working locally to combat climate change impacts and develop a more sustainable community.

Together, these groups identified and engaged the community stakeholders to participate in the CRB workshops and the listening session. Community stakeholders included municipal staff not already a member of the Core Team, elected and appointed officials in Pepperell, municipal staff and representatives from abutting communities, NMCOG staff, environmental non-profits, representatives from power utilities, owners and managers of local businesses (including pharmacies, large employers, contractors, farms, tree removal services), and the citizens involved in local planning such as the ongoing Master Plan.

The following provides additional detail on the overcall CRB planning process undertaken by the Town of Pepperell to obtain MVP Community Designation and support the ongoing town specific HMP update.

1.2.1 Core Team Meetings

The MVP kickoff meeting, held on July 15, 2019, was coordinated to involve the Core Team at an early stage in the planning process. At this meeting, Tighe & Bond presented an overview of EEA's MVP Program and Goals, reviewed the scope, schedule, and budget, discussed public involvement and outreach, and reviewed the CRB process.

The Core Team met on September 26, 2019, to review and prioritize natural hazards, discuss the draft asset inventory and assets most at risk, and plan for the workshops including logistics and outreach.

The Core Team met again on February 13, 2020, to review and prioritize the mitigation strategies, review draft deliverables to date, and finalize the schedule for the public meeting and listening session, and define further Advisory Group actions.

Materials documenting the Core Team meetings are provided in Appendix A.

1.2.2 Advisory Group Meetings

The Advisory Group met on October 7, 2019, to review the prioritization of natural hazards that apply to Pepperell and to discuss the top four hazards, review and confirm community assets, and define a strategy to help engage local businesses to attend MVP Workshops.

The Advisory Group also met on January 27, 2020, to review progress to date and set deadline for input by Group on draft documents, and review previous mitigation strategies and discuss new mitigation strategies.

Materials documenting the meetings are provided in Appendix A.

1.2.3 Community Resilience Building Workshops

Community stakeholders were invited to participate in one of two CRB workshops on October 28 or November 2, 2019, at the Pepperell Community Center. The list of community stakeholders invited to the workshops is included in Appendix A.

The October 28th workshop was attended by 25 participants. The November 2nd workshop was attended by 16 participants.

Each workshop began with a chance for attendees to sign in and denote where they live or work in Pepperell.

Town Administrator Andrew MacLean provided an introduction to the Town's MVP/HMP planning process, welcomed attendees to the workshop, and thanked the Core Team and Advisory Group.

Tighe & Bond provide a formal presentation of the MVP program, the CRB workshop process, outlined climate change projections for the Town and Commonwealth, and reviewed Pepperell's top natural hazards (Step B of the CRB Guide). Attendees were invited to discuss the top hazards and modify as needed.



PHOTO 1: Town Administrator Andrew MacLean welcoming attendees to the first CRB Workshop and thanking the Core Team and Advisory Group

Participants were asked to complete a series of three facilitated small group discussions to fill out the CRB Risk Matrix by:

1. Identifying important community assets most vulnerable to natural hazards in four categories (for consistency with HMP requirements): infrastructure, societal, economic, and environmental, and define if these are a vulnerability, a strength, or both (Step C of the CRB Guide);
2. Determining mitigation actions to address vulnerabilities and protect strengths (Step D of the CRB Guide); and
3. Prioritizing and scheduling the mitigation actions (Step E of the CRB Guide).

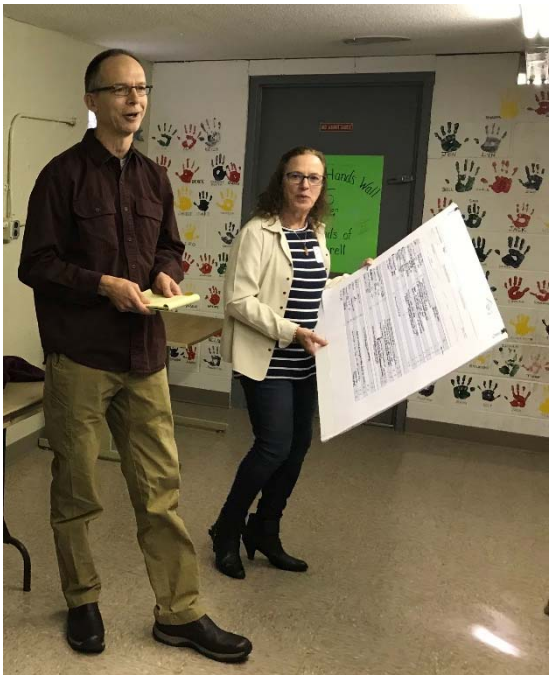


PHOTO 2: (On right) Group from Workshop #1 in process determining mitigation actions and completing a portion of the CRB Risk Matrix



PHOTO 3: (On left) Group from Workshop #2 working to refine priorities and timeline for mitigation actions and complete CRB Risk Matrix

PHOTO 4: (below) Group from Workshop #2 presenting top community assets and associated mitigation actions



Following this small group discussion process, each group reported to the full group on the top risks and strengths and mitigation actions based on the group's prioritization and scheduling. Collectively, the group voted to further define the priorities (Step E/F of the CRB Guide).

Workshop meeting materials including completed sign-in sheets, presentations, maps, notes, and completed matrices are provided in Appendix B. The compiled CRB matrix is provided in Appendix D.



PHOTO 5: (On left) Results of collective voting from workshop #1

1.2.4 Listening Session

A listening session to present the final report and review the high priority actions identified through the CRB workshops was held remotely on GoToMeeting due to the COVID-19 pandemic on May 21,2020. Town Staff and NMCOG led the session with support from Tighe & Bond. An invitation was sent to everyone who attended the workshops, the Core Team, the Advisory Group, the Master Plan Committee and Neighboring towns, and was posted on the Town's website and the very active Facebook group. Ten attendees participated in the Listening Session.

Town staff facilitated discussion including resident input on the following:

- The town's intent to submit an application for an MVP action grant; and
- The future advancement and implementation of mitigation actions.

Meeting materials, including advertisement, for the listening session are provided in Appendix E. Following the Listening Session, an article by the Nashoba Valley Voice was published in the Lowell Sun on May 31, 2020. A copy of this is included in Appendix E as well.

Section 2
Top Hazards and Vulnerable Areas

This section discusses Steps B and C of the CRB Process to characterize hazards and identify community vulnerabilities and strengths (a.k.a. community assets).

2.1 Natural Hazard Risks

2.1.1 State Identified Hazards

The 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP)[1] provides an in-depth overview of natural hazards in Massachusetts. The State Plan identifies 14 natural hazards that have impacted or historically occurred in communities within the Commonwealth of Massachusetts. These hazards are as follows:

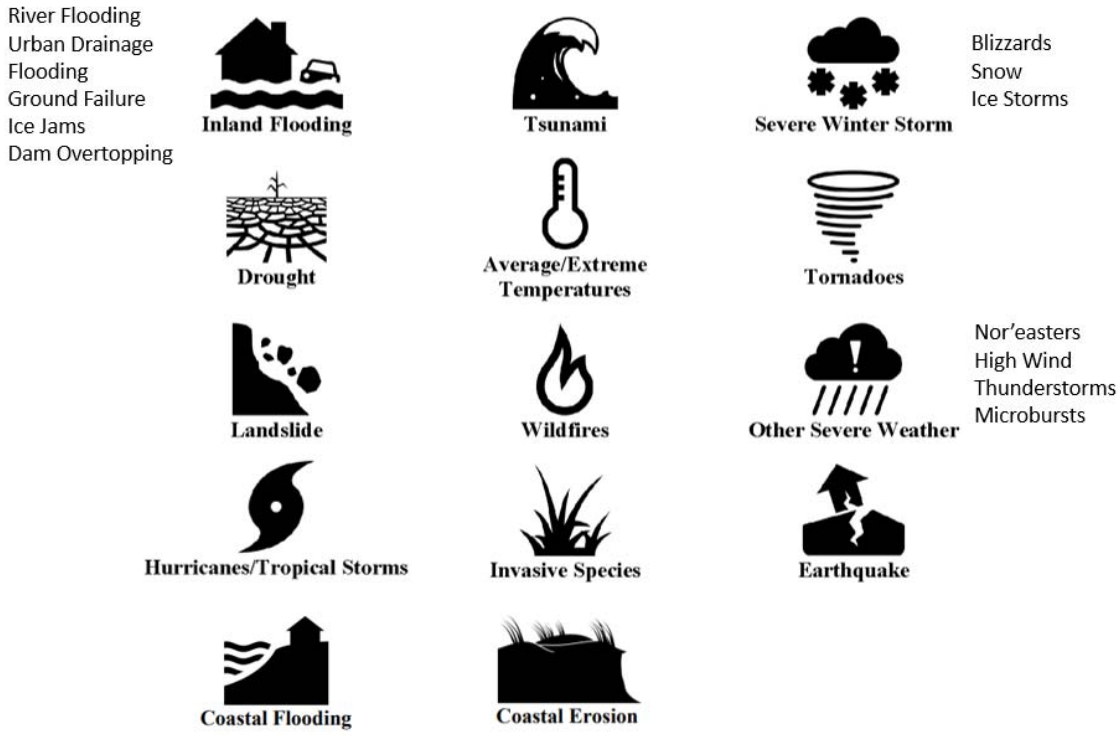


FIGURE 4: Hazards Identified in the SHMCAP

[1] https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

2.1.2 Hazards that Apply to Pepperell

The SHMCAP includes coastal flooding, coastal erosion, and tsunamis; however, because Pepperell is not a coastal community, these hazards are not applicable and therefore are not further discussed or evaluated in this report.

The Core Team and Advisory Team reviewed the remaining natural hazards identified in the SHMCAP and identified natural hazards that have impacted Pepperell in the past or could impact Pepperell in the future. The hazards selection for Pepperell was made using local expertise from the Planning Team, information from the 2015 Regional Hazard Mitigation Plan, the SHMCAP and other sources. All of the natural hazards presented in the SHMCAP, except those applicable to coastal communities, were included in the ranking process.

The Advisory Team reviewed each natural hazard and analyzed the history of occurrence in Town, hazard probability, hazard frequency, geographic extent, and severity of impact. Each of these categories were ranked based off of the Hazard Profile Definitions, displayed in Table 1 and taken from the 2018 SHMCAP.

TABLE 1: Hazard Profile Definitions (2018 SHMCAP)

Points	Rank	Description
Hazard Probability (Possible occurrence in the future)		
1	Unlikely	Less than a 1% probability over the next 100 years
2	Possible	1-10% probability in the next year or at least one chance in the next 100 years
3	Likely	10-100% probability in the next year or at least one chance in the next 10 years
4	Highly Likely	Near 100% probability in the next year
Hazard Frequency		
0	Very Low	Events that occur less frequently than once in 1,000 years (less than 0.1% per year)
1	Low	Events that occur from once in 100 years to once in 1,000 years (0.1% - 1% per year).
2	Medium	Events that occur from once in 10 years to once in 100 years (1% - 10% per year).
3	High	Events that occur more frequently than once in 10 years (greater than 10% per year).
Geographical Extent (Area Impacted by a Given Natural Hazard)		
1	Small	Less than 10% of the City affected
2	Medium	10-50% of the City affected
3	Large	More than 50% of the City affected
Severity of Impact from Hazard		
1	Minor	Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e. one or two communities); essential

Points	Rank	Description
		services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.
2	Serious	Scattered major property damage (more than 10% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services briefly interrupted up to 1 day; some minor injuries.
3	Extensive	Consistent major property damage (more than 25%); major damage public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and possible fatalities.
4	Catastrophic	Property and public infrastructure destroyed (more than 50%); essential services stopped for 30 days or more, multiple injuries and fatalities.

Table 2 includes list of the hazards selected by Pepperell for inclusion in this Summary of Findings Report and the HMP update. The HMP Update includes profiles for each natural hazard and documents additional detail about the history of occurrence and potential future occurrence.

TABLE 2: Relevant Natural Hazards for the Town of Pepperell

Type of Natural Hazard	History of Occurrence in Pepperell	Hazard Probability	Hazard Frequency	Geographic Extent	Severity of Impact	Hazard Risk Ranking
Inland Flooding	Yes	3	3	2	3	11
Severe Winter-Storm/Nor'easter	Yes	3	3	3	2	11
Drought	Yes	3	3	2	2	10
Extreme Temperature	Yes	3	3	3	1	10
Tropical Storms/ Hurricanes	Yes	3	2	3	2	10
Severe Weather-Strong Wind and High Precipitation	Yes	3	3	3	1	10
Invasive Species	Yes	4	3	2	1	10
Microburst	Yes	3	3	1	1	8
Earthquake	Yes	1	0	3	3	7
Wildfires	Yes	3	1	1	1	6
Tornadoes	No	1	0	1	3	5
Landslide	No	1	0	1	1	3

2.1.3 Top Hazards for Pepperell

Based on the evaluation of natural hazard risk ranking, coupled with the history of occurrence, the geographic extent of impact, economic impact, and consideration for climate change, the Advisory Group determined the highest ranked natural hazards for Pepperell consist of:

- Severe winter storms
- Other severe weather and tropical storms / hurricanes
- Inland Flooding
- Average/Extreme temperatures and drought

The 2015 Regional HMP natural hazard risk index rated Pepperell at high risk for flooding, earthquake, nor'easters, hurricanes, ice storms, snowstorms and blizzards; at moderate risk for wildfire, drought, and ice jams; and at low risk for dam failure, landslides, urban fire and tornadoes.

2.2 Areas of Concern

During the CRB Workshops, participants outlined areas of concern under three categories of community assets, consistent with the CRB Workshop Guide: infrastructural, societal, and environmental. In addition, for consistency with the HMP update, participants included areas of concern in Pepperell's economic assets. The completed CRB Risk Matrix in Appendix D provides additional information.

2.2.1 Infrastructural (Built Environment)

Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or for critical facilities to operate.

The workshop participants identified the following categories of or specific infrastructural assets with vulnerabilities or strengths within the community (presented alphabetically):

- Bridges (Main Street, Route 119, Route 113, Groton Street, Hollis Street, Mill Street)
- Culverts (town-wide)
- Department of Public Works facilities
- Fire and Police facilities
- Main Street Dam (private)
- Major traffic arteries
- Power grid
- Private medical center on Main Street
- Public safety communications including SCADA
- Public wells and water facilities
- Schools/town shelters
- Wastewater treatment plant and pump stations

2.2.2 Societal (People / Vulnerable Populations)

Areas of greater population density, or population with unique vulnerabilities or less able to respond and recover during a disaster.

The workshop participants identified the following categories or specific societal assets with vulnerabilities or strengths within the community (presented alphabetically):

- Child Care on Hollis Street
- Churches
- Emergency shelters
- Food Pantry
- Historical Places
- Nursing Homes/elderly housing
- Pepperell Airport
- PACH outreach
- Senior Center
- RV/Trailers
- SNMC
- Schools
- Town Library
- Veterinary hospitals

2.2.3 Environmental (Natural Environment)

Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.

The workshop participants identified the following categories or specific environmental assets with vulnerabilities or strengths within the community (presented alphabetically):

- Conservation lands and open space (e.g., Town Forest, Ch. 61 lands, open space)
- Farms
- Habitat (including vernal pools)
- Major Wetlands and Waterbodies (e.g., Nashua and Nississit Rivers, Gulf Brook)
- Properties in floodplain
- Trails (Nashua River Trail)
- Well contribution areas

2.2.4 Economy

Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.

The workshop participants identified the following categories or specific economic assets with vulnerabilities or strengths within the community (presented alphabetically):

- Banks
- Donelan's Supermarket (Main Street)
- Farms
- Funeral Homes (Main Street, Pleasant Street)
- Gas Heating Oil Company
- Gas Stations
- Hardware Store (Main Street)
- Industrial Park (Lomar Park)
- Kimball Fruit Farm (Hollis Street)

- Main Street Businesses
- Medical Center (Main Street)
- Oil Delivery (Groton Street, Hollis Street)
- Pharmacies
- Railroad Square (East Main Street)
- Recreational Areas
- Skydiving Park (Nashua Road)
- Tree removal services
- Veterinary Hospital (River Road)

Section 3
Current Concerns and Challenges Presented by Hazards and Climate Change

3.1 History of Natural Hazards that have Impacted Pepperell

Chapter 3 of the HMP Update includes hazard profiles for each of the natural hazards that have impacted the Town or can impact the Town in the future, including a definition and description of the hazard, previous occurrence and extent (including historical data), local areas of impact, and probability for future occurrence. Evaluation of the extent or severity of the hazard includes the measuring scale for a specific hazard. Locally identified areas of impact include maps showing the areas identified by the hazard whenever possible. The probability of future occurrences is based on best available science and historic events using the hazard probability.

The following provides an overview of the general concerns about natural hazards as expressed by workshop participants:

- Severe storms seem to be more frequent and have a great impact on the Town. The March 2018 back to back winter storms left over 20 inches of snow and many people were out of power for multiple days. Attendees recalled many blizzards including the "Snowtober" event in October 2011, and winter storms in February 2013 and January 2015.
- Flooding is a serious concern in Pepperell. There was a record storm in March 2010, where the Nashua River experienced its worst flood in 23 years, resulting in substantial impacts in Pepperell including closure of Routes 119 and 111. Hurricane Irene in August 2011 caused devastating flooding and wind damage.
- The community is feeling the impacts from extreme temperatures, including drought. Atmospheric hazards impact farmers, the public water supply, and private wells.
- Tropical storms and hurricanes impact Pepperell, resulting in flooding and power outages.
- Invasive species are everywhere and harm the Town's waterbodies.
- Microbursts have occurred a number of times and had significant impacts to localized areas.

These hazards are anticipated to be amplified by climate change as discussed in Commonwealth's resilient MA Climate Change Clearinghouse website (http://www.resilientma.org/)



Changes in Precipitation: Changes in the amount, frequency, and timing of precipitation—including both rainfall and snowfall—are occurring across the globe as temperatures rise and other climate patterns shift in response.



Rising Temperatures: Average global temperatures have risen steadily in the last 50 years, and scientists warn that the trend will continue unless greenhouse gas emissions are significantly reduced. The 9 warmest years on record all occurred in the last 20 years (2017, 2016, 2015, 2014, 2013, 2010, 2009, 2005, and 1998), according to the U.S. National Oceanographic and Atmospheric Administration (NOAA).



Extreme Weather: Climate change is expected to increase extreme weather events across the globe, as well as right here in Massachusetts. There is strong evidence that storms—from heavy downpours and blizzards to tropical cyclones and hurricanes—are becoming more intense and damaging, and can lead to devastating impacts for residents across the state.

The following table reproduced from the SHMCAP shows how climate change interacts with natural hazards.

TABLE 3: Climate Change Interactions

Primary Climate Change Interaction	Natural Hazard	Other Climate Change Interactions	Representative Climate Change Impacts
Changes in Precipitation	Inland Flooding	Extreme Weather	Flash flooding, urban flooding, drainage system impacts (natural and human-made), lack of groundwater recharge, impacts to drinking water supply, public health impacts from mold and worsened indoor air quality, vector-borne diseases from stagnant water, episodic drought, changes in snow-rain ratios, changes in extent and duration of snow cover, degradation of stream channels and wetland
	Drought	Rising Temperatures, Extreme Weather	
	Landslide	Rising Temperatures, Extreme Weather	
Rising Temperatures	Average/Extreme Temperatures	N/A	Shifting in seasons (longer summer, early spring, including earlier timing of spring peak flow), increase in length of growing season, increase of invasive species, ecosystem stress, energy brownouts from higher energy demands, more intense heat waves, public health impacts from high heat exposure and poor outdoor air quality, drying of streams and wetlands, eutrophication of lakes and ponds
	Wildfires	Changes in Precipitation	
	Invasive Species	Changes in Precipitation, Extreme Weather	
Extreme Weather	Hurricanes/Tropical Storms	Rising Temperatures, Changes in Precipitation	Increase in frequency and intensity of extreme weather events, resulting in greater damage to natural resources, property, and infrastructure, as well as increased potential for loss of life
	Severe Winter Storm / Nor'easter	Rising Temperatures, Changes in Precipitation	
	Tornadoes	Rising Temperatures, Changes in Precipitation	
	Other Severe Weather (Including Strong Wind and Extreme Precipitation)	Rising Temperatures, Changes in Precipitation	
Non-Climate-Influenced Hazards	Earthquake	Not Applicable	There is no established correlation between climate change and this hazard

3.2 Massachusetts Climate Change Projections

Researchers from the Northeast Climate Science Center at the University of Massachusetts Amherst prepared projections for changes in temperature, precipitation, and sea level rise for the entire state, as well as for each major watershed, in recognition that there are differences regionally. EEA is encouraging municipalities, industry, non-government organizations, state government and others to utilize this information as a standard, peer-reviewed set of climate change projections and is recommending these projections be included in MVP planning efforts. The Town of Pepperell is entirely included within the Nashua River watershed. The information presented in this section is specific to this watershed and was excerpted from Massachusetts Climate Change Projections, dated March 2018[2].

3.2.1 Increasing Temperatures

Warmer temperatures and extended heat waves could have very significant impacts on public health in our state, as well as the health of plants, animals and ecosystems like forests and wetlands. Rising temperatures will also affect important economic sectors like agriculture and tourism, and infrastructure like the electrical grid. Even what seems like a very small rise in average temperatures can cause major changes in other factors, such as the relative proportion of precipitation that falls as rain or snow.

In Massachusetts, temperatures are projected to increase significantly over the next century. Winter average temperatures are likely to increase more than those in summer, with major impacts on everything from winter recreation to increased pests and challenges to harvesting for the forestry industry. Beyond this general warming trend, Massachusetts will experience an increasing number of days with extreme heat in the future. Generally, extreme heat is considered to be over 90 degrees F, because at temperatures above that threshold, heat-related illnesses and mortality show a marked increase. Residents in Massachusetts – especially those who are very young, ill, or elderly, and those who live in older buildings without air conditioning – will face greater risks of serious heat-related illnesses when extreme heat becomes more common. Extreme heat and dry conditions or drought could also be detrimental to crop production, harvest and livestock.

While warmer winters may reduce burdens on energy systems, more heat in the summer may put larger demands on aging systems, creating the potential for power outages. The number of cooling degree days is expected to increase significantly by the end of the century adding to this strain. In addition, heat can directly stress transmission lines, substations, train tracks, roads and bridges, and other critical infrastructure.

Increased Average Temperature

The Nashua River watershed is expected to experience increased average temperatures throughout the 21st century. Maximum and minimum temperatures are also expected to increase throughout the end of the century. These increased temperature trends are expected for both annual and seasonal projections. Seasonally, maximum summer and fall temperatures are expected to see the highest projected increase throughout the 21st century. Table 4 on the following page demonstrates temperature change throughout the next century.

[2] https://www.mass.gov/files/ma-statewide-and-majorbasins-climate-projections-final.pdf

TABLE 4
Increased Average Temperature

Nashua Basin		Observed Baseline 1971-2000 (°F)	Projected Change in 2030s (°F)	Mid-Century Projected Change in 2050s (°F)	Projected Change in 2070s (°F)	End of Century Projected Change in 2090s (°F)
Average Temperature	Annual	46.8	+2.2 to +4.4	+3.0 to +6.4	+3.5 to +9.0	+3.9 to +11.0
	Winter	25.2	+2.2 to +5.1	+2.8 to +7.6	+3.7 to +9.2	+3.9 to +10.6
	Spring	44.9	+1.6 to +3.5	+2.5 to +5.5	+2.7 to +7.7	+3.3 to +9.5
	Summer	67.6	+2.2 to +4.6	+3.1 to +7.0	+3.5 to +10.1	+4.0 to +12.6
	Fall	49.0	+2.2 to +5.1	+3.7 to +6.6	+3.6 to +9.5	+4.1 to +11.8
Maximum Temperature	Annual	57.8	+2.1 to +4.3	+2.7 to +6.5	+3.2 to +9.1	+3.6 to +11.0
	Winter	35.1	+1.8 to +4.6	+2.4 to +7.1	+3.0 to +8.4	+3.4 to +9.6
	Spring	56.2	+1.5 to +3.4	+2.4 to +5.5	+2.7 to +7.9	+3.3 to +9.6
	Summer	79.2	+2.0 to +4.7	+3.0 to +7.2	+3.4 to +10.5	+3.9 to +12.9
	Fall	60.2	+2.3 to +4.9	+3.6 to +7.0	+3.5 to +9.8	+4.0 to +12.3
Minimum Temperature	Annual	35.8	+2.3 to +4.8	+3.3 to +6.5	+3.8 to +8.9	+4.2 to +11.0
	Winter	15.3	+2.5 to +5.6	+3.3 to +8.1	+4.2 to +10.0	+4.4 to +11.4
	Spring	33.7	+1.8 to +3.8	+2.7 to +5.9	+2.8 to +7.5	+3.3 to +9.3
	Summer	56.0	+2.5 to +4.6	+3.2 to +7.2	+3.7 to +9.8	+4.1 to +12.3
	Fall	37.8	+2.0 to +5.2	+3.6 to +6.6	+3.7 to +9.3	+4.1 to +11.6

Days with Maximum Temperatures

Due to projected increases in average and maximum temperatures throughout the end of the century, the Nashua basin is also expected to experience an increase in days with daily maximum temperatures over 90°F, 95°F, and 100°F. Table 5 demonstrates the number of days per season with extreme maximum temperatures.

TABLE 5
Days with Maximum Temperatures

Nashua Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Maximum Temperature Over 90°F	Annual	4	+6 to +17	+9 to +30	+10 to +50	+13 to +70
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	<1[72]	-0 to +1	+<1[72] to +1	+<1[72] to +3	+<1[72] to +4
	Summer	4	+5 to +15	+8 to +26	+10 to +42	+11 to +56
	Fall	<1[72]	+<1[72] to +1	+<1[72] to +3	+<1[72] to +7	+1 to +10
Days with Maximum Temperature Over 95°F	Annual	<1[72]	+1 to +6	+2 to +13	+3 to +27	+4 to +42
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	0	+0 to +<1[72]	+0 to +<1[72]	+0 to +1	+0 to +1
	Summer	<1[72]	+1 to +6	+2 to +12	+2 to +24	+3 to +37
	Fall	<1[72]	+<1[72] to +<1[72]	+<1[72] to +1	+<1[72] to +2	+<1[72] to +3
Days with Maximum Temperature Over 100°F	Annual	<1[72]	+<1[72] to +1	+<1[72] to +3	+<1[72] to +9	+<1[72] to +17
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	0	+0 to +<1[72]	+0 to +<1[72]	+0 to +<1[72]	+0 to +<1[72]
	Summer	<1[72]	+<1[72] to +1	+<1[72] to +3	+<1[72] to +8	+<1[72] to +16
	Fall	0	+0 to +<1[72]	+0 to +<1[72]	+0 to +<1[72]	+0 to +1

Days with Minimum Temperatures

Due to projected increases in average and minimum temperatures throughout the end of the century, the Nashua basin is expected to experience a decrease in days with daily minimum temperatures below 32°F and 0°F. Table 6 demonstrates the number of days per season with extreme minimum temperatures.

TABLE 6
Days with Minimum Temperatures

Nashua Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Minimum Temperature Below 0°F	Annual	9	-3 to -6	-4 to -7	-4 to -7	-4 to -8
	Winter	9	-3 to -6	-4 to -6	-4 to -7	-4 to -7
	Spring	<1[73]	-0 to -0	-0 to -0	-0 to -0	-0 to -0
	Summer	0	-0 to -0	-0 to -0	-0 to -0	-0 to -0
	Fall	<1[73]	-0 to -0	-0 to -0	-0 to -0	-0 to -0
Days with Minimum Temperature Below 32°F	Annual	156	-11 to -28	-19 to -38	-22 to -54	-23 to -64
	Winter	85	-1 to -5	-2 to -8	-3 to -16	-4 to -20
	Spring	40	-4 to -12	-6 to -16	-8 to -20	-9 to -22
	Summer	<1[73]	-0 to -0	-0 to -0	-0 to -0	-0 to -0
	Fall	31	-5 to -12	-9 to -15	-9 to -19	-9 to -22

Heating Degree-Days and Cooling Degree-Days

Due to projected increases in average, maximum, and minimum temperatures throughout the end of the century, the Nashua basin is expected to experience a decrease in heating degree days and increases in both cooling degree-days and growing degree-days. Table 7 below demonstrates this.

TABLE 7
Heating Degree-Days

Nashua Basin		Observed Baseline 1971-2000 (Degree-Days)	Projected Change in 2030s (Degree-Days)	Mid-Century Projected Change in 2050s (Degree-Days)	Projected Change in 2070s (Degree-Days)	End of Century Projected Change in 2090s (Degree-Days)
Heating Degree-Days (Base 65°F)	Annual	7092	-574 to -1223	-806 to -1701	-937 to -224	-1054 to -2623
	Winter	3602	-187 to -476	-248 to -697	-323 to -838	-366 to -974
	Spring	1861	-138 to -302	-215 to -473	-230 to -622	-290 to -736
	Summer	141	-49 to -84	-64 to -106	-73 to -120	-75 to -124
	Fall	1488	-169 to -400	-295 to -489	-276 to -683	-296 to -784
Cooling Degree-Days (Base 65°F)	Annual	432	+201 to +421	+271 to +712	+325 to +1091	+373 to +1458
	Winter	0	-2 to -2	+1 to +3	-1 to +1	-1 to +0
	Spring	17	+9 to +24	+15 to +48	+19 to +85	+15 to +118
	Summer	377	+163 to +335	+208 to +545	+241 to +817	+276 to +1038
	Fall	33	+23 to +78	+37 to +131	+44 to +216	+62 to +297
Growing Degree-Days (Base 50°F)	Annual	2270	+393 to +800	+533 to +1236	+647 to +1889	+730 to +2367
	Winter	4	-1 to +8	-0 to +10	+1 to +14	+2 to +19
	Spring	254	+59 to +127	+84 to +227	+101 to +346	+107 to +453
	Summer	1617	+206 to +417	+287 to +645	+323 to +931	+364 to +1158
	Fall	384	+109 to +283	+168 to +395	+159 to +593	+207 to +750

3.2.2 Changing Precipitation

Rainfall is expected to increase in spring and winter months in particular, with increasing consecutive dry days in summer and fall. More total rainfall can have an impact on the frequency of minor but disruptive flooding events, especially in areas where stormwater infrastructure (such as drainage systems, bridges, and culverts) has not been adequately sized to accommodate higher levels. Increased total rainfall will also affect agriculture, forestry and natural ecosystems.

More intense downpours often lead to inland flooding as soils become saturated and stop absorbing more water, river flows rise, and the capacity of urban storm water systems is exceeded. Flooding may occur as a result of heavy rainfall and snowmelt, but precipitation is the strongest driver of flooding in Massachusetts. Winter flooding is also common in Massachusetts, particularly when the ground is frozen.

The climate projections suggest that the frequency of high-intensity rainfall events will trend upward. Overall, it is anticipated that the severity of flood-inducing weather events and storms will increase, with events that produce sufficient precipitation to present a risk of flooding likely increasing. A single intense downpour can cause flooding and widespread damage to property and critical infrastructure. The coast will experience the greatest increase in high-intensity rainfall days, but some level of increase will occur in every area of Massachusetts.

Intense rainfall from developed areas can cause pollutants on roads and parking lots to get washed into nearby rivers and lakes, reducing habitat quality. As rainfall and snowfall patterns change, certain habitats and species that have specific physiological requirements may be affected.

Climate projections for Massachusetts indicate that in future decades, winter precipitation could increase, but by the end of the century most of this precipitation is likely to fall as rain instead of snow due to warmer winters. There are many human and environmental impacts that could result from this change including reduced snow cover for winter recreation and tourism, less spring snow melt to replenish aquifers, higher levels of winter runoff, and lower spring river flows for aquatic ecosystems.

A small projected decrease in average summer precipitation in Massachusetts could combine with higher temperatures to increase the frequency of episodic droughts, like the one experienced across the Commonwealth in the summer of 2016. Droughts will create challenges for local water supply by reducing surface water storage and the recharge of groundwater supplies, including private wells. More frequent droughts could also exacerbate the impacts of flood events by damaging vegetation that could otherwise help mitigate flooding impacts. Droughts may also weaken tree root systems, making them more susceptible to toppling during high wind events.

Days with High Precipitation

The projections for expected number of days receiving precipitation over one inch are variable for the Nashua basin, fluctuating between loss and gain of days. Table 8 details these projected fluctuations through the end of the century.

TABLE 8
Days with Precipitation over 1", 2", and 4"

Nashua Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century: Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century: Projected Change in 2090s (Days)
Days with Precipitation Over 1"	Annual	7	+<1[74] to +2	+1 to +3	+1 to +3	+1 to +4
	Winter	2	+0 to +1	+<1[74] to +1	+<1[74] to +2	+<1[74] to +2
	Spring	2	+0 to +1	+0 to +1	+0 to +1	+<1[74] to +1
	Summer	2	+0 to +1	+0 to +1	+0 to +1	+0 to +1
	Fall	2	+0 to +1	+0 to +1	+0 to +1	+0 to +1
Days with Precipitation Over 2"	Annual	1	+0 to +<1[74]	+<1[74] to +<1[74]	+<1[74] to +1	+<1[74] to +1
	Winter	<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]
	Spring	<1[74]	+0 to +<1[74]	+0 to +<1[74]	+<1[74] to +<1[74]	+<1[74] to +<1[74]
	Summer	<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]
	Fall	<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]
Days with Precipitation Over 4"	Annual	<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	0	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]
	Summer	<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]
	Fall	0	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]	+0 to +<1[74]

Total Precipitation

Similar to projections for number of days receiving precipitation over a specified threshold, seasonal projections for total precipitation are also variable for the Nashua basin. Table 9 below shows seasonal projected total precipitation changes through the end of the century.

TABLE 9
Total Precipitation

Nashua Basin		Observed Baseline 1971-2000 (Inches)	Projected Change in 2030s (Inches)	Mid-Century: Projected Change in 2050s (Inches)	Projected Change in 2070s (Inches)	End of Century: Projected Change in 2090s (Inches)
Total Precipitation	Annual	45.9	+0.4 to +4.9	+1.2 to +6.3	+2.3 to +7.9	+1.3 to +8.4
	Winter	11.0	-0.3 to +1.9	+0.2 to +2.5	+0.4 to +3.3	+0.6 to +4.3
	Spring	11.8	-0.0 to +2.2	+0.1 to +2.0	+0.5 to +3.0	+0.1 to +2.9
	Summer	11.3	-0.3 to +1.5	-0.3 to +2.2	-0.6 to +2.2	-1.1 to +2.2
	Fall	11.8	-1.1 to +1.1	-1.2 to +1.8	-1.6 to +1.7	-1.4 to +1.5

Consecutive Dry Days

Annual and seasonal projections for consecutive dry days, or for a given period, the largest number of consecutive days with precipitation less than 1 mm (~0.04 inches), are variable throughout the 21st century. Table 10 below projects consecutive dry days in the 2030s, 2050s and 2090s.

TABLE 10
Consecutive Dry Days

Nashua Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Consecutive Dry Days	Annual	16	-0 to +2	-1 to +2	-1 to +2	-1 to +3
	Winter	11	-1 to +1	-1 to +1	-1 to +1	-1 to +2
	Spring	11	-1 to +1	-1 to +1	-1 to +1	-2 to +1
	Summer	12	-1 to +2	-1 to +2	-1 to +3	-1 to +3
	Fall	12	-0 to +2	-0 to +3	-0 to +3	-0 to +3

3.3 Specific Categories of Concerns and Challenges

Workshop attendees identified 68 community assets that were either vulnerable to the impacts of climate change or that are strengths for the Town of Pepperell. Of that list, the following concerns and challenges were discussed:

- Maintaining communication for public safety services in the event of an emergency, including floods and power outages.
- Resiliency of the power grid, including power outages and ability to provide backup power via generators or a microgrid system for the Town.
- Ability to access medical services and facilities, including access to private pharmacies to procure prescription drugs.
- Mandatory water conservation or use restrictions to drinking water including on the regional level
- Available space and usage of emergency shelters.
- Flooding impacts on road networks and emergency response.
- Education of private entities and residents, including vulnerable populations like the elderly, about Town emergency response services, shelters, private well resiliency, and assessing generator need and/or condition if applicable.
- Obtaining gas during power outages and other severe storm events.
- Privately-owned dams and a need for formal Emergency Action Plans.
- Emergency response for livestock and farms.
- Access to food, including on a regional scale.

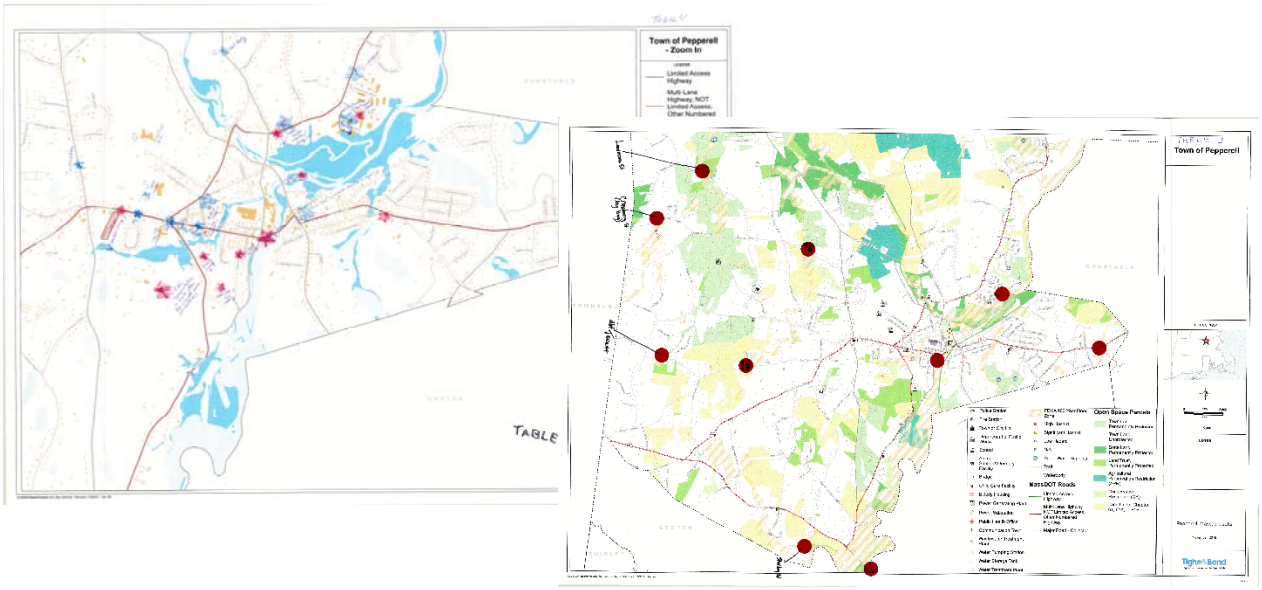


FIGURE 5: Examples of Marked up Maps showing areas of Concerns or Challenges

3.4 Current Strengths and Assets

Pepperell officials and emergency response staff are actively engaged in preparing the community to respond to and adapt to current and future natural hazards. Collaboration, communication, and responsiveness of these staff is viewed as a strength in Pepperell. In addition, Pepperell has an active and engaged resident base that helps facilitate outreach and education and that provided input on ongoing planning processes. Pepperell's public works staff are viewed as a strength in terms of their operation and management of the water and wastewater systems and assistance with emergency response.

The Town also completes thoughtful planning exercises, such as currently updating its Master Plan, and has begun the process of preparing a Town-specific HMP update. Capabilities are further discussed in Appendix D in the completed FEMA Capabilities Assessment Worksheet and narrative prepared by NMCOG on capabilities.

3.5 Top Recommendations and Strategies to Improve Resiliency

According the FEMA's Local Multi-Hazard Mitigation Planning Guidance, hazard mitigation measures can generally be sorted into six categories:

1. **Prevention**: Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built, and direct public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.
2. **Property Protection**: Modification or removal of existing buildings or infrastructure to protect them from a hazard. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.

3. **Public Education and Awareness**: Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and ways to mitigation them. Such actions include outreach projects, real estate disclosure requirements, hazard information centers, and school-age and adult education programs.
4. **Natural Resource Protection and Green Infrastructure**: Actions that, in addition to minimizing hazard losses, preserve or restore the functions of natural systems. These actions include low impact development, sediment and erosion control, stream corridor restoration, watershed management, urban forest and vegetation management, and wetland restoration and preservation.
5. **Structural Projects**: Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls (e.g., culverts), floodwalls, seawalls, retaining walls, and safe rooms.
6. **Emergency Services Protection**: Actions that will protect emergency services before, during, and immediately after an occurrence. Examples of these actions include protection of warning system capability, protection of critical facilities, and protection of emergency response infrastructure

All Mitigation Projects identified in the CRB workshops are considered resiliency actions for the Town. The list prepared below is subject to change based on evolving conditions in the Town.

TABLE 11: Mitigation Actions

Category of Action	Description of Action	Implementation Responsibility and Status	Hazard Addressed	Timeframe/ Priority
Emergency Services Protection	Evaluate the design and construction for a new Public Safety Complex	Building Committee	All Hazards	Short-term
Emergency Services Protection	Evaluate and identify backups for the existing communications system and define alternative communications and improve redundancy	Communications Director/Police and Fire	All Hazards	Short-term
Natural Resource Protection	Acquire and protect land including forests, agriculture, floodplains, and other local priorities	Town Planning Board/Conservation Commission.	Flooding, Hurricanes, Climate Change	Ongoing
Natural Resource Protection/ Prevention	Update Town floodplain, zoning, and stormwater bylaws	Town Planning Board/Conservation Commission	Flooding, Climate Change	Short-term
Natural Resource Protection	Conduct a town wide watershed/stormwater assessment (modeling, culvert assessments)	Conservation Commission/ Town Engineer	Flooding, Severe Storms, Climate Change	Ongoing

TABLE 11: Mitigation Actions

Category of Action	Description of Action	Implementation Responsibility and Status	Hazard Addressed	Timeframe/ Priority
Structural Projects	Address repetitive flood issues on Route 119	DPW & MassDOT, Conservation	Flooding, Severe Storms	Ongoing
Property Protection/ Natural Resource Protection/ Emergency Services Protection	Conduct a feasibility study and cost/benefit analysis for developing microgrids	Board of Selectmen	Severe Storms, Climate Change	Long-term
Prevention	Develop a large/dead tree management plan and conduct tree trimming	DPW, National Grid	Severe Storms, Hurricane, Tornado	Ongoing
Structural Projects	Conduct capacity planning study for culverts to analyze design, permit, and construction	DPW/Town Engineer, Conservation	Flooding, Climate Change	Short-term
Emergency Services Protection	Study inventory and conduct an evaluation on private emergency generator readiness and condition	Building Department	All Hazards	Long-term
Natural Resource Protection	Conduct a watershed evaluation study for stormwater retrofits	Conservation Commission/DPW	Flooding, Climate Change	Short-term
Emergency Services Protection	Conduct an agreement with a private vendor regarding gas/oil supplies for the highway department in the event of an emergency	DPW/Emergency Manager	All Hazards	Short-term
Emergency Services Protection	Develop an evacuation plan for nursing homes, elderly housing, and other facilities that house vulnerable populations	Emergency Manager, Council on Aging	All Hazards	Short-term
Emergency Services Protection	Develop a Reactive Regional Emergency Planning Committee (REPC)	Emergency Services	All Hazards	Ongoing

TABLE 11: Mitigation Actions

Category of Action	Description of Action	Implementation Responsibility and Status	Hazard Addressed	Timeframe/ Priority
Natural Resource Protection	Conduct a floodplain impact evaluation for the Wastewater Treatment Facility and collection system	DPW/Conservation	Flooding	Short-term
Public Education/ Structural Project	Add a shower at Senior Center to allow the facility to serve as the primary shelter	Emergency Manager/ CoA	All Hazards	Short-term
Natural Resource Protection	Develop a wildlife (beavers, mosquitos, etc.) management plan for major wetlands and waterbodies	Board of Health	Climate Change	Short-term

Section 4
Workshop Details

4.1 Workshop Participants

A list of those invited to participate in the workshops is included in Appendix B. The following provides a list of participants and their affiliations. Members of the workshop project team that had a role are also documented.

4.1.1 Workshop #1 Attendance

Workshop Host: Andrew MacLean, Town Administrator, and Lisa Davis, Planning Board Advisor

Workshop Facilitators: Gabrielle Belfit, CFM, Sharon Rooney, AICP and Janet Moonan, PE (Tighe & Bond)

Table Facilitators: Gabrielle Belfit, and Sharon Rooney (Tighe & Bond), Beverly Woods (NMCOG), and Lisa Davis (Town of Pepperell)

Table 12: Workshop #1: October 28, 2019

Name	Affiliation	Name	Affiliation
Paula Terrasi	TOP Cons & DPW	Margie LaFleur	BOH Chair
Brynn Montesanti	TOP PB & BOH	Cheryl Lutcza	Assistant to Zoning BD of Appeals
Scott Farrar	National Grid	Beverly Woods	NMCOG
Walter Richard	IA Auto	Joyce Morrow	PB/MPC
Deb Fountain	Master Plan Comm	David Querze	Emergency Management
Debbie Nutter	Treasurer	Deb Spratt	Library
Ken Kalinowski	DPW	Kalene Gendron	Board of Health
Kris Hartwell	DPW	Andrew MacLean	Town Administration
Joan Ladik	Town Clerk	Denise Pigeon	Nashoba Tech
John Ladik	Fin Com	Michelle Rowden	EEA
Tony Beattie	Robinwood Farm	Tom Nephew	BPW Realty

4.1.2 Workshop #2 Attendance

Workshop Host: Andrew MacLean, Town Administrator, and Lisa Davis, Planning Board Advisor

Workshop Facilitators: Gabrielle Belfit, CFM, Sharon Rooney, AICP and Janet Moonan, PE (Tighe & Bond)

Table Facilitators: Gabrielle Belfit, and Sharon Rooney (Tighe & Bond), Carlin Andrus (NMCOG), and Paula Terrasi and Lisa Davis (Town of Pepperell)

Table 13: Workshop #2: November 2, 2019			
Name	**Affiliation**	**Name**	**Affiliation**
Renee D'Argento	Master Planning Adv Com Climate Working Grp	Ken Hartlage	Nashoba Conservation Trust
Tony Beattie	Robinwood Farm	Charles P Walker	Planning Board
Jim Scarsdale	NASHUARD	Rick McHugh	Planning Board
Wm Van Lennys		Casey Campetti	Planning Board
Carlin Andrus	NMCOG	Rob Rand	Cons. Comm
Beth Faxon	Resident	John Masiello	MASY
Gabrielle Belfit	Tighe & Bond	David Walsh	Walsh Bros.
Lauri Masiello	MASY	Andrew MacLean	Town of Pepperell

4.2 Workshop Project Team

The following individuals provided invaluable assistance with coordination and implementation of the workshops and listening session.

TABLE 14: Core Team and Advisory Committee Members

	Name	**Title / Department / Affiliation**
MVP / HMP Core Team	Lisa Davis	Town Planner
	David Querze	Emergency Management Director
	Beverly Woods	NMCOG
	Brynn Montesanti	Planning
	Paula Terrasi	Conservation Agent
	Ken Kalinowski	DPW Director
	Andrew MacLean	Town Administrator
	Kalene Gendron	Health Agent
MVP / HMP Advisory Committee	Walter Richards	Resident
	Denise Pigeon	Nashoba Tech
	Lisa Davis	Town Planner
	Beverly Woods	NMCOG
	Tony Beattie	Robinwood Farm and resident
	Casey Competti	Planning Board
	Paula Terrasi	Conservation DPW
	Kalene Gendron	Board of Health
	Jim Scarsdale	Resident
	David Querze	Emergency Management Director
	Kat Belliveau	Resident
	Andrew MacLean	Town Administrator

4.3 Acknowledgements

Funding for the CRB workshop was provided through a Massachusetts Executive Office of Energy and Environmental Affairs (EEA) Municipal Vulnerability and Preparedness Planning Grant during Fiscal Year 20.

Many thanks to Lisa Davis, Pepperell Planning Department and Andrew MacLean, Town Administrator for serving as leads for the MVP Planning Process. Thank you to Brynn Montesanti for coordinating all meetings including the workshops. A special thanks to all

MVP Core Team members and everyone who participated in the CRB workshops as presenters, facilitators, scribes and stakeholders. Thanks to the Pepperell Town Staff for providing a great meeting space in the Community Center for both MVP workshops and the listening session. Thank you to the Advisory Committee members who encourage the Town to apply for this grant.

4.4 Report Citation

Tighe & Bond (2020). *Community Resilience Building Workshop Summary of Findings*, Town of Pepperell, Massachusetts.

Tighe&Bond
Engineers | Environmental Specialists

APPENDIX A

Pepperell MVP / HMP Core Team Kickoff Meeting Agenda

TO: Attendees (See sign-in sheet)

LOCATION: Pepperell Town Hall – Conference Room A

DATE: July 15, 2019

TIME: 1:00 to 2:30 PM

Overview Executive Office of Energy and Environmental Affairs (EEA) Municipal Vulnerability Preparedness (MVP) Program and Goals

- Overview of the Community Resilience Building (CRB) Workshop Guide & Scope of Work from EEA (*handout*)
- Deliverable deadlines
    a. Workshops - April 30, 2020
    b. Draft report and listening session - May 30, 2020
    c. All deliverables to EEA and MEMA - June 30, 2020
- Roles and Responsibilities (*handout*)

Steering Committee, Stakeholders & Public Outreach

- Town to identify steering committee members
- Town to identify and engage stakeholders (e.g. business owners, elder service providers, neighboring communities, regional environmental advocates, educators, etc.) to get a broader community perspective on Pepperell's societal and environmental vulnerabilities and strengths and their perspective on priority actions to mitigate climate change
- Review worksheet (*handout*) and suggest assignments to reach goal for 25+ participants at each workshop
- Public outreach process

Workshop Planning

- Review example 4-hour and 8-hour workshop
- Workshop materials will include:
    - Presentation
    - Selected base maps of Town with critical assets
    - Climate change data relevant to the Town and summary of potential impacts
    - CBC Risk matrix
- Locations and dates for Workshops
- Workshop facilitators - T&B will provide 2 facilitators and one additional staff to coordinate the workshop and facilitate the small groups. For each small groups one volunteer will be chosen to act as scribe and report back to the large group, a few additional volunteers from the Town are needed to help facilitate groups, as well as assist with sign-in, setting up the room and refreshments.

Town of Pepperell, MA
Sign-in Sheet

Date: July 15, 2019 **Time:** 1:00 PM

Location: Town Hall, Conference Room A

RE: MVP Planning Grant

Attendees:

Name (please print)	Title/Department	Email
Emily Scerbo	Tighe & Bond	EJScerbo@tighebond.com
LISA DAVIS	PLANNING	LDAVIS@pepperell.ma.us
David Queeuré	Emergency Management Director	dqueeuré@town.pepperell.ma.us
Beverly Woods	NMCOG	bwoods@nmcog.org
Brynn Montesanti	Planning	bmontesanti@town.pepperell.ma.us
Paula Terrasi	Conservation/DPW	pterrasi@town.pepperell.ma.us
Ken Kalinowski	DPW Director	Kkalinowski@town.pepperell.ma.us
Andrew MacLean	Town Administrator	amacLean@Town.pepperell.MA.US
Janet Moran	Tighe & Bond	jsmoran@tighebond.com

ATTACHMENT B - SCOPE OF SERVICES: INTEGRATING MVP AND HAZARD MITIGATION PLANNING

INSTRUCTIONS: In order to ensure that the Department and the Contractor have a clear understanding of their respective responsibilities and performance expectations, the Following attachment shall contain a specific detailed description of all obligations, responsibilities and additional terms and conditions between the Contractor and the Department which do not modify the Contract boilerplate language. *Attach as many additional pages as necessary.* {See INSTRUCTIONS sheet for more information and suggested provisions to include in ATTACHMENT B.}

The Executive Office of Energy and Environmental Affairs (EEA) and the ("the municipality") hereby contract for the municipality to complete the Municipal Vulnerability Preparedness (MVP) planning process to achieve MVP climate community designation. Using funds awarded through this grant program, the municipality will hire a state certified MVP provider to complete the planning process required to achieve MVP designation and deliver outputs of the process to EEA. **The municipality will receive additional funds to simultaneously prepare a Hazard Mitigation Plan (HMP) in accordance with FEMA guidelines as part of this scope of work Requirements to fulfill a HMP are largely aligned with those of MVP. Highlighted are HMP components that are in addition to the standard MVP planning scope of work. To fulfill the requirements of both the MVP and HMP processes, the municipality will complete its portion of a regional integrated MVP/HMP report for submittal to both EEA and MEMA.** Upon execution of the grant contract, the municipality will be provided with an advance payment of **$37500**. This payment is intended to support completion of the planning grant scope and expanded scope outlined in further details below. **Expanded scope requests are detailed on page 6. Failure to submit all project deliverables by the contract end date will prohibit the municipality from being eligible for future EEA grants.**

This project will run from the effective date of this contract through **June 30, 2020**. Municipalities will select a vendor from a list of state-certified MVP providers, provided by EEA, to complete the planning and stakeholder engagement exercise with the municipality. For more information on the Hazard Mitigation Planning requirements, see:

https://www.mass.gov/service-details/local-hazard-mitigation-planning
https://www.fema.gov/media-library/assets/documents/23194

Process Summary:
The contract will support the municipality in completing a comprehensive, baseline climate change and natural hazard vulnerability assessment, development of prioritized actions for dealing with priority hazards using the Community Resilience Building (CRB, www.communityresiliencebuilding.com) workshop guide, and beginning broader community outreach to satisfy both the MVP and HMP requirements. Through the program EEA will provide the municipality access to newly developed downscaled climate change projections, available on the www.resilientMA.org website, which must be incorporated into the planning process.

Led by a local project lead, a core team from the municipality, and the MVP provider, communities will gather available background information on hazards, vulnerabilities and strengths, conduct interviews with staff and volunteers, and plan two 4-hour workshops or one 8-hour workshop. Communities working through regional workshops may chose to hold workshops in a slightly different format, but should review their plans with EEA prior to commencing these workshops. During the workshop(s), approximately 20-60 municipal staff, residents, partners, and volunteers will work to:

- Understand connections between ongoing community issues, climate change and natural hazards, and local planning and actions in the municipality;
- Understand how climate change will exacerbate or lead to new community issues, hazards and other challenges the municipality faces;
- Identify and map vulnerabilities and strengths to develop infrastructure, societal, and natural resource risk profiles for the municipality;
- Explore nature-based solutions to build resiliency in the municipality;
- Develop and prioritize actions and clearly delineated next steps for the municipality, local organizations, businesses, private citizens, neighborhoods, and community groups; and,
- Identify opportunities to advance actions that further reduce the impact of climate change and natural hazards and increase resilience across and within municipalities.

Process Details:
The municipality will engage a state certified MVP provider from a list provided by EEA to faciliate and help the municipality to define extreme weather and natural and climate-related hazards, identify existing and future vulnerabilities and strengths, develop and prioritize actions for the municipality and broader stakeholder networks, and identify opportunities for the municipality to advance actions to reduce risks and build resilience. **The municipality working with the MVP provider will organize and conduct two 4-hour workshops or one 8-hour workshop. Following the workshop(s), the municipality will conduct at least 1 public listening session that will be open to the entire municipality. This public listening session must be completed by May 30, 2020 to ensure the municipality receives designation and is eligible for FY21 MVP Action Grants.**

The municipality will conduct the following tasks, working with the contracted MVP provider:

1. **Prepare for the workshop(s):**
   - Establish a core team that includes government officials, community leaders and business owners. This team will serve as a liaison to the MVP provider and assist in the planning process by providing access to relevant local data, facilitating community input on plan recommendations and priorities, reviewing draft products, and assisting with outreach to community stakeholders. This group may also include residents and the general public.
   - Engage stakeholders from the municipality, including but not limited to municipal officials, business, neighboring communities, private non-profits, and community residents, and develop partnerships with key non-profits, state and local government agencies, neighboring communities, local businesses and academic institutions who can help to improve outcomes at the workshops
   - Prepare materials for the workshop, including state climate change projections, and data specific to the municipality which may help to understand where past hazards have occurred
   - Decide on participants and arrangements/logistics

2. **Characterize hazards:**
   - The MVP provider will describe the past, current and future hazards in terms of impact location within the jurisdicton, using resilientMA Climate Change Clearinghouse, the State Hazard Mitigation and Climate Adaption Plan, and other best available data, reports, and technical documents.. Each hazard will need to document the likely extent (a scale or measure of magintude) and probability of future occurance
   - The MVP Provider will create a map of areas affected by multiple natural hazards for the Town/City. This map will be used at the workshops and incorporated into the final deliverables. Providers may choose to create a series of maps showing each hazard or impact separately. A set of hazard maps will be included within the Hazard Mitigation plan, and GIS files will be made available to the Town/City for integration with their other community plans.

3. **Identify community vulnerabilities and strengths, and how these intersect with known hazards in the community.**
   - Identify infrastructure and critical facilities vulnerabilities and strengths: The provider may consider using FEMA's HAZUS-MH or a GIS map analysis to delineate those critical facilities that are located within mapped hazard areas. Critical facilities could include but are not limited to:
     - Roads, bridges, and dams
     - City or town owned buildings or offices
     - Water and wastewater treatment plants
     - Sewage pumping stations
     - Schools and emergency shelters
     - Hospitals and critical care facilities
   - Identify societal vulnerabilities and strengths, including but not limited to:
     - Youth or elderly populations
     - Low to no income populations
     - Communities of color
     - Communities with limited English proficiency
     - People with disabilities

- Cases of medical illness

- Identify land use and environmental vulnerabilities and strengths, including:
  - Land use maps that depict the location of developed land uses, delineated by categories based on use (e.g. residential, commercial, industrial, institutional, other public use, etc.) and intersections with known hazards.
  - Anticipated future land use areas and intersections with known hazards.
  - Natural resources areas
  - Repetitive flood loss structures and structures which have incurred substantial damage, if they exist, as defined by FEMA (the community will need to request this data from DCR's Flood Hazard Management Program on letterhead)

- Identify vulnerabilities in other sectors as chosen by the community

4. Assess and summarize vulnerabilities:

- The MVP provider will take the identified community vulnerabilities and complete a vulnerability assessment that includes:
  - The types and numbers of buildings (including NFIP losses), infrastructure, and critical facilities located in the hazard areas
  - Documentation of the communities' current capabilities to mitigate and adapt to the identified vulnerabilities; providers are recommended to use the FEMA Capability Assessment Worksheet (attached).
  - Evaluation of the capabilities and if any need improvements, development of recommended actions
    A review and documentation of the communities' continued compliance with the NFIP.

5. Determine the highest priority hazards within the municipality.

6. Identify and prioritize community actions:

- Begin by sumarizing overall goals the community identified at the Workshop in goal staments that reduce or elimate long term vulnerabilty to identified hazards and climate change. Please note that MVP Action Grants, available through EEA prioritize nature-based solutions. Municipalities are encouraged to explore these types of strategies which include Low-impact design, green infrastructure, land conservation and other techniques.

7. Determine the overall priority actions:

- Identify actions and how they will be administerd (including responsible party, time frame for completion, possible funding source, etc.
- Use a prioritization process that will define urgency, cost and benifet and timing of the action
- Identify process for monitoring, updating, and evaluating the plan/final report, including the process for continued public engangement

8. Move forward

- Continue community outreach and engagement which includes at least 1 public listening session before May 30, 2020 where a draft report findings will be shared and feedback incorporated.
- Secure additional data and information for key gaps and questions identified through the process
- Use the process and report to inform existing planning efforts and project activities and incorporate priority actions into other local planning processes, such as a Comprehensive Plan, or orther local by-laws and ordinances.

9. Put it all together:

- If this is an update to a previously appoved HMP, document any changes in priorities, development, and local progress of mitigation actions taken place in the community, if applicable.
- Be sure to clearly document these planning steps, participants, and when the public was involved in the MVP process.
- Generate final workshop products and combined MVP/ HMP report (described in detail below)

9. Review and Approval

- Submit the plan to MEMA via mitigation@mass.gov.
- Submit the plan to the MVP Portal on the resilientMA.com Climate Change Clearinghouse.

Upon successful completion of Steps 1-8 of the CRB process and clearly defined efforts to begin Step 8 including conducting at least 1 public session, municipalities will be designated as a "Municipal Vulnerability Preparedness Program Climate Community," or "MVP Climate Community" which may lead to increased standing in future funding opportunities and follow-on opportunities. MEMA AND FEMA are responsible for reviewing and approving Hazard Mitigation plans.

All workshop outputs and background materials must be compiled into an easily accessible Community Resilience Building final report/ Hazard Mitigation Plan, based on a template provided by the state below. Municipalities may build on the template provided below, but must include the items in the template at a minimum to satisfy the requirements of the grant. Derivatives from the report can be used by the municipality following this initial phase of the process to inform existing planning processes, capital budgeting, and grant applications.

As an immediate next step, each community must complete at least one public listening session meant to share draft findings and incorporate feedback. The community should have a clearly articulated list of priority next steps and actions and how to implement these.

General guidelines for (~60 min) MVP public listening sessions include:

- Schedule and post listening session using best practives or requirements for posting public meetings in the municipality
- Ensure listening session is open to the public in a central, easily accessible location in the municipality (city/town hall, public library, community center, etc.)
- Ensure that the core team is present and ideally elected officials
- Provide a speaker(s) to present an overview of the Summary of Findings Report
    - Speaker(s) should be from the core team members and/or elected official(s)
    - Service provider for the respective municipality should not be the principle speaker(s)
    - Speaker(s) to review purpose, intent, objectives, and outcomes of workshop process
- Provide a question and answer period for members of the concerned public
    - Core team member(s) and/or service provider(s) respectfully listen and record responses from public
    - Provide clarification about Findings
- Provide opportunity for members of the concerned public to contribute in writing further inpurt at the listening session
- Provide web link to Summary of Findings report at the listening session

Acceptable alternative formats include:

- A public listening session can take place at a selectmen meeting only if they are open and promoted for public attendance, with similar allotment of time (~60 min) for the MVP listening session portion.

Maintaining Designation:
To maintain the designation as an MVP community year over year the municipality must provide the Commonwealth with a yearly progress report outlining the steps they have taken towards implementing their priority actions signed by a local official. Steps may include applying for grant funding, working to implement local changes to policies or bylaws, updating existing local plans using the outcomes of the workshop, completing more detailed vulnerability assessments, etc. A progress report template will be provided to the municipality to help them complete this requirement. A full update to this process would be required every 5 years to maintain FEMA HMP Approval.

Municipal Staff Commitment:
The municipality must provide sufficient staff time (estimated at 120-200 hours) to assure completion of this planning exercise and community engagement. Staff time provided by the municipality will include the following activities:

- Complete a contract with the Commonwealth and maintain all necessary reports and paperwork;

- Procure a state certified MVP provider;
- Establish a core team (or steering committee) within the municipality or region to steer the project;
- Help identify and complete outreach to critical stakeholders, partners and town officials who will be involved in the workshops;
- Help coordinate, schedule, send invitations and attend planning meetings and workshop(s);
- Conduct significant outreach in the community to ensure good attendance at the works hop(s) and public listening session(s);
- Help coordinate staff interviews with key experts, such as emergency response and the department of public works, to collect information prior to the workshop(s);
- Help the MVP provider find relevant data and other information useful to conducting the planning exercise;
- Provide access to relevant planning documents, budget information, and other information as needed;
- In concert with the MVP provider, complete and send 3 progress reports to EEA with information on prog ress and contract spending to date. The final CRB report will be counted as the final progress report, but must be accompanied by a final invoice showing all spending to date;
- With consultant support as budget allows, complete at least 1 public listening session to engage the broader public in a discussion of the workshop results and completed plan; and,
- Commit to working to continue municipal outreach and engagement, use the completed plan to inform existing planning and project activities, and secure additional data and information needed to improve the plan.

Reporting & Final Deliverables:
In concert with the MVP provider, the municipality is required to provide EEA with quarterly reporting, including information on spending, and the completed CRB/ HMP report which will result from the process. Quarterly reports are simple summaries (1-3 pages) of work that has been accomplished to date towards MVP certification, including status of scheduling and completion of workshop(s) and listening sessions. Municipalities shall provide a Summary of Findings Report (final CRB report), a list of workshop participants, contact information for the project lead and core team, a completed Risk Matrix in excel format, documentation of at least one public listening session, and a final invoice as deliverables for completion of the Community Resilience Building (CRB) process. The following is an annotated template for the CRB Workshop(s) Summary of Findings report. **Communities may submit a Hazard Mitigation Plan as their Summary of Findings Report, as long as it adheres to the layout, sections (bold and underlined), and associated details provided herein.** Consistency will increase reporting consistency which will in turn will accelerate the exchange and transfer of knowledge within and amongst municipalities, regions, and ultimately, across the Commonwealth. To assist further examples of completed CRB Summary of Findings reports can be reviewed and downloaded for reference on the Community Resilience Building website (www.communityresiliencebuilding.com). **Failure to submit all project deliverables by the contract end data will prohibit the municipality from being eligible for future EEA grants.**

The satisfactory documentation of at least once completed public listening session, and submittal of the MVP report, and associated materials described above, are the trigger for the MVP designation that entitles each municipality to partcipate in the MVP Action Grant to fund priorities identified through the planning process as well as to receive advanced standing in EEA grant programs. These deliverables and a completed FEMA Local Hazard Mitigaiton Plan Review Tool need to be submitted to MEMA for HMP plan review.

Materials:
All materials, software, maps, reports, and other products produced through the grant program shall be considered in the public domain and thus available at the cost of production. All materials created through this opportunity and as a result of this award should credit the Executive Office of Energy and Environmental Affairs Municipal Vulnerability Preparedness (MVP) program.

Sample MVP/HMP Report Template:

SUMMARY OF FINDINGS TEMPLATE GUIDANCE

Cover Page:
{List Municipalities Covered by Summary of Findings}
{insert descriptive community photos and or logos (as appropriate)}
{insert - Community Resilience Building Workshop Summary of Findings – below photo/logos}
{insert Month & Year report completed}

Overview:
{insert following at top of page}
{List Municipalities Engaged in CRB Workshop(s)}

Community Resilience Building Workshop
Summary of Findings

Text (refer to Step A in CRB Guide): Summarize the need for Workshop from community perspective and the path taken to arrive at Workshop(s). Discuss partnerships critical to enabling Workshop(s) and define "community" engaged in process (i.e., single or multiple municipalities – which ones? Other significant organizations as core partners). Reference the use of the CRB process (www.communityresiliencebuilding.com) and include all presentation and meeting materials

{insert the following text within this "Overview" section}

The Workshop's central objectives were to:
- Define top local natural and climate-related hazards of concern;
- Identify existing and future strengthen and vulnerabilities;
- Develop prioritized actions for the Community;
- Identify immediate opportunities to collaboratively advance actions to increase resilience.

Top Hazards and Vulnerable Areas:

Text (refer to Step B & C in CRB Guide and triggering questions page 26): Include summary of the discussions on top hazards that have had and will have impacts on the community (past, current, future). Define Top Hazards.

Top Hazards
{insert bulleted list of top hazards identified by community}

Areas of Concern
{insert categories followed by specific locations and other assets – confirm place names}
{examples of categories: Neighborhoods, Ecosystems, Transportation, Infrastructure, Critical Facilities, etc.}

Current Concerns and Challenges Presented by Hazards and Climate Change:

Text (refer to Step C in CRB Guide and triggering questions page 26): Provide brief history on all of the natural hazards that have impacted the community in and what those impacts were/are (i.e., long period of elevated heat, flooded intersections, impact of multiple hazards, etc.). Include reflection on the general concerns expressed by the Workshop participants on hazards today and in the future (5, 10, 25 yrs. or more).

Provide information on the types of climate change impacts the community expects to see in the future.

Include land use maps that depict the location of developed land uses, delineated by categories based on use (e.g. residential, commercial, industrial, institutional, other public use, etc.) and how it intersects with known hazards. Identify anticipated future land use areas and how they intersect with known hazards.

Specific Categories of Concerns and Challenges
Text: Insert paragraph or more for each major categories of concern for the community – as expressed by the participants. These often include emergency management capacity, vulnerability of road networks, inadequate community-wide communications and collaboration, critical infrastructure limitations (wastewater systems, energy), degraded floodplains and wetlands, and drinking water supply. These specific categories of concerns and challenges become the principle focal points highlighted in the following sections of the Summary of Findings.

Current Strengths and Assets:
Text (refer to Step C of CRB Guide and triggering questions page 26): Provide brief overview paragraph or two on the current strengths of the community as expressed by the participants.
{insert bullet statements (1-2 sentences) of current strengths. For example: "The responsive and committed leadership exhibited by elected officials and senior staff was viewed as a current strength. Ongoing collaboration and support amongst leadership and staff will help to advance comprehensive, cost-effective approaches to resilience as identified in this Summary of Findings".}
Completed FEMA Capability Assessment Worksheet

Top Recommendations and Strategies to Improve Resilience:
Text (refer to Step D of CRB Guide): Provide brief overview paragraph or two on the top recommendations for the community as expressed by the participants. Include a list of prioritized hazard mitigation projects that best meet the communities' needs for multiple hazard damage reduction
{insert bulleted of priority actions from Risk Matrix organized in sequential order first by "Highest Priority" then "Moderate Priority" and finally, "Lower Priority". Prioritized actions can be inserted directly from final Risk Matrix for the community.}

CRB Workshop Participants: Department/Commission/Representative:
{insert list of invited and participating entities. Place asterisks next to "attendees".}
{include an overall summary of the planning process}
{include documentation of the public listening session}

Citation:
{insert citation for Summary of Findings Report – this provides way to reference report for future plans and funding opportunities. Example:
{Insert name of municipality or persons responsible} (2017) Community Resilience Building Workshop Summary of Findings. {insert core team partnerships}. {insert municipality}, Massachusetts.

CRB Workshop Project Team: Organization, Name, Role:
{Example: Town of XXXX, Susan Smith, Core Team Member. Other roles can include: Lead Facilitator, Project Coordinator, Project Sponsor, Facilitator}

Acknowledgements:
{insert recognition of leadership and core team members by name and affiliation. Recognize entity that provided facility and meals/refreshments. In addition, provide recognition of funding sources utilized to advance the Workshop as well as the CRB process itself.}

Appendix:
{insert in subsequent pages of the Appendix the following items as available: Base Map(s) used for participatory mapping exercise (Step C and D of CRB Guide), Participatory Mapping Map(s) (outputs from Step C and D), supporting risk maps

(FEMA flood maps, etc.) used during workshop, supporting hazard information from the state plan, ResilentMa.org, etc. which was used in the risk assessment process, and powerpoint presentations or handouts used by participants.}

Expanded Scope

The Municipality has been funded **$15,500** to pursue the below expanded scope to build on the MVP planning process and further advance their community resiliency building efforts. Expanded scope deliverables must also be complete and submitted to EEA along with the MVP Report by June 30, 2020. **Failure to submit all project deliverables by the contract end date will prohibit the municipality from being eligible for future EEA grants.**

Please note that we are removing $7,000 from your expanded scope ask, as your award already includes $7,000 for integrating your plan with HMP.

1. ENHANCED COMMUNITY ASSET INVENTORY:

Community assets in Town important to the character and function of the community will be included in the enhanced inventory under Task 1. This Task builds on the previous community asset inventory from the 2015 HMP adding additional societal, infrastructural and natural resource assets identified by the MVP core team and in the community resilience building workshop. The inventory will be enhanced to include site specific details such as parcel elevation, building value, contact information, and known emergency management assets and issues

- Task 1 Deliverables (expected due date October 2019):
    - Enhanced matrix of community assets (societal, infrastructure, natural resources, and others as required) detailing specific attributes required for the vulnerability analysis.
    - Map and GIS database of community asset locations, attributes and natural hazard areas

2. NATURAL HAZARD RISKS WITH CLIMATE CHANGE:

Task 2 includes an update to the 2015 risk assessment of natural hazards to include climate change. The update will include all natural hazards identified in the 2018 Massachusetts State Hazard Mitigation Plan and use the Massachusetts Climate Change projections developed by the Northeast Climate Science Center at the University of Massachusetts. The prioritization of natural hazard risks will be reviewed by the MVP core team.

- Task 2 Deliverables (expected due date November 2019):
    - A matrix of natural hazards impacting Pepperell that include history of occurrence, future probability, frequency, geographic area of impact and extent to serve as the basis for a prioritization of hazards.
    - Hazard Profiles for each natural hazard.
    - Hazard Maps showing the geographic extent of impacted areas.
    - Revised data analysis and inundation mapping for future flooding risk due to climate change based on future extreme precipitation values.
    -

3. MULTI-HAZARD VULNERABILITY ASSESSMENT:

Task 3 includes an evaluation of both Town-wide and asset specific vulnerability to natural hazard risk. The evaluation will focus on wind and flood hazards including climate change using GIS-based tools to calculate risk probability and potential damages. The analysis will be compiled in a table with a rating for determining the relative risk to each community asset. The rating will be discussed at the MVP workshop.

- Task 3 Deliverables (expected due date December 2019):
    - A matrix of results from the vulnerability assessment.

4. ADAPTATION STRATEGIES:

Task 4 will include the development of adaptation strategies for the top 3 community assets most at risk. The adaptation strategies will focus on short, mid and long-range goals to help Pepperell become a more resilient community by proactively addressing impacts due to climate change at the three specific locations. The strategy summaries will support discussions at the MVP workshops and seeking future grant funding.

- Task 4 Deliverables (excepted due date January 2020):
  - The adaptation strategy will be presented as a bulletin format for each selected community assets including maps, graphic and discussion of the strengths, vulnerabilities and adaptation strategies with time lines for implementation, funding strategies and opinions of probable cost for each proposed strategy.

Pepperell MVP Planning Grant - Budget for Expanded Scope

	PIC	Project Manager	Certified Floodplain Manager	Staff Eng	GIS	Planning Advisor	Total Man-hours	Reimbursable	Labor Effort	Total Phase/Task Cost
1.ENHANCED COMMUNITY ASSET INVENTORY										
Complete Inventory in GIS and Prepare Draft Maps	0.5	0.5	2	4	8		15	$ -	$ 1,485	$ 1,485
Update based on Town Input		0.5	1	1	2		4.5	$ -	$ 465	$ 465
Subtotal	**0.5**	**1**	**3**	**5**	**10**	**0**	**19.5**	$ -	$ 1,950	$ 1,950
2.NATURAL HAZARD RISKS WITH CLIMATE CHANGE:										
Prepare draft matrix, hazard profiles, and mapping	0.5	0.5	4	8	8		21	$ -	$ 2,135	$ 2,135
Expand innudation mapping		0.5	4	6	12		22.5	$ -	$ 2,145	$ 2,145
Subtotal	**0.5**	**1**	**8**	**14**	**20**	**0**	**43.5**	$ -	$ 4,280	$ 4,280
3.MULTI-HAZARD VULNERABILITY ASSESSMENT:										
Vulnerability assessment and preparation of Matrix	0.5	2	3	10	8		23.5	$ -	$ 2,415	$ 2,415
Meeting to review with Town staff		2	2	1			5	$ 58	$ 665	$ 723
Preparation of Final Matrix	0.5	2	2	2			6.5	$ -	$ 880	$ 880
Subtotal	**1**	**6**	**7**	**13**	**8**	**0**	**35**	$ 58	$ 3,960	$ 4,018
4.ADAPTATION STRATEGIES:										
Develop adaptation strategies	0.5	2	8	4	6		20.5	$ -	$ 2,360	$ 2,360
Site visits and Meeting			8	8			16	$ 58	$ 1,840	$ 1,898
Costs	1	4		8			13	$ -	$ 1,600	$ 1,600
Subtotal	**1.5**	**6**	**16**	**20**	**6**	**0**	**49.5**	$ 58	$ 5,800	$ 5,858
Additional Planning Board Advisor Assistance										
Additional hours (average 4 per week) for Planning Board Consultant (above normal 10 hours a week)						120	120	$ -	$ 6,360	$ 6,360
Grand Total	4	14	34	52	44	120	267.5	$ 116	$ 22,350	$ 22,466

Town of Pepperell MVP / HMP Roles and Responsibilities

Task	Task Leader	Task Support	Assumptions
Task 1: Kickoff Meeting	Town	Tighe & Bond	Assumes Town staff will identify and invite Core Team (with input by Tighe & Bond via conference call). Core team may include: Town Admin, Emergency Management, Engineering/Highway, Health, Conservation, Building/Facilities, etc. To be efficient with staff time, representatives from Fire and Police may be included as part of stakeholder process, not on core team.
Task 2: Characterize Natural Hazard Risks Including those from Climate Change	Tighe & Bond	NMCOG /Town	Assumes Tighe & Bond will lead this task using data from previous HMP and update based on more recent available data consistent with state information. Includes consideration for climate change. Assumes Core Team will provide input on local hazards (e.g., areas of flooding, dams, winter storms, etc.) and will identify priority hazards.
Task 3: Enhanced Community Asset Inventory	NMCOG	Town	Assumes NMCOG will create mapping and prepare list of critical facilities, infrastructure, societal, environmental, and economic assets. Town to obtain repetitive loss data, if any, and review draft, and provide input on known emergency management assets and issues. Tighe & Bond to provide guidance on process.
Task 4: Multi-Hazard Vulnerability Assessment	Tighe & Bond	Town	Tighe & Bond to lead this effort. NMCOG to provide Community Asset Inventory GIS to Tighe & Bond. Our work includes: - Hazus-MH for Hurricanes and Earthquakes - Exposure assessment of parcel and building flood risk - The types and number of community assets located in priority hazard areas

DRAFT

Task	Task Leader	Task Support	Assumptions
Task 5: Capabilities Assessment	Town	Tighe & Bond	Assumes Town staff will complete this exercise with guidance from Tighe & Bond. Use form from FEMA handbook. The Capabilities assessment will include the following elements: • Review of all existing multiple hazard protection measures within the City, including protective measures under NFIP. • Review of exiting administrative capacity. • Review of existing funding mechanisms. • Review of education and outreach methods. • Description of each mitigation measure and method of enforcement and/or point of contact responsible for implementation of each measure. • Update of historic performance of each measure and description of improvements or changes needed.
Task 6: Development of Mitigation Strategies and Targeted Adaptation Analysis	Tighe & Bond	NMCOG/Town	Assumes Core Team will review/update goals and previous action items from 2016 Regional hazard mitigation plan. Development of new mitigation actions arise from Core Team input and workshops. Tighe & Bond will complete targeted adaptation analysis for top three
Task 7: Meeting with Advisory Committee	Tighe & Bond	Town	Assumes Tighe & Bond will lead a meeting with the Advisory Committee to discuss the natural hazards, vulnerability assessment, and adaptation/mitigation strategies.

DRAFT

Town of Pepperell MVP / HMP Roles and Responsibilities

Task	Task Leader	Task Support	Assumptions
Task 8.1: Prepare for Workshops	Town	Tighe & Bond/ NMCOG	Town staff to identify stakeholders with input from Tighe & Bond and invite stakeholders. Tighe & Bond to prepare presentation for workshops. Other materials for workshops will be prepared during other tasks Assumes Town staff will arrange location, order and facilitate food, and invite stakeholders.
Task 8.2: MVP workshops	Town/ Tighe & Bond	NMCOG	Two 4-hour meetings. Assumes Tighe & Bond will facilitate workshops Assumes NMCOG will attend one workshop.
Task 9: Draft and Final MVP/HMP Report	Tighe & Bond	Town	Assumes Tighe & Bond will compile draft MVP/HMP report and deliver documentation of tasks completed to support HMP update. Town staff will submit report to EEA and MEMA/FEMA.
Task 10: Public Community Listening Session	Town	Tighe & Bond	Tighe & Bond will prepare a brief PowerPoint presentation and attend listening session. Town staff will lead presentation
Task 11: Ongoing Coordination	Town	Tighe & Bond	Town to facilitate and document meetings, including invitations, meeting space, and meeting notes Town to prepare and issue press releases about project and notifications about meetings. Tighe & Bond to provide agendas and necessary handouts.

DRAFT

Task	Task Leader	Task Support	Assumptions
			Town to complete required quarterly reporting on grant. Tighe & Bond to provide invoices and review quarterly reports prior to Town submitting. NMCOG to review all draft deliverables prepared by Tighe & Bond

DRAFT

Community Resilience Building

WORKSHOP GUIDE



Excluding entirety of report to reduce paper use

www.CommunityResilienceBuilding.org

CRB Workshop Participant Worksheet

The following guidance is designed to help you and your core team identify a diverse, cross-section of participants for a Community Resilience Building Workshop(s). Ultimately, the participants will be representatives of and vested in a resilient future for your community. The final list of participants is yours to create and will depend largely on the goals and intended outcomes that are right for your community (refer to Step A1 and A2 of the CRB Workshop Guide). Review attached list of participant affiliations from previous Workshops.

Guiding Questions to Help Surface Workshop Participants:

A. Who are the key decision makers in your community? (leadership)
B. Who is directly responsible for implementing decisions? (staff/volunteers)
C. Who has influence on decisions in your community? (boards, commissions, etc.)
D. Which entities will be impacted by decisions? (community members)

CRB Core Team (refer to Step A1 of the CRB Workshop Guide):

Name	Affiliation

Participants:

Categories - Positions	Name	Affiliation	Vantage Point (State, Regional/County, Local)
LEADERSHIP (Mayor, President, Elected Council Members, Provost, State/US Representatives, CEO, etc.)			
BOARDS, COMMISSSIONS, FORMAL COMMITTEES (Planning and Zoning, Finance/Budget/Capital Plan, Conservation, Economic/Community Development, Education, etc.)			

PUBLIC SAFETY - HAZARD MITIGATION (Police/Fire/Ambulance; Safety Officer, Homeland Security, Port Authority, CERT, Campus Security, etc.)			
COMMUNITY PLANNING (Municipal/Campus Planner, Economic Development, Long Range – Regional Planner, Neighborhood Association, Land Trusts, Faith-based/Civic Organization, etc.)			
OTHERS (Finance, Administration, Operations, Neighborhood Associations, Chamber of Commerce)			

Elected Officials (or equivalents):
City/Town Council Members – (other appointed boards/commissions)
State Representatives and Senators
U.S. Representatives and Senators (or state-based aids/liaison)

Corporation Leadership: CEOs/Board Chair/President (or equivalent)
Federal Government: Secretary/Director/Division Head (or equivalent)
Academia: Provost/President (or equivalent)

Municipal Departments (or equivalents):
Emergency Management & Homeland Security
Engineering Department
Finance Department
Fire Department
Grants Office
Health & Social Services Department
Land Use, Construction & Review Department
Legal Affairs Department
Neighborhood Revitalization Zone Coordinator
Office of Planning & Economic Development
Parks and Recreation Department/Conservation
Police Department
Port Authority
Public Facilities Department
Public Library
Small & Minority Business Resource Office
Special Service Districts
Water Pollution Control Authority
Zoning Department
Corresponding Volunteer or Appointed Boards and Commissions

Key Stakeholders:
Water/Power Utility
Museums and Zoos
Sustainability Groups/Committees
Residential/Commercial Real Estate Agencies
Local Chapters of Professional Organizations: (APA. ASLA, PWS, etc.)
Land Grant Universities, Private Universities/Colleges, Community Colleges
Local & Regional Community Foundations
Local/Regional/State Housing Authorities
Major Employers
Environmental/Conservation NGOs
Engineering and Design Consulting Firms
Independent Nursing/Hospice Providers
Animal Shelters
Neighborhood Associations/Partnerships
Chamber of Commerce/Business Councils

HAZARD MITIGATION PLAN FOR THE NORTHERN MIDDLESEX REGION

2015 Update



Prepared by:
Northern Middlesex Council of Governments
40 Church Street
Lowell, Massachusetts 01852

Excluding entirety of report to reduce paper use

Tighe&Bond
Engineers | Environmental Specialists

APPENDIX B

Pepperell MVP / HMP Advisory Committee Meeting Agenda

TO: Attendees

LOCATION: Pepperell Town Hall – Conference Room A

DATE: October 7, 2019

TIME: 3:30 to 4:30 PM

3:30 PM Introductions & Sign In

3:35 PM Inventory and Rank Natural Hazards

Goal: Finalize list of natural hazards that apply to Pepperell, and determine the top four.

- Worksheet will be presented on computer.
- Together as a group we will discuss each hazard and complete the ranking.

4:00 PM Review and Confirm Community Assets

Goal: Finalize list of Pepperell's "Community Assets" to be used in the risk and vulnerability assessment.

- Community Asset Inventory and mapping will be presented on computer.
- Together as a group we will discuss the four categories (see back of this agenda) and the inventory to confirm whether items are missing or should be excluded.

4:20 PM Define Business Engagement Strategy

Goal: Advisory group to help engage local businesses to attend MVP Workshops on October 28, 2019 or November 2, 2019

4:30 PM Adjourn

1. **Built Environment**: Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or for critical facilities to operate.
    a. Bridges
    b. Communication utilities (e.g., cell towers)
    c. Power utilities (e.g., gas pipeline, power plant, etc.)
    d. All town-owned buildings/facilities, including police, fire, IT, etc.
    e. Dams (public and private)
    f. Medical facilities (e.g., urgent care, etc.)
    g. Funeral homes
    h. Post offices
    i. Water facilities
    j. Wastewater facilities
    k. Transportation (e.g., local or regional bus stations, etc.)
    l. Railroad
    m. Gas stations

2. **Economy**: Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.
    a. Major employers
    b. Supermarkets
    c. Pharmacies
    d. Towing services
    e. Hardware stores
    f. Oil delivery services
    g. Tree removal services
    h. Construction companies

3. **People**: Areas of greater population density, or population with unique vulnerabilities or less able to respond and recover during a disaster.
    a. Schools
    b. Vulnerable populations, environmental justice area
    c. Churches
    d. Child care
    e. Food pantries
    f. Historic sites
    g. Special needs schools
    h. Nursing homes/elderly housing/elderly care
    i. Community centers
    j. Libraries
    k. Cemeteries
    l. Affordable housing
    m. Shelters

4. **Natural Environment**: Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.
    a. Open space
    b. Major wetlands and waterbodies
    c. Vernal pools
    d. Trails
    e. Habitat

Meeting Sign-in Sheet

Date: October 7, 2019 **Time:** 3:30 PM

Location: Town Hall, Conference Room A

RE: MVP Planning Grant

Attendees:

Name (please print)	Email
Walter Richards	skeeter.Richards@Gmail.com
Denise Pigeon	dpigeon@nashobatech.net
Lisa Davis	ldavis@town.pepperell.MA.US
Beverly Woods	bwoods@nmcog.org
Tony Beattie	Robinwoodfarm@gmail.com
Janet Moonan (TRB)	jsmoonan@theboard.org
Tom Nephew	tanephew@gmail.com
Casey Campetti	lccampetti@gmail.com
Paula Terrasi	pterrasi@town.pepperell.ma.us
Kalene Gendron	Kgendron@nashoba.org
Jim Scarsdale	jscarsdale@outlook.com
David Querze	dquerze@town.pepperell.ma.us
Kat Belliveau	katjbelliveau@gmail.com
Andrew MacLean	amaclean@town.pepperell.ma.us

Pepperell MVP / HMP Advisory Committee Meeting Agenda

TO: Attendees

LOCATION: Pepperell Town Hall – Conference Room A

DATE: January 27, 2020

TIME: 3:30 to 4:30 PM

Please sign in

3:30 PM Status Update & Review of Draft Documents

Goal: Review progress to date and set deadline for input by Committee on draft documents.

- Asset inventory maps and lists
- Draft multi-hazard vulnerability assessment
- Draft capabilities assessment

4:00 PM Mitigation Strategies

Goal: Review previous mitigation strategies and discuss new mitigation strategies.

What is a hazard mitigation? Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects, and other activities. *See reverse of agenda for categories under which mitigation actions fall.*

- Worksheet will be presented on computer.
- Together as a group we will discuss existing strategies and future strategies.

4:30 PM Adjourn

Hazard mitigation measures can generally be sorted into six categories, according to FEMA's Local Multi-Hazard Mitigation Planning Guidance:

1. **Prevention:** Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built, and direct public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.

2. **Property Protection:** Modification or removal of existing buildings or infrastructure to protect them from a hazard. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.

3. **Public Education and Awareness:** Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and ways to mitigate them. Such actions include outreach projects, real estate disclosure requirements, hazard information centers, and school-age and adult education programs.

4. **Natural Resource Protection and Green Infrastructure:** Actions that, in addition to minimizing hazard losses, preserve or restore the functions of natural systems. These actions include low impact development, sediment and erosion control, stream corridor restoration, watershed management, urban forest and vegetation management, and wetland restoration and preservation.

5. **Structural Projects:** Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls (e.g., culverts), floodwalls, seawalls, retaining walls, and safe rooms.

6. **Emergency Services Protection:** Actions that will protect emergency services before, during, and immediately after an occurrence. Examples of these actions include protection of warning system capability, protection of critical facilities, and protection of emergency response infrastructure.

Meeting Sign-in Sheet

Date: January 27, 2020 **Time:** 3:30 PM

Location: Town Hall, Conference Room A

RE: MVP/HMP Planning Grant

Attendees:

Name (please print)	Signature
Tom Stephen	
Paula Terrasi	
Ken Kalinowski	
Dave Quenze	
Jim Scanzani	
Tony Beattie	
Andrew Maylor	
Lisa Davis	phone
Jennie Moore	

Tighe&Bond
Engineers | Environmental Specialists

APPENDIX C

MVP Workshop Guest List

NAME	AFFILIATION
Tracie Ezzio	Pepperell Family Pharmacy
Laurie Masiello	Masy Corporation
Owner / Manager	Astron Corporation
Bill Gikas	C & S Pizza
Chief Brian Borneman	Pepperell Fire Chief
Chief David Scott	Pepperell Police Chief
David Stairs	Communications Director, TOP
Dave Walsh	Walsh Brothers
Frank Masarelli	Massarelli Escavating
Carl Shattuck	Shattuck Trucking
George Clark	Clark Retirement Park
Virginia Malouin	Resident, Farm Owner
Dave & Mary Sears	Clover Luck Farm
Owner / Manager	Kimball's Farm
Owner / Manager	Wilkins Farm
David Mead	Mead Tree Service
Owner / Manager	Shattuck Oil
Owner / Manager	Wilson Brothers HVAC
Owner / Manager	Lorden Oil
Master Plan Committee Members	Town of Pepperell
Conservation Commission	Town of Pepperell
Department of Public Works Staff	Town of Pepperell
First Responders	Town of Pepperell
Board of Assessors	Town of Pepperell
Tax Collector	Town of Pepperell
Board of Health Members	Town of Pepperell
Council of Aging Members	Town of Pepperell
Lawrence Library Staff	Town of Pepperell
Senior Center Staff	Town of Pepperell
Members of Finance Committee	Town of Pepperell
Town Hall Staff	Town of Pepperell
Planning Board Members	Town of Pepperell
Board of Selectmen	Town of Pepperell
Kalene Gendron	Nasoba BOH / Health Agent
Alicia Geilen	NMCOG
Beverly Woods	NMCOG
Jay Donovan	NMCOG
Janet Cramb	Janet Cramb Real Estate
Melissa Tzandoudakis	Lyons & Tzandoudakis
Town of Dunstable - BOS, TA & PB	Town of Dunstable
Town of Groton - BOS, TA & PB	Town of Groton
Town of Townsend - BOS, TA & PB	Town of Townsend
Samule Melanson	Hydro Dam on Main Street

NAME	AFFILIATION
Judy Lorimer	Pepperell Horse Association
Michael Rosser	Trout Unlimited
Elizabeth Campbell	NRWA Director
Kara Runsten	State of MA
Michelle Rowden	State of MA
Scott Farrar	National Grid

Town of Pepperell
MVP/HMP Workshop #1
October 28, 2019

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Prioritized Recommendations and Voting Results

Meeting Agenda

ATTENDEES: Pepperell Municipal Vulnerability Preparedness Community Resilience Building Workshop

LOCATION: Community Center

DATE: October 28, 2019

START TIME: 12:00 PM

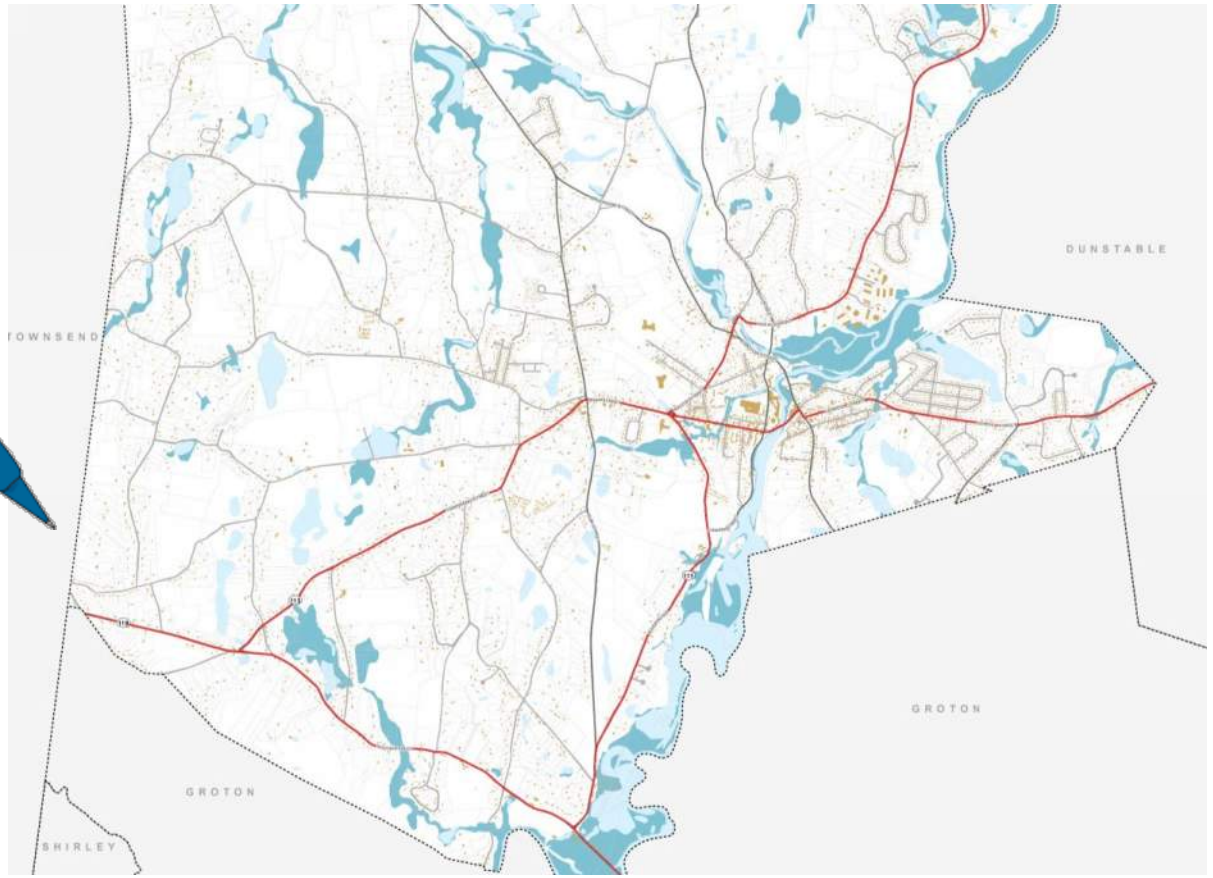
12:00 PM	Sign in, Refreshments	
12:15 PM	Welcome and Introductions	Town Administrator or Town Planner
12:20 PM	Individual Mapping Exercise – Community Assets Strengths and Vulnerabilities	Tighe & Bond
12:40 PM	Workshop Logistics and Table Icebreakers, 5 minute break	Core Team - Lead
1:00 PM	Session 1: Natural Hazard Risks and Climate Change	Tighe & Bond
1:10 PM	Table Discussion #1: Identifying Risk Areas and Community Strengths	Table groups
1:50 PM	Break	
2:00 PM	Session 2: Mitigation Strategies for Vulnerable Assets	Tighe & Bond
2:10 PM	Table Discussion #2 Identify Actions to Address Vulnerabilities or Protect Strengths	Table groups
2:50 PM	Short Break	
3:00 PM	Session 3: Groups Priortize top 5 to 6 actions Small group report out to full group on top 5-6 actions	Table groups report out
3:45 PM	Wrap up and closing remarks	Tighe & Bond & Town
4:00 PM	Adjourn	

PLEASE SIGN IN

Where do you live or work in Pepperell?

Help us by marking it on the map on the table.







TOWN OF PEPPERELL



COMMUNITY RESILIENCE BUILDING WORKSHOP

October 28, 2019

Tighe&Bond

WELCOME & INTRODUCTIONS

Help Pepperell Build Resilience and Preparedness:

- Plan for more frequent and intense weather events
- Improve pre-event planning, response & recovery, and long-term actions
- A prepared and resilient Pepperell will be able to maintain functions, protect its residents and businesses, and be ready for future storm events and a changing climate

A brief thanks to Pepperell's Hazard Mitigation Plan and MVP Core Team



Lisa Davis

David Querze

Beverly Woods

Brynn Montesanti

Paula Terrasi

Ken Kalinowski

Andrew MacLean

Kalene Gendron

BEFORE WE GET STARTED



Help us complete a preliminary mapping exercise

- Question #1: Which community assets are most important to you or the community?

WHAT ARE COMMUNITY ASSETS?

Built Environment: Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or for critical facilities to operate.

Economy: Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.

People: Areas of greater population density, or population with unique vulnerabilities or less able to respond and recover during a disaster.

Natural Environment: Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.

BEFORE WE GET STARTED



Help us complete a preliminary mapping exercise

- Question #1: Which community assets are most important to you or the community?
- Question #2: In your experience, which community assets are most vulnerable to natural hazards*?

WHAT ARE NATURAL HAZARDS?


Inland Flooding


Tsunami


Severe Winter Storm

Blizzards
Snow
Ice Storms


Drought


Average/Extreme Temperatures


Tornadoes


Landslide


Wildfires


Other Severe Weather

Nor'easters
High Wind
Heavy Precipitation
Microbursts


Hurricanes/Tropical Storms


Invasive Species


Earthquake

PEPPERELL'S TOP NATURAL HAZARDS

Inventory of Natural Hazards

Type of Natural Hazard	History of Occurrence in Pepperell	Hazard Probability	Hazard Frequency	Geographic Extent	Severity of Impact	Hazard Risk Ranking
Hydrological Hazards						
Inland Flooding	Yes	3	3	2	3	11
Coastal Flooding	No	0	0	0	0	N/A
Drought	Yes	3	3	2	2	10
Atmospheric Hazards						
Extreme Temperature	Yes	3	3	3	1	10
Hurricanes / Tropical Storms	Yes	2	2	3	2	9
Other Severe Weather	Yes	3	3	3	1	10
Severe Winter Storm	Yes	3	3	3	2	11
Tornadoes	No	1	0	1	3	5
Microburst	Yes	3	3	1	1	8
Geological Hazards						
Coastal Erosion	No	0	0	0	0	N/A
Earthquake	Yes	1	0	3	3	7
Landslide	No	1	0	1	1	3
Tsunami	No	0	0	0	0	N/A
Other Hazards						
Wildfires	Yes	3	1	1	1	6
Invasive Species	Yes	4	3	2	1	10

Tighe&Bond

ASSESSMENT METHOD

Definitions

Points		Description
Hazard Probability (Possible occurrence in the future)		
1	Unlikely	Less than a 1% probability over the next 100 years
2	Possible	1-10% probability in the next year or at least one chance in the next 100 years
3	Likely	10-100% probability in the next year or at least one chance in the next 10 years
4	Highly Likely	Near 100% probability in the next year
Hazard Frequency		
0	Very Low	Events that occur less frequently than once in 1,000 years (less than 0.1% per year).
1	Low	Events that occur from once in 100 years to once in 1,000 years (0.1% - 1% per year).
2	Medium	Events that occur from once in 10 years to once in 100 years (1% - 10% per year).
3	High	Events that occur more frequently than once in 10 years (greater than 10% per year).
Geographical Extent (Area Impacted by a Given Natural Hazard)		
1	Small	Less than 10% of the Town affected
2	Medium	10-50% of the Town affected
3	Large	More than 50% of the Town affected
Severity of Impact from Hazard		
1	Minor	Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e. one or two communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.
2	Serious	Scattered major property damage (more than 10% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services briefly interrupted up to 1 day; some minor injuries.
3	Extensive	Consistent major property damage (more than 25%); major damage public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and possible fatalities.
4	Catastrophic	Property and public infrastructure destroyed (more than 50%); essential services stopped for 30 days or more, multiple injuries and fatalities.

PEPPERELL'S TOP NATURAL HAZARDS

SEVERE WINTER STORMS

OTHER SEVERE WEATHER

INLAND FLOODING

DROUGHT & EXTREME TEMPERATURE



+ **CLIMATE CHANGE**



=

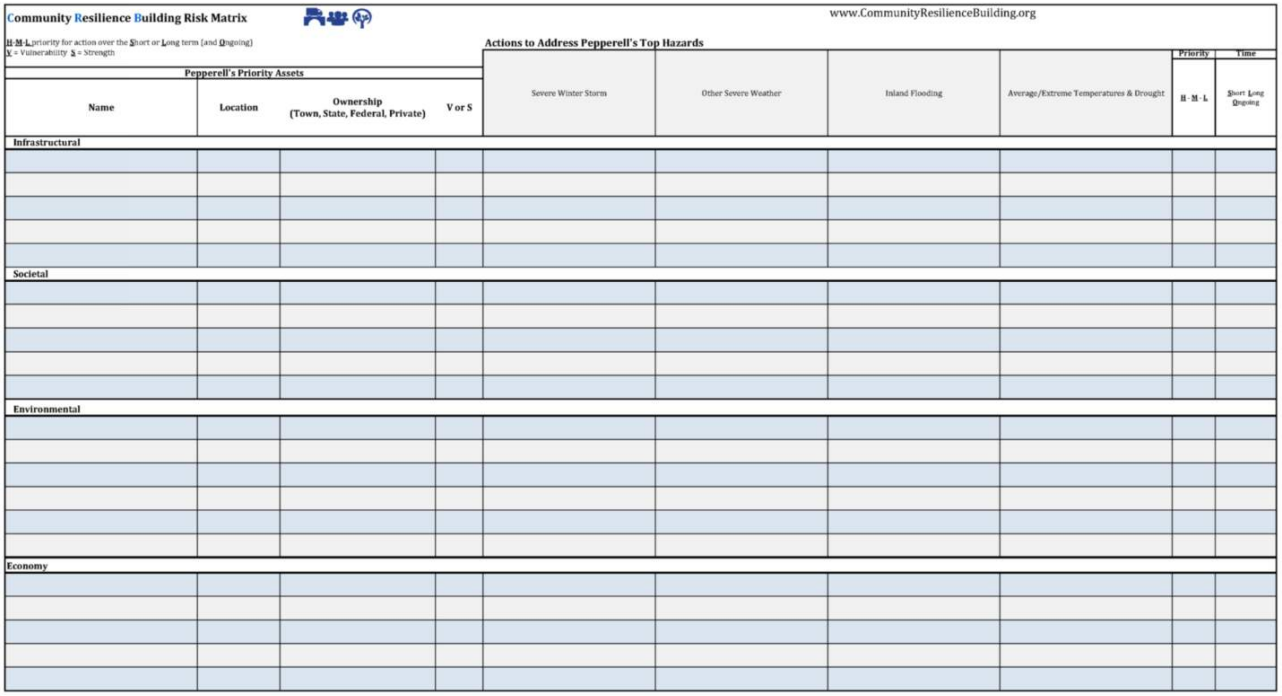
AMPLIFIED EXISTING RISKS

- Community and regional infrastructure
- Local and regional economies
- Public Health
- Natural resources and our environment

Tighe&Bond

WORKSHOP LOGISTICS

- **Two table-top/group discussions**
- **Fill out matrix**



Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
								Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
Infrastructural									
Societal									
Environmental									
Economy									

- **Facilitated group prioritization**

BRIEF OVERVIEW OF THE HAZARD MITIGATION and MVP PLANNING PROCESS

1) Define potential risk due to natural hazards including impacts of climate change

2) Identify key community assets and vulnerability to risk

3) Define mitigation projects to improve resiliency

4) Prioritize projects for areas most at risk



HISTORICAL EVENTS

- **August 1948 Highest Temperature Recorded**
  Temperature of 105 degrees recorded in Pepperell
- **January 1957 Lowest Temperature Recorded**
  Temperature of -29 degrees recorded in Pepperell
- **March 1968 Ice Jam**
  Ice jam on the Nashua River
- **1987 Major Flooding of Nashua River**
  Road closures, school closed
- **July 2002 Thunderstorm Wind**
  Winds recorded over 70 mph
- **March 2010 Nashua River Flooding**
  Flooding of the Nashua River leads to closure of Route 111 and Route 119
- **August 2011 Hurricane Irene**
  Devastating flooding, wind damage
- **October 2011 Halloween Storm**
  Power out for seven days
- **March 2018 Nor'easter**
  Pepperell received 20 inches of snow from a winter nor'easter

SEVERE WINTER STORMS

OTHER SEVERE WEATHER

INLAND FLOODING

DROUGHT & EXTREME TEMPERATURE







Session #1

Identify Risk Areas and Community Strengths

1:00 PM



DISCUSSION AT TABLE





Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
								Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
Infrastructural									
Societal									
Environmental									
Economy									

Tighe&Bond

EXAMPLES OF VULNERABILITIES & STRENGTHS



Vulnerabilities

- Main road floods during storms, blocking emergency response.
- Power outages during heat waves lead to health concerns.
- Sewer pump stations become submerged and inoperable
- Senior housing without back-up generators during heat waves.
- Residents without access transportation during hurricane evacuation.
- Limited areas of refuge in schools during tornados.

Strengths

- Critical road elevated and passable by emergency management.
- Hardened utility lines reduce outages due to ice storms.
- Undersized culvert replaced to reduce flooding in key intersection.
- Improvement to communication systems during extreme weather.
- Private businesses provide services aligned with emergency operations.
- Floodplains provide stormwater storage and downstream flood reduction.

TRIGGER QUESTIONS



- What infrastructure/facilities are exposed to current and future hazards? Transportation, waste water treatment, nursing homes, schools, office park, hazardous materials facility, dams, laboratories, churches, pharmacies, groceries, gas stations?
- What makes this infrastructure vulnerable? Location, age, building codes, type of housing?
- What are the consequences of this infrastructure being vulnerable? Lack of access to critical facilities – urgency care/ pharmacies?
- What are the population characteristics of the people living in high-risk areas? Elderly, low/moderate income, special needs, languages spoken?
- What are the strengths and vulnerabilities of people in your community? Active civic groups, organizations, associations; full-time police, fire, and emergency medical services; strong lines of communication for emergency information?
- How can hazards intensify these characteristics? Where are areas for improvement in the community?
- What natural resources are important to your community?
- What benefits do these natural resources provide (storm buffering, fire breaks, erosion control, water quality improvement, slope stabilization, recreation)?
- Which natural resources are exposed to current and future hazards?
- What have been the effects of these hazards on these natural resources?
- Where are the high-risk areas and what vulnerabilities exist for the environment?





Session #2

Identify Actions to Address Vulnerabilities and Protect Strengths

2:00 PM

DISCUSSION AT TABLE





Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
								Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
Infrastructural									
Societal									
Environmental									
Economy									

Tighe&Bond

TYPES OF MITIGATION ACTIONS



1. Prevention
2. Property Protection
3. Public Education and Awareness
4. Natural Resource Protection and Green Infrastructure (nature-based solutions)
5. Structural Projects
6. Emergency Services Protection

Session #3





Table Groups report out to Full Group

3:00 PM

WHEN PRIORITIZING, CONSIDER…

- Funding availability and terms
- Consensuses in community for project
- Needed to advancing longer-term outcomes (e.g. phase of a project)
- Does it contribute towards meeting local and regional planning objectives

DISCUSSION AT TABLE





Select Top 5 to 6

www.CommunityResilienceBuilding.org

Community	Location	Ownership (Town, State, Federal, Private)	V or S	Actions to Address Pepperell's Top Hazards: Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	Priority H-M-L	Time Short Long Ongoing
Societal									
Environmental									
Economy									

Tighe&Bond

REPORT TO LARGE GROUP & RANK

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards				Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
Infrastructural									
Societal									
Environmental									
Economy									

Tighe&Bond

NEXT STEPS

- Second Workshop on November 2, 2019
- Prepare MVP/HMP Report
- Become a certified Municipal Vulnerability Preparedness Community
- Maintain MVP status with annual progress updates to State (combined with Hazard Mitigation Planning update)
- Eligible for MVP action grant funding



Community Asset Categories

1. **Built Environment**: Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or for critical facilities to operate.
    a. Bridges
    b. Communication utilities (e.g., cell towers)
    c. Power utilities (e.g., gas pipeline, power plant, etc.)
    d. All town-owned buildings/facilities, including police, fire, IT, etc.
    e. Dams (public and private)
    f. Medical facilities (e.g., urgent care, etc.)
    g. Funeral homes
    h. Post offices
    i. Water facilities
    j. Wastewater facilities
    k. Transportation (e.g., local or regional bus stations, etc.)
    l. Railroad
    m. Gas stations

2. **Economy**: Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.
    a. Major employers
    b. Supermarkets
    c. Pharmacies
    d. Towing services
    e. Hardware stores
    f. Oil delivery services
    g. Tree removal services
    h. Construction companies
    i. Farms

3. **People**: Areas of greater population density, or population with unique vulnerabilities or less able to respond and recover during a disaster.
    a. Schools
    b. Vulnerable populations, environmental justice area
    c. Churches
    d. Child care
    e. Food pantries
    f. Historic sites
    g. Special needs schools
    h. Nursing homes/elderly housing/elderly care
    i. Community centers
    j. Libraries
    k. Cemeteries
    l. Affordable housing
    m. Shelters

4. **Natural Environment**: Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.
    a. Open space
    b. Major wetlands and waterbodies
    c. Vernal pools
    d. Trails
    e. Habitat

Pepperell Community Assets- Strengths and Vulnerabilities

Individual Mapping Exercise: The purpose of this mapping exercise is to allow workshop participants to consider important community assets and see which locations should be counted at the top for assets that providing a significant strength to the community in the face of natural hazards. The mapping exercise also asks participants to consider which assets or locations in Pepperell are most vulnerable to natural hazards*.

What is a Community Asset? Community asset as anything that is important to the character and function of Pepperell. Community assets are split up into four different categories: People, Economy, Built Environment, and Natural Environment described below.

Community Asset Categories	Critical Sectors	Characteristics of Community Assets
People	Schools, Vulnerable Populations, Cultural Facilities, Cultural Resources	Areas of greater population density, or population with unique vulnerabilities or less able to respond and recover during a disaster.
Built Environment	Critical Municipal Facilities, Emergency Response, Water, Wastewater, Energy, Stormwater, Transportation,	Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or needed for critical facilities to operate.
Economy	Business District, Food and Drug Supplies,	Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.
Natural Environment	Natural Resources	Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.

PLEASE USE YOUR DOTS AND POST-ITS TO COMPLETE THE FOLLOWING:

Question #1: Which community asset(s) are most important to you?

Directions: Put green dot on the assets, write asset name on post it and note why you made this choice.

Question #2: In your experience, which community assets are most vulnerable to natural hazards*?

Directions: Put a red dot on the asset(s) or area, write asset/area name on post it and note why you made this choice.

***Natural Hazards: Severe Winter Storms, Other Severe Weather, Inland Flooding, Average/Extreme Temperatures & Drought**

Town of Pepperell
Municipal Vulnerability and Preparedness Stakeholder Workshop
October 28, 2019
12:00 pm – 4:00 PM

Name	Affiliation	Contact Information – Email or Phone
Paul aTerrasi	TOP Cons + DPW	pterrasi@town.pepperell.ma.us
Jennie Mooney	Tighe & Bond	jsmooney@tighebond.com
Brynn Montesanti	TOP - PB + BOH	bmontesanti@town.pepperell.ma.us
SCOTT FARRAR	NATIONAL GRID	SCOTT.FARRAR@NATIONALGRID.COM
Walter Richards	IA Auto	W Richards @ IA Auto.com
Deb Fountain	Master Plan Comm	deborahffountain@gmail.com
Debbie Nutter	Treasurer	dnutter@town.pepperell.ma.us
Margie Lafleur	BOH Chair	mlafleur@town.pepperell.ma.us
Cheryl Luteza	Assistant to Zoning Board of Appeals	CLuteza@town.pepperell.ma.us
Beverly Woods	NMCOG	bwoods@nmcog.org
Joyce Mooney	PB/MPC	pepperknollfarm@yahoo.com jmooney@town.pepperell.ma.us

Town of Pepperell
Municipal Vulnerability and Preparedness Stakeholder Workshop
October 28, 2019
12:00 pm – 4:00 PM

Name	Affiliation	Contact Information – Email or Phone
David Quenzi	Emergency Mgmt	dquenzc@town.pepperell.ma.us
Deb Spratt	Library	dspratt@cwmars.org
Ken Kelinnski	DPW	Kkelinowski@town.pepperell.ma.us
Kris Hartwell	DPW	Khartwell@town.pepperell.ma.us
JOAN LADIK	TOWN CLERK	JOANLADIK@YAHOO.COM
JOHN LADIK	FINCOM	JOHN.F.LADIK@GMAIL.COM
Tony Beattie	Robinwood Farm	978-877-7545 Robinwoodfarm@gmail.com
Tom Nephew	B & W Realtor	508-331-6400 tanephew@gmail.com
Kalene Gendron	Board of Health	Kgendron@nashoba.org
Andrew MacLean	Town Administrator	
Denise Pigeon	Nashoba Tech	dpigeon@nashobatech.net

Town of Pepperell
Municipal Vulnerability and Preparedness Stakeholder Workshop
October 28, 2019
12:00 pm – 4:00 PM

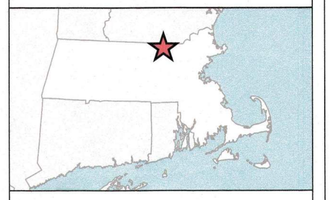
Name	Affiliation	Contact Information – Email or Phone
Michelle Rowden	EEA	michelle.rowden@mass.gov
Gabrielle Belfit	Tighe & Bond	
Sharon Rooney	Tighe & Bond	

Town of Pepperell

LEGEND

- Limited Access Highway
- Multi-Lane Highway, NOT Limited Access; Other Numbered Highway
- Major Road - Collector
- Building Footprint
- Parcels
- Waterbody
- FEMA 100-Year Flood Zone
- Town Boundary

LOCUS MAP



0 1,250 2,500
Feet

1:15,000

NOTES

Pepperell, Massachusetts

October 2019

Tighe&Bond
Engineers | Environmental Specialists

TOWNSEND
DUNSTABLE
GROTON
GROTON
SHIRLEY

BEMIS ROAD
HIGH OAKS PATH
WHEELER ROAD
LAWRENCE STREET
LORD EN LANE
CRANBERRY ROAD
CHESTNUT STREET
OAK HILL STREET
BAYBERRY ROAD
BONTON STREET
NORTH STREET
SEMINOLE DRIVE
BROOKLINE STREET
PRESCOTT STREET
BLOOD STREET
SHEFFIELD STREET
PALMER ROAD
OLD LITCHFIELD ROAD
VILLAGE ROAD
SARTELLE STREET
CLARK STREET
MAPLE STREET
HEALD STREET
ASHLEY STREET
WEST STREET
SHIPLEY HILLS
HOG HILL ROAD
EDGEWOOD STREET
AMES STREET
JEWETT STREET
WILLOW STREET
FOX LANE
WILDERNESS WAY
KAYLA LANE
SHATTUCK STREET
HARBOR STREET
HILLSIDE STREET
SUNCREST DRIVE
LAKIN STREET
FRIENDS WAY
LIRYC LANE
BANCROFT STREET
OTTADA WAY
SOUTHS STREET
POWHATAN ROAD
POWHATAN ROAD
OWENS END STREET
ORION ROAD
CELESTIAL WAY
SIRIUS LANE
REED STREET
BIRCH HILL DRIVE
MAURA LANE
MOUNT LEBANON STREET
SHIRLEY STREET
MASON STREET
SAM STREET
ELLIOT STREET
JULIA LANE
MADDS ROAD
HIGHLAND STREET
MILES STREET
CASSIE LANE
NASHUA ROAD
GROTON STREET
TUCKER PARK
TUCKER STREET
MINNS STREET
COTTAGE STREET
PROSPECT STREET
ST JOHNS STREET
HIGH STREET
WILLIAM STREET
PIERCE STREET
DEERFIELD DRIVE
DEERFIELD DRIVE
MERRIMACK DRIVE
LOMAR PARK DRIVE
LOMAR PARK DRIVE
SHAWNEE ROAD
HERGET DRIVE
HARDELL AVENUE
PARKWOOD DRIVE
OAKLAND STREET
FIRST AVENUE
TARBELL STREET
LEGION STREET
PROVINCE STREET
HOWE ST STREET
ALLEN STREET
NOVA DRIVE
SCOTIA DRIVE
EAST STREET
VERSES STREET
1ST STREET
IDAL STREET
BACON STREET
YVONNE DRIVE
CYNTH DRIVE
RIDGE ROAD
DOW STREET
BROOKDALE LANE
GLADMAN LANE
JUNE STREET
OAK STREET
CANAL STREET
RIVERSIDE
YALE STREET
111
113
119

G:\GIS\MA\Pepperell\Pepperell_MVP_Map_24x36.mxd Date Saved: 10/28/2019 User: ABC

P-0671

Table 1

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought (WILDFIRE)	Priority H - M - L	Time S Short L Long O Ongoing
Infrastructural									
Main St. Dam	1	Private - Power Co.	V	damage from ice, debris ✓ assess feas. of microgrid to mit. downstream props. ✓				M	ongoing
Main St. Bridge	2	Public	S					M	Long
Covered Bridge	3	Town	S					L	L
Sewer main/pump sta.	# N/A - throughout town	Town	S/V					M	O
Route 119		State	S		assess feas. ✓ bldg at raising road ✓ and/or acquire town & reconstruct bridge props.			L	O-L
Societal									
Senior center	4	Public/Town	S					L	L
Varnum School	5	Town/Regional	S					L	L
SNMC	6	Priv.	S					L	L
Senior housing	River Rd & Foster St. 7 & 8	State/Fed.	V	develop ✓ create database of contact notifications contingency plan for evacuation w/senior ctr.				M	S
2 veterinary hosp.	9A + 9B	Priv.	S					L	S
Environmental									
Farms	several throughout town	Private.	S			increase ✓ water holding capacity		L	O
Town Forest	10	public	V				implement/update mgmt. plan ✓	M	O
Ch. 61 lands	several throughout town	Priv.	V				public education of value ✓ + BMPs to mit. for other infra.	L	S
~~Town~~ conservation lands	"	Town, State, land trust	V					L	S
Gulf Brook						Restore orig. stream ✓ flow & remove berms/mill		H	S
Economy									
Gas heating oil Co.	#11	Priv.	S/V	emergency plan/ generator ✓ MOA w/town to ensure pub. safety can continue ✓				H	S
Farms	throughout town	"	S					L	O
Tree removal service	across town	"	S	emer. ✓ service agreement ✓				H	S
Pharmacies	12A + B	"	S	access ✓ to emer. supplies ✓ of prescriptions		✓		H	S
Donelands	13	"	S					L	L
Kimballs Fruit farm	14	"	S					L	L
veterinary hosp.	—	"	S					L	L

TABLE 1

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards				Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
Infrastructural									
Public safety communications	15 throughout town	Town	S/V		explore redundant backup sys. / wireless relocation			H	O
Scada system	"	"	S/V		replace/upgrade to wireless			H	S
Police + fire facilities	15/16 A+B	"	S	resilient comm. redundant comm. sys.				H	O
Public wells/water sys.	17 A+B+C	"	S/V			see Gulf Brook action	water loans	H	S
Sewage Treat. plant + discharge	18	"	S/V				study of covering clarifier	L	L
Societal									
Route 113		Town	S/V				investigate ✓ causing road + culvert replacement	L	L
Town library	19	Town	S	investigate use as shelter →				L	L
airport	20	Private	S/V			in floodplain		L	L
Environmental									
Economy									

#1

Table 1

#Built Environment
Communication
DPW
Police see #1
Fire

The group decided upon categories for assets and plotted them on a matrix board.
In Built environment we listed

		Priority
V	Main St Dam	ongoing M
S	" " Bridge	long M
S	Covered Bridge	long L
S/V	Sewer Main	ongoing H
S	Rte 119	long L
S/V	Public Safety Communication	ongoing H
V	SCADA (sewer)	short H
S	Police & Fire	ongoing H
S/V	Public wells/water mains	short H
S/V	Sewer treatment	long L
S/V	Rte 113	long L
S/V	Airport	long L

1 #2

Society

S	Senior ctr	Long L
S	VB school	Long L
S	Southern NH Med Ctr	Long L
V	Senior housing	Short M
S 2	Vet hospitals	Short L
S	Libraries	Long L

Environmental

S	Farms	ongoing L
V	Town forest	" M
V	Ch 61 land	Short L
V	Conservation land	Short L
V	Gulf Brook - beaver	Short H

Economy

S/V	Gas/heating/oil	Short H
S	Farms	ongoing L
S	Tree Removal	Short H
S	Pharmacies	Short H
S	Doctors	Long L
S	Kimball's Trust Farm	Long L
S 2	Vet hosp	Long L

#3

Identified each assets as Vulnerable or Strengths

Mitigation Actions

1. Prevention
2. Property Protection
3. Public Education & Awareness
4. Natural Resource Protection & Green Infrastructure
5. Structural Projects
6. Emergency Services Protection.

Susceptibility / Assets	Severe Winter Storms	Other Inland Impacts - Storms flood	Coastal
~~Main St Dam~~			
Main St dam	✓ ice, wind co-ordinate w/ owner	✓ add flood gates to mitigate flooding	
Main St Bridge	floods street downstream flooding		
Covered Bridge			
Sewer Main / Pump Station			
Rte 119 (State owned)		Assess feasibility of elevating road & reconstruct bridge ✓	

#4

Susceptibility of Assets	Sewer Water Storm	Other Storm	Inland Flood	Temp & Wild Fires
Public Safety Communication		Wireless leak Assess & mitigate new facility replace/maintain		
Sewer System				
police & fire	resilient redundant System	mitigate w/ wireless		
Public wells	can mitigate by shutting well heads down or pumping less			
Treatment plants		see Flood Book action		
RT 113		study & covers clarifier		
		racking - chg culvert elevated & road		

#5

Susceptible Areas	Severe Storms	Other Inland Storms	Temp & Fires
Library	✓ power outages	✓	

Society

Senior Hsng	✓ power outages	✓ contingencies to aid residents to evacuate. Senior Ctr may have data base of vulnerable residents	
Town Forest	✓	✓ Harvest trees	✓ Cut fire maintenance plan fire roads
airport	✓	✓ Have helicopters assist.	
Ch 61A	✓	✓ public educ awareness best mgmt practices	✓ forest fires

#

Assets	Wendell Starr	Arthur Starr	Richard Flood	Temps & Others
Gas/Heating Oil	✓	✓	✓	

Memorandum from town to purchase appropriate gas to run emergency vehicles.

Pharmacies	✓	✓	✓	

access to emergency supplies of prescriptions

Tree removal contracts	✓	✓		

to remove

#7

TABLE #1

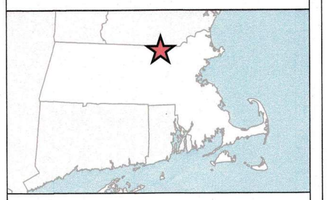
Table 1

Town of Pepperell

LEGEND

- Limited Access Highway
- Multi-Lane Highway, NOT Limited Access; Other Numbered Highway
- Major Road - Collector
- Building Footprint
- Parcels
- Waterbody
- FEMA 100-Year Flood Zone
- Town Boundary

LOCUS MAP



0 1,250 2,500
Feet

1:15,000

NOTES

Pepperell, Massachusetts

October 2019

Tighe&Bond
Engineers | Environmental Specialists

P-0671

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TABLE 2

Table 2

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

Actions to Address Pepperell's Top Hazards

Pepperell's Priority Assets				Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	Priority	Time
Name	**Location**	**Ownership (Town, State, Federal, Private)**	**V or S**					**H - M - L**	**S**hort **L**ong **O**ngoing
Infrastructural									
Bridges	119, 113, Groton St. Hollis St., Mill St	Town / State	V/S	Plowing & sanding	Sandbag None	Sandbagging; adjust flashboards; update floodplain bylaw	Inspect expansion joints	M/L	O
Power utilities	Groton St. Lowell St.	Private	V/S	Tree trimming; hazard tree removal; education on proper generator installation	Tree trimming; hazard tree removal	ongoing natural gas pipe replacement to address leaks	Educate homeowners	H	O
Dams	Main St.	Private	V	Monitor ice conditions on river/assess conditions for ice jams	None	address flashboards; regular dam inspections; get AEP from Eagle Creek	Monitor ice conditions	M/L	O
Water facilities	Bemis Br. Rd. Jersey St., Nashua	Town / Private	V/S	Replace water mains to prevent breaks; generator education for private wells	None	Analyze vulnerability of Nashua Rd wells to contamination from flooding	Continues monitoring of well levels, public education on water conservation	M	L
Waste water facilities	Lomer Park	Town	V/S	Runoff management/stormwater BMPs	None	Flood plain analysis on impact to plant.	Monitor for sufficient flow into plant	H	S
Societal									
Schools	Hollis St. (2) Chase Ave.	Town / Private	V/S	Snow removal from roofs. Evaluate design weight loads for roofs.	Structural assessments for vulnerabilities.	None needed	Confirm air conditioning for schools	M	O
Vulnerable Pops/Medically Frag.	Town wide		V	Educate the vulnerable population for preparing for an event of Power management.	Leveraging the CERT program.	→	→	M	O
Child care	Hollis St.	Private	V						
Nursing homes/elderly housing	Main St. River Rd Nason St., Maple, Hollis	Town / Private	V/S	maintaining transportation access & ensure door ways are accessible for emergencies	→	None	Install air conditioning systems	m	S
Food Pantries	Hollis	Private	V/S	generator?	→	None	None	m	S
Environmental									
Major Wetlands and Waterbodies	Town wide	Public / Private	V/S	None	None	Mosquito management	Monitor water quality for toxic algae	m	S
Trails	Nashua River Trail	state	V/S	Manage tree canopy	→	None	None	L	L
Open Space	town wide	Town / Private	S					L	L
Economy									
Major Employers	Lomer Park	Private	V/S	Norman Bros. is a resource for debris removal.	→	Floodplain awareness/education	None	m	S
Supermarkets	Main St.	Private	S						
Pharmacies	Groton St. College St.	Private	S						
oil delivery	Groton St. Leighton St (?)	Private	V?/S						
Farms	Town wide	Private	V/S						
Hardware stores	Main St.	Private	S						
								H.	S

* Add shower facilities at the COA to serve as an additional shelter.

Table 2

Vulnerable Population/
Medically fragile population—

- Perform an exceptional
  Needs survey

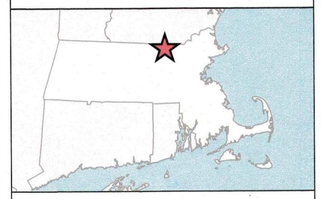
TABLE2

Town of Pepperell

LEGEND

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LOCUS MAP



0 1,250 2,500
Feet

1:15,000

NOTES

Pepperell, Massachusetts

October 2019

Tighe&Bond
Engineers | Environmental Specialists

P-0671

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TABLE #3

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards				Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
CULVERTS	T. W.	Town, State	V	In depth analysis and evaluation of all town culverts, engineering, design + construction of most enhanced maintenance equipment			Vulnerable culverts	H	S, L – analysis L – construction
Infrastructural									
ROUTE 119, 113, 111	1a, 1b, 1c	State + town	V	~~Participate in~~ Participate in, partnership, storm mitigate resident assessment		Floodplain By-law raise it 4'. Coordinate with	MADOT	H	S
COMMUNICATIONS CENTER	2	Town	V/S	- evaluate potential addition + construct an enhanced safety complex			Backup systems	H	L S
WWTP	3	Town	V	~~create~~ engineering evaluation to minimize impact of flooding				M	O
SCHOOLS / SHELTERS	Pepperell 4A Varnum Brook 4B	Town	S	school evaluate their capabilities for use		in an emergency –	outreach + communication of available resources	M	S
HYDRO DAM	5	PRIVATE	V			study to assess dam + how to minimize risk,		H	S, L
Societal									
ELDERLY HOUSING	7A, 7C, 7B, Town Wide	PRIVATE	V	prepare evacuation plan to include transportation, shelters, cooling AC				M	S
PEOPLE W/ DISABILITIES			V						
CHURCHES	8a, 8b, 8c 8D, 8E	PRIVATE	S	public education/outreach - help them to be prepared.				M	S
PATCH	9	PRIVATE – NON PROFIT	S	COMMUNICATION -				M	S
INFRA. FIRESTATION, DPW	6A	TOWN	S/V	TOWN WIDE SAFETY COLD COMPLEX				M	L
Environmental									
MUNICIPAL WELLS	Berns. 10A/B Nashoba 10C	Jerseyst - 10D/E Town	V/S	evaluate to minimize risk to ~~susceptive~~ isolate tanks to provide clean water				H	S
PRIVATE WELLS	Town Wide	PRIVATE	V	educate, have backup source of water				H	S
TRANSFER STATION	11	TOWN	V/S	debris management plan				L	S
CONSERVATION LANDS	T.W	TOWN, PRIVATE	S/V	land acquisition to mitigate flooding, snow dump property protection				L	L
Economy									
SUPERMARKET (CONVENIENCE, PACKAGE STORE, RESTAURANT)	13A, 13B	PRIVATE	S	public education, outreach, engagement				M	S
GAS STATIONS	15a, b, c	PRIVATE	S/V					M	S
PHARMACIES	14A 14B	PRIVATE	S					N	S
HORSE FARMS / FARMS	Town Wide	PRIVATE	S/V			manure management vets / tick + mosquito control best management practices		L	S
MEDICAL CENTER	16	PRIVATE	S	education / community engagement understanding their capacity				M	S
FUNERAL HOMES	17	PRIVATE	S					L	S
LOCAL CONTRACTORS	T.W.	PRIVATE	S/V	public education, outreach making certain they have a plan in place - making certain they know they are first responders				H	S
LOMAR PARK	18	PRIVATE	S/V					M	S
Shattuck Cir / Wilson Rds									

MAJOR ARTERIES

Fire Station DPW

6A 6B ~~Privat~~ Town, S

* Infrastructure Needs Pond. DAM - #12

Public Study and determine to fixes

Private Federal Control ?

Together

Table 3

Economy:
Gas station

Urgent Care – Stay put or move to schools to provide

PFS – Public Safety

Landfill / Staging area
Transfer Station

Local contractors (asset)
local economy

Townsend H2O tank street 8th + have clean water

- Flood Zone Bylaw Floodway
- LID Bylaw

Flooding Rte 119 ⇒ Goshen
Flooding Main St
Shelter school
Flooding School bus advise (stored w/in flood zone)
+evac
shelter school - cool / temp
power grid or Goshen

Table 3 Mitigation Actions

Culverts - we have identified some culverts as vulnerable, need complete evaluation of culverts
- maintenance of culverts

Rte 119, 113, 111 = floodplain bylaw to eliminate, petition State Officials to raise Rte. 119 MASSDOT
- watershed study w/ retrofit evaluation for Rte. 119

- Hoosac Dam - Study to determine fixes
- Communications - cell tower public service Center
  do we need a safety complex

Schools - evaluate their ability in emergencies

Hydro dam - emergency plan

Public Churches + PACH -

Outreach when shelters available

Public Wells - minimize negative impacts

Public/Private wells - backup source (tank on Mason St + Tannery St)

Transfer Station - clean up debris?

Hydro - Private owned but Grants to help?

Town of Pepperell

LEGEND

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LOCUS MAP



0 1,250 2,500
Feet

1:15,000

NOTES

Table #3

Pepperell, Massachusetts

October 2019

Tighe&Bond
Engineers | Environmental Specialists

TOWNSEND

DUNSTABLE

GROTON

GROTON

SHIRLEY

BEMIS ROAD
HIGH OAKS PATH
WHEELER ROAD
LAWRENCE STREET
LORD EN LANE
CHARLES CIRCLE
CRANBERRY ROAD
CHESTNUT STREET
OAK HILL STREET
BARBERRY ROAD
ASHLEY STREET
WEST STREET
HEALD STREET
SHIPLEY HILLS
HOG HILL ROAD
EDGEWOOD STREET
BOWERS STREET
BOYNTON STREET
NORTH STREET
SEMINOLE DRIVE
BROOKLINE STREET
PRESCOTT STREET
BLOOD STREET
SNEFIELD STREET
PALMER ROAD
PLANEFIELD ROAD
SARTELLE STREET
VILLAGE ROAD
MAPLE STREET
AMES STREET
JEWETT STREET
WILLOW STREET
FOX LANE
PRINCE STREET
CONN STREET
TOWNSEND STREET
SNAITUCK STREET
WILDERNESS WAY
KAYLA LANE
HARBOR STREET
HILLSIDE STREET
LIRYC LANE
BANCROFT STREET
LAKIN STREET
FRIENDS WAY
SUNNYCREST DRIVE
OTTADA WAY
SOUTH STREET
POWHATAN ROAD
ORION ROAD
CELESTIAL WAY
SIRIUS LANE
REED STREET
MASON STREET
SHIRLEY STREET
BAM STREET
BIRCH HILL DRIVE
MAURA LANE
MOUNT LEBANON STREET
VALE STREET
RIVER ROAD
CANAL STREET
ELLIOT STREET
JULIA LANE
HADLEY ROAD
HOLDEN STREET
CASTLE LANE
OMAR PARK DRIVE
STUART PARK
DEERFIELD DRIVE
MEADOWMAC DRIVE
NISSITISSIT LANE
RIDGE ROAD
DOW STREET
BROOKDALE LANE
SUNNYBANK LANE
PIERCE STREET
NASHUA ROAD
RT 111
TUCKER AVENUE
CHASE AVENUE
GROTON STREET
CUMMINGS STREET
PROSPECT STREET
WILLIAM STREET
PROVINCE STREET
SHAWNEE ROAD
HERGET DRIVE
HAKEL AVENUE
PARKWOOD DRIVE
OAKLAND STREET
FIRST AVENUE
JUNE STREET
OAK STREET
EAST STREET
BALDWIN STREET
BACON STREET
DALE STREET
NOVA DRIVE
SCOTIA DRIVE
EAST STREET
CINTH DRIVE
YVONNE DRIVE
POWELL STREET
ROWE STREET
ROUTE 119
ROUTE 111
ROUTE 113

TABLE # 4

No public transportation other than senior shuttle BUS

** Emergency evacuation for livestock in floods

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards				Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm: Snow/Blizzard/Ice	Other Severe Weather: WIND	Inland Flooding: Precip/Ice Jam	Average/Extreme Temperatures & Drought	H-M-L	Short Long Ongoing
Infrastructural									
Major Routes - 119, 111, 113 *	crossing Town	119 State, others T	V/S	Old Plows need replacing	support DPW w/ brush removal eq.	Elevate Rt. 111 & Bridges	Dam removal / Road Washout	H	L
Airport / Helipad	Rt. 111	Private	S	source of supplies/evacuation - maintain as 'important asset'				L	O
Medical facility	Rt. 113	Private	S	immediate care - protect access / power				M	O
Town emergency communication RV	911 Town		V/S	generator maintenance - building maintenance			mold - leaky roof	H	L
Power Utilities	various	NGRID, PrivateU	V/S	vulnerability of substation on river; push utility for flood proofing				H	L
Societal				tree trimming needs to be escalated effort					
Elderly Housing Foster	River Rd Mason St	State	V	provide evacuation trans. / adequate sheltering?				H	O
Senior Center / Shelter	Nashua	Town	S/V	senior center can flood: flood Proofing Bldg / No showers / replace generator				H	S/L
Food Pantry	Rt. 111	Town	S	transportation to delivery towns / generator?				H	S/L
Churches & Libraries / CommCat		Town / Private	S	Historic Site / generator for Library / Designate as another shelter / Evaluate to remediate as well Retrofit Shelter				H	S/L
Schools (Shelters) G	Barrum Brook Nissi Hi	TOWN/R.D.	S					H	S/L
Environmental									
Rail Trail	Crosses Town	State	S/V	Not accessible in winter / Purchase snowmobile				M	S/O
Nashua, Nissitit R	Townwide	N.R.W.A. funds projects	S/V	wild/scenic river / Address pinkeye Dam issue / Provide public ed on			# flood risk to abuttors / Revel marina, W.Q.	M	O
Wheeler St. sensitive	Wheeler St		S/V	Increase Public awareness of habitat values & role in flood protection				M	O
Rt 111 sensitive Hab	Rt. 111		S/V					M	O
Wetlands / Vernal Pools	Town wide		S/V					M	O
Conservation Lands	various	Town	S					M	O
Economy			S/V						
Tove Value Banks	various	Private	S					L	O
Donalans Supermarket		Private	S					L	O
Shattuck Oil		Private	V	fuels have leaked	stricter inspection Standards as part of annual inspection / licencing			M-H	O
Farms	119		V/S	allow alt. energy sources WINDFARM **		$ subsidize to address loss ** dealing w/ drought or floods		M-H	O
Lomar Ind. Park		Private	S/V	floods: encourage road maintenance, floodproofing to keep operations active				L	O

Cell Towers

Can also be used as Emergency access

Dam blocks flow

* main corridor

Infra Dams & Bridges - town (private)

Covered Bridg - Historical site V/S

private

State

V/S

gas stations on Main St corridor

NW facility - Rt. 111 TOWN V/S

FLOOD mitigation assessment + ps elevate utilities

3 wells Public

Bemis Rd
Jersey St.
Nashua Rd

generators??
elevating elec. utilities

Table #4 notes

JM - portable generator for vulnerable town assets if not equipped w/ a generator
  i.e... library
    - cooling center but not a warming center

DS - senior center? generator? but in a flood zone

DS - churches are an asset, communication tool to members who are residents

DS - reverse 911 / communications facility

DN - JM → livestock on farms that are sources of food —
  Lyndell Farm - Heald St
  Clover Luck - Jewett St

DN - our schools are our shelters

4

DN - can funds help us for example cut trees in a vulnerable area to prevent natural disaster

JM - can any funding be used on generators, etc...

Winterstorm weaknesses

1) old fleet of equipment & trucks had to keep up w/ some storms

- ensure electrical supply for wells elevated
- elevating roadways
- bridges may need elevating
- preventative maintenance on town buildings
- flood proof utility areas?

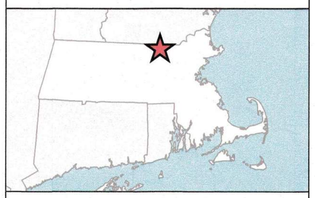
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Town of Pepperell

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LOCUS MAP



0 1,250 2,500
Feet

1:15,000

NOTES

Pepperell, Massachusetts

October 2019

Tighe&Bond
Engineers | Environmental Specialists

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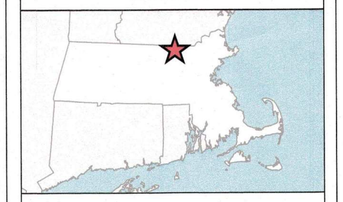
Table 4

Town of Pepperell - Zoom In

LEGEND

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LOCUS MAP



0 650 1,300
Feet

1:7,800

NOTES

Pepperell, Massachusetts

October 2019

Tighe&Bond
Engineers | Environmental Specialists

TABLE 4

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P-0671

Culverts

- in depth analysis & eval
- implement design, permit, const. program

Major Arteries (Rt 119, 113, 111)

- watershed / stormwater assess
- bylaws, update floodplain bylaw
- floodplain
- study on 119 to elevate
- need new plans?

Communications Center

- eval design/const for advanced safety complex - LT
- backups for existing system - ST
- alternative comm, Redundancy

Hydro Dam

- EAP - require them to do it

Municipal & Private Wells

- educate
- backup sources
- isolate tanks to provide clean H_2O
- Reduce impacts from ↑ stormwater - Lawrence St/Gulf Brook Restore remove Dam

Power Utilities

- tree trimming & lg. dead tree mgmt
- public ed on power use

WWTF

- management/maint
- floodplain adjustment will impact? evaluation

Nursing Homes / Elderly Housing

- plan for AC, evacuation

Major Wetlands

- beavers
- mosquito management

add Shower @ COA

Emergency Mgmt

- Generators for facilities ~~(eg. library)~~
-

~~Elderly Housing~~

- ~~evacuation transportation~~

Schools | Churches | Libraries

- generators
- communication

Farms

- emergency evacuation plan for livestock

~~Public Works~~

~~water + sewer~~

Pharmacies

- agreement to allow access for energy supplies

Gas Heating & Diff

- agreement w/ private vendor about supplies for highway dep.

Town of Pepperell
MVP/HMP Workshop #2
November 2, 2019

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Agenda
Presentation
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Sign in Sheet
Overview Map
Table 1:
- Matrix
- Notes
- Maps

Table 2:
- Matrix
- Notes
- Maps

Table 3:
- Matrix
- Notes
- Maps

Prioritized Recommendations and Voting Results

Meeting Agenda

ATTENDEES: Pepperell Municipal Vulnerability Preparedness Community Resilience Building Workshop

LOCATION: Community Center

DATE: November 2, 2019

START TIME: 9:00 AM

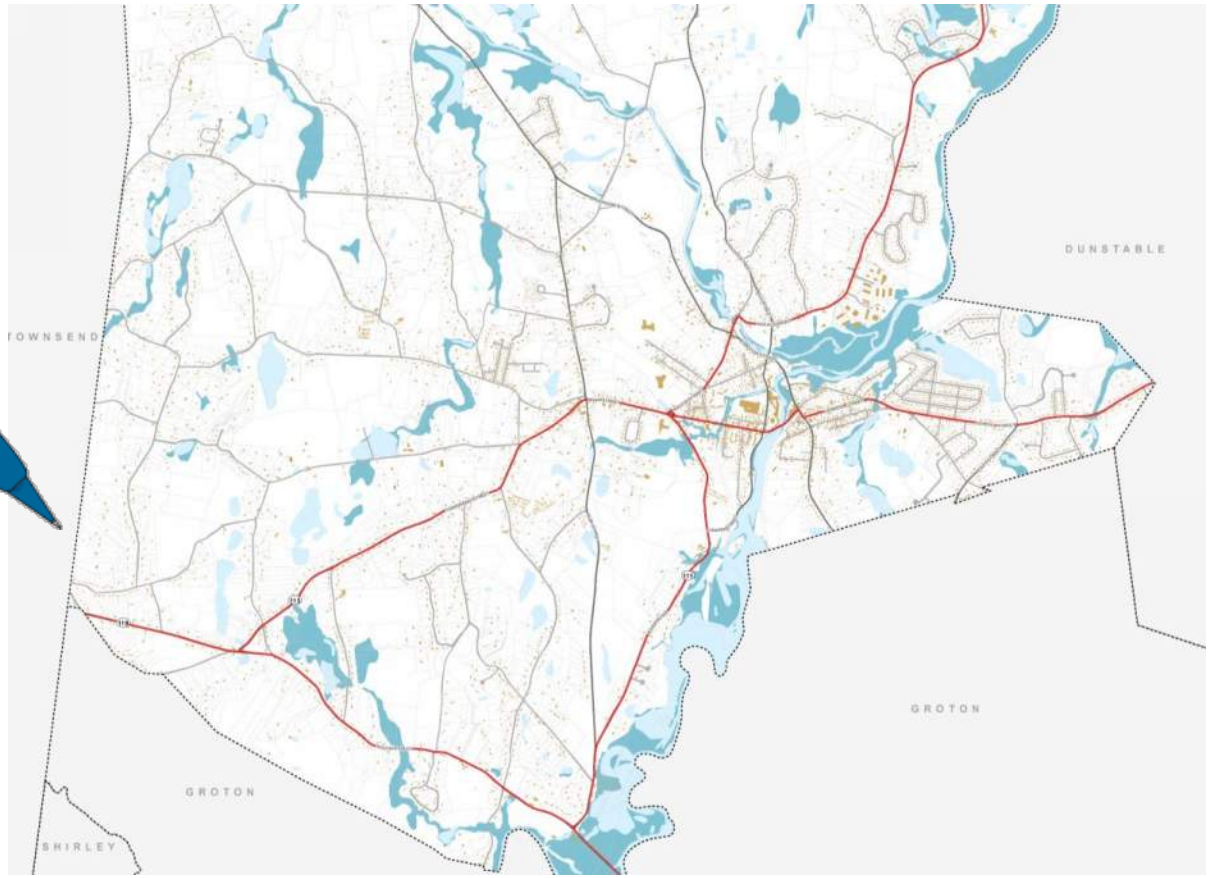
9:00 AM	Sign in, Refreshments	
9:15 AM	Welcome and Introductions	Town Administrator
9:20 AM	Presentation on Hazards, Climate Change, and Workshop Logistics	Tighe & Bond
9:45 AM	Session 1: Identifying Risk Areas and Community Strengths	Tighe & Bond
10:00 AM	Table Discussion #1: Identifying Risk Areas and Community Strengths	Table groups
10:45 AM	Break	
11:00 AM	Session 2: Mitigation Strategies for Vulnerable Assets	Tighe & Bond
11:10 AM	Table Discussion #2 Identify Actions to Address Vulnerabilities or Protect Strengths	Table groups
11:50 AM	Short Break	
12:00 PM	Session 3: Groups Priortize top 5 to 6 actions	Table groups
12:20 PM	Session 4: Table Groups Report to Full Group	Table groups
12:45 PM	Wrap up and closing remarks	Tighe & Bond & Town
1:00 PM	Adjourn	

PLEASE SIGN IN & MAKE A NAMETAG

Where do you live or work in Pepperell?

Help us by marking it on the map on the table.





Tighe&Bond



TOWN OF PEPPERELL



COMMUNITY RESILIENCE BUILDING WORKSHOP

November 2, 2019

Tighe&Bond

WELCOME & INTRODUCTIONS

Help Pepperell Build Resilience and Preparedness:

- Plan for more frequent and intense weather events
- Improve pre-event planning, response & recovery, and long-term actions
- A prepared and resilient Pepperell will be able to maintain functions, protect its residents and businesses, and be ready for future storm events and a changing climate

A brief thanks to Pepperell's Hazard Mitigation Plan and MVP Core Team



Lisa Davis

David Querze

Beverly Woods

Brynn Montesanti

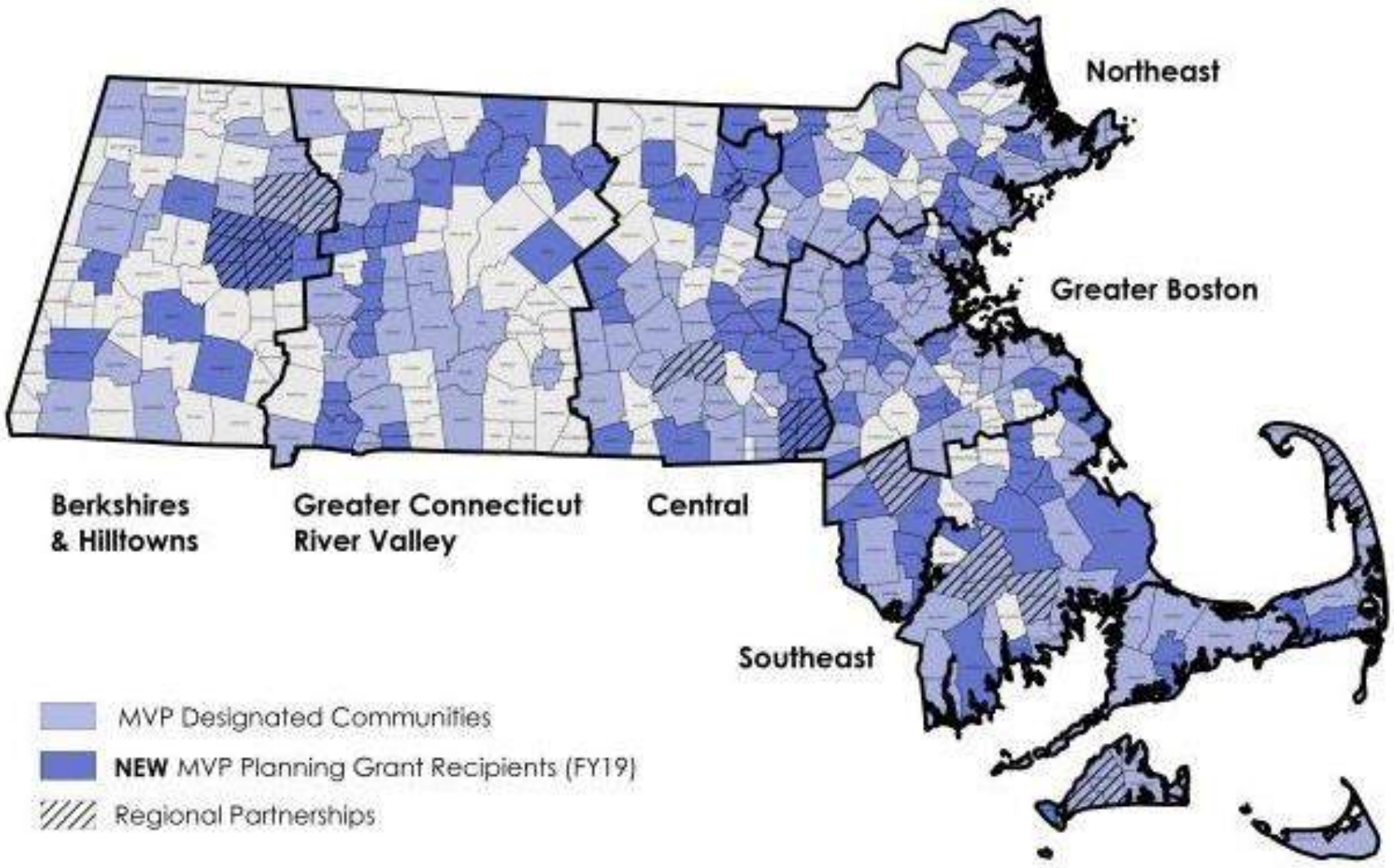
Paula Terrasi

Ken Kalinowski

Andrew MacLean

Kalene Gendron

MVP PLANNING GRANTS



MVP ACTION GRANTS

- Detailed Vulnerability and Risk Assessment*
- Community Outreach and Education
- Local Bylaws, Ordinances, Plans, and Other Management Measures**
- Redesigns and Retrofits***
- Nature-Based Flood Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques
- Nature-Based, Infrastructure and Technology Solutions to Reduce Vulnerability to Extreme Heat and Poor Air Quality



* Most common project type

** Second-most common project type

***Third-most common project type

MVP ACTION GRANTS (CONT)



- Nature-Based Solutions to Reduce Vulnerability to other Climate Change Impacts
- Ecological Restoration and Habitat Management to Increase Resiliency

NEW IN 2019

- Energy Resilience
- Chemical Safety
- Land Acquisition for Resilience
- Subsidized Low-Income Housing Resilience Strategies

\+ Expanded eligibility of project location

BRIEF OVERVIEW OF THE HAZARD MITIGATION and MVP PLANNING PROCESS

1) Define potential risk due to natural hazards including impacts of climate change

2) Identify key community assets and vulnerability to risk

3) Define mitigation projects to improve resiliency

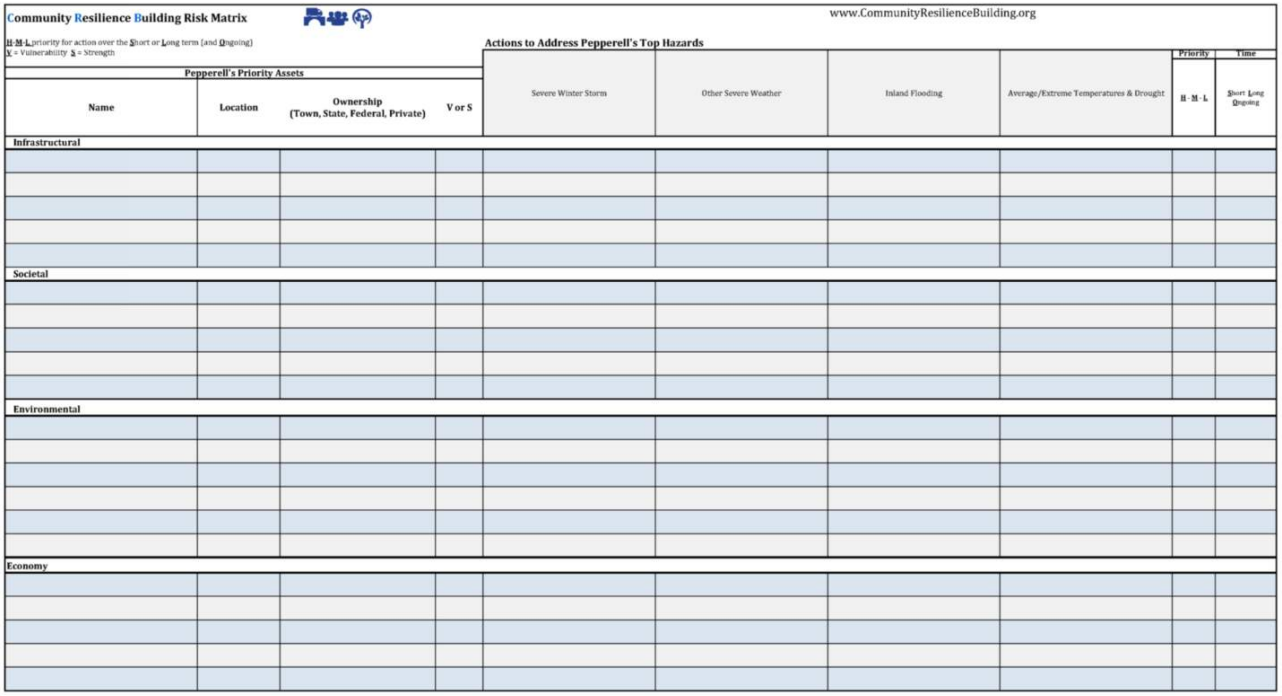
4) Prioritize projects for areas most at risk



WORKSHOP LOGISTICS

- **Three facilitated table-top/group discussions**

- **Fill out matrix**



Community Resilience Building Risk Matrix — www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Societal									
Environmental									
Economy									

- **As a group, we report and prioritize**

NATURAL HAZARD RISK ASSESSMENT

HISTORICAL EVENTS

- **August 1948 Highest Temperature Recorded**
  Temperature of 105 degrees recorded in Pepperell
- **January 1957 Lowest Temperature Recorded**
  Temperature of -29 degrees recorded in Pepperell
- **March 1968 Ice Jam**
  Ice jam on the Nashua River
- **1987 Major Flooding of Nashua River**
  Road closures, school closed
- **July 2002 Thunderstorm Wind**
  Winds recorded over 70 mph
- **March 2010 Nashua River Flooding**
  Flooding of the Nashua River leads to closure of Route 111 and Route 119
- **August 2011 Hurricane Irene**
  Devastating flooding, wind damage
- **October 2011 Halloween Storm**
  Power out for seven days
- **March 2018 Nor'easter**
  Pepperell received 20 inches of snow from a winter nor'easter

WHAT ARE NATURAL HAZARDS?


Inland Flooding


Tsunami


Severe Winter Storm

Blizzards
Snow
Ice Storms


Drought


Average/Extreme Temperatures


Tornadoes


Landslide


Wildfires


Other Severe Weather

Nor'easters
High Wind
Heavy Precipitation
Microbursts


Hurricanes/Tropical Storms


Invasive Species


Earthquake

MASSACHUSETTS CLIMATE PROJECTIONS

By end of century:

Changes in precipitation

- 18% increase in consecutive dry days
- 57% increase in days with > 1 in. rainfall
- 7.3 inches additional annual rainfall

Rising temperatures

- 10.8°F increase in average annual temperature
- 42% decrease in days/year with min. temperatures < 32* F
- 1,280% increase in 90-degree days/year

Sea level rise

- 4-10.5 feet along the MA coast

Extreme weather

- Increase in frequency and magnitude



CHANGES IN PRECIPITATION

Climate Indicator		Observed Value **1971-2000 Average**	Mid-Century **Projected Change in 2050s**	End of Century **Projected Change in 2090s**
Days with Precipitation > 1"	Annual	7 days	Increase by 10-42% 8-10 more days per year	Increase by 15-55% 8-11 more days per year
	Winter	2 days	Increase by 10-69% 2-3 more days per year	Increase by 25-109% 2-3 more days per year
	Spring	2 days	Increase by 2-46% 2 more days per year	Increase by 11-82% 2-3 more days per year
Total Precipitation	Annual	47 inches	Increase by 2-13% Increase of 1 - 6 inches	Increase by 3-16% Increase of 1.2 - 7.3 inches
	Winter	11.2 inches	Increase by 1-21% Increase of 0.1 - 2.4 inches	Increase by 4-35% Increase of 0.4 - 3.9 inches
Consecutive Dry Days	Summer	12 days	Variable (-1 - +2 days)	Variable (-1 - +3 days)
	Fall	12 days	Increase by 0 - 3 days	Increase by 0 - 3 days

Projected changes in precipitation variables by the middle and end of century based on climate models and the medium and high pathways of future greenhouse gas emissions.

https://resilientma.org/changes/changes-in-precipitation

IMPACTS OF CHANGING PRECIPITATION

- Episodic droughts
- Public drinking water supply
- Flora and fauna
- Agriculture



RISING TEMPERATURES

Nashua Basin		Observed Baseline 1971-2000 (°F)	Projected Change in 2030s (°F)	Mid-Century Projected Change in 2050s (°F)	Projected Change in 2070s (°F)	End of Century Projected Change in 2090s (°F)
Average Temperature	Annual	46.78	+2.20 to +4.44	+2.99 to +6.39	+3.54 to +9.02	+3.90 to +10.95
	Winter	25.2	+2.20 to +5.10	+2.81 to +7.60	+3.65 to +9.22	+3.94 to +10.58
	Spring	44.94	+1.64 to +3.47	+2.51 to +5.53	+2.72 to +7.71	+3.25 to +9.45
	Summer	67.56	+2.24 to +4.55	+3.14 to +7.02	+3.53 to +10.13	+3.98 to +12.60
	Fall	49.01	+2.18 to +5.10	+3.71 to +6.64	+3.58 to +9.54	+4.05 to +11.79
Maximum Temperature	Annual	57.77	+2.06 to +4.26	+2.73 to +6.47	+3.23 to +9.09	+3.55 to +10.95
	Winter	35.13	+1.84 to +4.62	+2.44 to +7.05	+3.02 to +8.41	+3.43 to +9.60
	Spring	56.16	+1.52 to +3.43	+2.35 to +5.51	+2.67 to +7.91	+3.25 to +9.55
	Summer	79.16	+1.97 to +4.68	+2.98 to +7.23	+3.42 to +10.45	+3.87 to +12.93
	Fall	60.19	+2.34 to +4.92	+3.56 to +6.97	+3.45 to +9.79	+3.96 to +12.25
Minimum Temperature	Annual	35.78	+2.33 to +4.78	+3.26 to +6.47	+3.80 to +8.94	+4.24 to +11.00
	Winter	15.26	+2.49 to +5.62	+3.27 to +8.10	+4.23 to +10.02	+4.41 to +11.40
	Spring	33.72	+1.77 to +3.82	+2.66 to +5.92	+2.83 to +7.51	+3.25 to +9.31
	Summer	55.97	+2.46 to +4.60	+3.23 to +7.16	+3.65 to +9.81	+4.12 to +12.27
	Fall	37.83	+1.99 to +5.23	+3.62 to +6.59	+3.68 to +9.27	+4.11 to +11.62

https://resilientma.org/changes/rising-temperatures

IMPACTS OF RISING TEMPERATURES

- Heat and public health
- Agriculture and livestock
- Aquatic and terrestrial habitat
- Energy systems and infrastructure
- Drought and wildfires



EXTREME WEATHER & IMPACTS

Blizzards

- There have been more than 5 in Massachusetts since 2011

Nor'easters and Hurricanes

- Upward trend since the 1970s



- **Public safety**
- **Economy**
- **Property and infrastructure**
- **Natural resources**

https://resilientma.org/changes/extreme-weather

PEPPERELL'S TOP NATURAL HAZARDS

Inventory of Natural Hazards

Type of Natural Hazard	History of Occurrence in Pepperell	Hazard Probability	Hazard Frequency	Geographic Extent	Severity of Impact	Hazard Risk Ranking
Hydrological Hazards						
Inland Flooding	Yes	3	3	2	3	11
Coastal Flooding	No	0	0	0	0	N/A
Drought	Yes	3	3	2	2	10
Atmospheric Hazards						
Extreme Temperature	Yes	3	3	3	1	10
Hurricanes / Tropical Storms	Yes	2	2	3	2	9
Other Severe Weather	Yes	3	3	3	1	10
Severe Winter Storm	Yes	3	3	3	2	11
Tornadoes	No	1	0	1	3	5
Microburst	Yes	3	3	1	1	8
Geological Hazards						
Coastal Erosion	No	0	0	0	0	N/A
Earthquake	Yes	1	0	3	3	7
Landslide	No	1	0	1	1	3
Tsunami	No	0	0	0	0	N/A
Other Hazards						
Wildfires	Yes	3	1	1	1	6
Invasive Species	Yes	4	3	2	1	10

Tighe&Bond

ASSESSMENT METHOD

Definitions

Points		Description
Hazard Probability (Possible occurrence in the future)		
1	Unlikely	Less than a 1% probability over the next 100 years
2	Possible	1-10% probability in the next year or at least one chance in the next 100 years
3	Likely	10-100% probability in the next year or at least one chance in the next 10 years
4	Highly Likely	Near 100% probability in the next year
Hazard Frequency		
0	Very Low	Events that occur less frequently than once in 1,000 years (less than 0.1% per year).
1	Low	Events that occur from once in 100 years to once in 1,000 years (0.1% - 1% per year).
2	Medium	Events that occur from once in 10 years to once in 100 years (1% - 10% per year).
3	High	Events that occur more frequently than once in 10 years (greater than 10% per year).
Geographical Extent (Area Impacted by a Given Natural Hazard)		
1	Small	Less than 10% of the Town affected
2	Medium	10-50% of the Town affected
3	Large	More than 50% of the Town affected
Severity of Impact from Hazard		
1	Minor	Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e. one or two communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.
2	Serious	Scattered major property damage (more than 10% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services briefly interrupted up to 1 day; some minor injuries.
3	Extensive	Consistent major property damage (more than 25%); major damage public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and possible fatalities.
4	Catastrophic	Property and public infrastructure destroyed (more than 50%); essential services stopped for 30 days or more, multiple injuries and fatalities.

PEPPERELL'S TOP NATURAL HAZARDS

SEVERE WINTER STORMS

OTHER SEVERE WEATHER

INLAND FLOODING

DROUGHT & EXTREME TEMPERATURE



+ **CLIMATE CHANGE**



=

AMPLIFIED RISKS

- Community and regional infrastructure
- Local and regional economies
- Public Health
- Natural resources and our environment

Tighe&Bond







Session #1

Identify Risk Areas and Community Strengths

9:45 AM

Tighe&Bond

DISCUSSION AT TABLE





Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
								Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
Infrastructural									
Societal									
Environmental									
Economy									

Tighe&Bond

WHAT ARE COMMUNITY ASSETS?

Built Environment: Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or for critical facilities to operate.

Economy: Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.

People: Areas of greater population density, or population with unique vulnerabilities or less able to respond and recover during a disaster.

Natural Environment: Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.

EXAMPLES OF VULNERABILITIES & STRENGTHS



Vulnerabilities

- Main road floods during storms, blocking emergency response.
- Power outages during heat waves lead to health concerns.
- Sewer pump stations become submerged and inoperable
- Senior housing without back-up generators during heat waves.
- Residents without access transportation during hurricane evacuation.
- Limited areas of refuge in schools during tornados.

Strengths

- Critical road elevated and passable by emergency management.
- Hardened utility lines reduce outages due to ice storms.
- Undersized culvert replaced to reduce flooding in key intersection.
- Improvement to communication systems during extreme weather.
- Private businesses provide services aligned with emergency operations.
- Floodplains provide stormwater storage and downstream flood reduction.





Session #2

Identify Actions to Address Vulnerabilities and Protect Strengths

11:00 AM

DISCUSSION AT TABLE





Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
								Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
Infrastructural									
Societal									
Environmental									
Economy									

Tighe&Bond

TYPES OF MITIGATION ACTIONS



1. Prevention
2. Property Protection
3. Public Education and Awareness
4. Natural Resource Protection and Green Infrastructure (nature-based solutions)
5. Structural Projects
6. Emergency Services Protection





Session #3

Table Groups Prioritization

12:00 PM

DISCUSSION AT TABLE



Select Top 5 to 6

www.CommunityResilienceBuilding.org

Community	Location	Ownership (Town, State, Federal, Private)	V or S	Actions to Address Pepperell's Top Hazards: Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	Priority H-M-L	Time Short Long Ongoing
Societal									
Environmental									
Economy									

Tighe&Bond

WHEN PRIORITIZING, CONSIDER…

- Funding availability and terms
- Consensuses in community for project
- Needed to advancing longer-term outcomes (e.g. phase of a project)
- Does it contribute towards meeting local and regional planning objectives





Session #4

Table Groups report out to Full Group

12:20 PM

REPORT TO LARGE GROUP & RANK



Community Resilience Building Risk Matrix www.CommunityRe

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flood			
Infrastructural									
Societal									
Environmental									
Economy									

Tighe&Bond

NEXT STEPS

- Prepare MVP/HMP Report
- Become a certified Municipal Vulnerability Preparedness Community
- Maintain MVP status with annual progress updates to State (combined with Hazard Mitigation Planning update)
- Eligible for MVP action grant funding



Community Asset Categories

1. **Built Environment**: Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or for critical facilities to operate.
    a. Bridges
    b. Communication utilities (e.g., cell towers)
    c. Power utilities (e.g., gas pipeline, power plant, etc.)
    d. All town-owned buildings/facilities, including police, fire, IT, etc.
    e. Dams (public and private)
    f. Medical facilities (e.g., urgent care, etc.)
    g. Funeral homes
    h. Post offices
    i. Water facilities
    j. Wastewater facilities
    k. Transportation (e.g., local or regional bus stations, etc.)
    l. Railroad
    m. Gas stations

2. **Economy**: Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.
    a. Major employers
    b. Supermarkets
    c. Pharmacies
    d. Towing services
    e. Hardware stores
    f. Oil delivery services
    g. Tree removal services
    h. Construction companies
    i. Farms

3. **People**: Areas of greater population density, or population with unique vulnerabilities or less able to respond and recover during a disaster.
    a. Schools
    b. Vulnerable populations, environmental justice area
    c. Churches
    d. Child care
    e. Food pantries
    f. Historic sites
    g. Special needs schools
    h. Nursing homes/elderly housing/elderly care
    i. Community centers
    j. Libraries
    k. Cemeteries
    l. Affordable housing
    m. Shelters

4. **Natural Environment**: Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.
    a. Open space
    b. Major wetlands and waterbodies
    c. Vernal pools
    d. Trails
    e. Habitat

Town of Pepperell
Municipal Vulnerability and Preparedness Stakeholder Workshop
November 2, 2019
9:00 am – 1:00 PM

Name	Affiliation	Contact Information – Email or Phone
Renee D'Argento	Master Planning Adv. Com. Climate Working Grp	978-807-3875 rdargento01463@yahoo.com
Ken Hartlage		khartlage@mac.com
Tony Beattie	Robinwood Farm	975-877-7545
Jim Scandalis	MASHARD	978-495-0480
Wm Van Leeuwen		978-433-6031
Caitlin Andrus	NMCOG	978-454-8021
Charles P Walkovich	Planning Board	cwalkovich@GMail.com 508-771-2137
Bruce McHugh	Planning Board	rmchugh@pepperellma.us
Casey Compeau	Planning Board Historical Comm.	412-689-3710
Rob Pond	Cons. Comm	978 433 5842
Beth Faxon	Resident	978 697 1556

Town of Pepperell
Municipal Vulnerability and Preparedness Stakeholder Workshop
November 2, 2019
9:00 am – 1:00 PM

Name	Affiliation	Contact Information – Email or Phone
Gabrielle Belot	Tighe & Bond	gbelfit@tighebond.com
Laurie Masiello	MASY	Laurie.Masiello@masy.com
John Masiello	MASY	John.Masiello@masy.com
DAVID WALSH	WALSH BROS.	978 621 9976
Andrew MacLean	Town of Pepperell	

Town of Pepperell

Where do you live or work?

Nov 2, 2019

TOWNSEND

DUNSTABLE

GROTON

SHIRLEY

Police Station
Fire Station
Town or City Hall
Department of Public Works
School
Animal Shelter/Veterinary Facility
Bridge
Child Care Facility
Elderly Housing
Power Generating Plant
Power Substation
Public Health Office
Communication Tower
Wastewater Treatment Plant
Water Pumping Station
Water Storage Tank
Water Treatment Plant

FEMA 100-Year Flood Zone
High Hazard
Significant Hazard
Low Hazard
N/A
Public Water Supplies
Trail
Waterbody

MassDOT Roads
Limited Access Highway
Multi-Lane Highway, NOT Limited Access; Other Numbered Highway
Major Road - Collector

Open Space Parcels
Town Land, Permanently Protected
Town Land, Unprotected
State Land, Permanently Protected
Land Trust, Permanently Protected
Agricultural Preservation Restriction (APR)
Conservation Restriction (CR)
Land Under Chapter 61, 61A, or 61B

LOCUS MAP



0 1,250 2,500
Feet

1:15,000

NOTES

Pepperell, Massachusetts

November 2019

Tighe&Bond
Engineers | Environmental Specialists

G:\GIS\MA\Pepperell\Pepperell_MVP_Map_24x36.mxd Date Saved: 11/1/2019 User: jsm

P-0671

Table 1

To Pepperell a Regional evacuation center

Electrical Resiliency: micro grid would benefit sustaining power for Utilities + Town Buildings, Shelters etc. — Study of Feasibility & Benefits vs Private Generators H-S

General Public - Emergency Management Protocol. what to do, where to get help. in event of natural disaster. Sign up Reverse 911

Town Hall

Police/Fire

see more below

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
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Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards				Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
Infrastructural									
Bridges - Nashua St.	- Nashua R - Town; - Nissitissit R (Hollis) - State		V/S			Rt 119 - Study on Condition & Improvements		H	L
" - Main St	- Rt. 113 Nashua, Rt. 119		V/S						
Emergency Services (in shelter)	Main St.	TOWN	V/S	Feasibility & Design for New Public Safety Complex - phase 1				H	S
~~(Lower Park)~~ * WWTPs DPW	Lomar Rd	Town/Private	V/S	WWTP ~~Resiliency~~ Improvements - ROAD Access Study				M	S
Private & Public Water	3 wells 50/50 private	Town/Private	V/S	Public = Resiliency Improvements; sustainable water supply; Wellhead Plans; Water System Master Plan				M	S
				study; FloodProofing		Zoning & overall Micro Grid to sustain utilities [Zoning & bylaw updates - private]			
Societal									
Senior Center	Lomar Rd	TOWN	V/S	Floodproofing Bldg - generator				H	S
Elderly Housing	varies	Private/Public	V	Preparedness education, evacuation transportation, generators					
Schools/Shelter**	varies	TOWN	S	Generator upgrades - Overall Shelter Management Plan				Emergency Preparedness	
Library	Main St	TOWN	S	Generator, evaluate efficacy as PS OR 2nd tier PS				Plan & Shelter Assessment	
Historic Places	varies	TOWN / Private	V/S	Inventory & BC guidelines Development following NFIP guidelines					
Environmental									
Nashua & Mascoma floodPlains -	Storage Habitats - aquifer		S	WQ study 36 sources to control from septics public education. update BOH regs + inspections				H	O
Sensitive habitats	varies		S/V	invasive species removal: conditions survey: public education				Priority - "Local" Lands Aquisition Buy Land	
farms + Open Space	varies	TOWN / Private	S/V	purchase lands in floodplain & open space / zoning bylaws to maintain OS					
Forest + Woodland	varies	TOWN / State	S/V	~~conservation~~ ~~forest~~ dev. forest management plans for resiliency					
Recharge from Septics	varies	Private	S/V	Benefit to recharge / treatment to pollute floodplains/aquifer CWMP					
Trail Systems	varies	Town / State	S						
Economy									
Farms	varies	Private	S	ask DEP for ground water; More incentives to grow; Plan Regional storage + distribution; Farmers Market; Food Hub - Equity issue to seniors & SVP (Schools)				H - O	
Trails + ~~recreation~~ recreation trails	varies	TOWN	S	Look for local sites to restore & remove invasives				M	O
Rail/road Square	E. Pepperell (east Main)		S/V	plant trees for shade/cooling as				M	S
Main St. Business	Main St	Private	S	(Utility Resilience Grants) Target PE to business owner about utility resiliency & staying open & safe in a storm					S/L
Lomar Park + Mill St.	Ind Park	Private							

Trail Hub

* WWTP
Cable
Cell Town
DPW
Senior Center

** Culverts

** Maple St Fallout Shelter

*** Jersey St. Fire Station Park Assess -

*** Loss of transportation corridors impact everything in Pepperell
Complete Streets ensure "access"

Need more Plows

(D TABLE 1

— fill out Complete Sts survey

Advisory team - Jim, Tony,

Core Team: core team: Ken, Kaline, Andrew, David Querze, Paula, Lisa Davis, Beverly Woods, Brynn Montesanti.

Inventory people, places, hx past. impacted by weather -

report presented to Comm'g - get add'l comments -
End in late winter -
Spring 2020.

Nature based solutions.

NJMC06 - regional hazard mitigation plan - will be updating Pepperell's piece

S/W - Hazards (2) TABLE 1

Societal

~~Sackville~~. affordable hsg on Canal St - exposed to flooding

Babcia-sit Village - risk of isolation, being cut off from services

Asset. - library; cooling; generator; social etc.

Vulnerable ~~pop~~. pop: Clark's off of 111

Schools as shelters.

60x120 - Fallout shelter size

Environmental

NASkwa/Nissitissit - stores flood H_2O; vulnerable to contamination

protection of aquifers -

strength + vulnerable -

flora/fauna: both strength + vulnerable.

Farms - open spaces -

forests/woodlands - carbon capture -

private septic systems.

Trail systems.

S/W Hazards (3) TABLE 1

Infrastructure:

- Covered bridge: historic but also transportation nexus - alternate route if others are closed - wld end up being a critical route -
- Mill Street bridge -
- Hollis St bridge

Multiple vulnerable bridges to flooding on the Nashua & ~~Mis~~ Nissitissit

- 113 Main St.
- 119

Critical circulation in all directions - n. to N. H; E ↔ W

Municipal emergency services
Shattuck School - police

sewer treatment plant -
proximity to Nashua River -
cell tower; cable -
} Lomar Park.

Jersey St. Fire Station -
Town Hall

S/W (4) TABLE 1

Sr. Ctr — cooling center; Meals on Wheels; shelter. w/in the 100 yr flood plain.

wells water:

Jersey St. well is in service

Nashua River well: toxic dirt. — affects S. New Hampshire

potential for dams/bridge going out trumps road infrastructure —

water supply absolutely critical 50% of town is on private H_2O.

Bemis well is being upgraded — 8½ million for manganese/iron. Shut down now.

societal

S|W Hazards. (5) TABLE 1

Economy

RR # – biggest concentration of economy – right next to rivers

Rivers – trails/recreation – eco-tourism as impo to the town.

Main St. businesses – historic bldgs. –

highly vulnerable to loss of transportation

Mitigation (6) TABLE 1

- need study About town's water capacity (wells) WATER System masterplan — private + public.
  - bylaw that protects private wells as well as public. master plan - current + future water (MASS DEP/Sustainable water initiative)

- Septic systems + ground water re-charge in flood plain areas. improve regulations + inspection practices - not part of MVP plan.

- purchase more open spaces - especially in sensitive ecosystem areas.

- forest management — rare eco habitats. sensitive habitats that old be experiencing invasive species — remove them.

Farming: plan for regional food storage + distribution.

Mitigation (7) TABLE 1

Strategies.

— $ FEMA grants — cld be down the road as part of hazard mitigation program.

Protect bridges + dams:

— ~~do we need~~ 11A is the most vulnerable; need engineering study.

— loss of transportation corridors & severe weather — need more plows + street clearing/ maintenance equipment

— need ~~here~~ feasibility + design study for public safety complex

— need infrastructure + road access study for Lamar Park as public/private venture

— electrical resiliency for all town operations, Senior Center, for all town bldgs + operations. — need a study for that.

— Zoning study to protect public water supplies.

Mitigation (8) TABLE 1

Strategies

— SR. Ctr (flooding + power Risk) flood proofing the Bldg.

— all designated shelters must have generators

— for private homeowners we need public education about emergency mngmt protocols; available state resources.

— need town plan for ex: Emergency response (reverse 911 on cell phone)

— identify 1 or more of town bldgs that come up to standard best practices. Pepperell cld be major evacuation center? Are we now? Are we regional? Fallout Shelter (1962)

— do not have local historic district. Under nat'l flood insurance program diff. set of requirements to receive $ — adapt Building Code for Pepperell to restore historic bldgs after weather disaster.

Mitigation (9) TABLE 1

farmer's water use in drought periods —.

SRs access to affordable food is an equity issue and part of the Food Hub idea as a regional storage + distribution system for farmers —

also speaks to school nutrition.

target info to business owners. about utility resilience.

(10)

Key

bc = because
wld = would
w/in = within

Town of Pepperell

Table 1

TOWNSEND

DUNSTABLE

GROTON

SHIRLEY

Nashua River – 119 Groton → Pepperell

Jersey St. Well

Tractor Park

Police Station
Fire Station
Town or City Hall
Department of Public Works
School
Animal Shelter/Veterinary Facility
Bridge
Child Care Facility
Elderly Housing
Power Generating Plant
Power Substation
Public Health Office
Communication Tower
Wastewater Treatment Plant
Water Pumping Station
Water Storage Tank
Water Treatment Plant

FEMA 100-Year Flood Zone
High Hazard
Significant Hazard
Low Hazard
N/A
Public Water Supplies
Trail
Waterbody

MassDOT Roads

Limited Access Highway
Multi-Lane Highway, NOT Limited Access; Other Numbered Highway
Major Road - Collector

Open Space Parcels

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Town Land, Unprotected
State Land, Permanently Protected
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LOCUS MAP

0 1,250 2,500
Feet

1:15,000

NOTES

Pepperell, Massachusetts

November 2019

Tighe&Bond
Engineers | Environmental Specialists

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Town of Pepperell

Table 1

DUNSTABLE

Police Station
Fire Station
Town or City Hall
Department of Public Works
School
Animal Shelter/Veterinary Facility
Bridge
Child Care Facility
Elderly Housing
Power Generating Plant
Power Substation
Public Health Office
Communication Tower
Wastewater Treatment Plant
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Infrastructure

Environmental (not noted-varies) Townwide

Societal

Economy

LOCUS MAP



N W E S

0 625 1,250
Feet

1:7,500

NOTES

Pepperell, Massachusetts

November 2019

Tighe&Bond
Engineers | Environmental Specialists

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Table 2

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards					
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Dams	Dead St Sartelle, Main	Public private	V			study of dam removal or improve		H/M	S
WWTP + pump stations	3 across town	town	S/V	study of improved resiliency of WWTP and/or expansion to serve addtl users				L	Long-term
Public + priv. wells + water plant	three major wells throughout town	pub./priv.	S/V	investigate more distributed power incl. renewable energy for renewable energy tribe.	-study of siting			H	S
Power grid	throughout - south town by bridge	priv.	"	↑ time ↑ study of impacts of climate change on water supply quant + qual.				H	S
Bridges + major arteries	Main St. Rt. 119	State/town	"	structural analysis of bridges + flooding impacts/remediation of major roadways				H	S
Societal Culverts	Town-wide			capacity anal. to address climate change				H	S
RV/Trailer	throughout town	priv.	V	survey of pop. on wells +	emergency response plan w/NGOS shelter capacity w/community input			H	S
elders/disability/low-income	"	N/A	V	"	"			H	S
school-aged children	Varnum Mass.	"	V	"	"			H	S
emer. shelters			S/V	power redundancies for shelters				H	S
Environmental									
Nashua + Nissitissit Rivers	on map	Pub. + priv. lands abutting	S/V		land acquisition + best practices for	education for on land management in	light of climate chg.	H	S
well contributing areas	mapped areas	Pub./priv.	V		review + up date aquifer prot. by law	+ overlay dist. bylaw		M	S
Wet. + prop.	across town	priv.	S/V		+ pub. education on BMPs; strengthen bylaws for enforcement			H	S
properties w/in flood plain	Rt. 119 corridor	Pub/priv.	V		permanent protection	- munic. training for enforcement BMPs			
forested land (CR)	throughout town	"	S/V			bylaw revs/ops to address floodplain level. land acquisition - study of		H	S/O
					acquisition + BMPs	policy, land + impact on natural resources (incl. species)	state-listed	H	S/O
						invasive species removal	apply for grant prog.		
Economy									
Shattuck oil	Groton St.	priv.	V/S		MOU to allocate resources	munic. user services		M	S
Wilson Auto	Nashua St.	"	V/S					M	S
Farms	across town	pub. + priv.	S/V		develop best practices for land mgmt. to address	climate chg. + education		M	L
supermarkets/food security	Main St.	priv.	S/V		coordinate efforts of NGOs (Patch + other NGOs)		for emer. food +	H	S
Pharmacies	Main St. Lowell + Groton	"	S/V				medicines - emer. response network	H	S
sky-diving park			S						

11/2 Workshop - Table 2

~~NTSS~~

- Infrastructure
  Bridges - town would set shut off
  DAMS -
- Societal -
  - schools vs. school age pop
  elderly / senior housing
- environmental

Nashua & Nissitissit

WRPD -

open space parcels

FLOOD Plain

- fuel companies - fuel depot

1

fuel storage –
Shattuck
~~Oil~~ Nillson Bros

- environmental –
  forested lands ?

- cell service spotty only
  1 internet provide

Farms – 1600 acres
in ag production
39 families town

Supermarket – only
1 in town –
food & food security

- streams are private
land acquisition
Stormwater – none

flen flooding:

- stormwater impacts on species - natural resources + habitats

- study + analyze floodplains + current impacts on natural resources including endangered species

- power supply - distributed power sources -

identify alternative feasibility for sitting renewable

Events: study of
volunteer
water supply -
emergency response
plan. land manage,
state program - how
do you manage your
past + agricultural
lands - best practices
"
leadership
revisit, weekly
districts
enforcement plan -
training -

non profit groups
community based orgn
are resources that can
be pulled together -
Study. emergency MAN-
S. plan -

emergency management
plan needs to include
non profits. how do
we make them successful

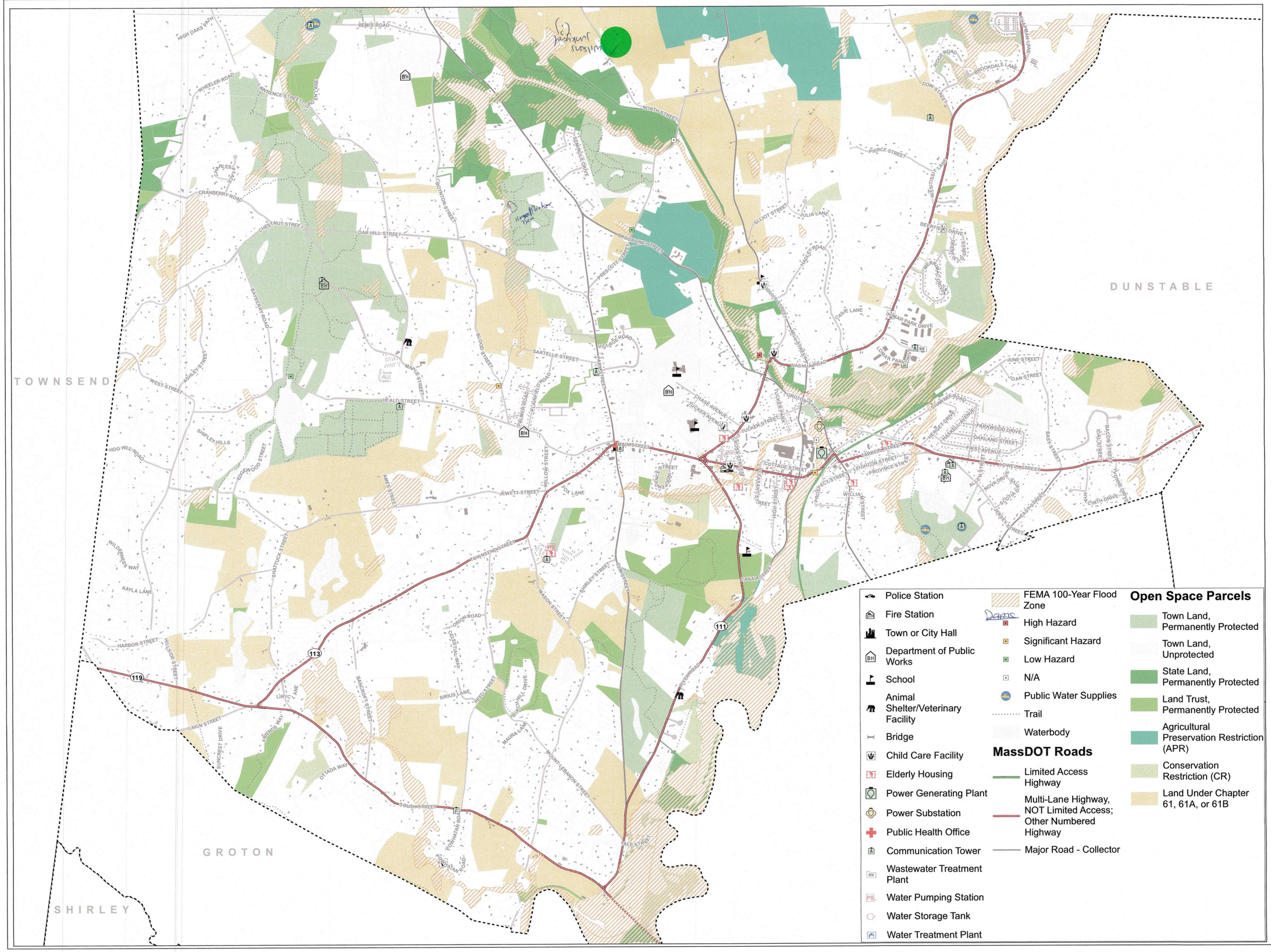
action items - studies
are short term but
implementation is
long term & ongoing

vulnerable population - high priority

top 5

1. - emergency management plan for vulnerable populations + critical infrastructure
2. culverts for properties within flood plain
3. land acquisition
4. zoning by law revising
5. Major Arteries - 119 111 113 (Bridges) FLOODING

Town of Pepperell



LOCUS MAP



0 1,250 2,500
Feet

1:15,000

NOTES

Table 2

Pepperell, Massachusetts

November 2019

Tighe&Bond
Engineers | Environmental Specialists

- Police Station
- Fire Station
- Town or City Hall
- Department of Public Works
- School
- Animal Shelter/Veterinary Facility
- Bridge
- Child Care Facility
- Elderly Housing
- Power Generating Plant
- Power Substation
- Public Health Office
- Communication Tower
- Wastewater Treatment Plant
- Water Pumping Station
- Water Storage Tank
- Water Treatment Plant
- FEMA 100-Year Flood Zone
- Dams
  - High Hazard
  - Significant Hazard
  - Low Hazard
  - N/A
- Public Water Supplies
- Trail
- Waterbody

MassDOT Roads

- Limited Access Highway
- Multi-Lane Highway, NOT Limited Access; Other Numbered Highway
- Major Road - Collector

Open Space Parcels

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Town of Pepperell

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Pepperell, Massachusetts

November 2019

Tighe&Bond
Engineers | Environmental Specialists

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P-0671

Table 3

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets — Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	Priority H-M-L	Time Short Long Ongoing
Actions to Address Pepperell's Top Hazards									
Infrastructural									
Fire Dept (both sides of river)		Town	S						
Airport (private)			S/V						
Fuel facilities		Private	S/V						
Bank									
Generators			S					H	S
hydro dam		Private	V						
urgent care		private	V/S						
pharmacy		private	S						
Societal			V/S						
Senior living (Babbitt, Brown, Pepperell Meadows)		town/state	V						
Schools			S						
Churches			S						
child care centers			S						
Funeral Homes			S						
Environmental									
Open space			S/V						
rivers			V						
Fire (forest) heavily forested			S						
Trails (access)			S						
Nashua River Rail Trail (plow)									
Economy									
Lamar Park		private	S/V						
Tree Removal/heavy equip op.		private	S						
restaurant			S						
oil delivery			S/V						
FARMS/rest/grocery			S/V						

Private Public Mixed

B. Generator-ready

* Applies to multiple

table 3 (1)

MVP - Municipal Vulnerability Preparedness
DoE grant - 71% cities + towns

Sustainability - core value

identifying inventory + resources impacted by climate changes

Jennie
Sharon
Gabrielle

Complete streets → Share w/ Lamar

MVP - action grants $10 M funds

4 Steps →

Key strengths + assets

4 top hazards
- Xtrem temps + drought
- Sever weather
- Severe winter storms
- inland flooding

} + climate change-amplified risks

(2)

vunerabilities + strengths

(3)

fuel - diesel / oil / gas
generators - plan
dam is vulnerable
Babitassit village - near river
urgent care + doctors office + pharmacy
supermarkets + restaurant
2 bridges bisect town
119 bridge floods
trees down - block roads
communications center + cell towers
cable company - communications
banks - cash ⇒ credit cards don't work w/ no power
people - need individual plans
AED / CPR trained people
Grotton St substation electricity
boats - canoes - ATVs - off roads
airports
floodplains - how river has changed
rivers - Gneff ~~Stream~~ Brook - perennial stream
wild fires - wheeler / Lawrence / head pond areas
back lots, limited access
rail trails - access
hiking trails ⇒ throughout town

(4)

37
farms - flooding
cultural monuments / covered bridge
wells - Bemis, 2 Jersey, Nashua Rd

(3)

threats most likely
extreme winter + flood
(summer drought less effect)
fire dept on both side of river - asset!
oil facilities - shattuck oil
Council 5+ Main St. Banks - local staff
severe weather issue - power outages

Seniors →
Babysit village
Pepperell Meadows
Tarbell Dunhauses (over 55)
police/emergency services issued 'cards'
for seniors to complete of health issues/
vulnerabilities that need help

better communication plan
fill bathtub of water
help people to help themselves - before

marked flooding areas in town
do culverts need to be fixed?
communication plan - how to test and hand
service your generators + gas on hand

facilities round tables
to share emergency preparedness tips
services people - technicians
to solve mechanical/electrical issues
prepare electric connections for generators
for town facilities, businesses, homes
store water for emergencies
have containers for water to fill up
plan for generators for key facilities
Churches - large empty spaces
some have kitchen facilities
network of volunteers + skilled people
'Sister Community' to offer aid, not from
an area that is also affected
Pepperell - aging population
evaluate flooding + bridge + culvert issues
storm water bylaws
fuel emergency access
promote self sufficiency - education

(1)

On going, short term, long term

Education + Communication plan
Resiliencies / maintenance
facilities generator ready + individuals
storm water bylaw, Culverts + bridges evaluation
storm water management
flood plain bylaw

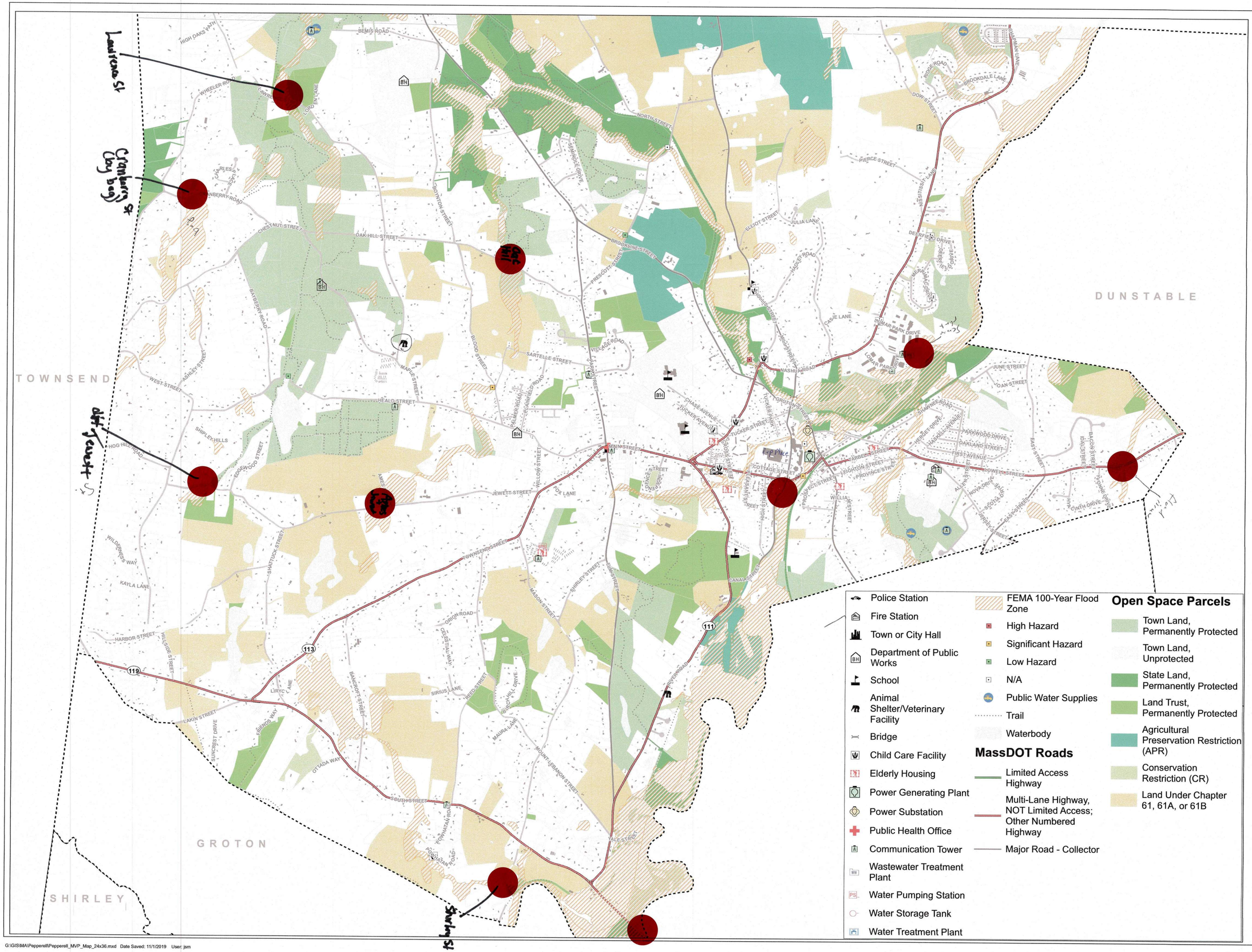
Watershed evaluation

aging population, 3 senior neighborhoods
vulnerable populations

regrandication

TABLE 3

Town of Pepperell



LOCUS MAP



N
W E
S

0 1,250 2,500
Feet

1:15,000

NOTES

Pepperell, Massachusetts

November 2019

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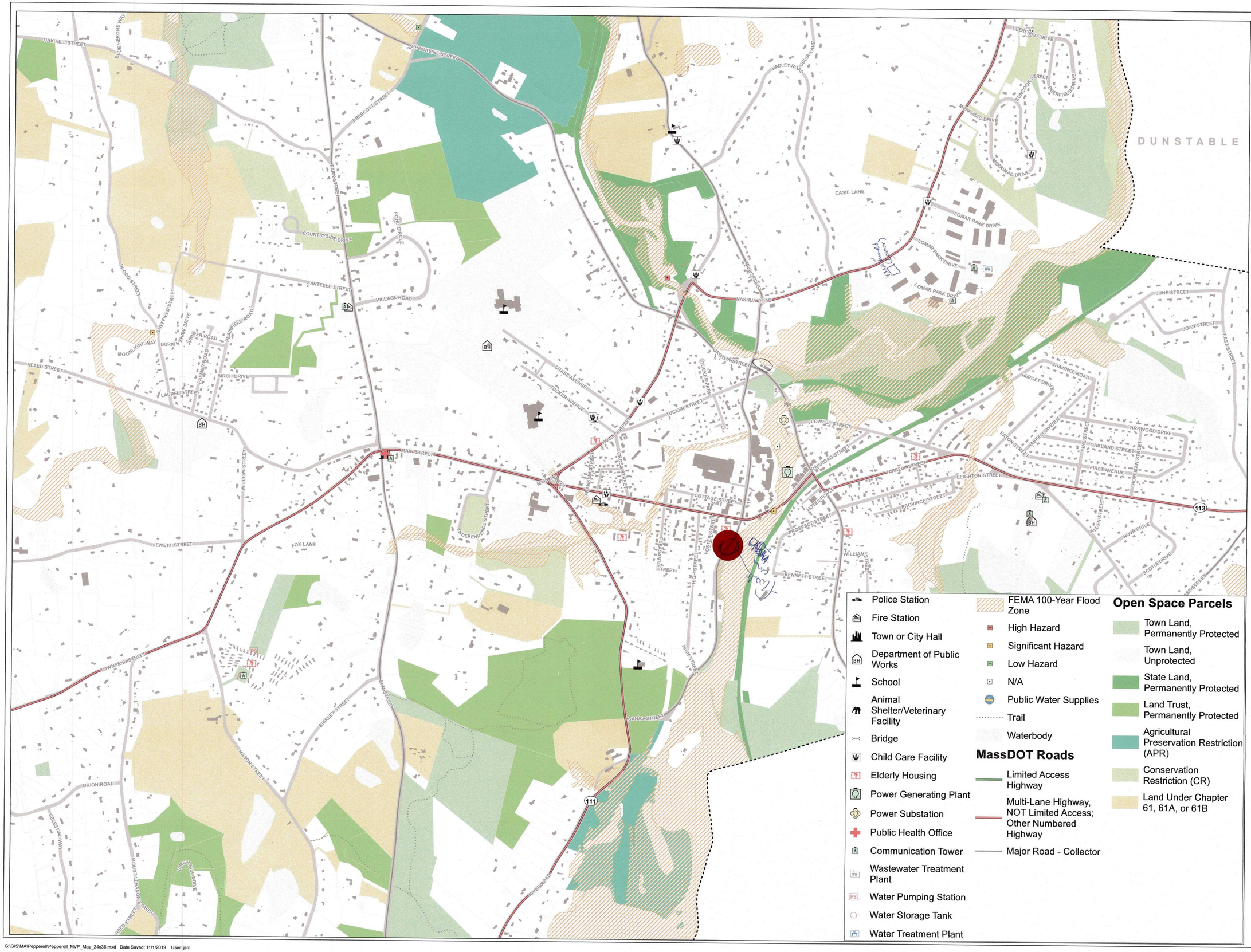
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TABLE 3

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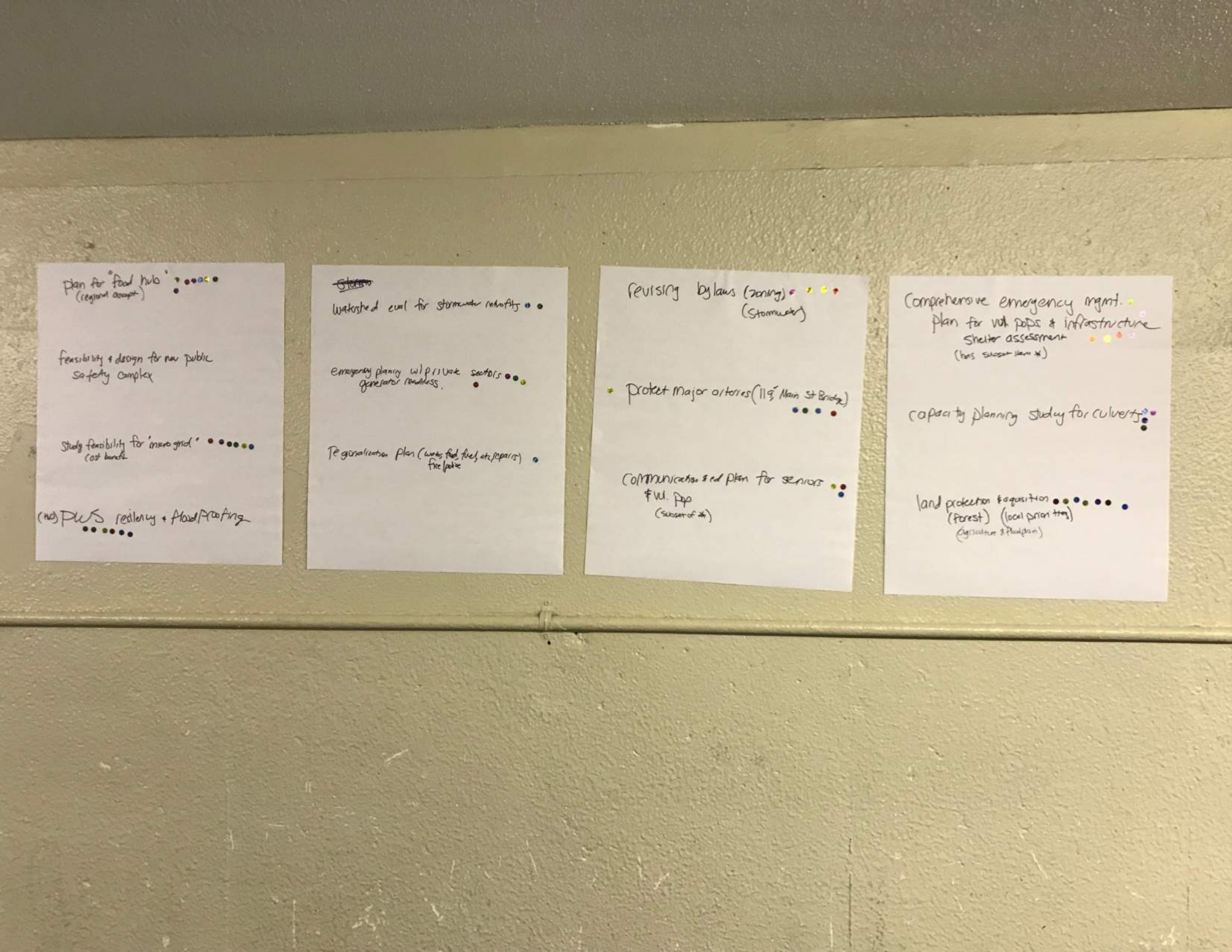
Pepperell, Massachusetts

November 2019

Tighe&Bond
Engineers | Environmental Specialists

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P-0671


plan for "food hub"
(regional concept)
feasibility + design for new public safety complex
study feasibility for "micro grid"
cost benefit
(incl) PWS resiliency + flood proofing
~~Storm~~
watershed eval for stormwater retrofits
emergency planning w/ private sectors
generator readiness.
Regionalization plan (work, food, fuel, etc./repairs)
fire/police
revising by laws (zoning)
(stormwater)
protect major arteries (119, Main St Bridge)
communication & ed plan for seniors
& vul. pop
(subset of #)
Comprehensive emergency mgmt.
plan for vul pops & infrastructure
shelter assessment
(has subset items #)
capacity planning study for culverts
land protection & acquisition
(forest) (local priorities)
(agriculture & floodplain)

Tighe&Bond
Engineers | Environmental Specialists

APPENDIX D

EXISTING CAPABILITIES OF PEPPERELL TO ADDRESS NATURAL HAZARDS

Local mitigation capabilities are existing authorities, policies, programs, and resources that reduce hazard impacts or that could be used to implement hazard mitigation activities.

Please review the list below- taken from the 2015 Adopted HMP. Provide any comment you would like to see in the updated plan, or update as indicated (highlighted items). Comments might include specific improvements since the last plan, or identified weakness based on experience over the last 5 years. Please add any new Implementation Elements as appropriate.

Existing Flood Hazard Mitigation Resources					
Implementation Element	*Lead Agency*	***Area Covered***	**Effectiveness/ Enforcement**	**2015 Adopted HMP Recommended these Improvements/ Changes**	**Is this Element still effective? If not, what changes are needed for 2020 HMP Update?**
National Flood Insurance Program (NFIP) – Pepperell participates in the National Flood Insurance Program. NFIP provides flood insurance to property owners in exchange for compliance with floodplain management.	*Planning Board*	FEMA 100-year flood zones	Effective	None.	Effective, no changes are needed.
Local Wetlands Protection Bylaw – In addition to the requirements of the state's Wetlands Protection Act, the local bylaw states that a 50-foor wide undisturbed, vegetated strip of naturally occurring plant species must be maintained between a certified vernal pool or wetland resource area.	*Conservation Commission*	Town-wide	Moderately effective	Bylaw should be reviewed and modifications considered.	Effective, no changes have been made, but modifications are needed.
Zoning bylaw addresses erosion control. The Town's zoning bylaw states that site design, materials, and construction processes shall be employed to avoid erosion damage, sedimentation, or uncontrolled surface water runoff.	*Planning Board*	Town-wide	Effective	None.	Effective.
Zoning bylaw contains a Water Resource Protection Overlay District. The Water Resource Protection Overlay District consists of three zones: Water Source Protection Zone (Zone I); Well Protection Zone (Zone II) and an Aquifer-Watershed Protection Zone (Zone III). Activities within each of these zones are regulated to protect groundwater from degradation.	*Planning Board/ Water Division*	Town-wide	Effective	None.	Effective.
Local Flood Control Bylaw (Chapter 95) – The Town bylaws contain a local floodplain bylaw consistent with the requirements of the National Flood Insurance Program.	*Conservation Commission*	Town-wide	Effective	None.	Flood control is effective, but bylaw should be updated and integrated into zoning bylaw rather than through town code.
Subdivision Regulations	*Planning Board*	Town-wide	Moderately effective	N/A	New element. Current requirements require drainage to be designed to handle a 25-year storm and culverts handle a 50-year storm. Should be updated to reflect the new MS4 permit and consistent with OSRD special permit which encourages LID.
Stormwater Regulations	*To be determined*	Town-wide	Moderately effective	N/A	New element. Town needs to develop, by 2021, to meet MS4 permit.

Capability Assessment Worksheet

Local mitigation capabilities are existing authorities, policies, programs, and resources that reduce hazard impacts or that could be used to implement hazard mitigation activities. Please complete the tables and questions in the worksheet as completely as possible. Complete one worksheet for each jurisdiction.

Planning and Regulatory

Planning and regulatory capabilities are the plans, policies, codes, and ordinances that prevent and reduce the impacts of hazards. Please indicate which of the following your jurisdiction has in place.

Plans	Yes/No Year	Does the plan address hazards? Does the plan identify projects to include in the mitigation strategy? Can the plan be used to implement mitigation actions?
Comprehensive/Master Plan	Yes	Update is in Process. Yes, plan identifies hazards and mitigation strategies.
Capital Improvements Plan	Yes	Capital Planning Committee is in the process of updating the CIP to improve it further.
Economic Development Plan	No	
Local Emergency Operations Plan	Yes	Plan identifies assets that are at risk
Continuity of Operations Plan	Yes	Does not really address hazards, but deals with backup and redundancy
Transportation Plan	Yes	NMCOG Regional Transportation Plan
Stormwater Management Plan	Yes	Written Stormwater Management Plan prepared to address compliance with EPA's MS4 General Permit
Community Wildfire Protection Plan	No	
Other special plans (e.g., brownfields redevelopment, disaster recovery, coastal zone management, climate change adaptation)	No	

Building Code, Permitting, and Inspections	Yes/No	Are codes adequately enforced?
Building Code	State	Version/Year: IBC 2015
Building Code Effectiveness Grading Schedule (BCEGS) Score	No	
Fire department ISO rating		
Site plan review requirements	Yes	Yes, site plan approval requires commercial projects greater than 3,000 square feet
Land Use Planning and Ordinances	**Yes/No**	**Is the ordinance an effective measure for reducing hazard impacts?** **Is the ordinance adequately administered and enforced?**
Zoning ordinance	Yes	Yes, the bylaw is effective but should be modified to encourage Low Impact Development (LID)
Subdivision ordinance	Yes	Subdivision bylaw needs to be revised to be consistent with the Open Space Residential Development Bylaw, which encourages LID, whereas subdivision bylaw does not. Bylaws can be updated to better reduce hazard impacts and to promote mitigation.
Floodplain ordinance	Yes	Not adequate and not adequately administered.
Natural hazard specific ordinance (stormwater, steep slope, wildfire)	No	Included in zoning bylaws
Flood insurance rate maps	Yes	Updated in 2010
Acquisition of land for open space and public recreation uses	Yes	Seven-year action plan included in Open Space and Recreation Plan, 2017
Other		

How can these capabilities be expanded and improved to reduce risk?

Administrative and Technical

Identify whether your community has the following administrative and technical capabilities. These include staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. For smaller jurisdictions without local staff resources, if there are public resources at the next higher level government that can provide technical assistance, indicate so in your comments.

Administration	**Yes/No**	**Describe capability** **Is coordination effective?**
Planning Board	Yes	
Mitigation Planning Committee	No	Pepperell has a Local Emergency Planning Committee
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems)	Yes	DPW responsible for clearing drainage; Highway Superintendent responsible for tree trimming.
Mutual aid agreements	Yes	
Staff	**Yes/No** **FT/PT[1]**	**Is staffing adequate to enforce regulations?** **Is staff trained on hazards and mitigation?** **Is coordination between agencies and staff effective?**
Chief Building Official	Yes, FT	Staffing is adequate. Staff are not trained.
Floodplain Administrator	No	Conservation Agent administers floodplain.
Emergency Manager	Yes, PT	Volunteer position with small stipend
Community Planner	Yes, PT	Staffing generally adequate Staff is trained
Civil Engineer	Yes, FT	Town Engineer is also head of DPW
GIS Coordinator	No	Town relies on regional agency (NMCOG) for GIS
Other Conservation Agent	Yes, PT	Yes, adequacy to enforce regulations.

1 Full-time (F) or part-time (PT) position

Worksheet 4.1
Capability Assessment Worksheet

Technical	Yes/No	Describe capability Has capability been used to assess/mitigate risk in the past?
Warning systems/services (Reverse 911, outdoor warning signals)	Yes	CodeRed, reverse 911, outdoor warning signals
Hazard data and information	Yes	Hazard mitigation plan, Pepperell Emergency Services Inventory does have some data on hazards
Grant writing	Yes	East department is responsible for grant writing.
Hazus analysis	No	
Other		

How can these capabilities be expanded and improved to reduce risk?

Financial

Identify whether your jurisdiction has access to or is eligible to use the following funding resources for hazard mitigation.

Funding Resource	Access/ Eligibility (Yes/No)	Has the funding resource been used in past and for what type of activities? Could the resource be used to fund future mitigation actions?
Capital improvements project funding	No	In process
Authority to levy taxes for specific purposes	Yes	Has not been used for mitigation
Fees for water, sewer, gas, or electric services	Yes	Used to expand services
Impact fees for new development	No	
Storm water utility fee	Yes	Yes, fee adopted.
Incur debt through general obligation bonds and/or special tax bonds	Yes	Could be used to fund routine mitigation.
Incur debt through private activities	No	
Community Development Block Grant	No	
Other federal funding programs	Yes	Received funds from FEMA for Halloween Storm (2011), Irene (2012), and Juno (January 2015), and Storm in 2018
State funding programs	Yes	Received grants from MEMA in past.
Other		

How can these capabilities be expanded and improved to reduce risk?

Education and Outreach

Identify education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information.

Program/Organization	Yes/No	Describe program/organization and how relates to disaster resilience and mitigation. Could the program/organization help implement future mitigation activities?
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	Yes	Town has a climate change and Resiliency Working Group
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Yes	Emergency Response Program includes an educational component.
Natural disaster or safety related school programs	No	
StormReady certification	No	
Firewise Communities certification	No	
Public-private partnership initiatives addressing disaster-related issues	No	
Other		

How can these capabilities be expanded and improved to reduce risk?

Capability Assessment

The capability assessment identifies the town's strengths and weaknesses for mitigating risks identified in the Hazard Mitigation Plan. The assessment examines the town's current capabilities and includes changes since completion of the 2015 Hazard Mitigation Plan. The assessment is useful in developing an effective hazard mitigation strategy in that it ensures that the goals and strategies articulated throughout the Plan are realistic and achievable, based on the town's governmental and staffing structure, and recognizing the extent of resources and tools available to the community.

FEMA defines four types of capabilities that should be considered within the Hazard Mitigation planning process:

1. **Planning and Regulatory Capabilities** based on the jurisdiction's implementation of ordinances/bylaws, policies, local laws, State statutes, plans and programs that relate to guiding and managing growth and development;
2. **Administrative and Technical Capabilities** associated with the jurisdiction's staff and their skills and tools that can be used for mitigation planning and implementation;
3. **Financial Capabilities** which include the fiscal resources that the town has access to or is eligible to use to fund mitigation actions; and
4. **Education and Outreach** programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information.

Each of these capabilities is discussed in detail in the following narrative.

Planning and Regulatory Capabilities

In 1974, Pepperell entered the National Flood Insurance Program, making residents eligible to buy subsidized flood insurance. As a result, a floodway regulation was enacted as part of the Town Code (Chapter 95), rather than through the Zoning Bylaw. This regulation addresses encroachment, including fill, new construction, and substantial improvements to existing structures. It also prohibits building in the floodway unless certification by a registered professional civil engineer is provided to the Building Inspector by the applicant, demonstrating that such encroachment will not result in any increase in flood levels within the community.

Pepperell has enacted a local Wetlands Protection Bylaw requiring that a 50-foot wide undisturbed, vegetated strip of naturally occurring plant species be maintained from a certified vernal pool or wetland resource area. The requirements of the bylaw go beyond what is outlined the state's Wetland Protection Act. The State's Rivers Protection Act also preserves the town's riverine areas, by protecting a 200-foot wide Riverfront area, as measured along each side of a river from the mean annual high water line outward horizontally and parallel to the river.

The Massachusetts Natural Heritage and Endangered Species Program (NHESP) has certified 45 vernal pools in Pepperell. An additional 132 potential vernal pools have been identified that have yet to be certified. These pools, are critical habitat for amphibians and invertebrate animals that use them to breed. They typically hold water in the winter and spring due to rising groundwater and rainfall, remain wet through the spring and into the summer, and dry out completely by mid- to late summer. The NHESP reports that Pepperell is home to sixteen (16) animal species listed as endangered, threatened or of special concern.

Much of the eastern portion of Pepperell is part of the Petapawag Area of Critical Environmental Concern (ACEC), which is located along and to the east of the Nashua River, from the Town of Ayer north to New Hampshire. The Squannassit ACEC is located on the west side of the Nashua River adjacent to the Petapawag ACEC. Projects within an ACEC that are subject to state agency jurisdiction or regulation (particularly those that are initiated by an agency, require a state permit, or are funded by a state agency) are reviewed with closer scrutiny to avoid or minimize adverse environmental impacts. The designations provide a framework for the town and state agencies to work together to ensure long-term preservation and management of these areas.

The Town's Zoning Bylaw addresses erosion control and requires that site design, materials, and construction processes be employed to avoid erosion damage, sedimentation, or uncontrolled surface water runoff. The Water Resource Protection Overlay District outlined within the Zoning Bylaw consists of three zones: Water Source Protection Zone (Zone I); Well Protection Zone (Zone II) and an Aquifer-Watershed Protection Zone (Zone III). Allowed activities within each of these zones are regulated to protect groundwater from degradation. In addition to each zone's individual land use restrictions, the WRPOD has general performance standards and construction standards that apply to all development in the three WRPOD zones.

The Town of Pepperell has established an Open Space and Residential Development Bylaw in order to:

- Allow for flexibility in design and minimize land disturbance;
- Encourage the protection of open space, natural and cultural resources, agricultural land, and the town's water supply;
- Enhance community character; and
- Provide affordable housing to persons of low and moderate income.

Pepperell's Open Space Residential Development (OSRD) regulation allows for the issuance of a Special Permit for flexible site design with reduced lots sizes and dimensional requirements. An OSRD must set aside at least 40% of the total tract area as permanently protected open space.

Pepperell's Subdivision regulations require that surface water drainage be designed to accommodate a twenty-five year storm, and that culverts be designed to handle a fifty-year storm, with consideration given to avoidance of damage for a one-hundred year storm. The regulations also require that stormwater management systems by designed in accordance with Massachusetts Department of Environmental Protection's (DEP) Stormwater Manual.

Pepperell requires a site plan review for nearly all development projects other than single and two family dwellings. In approving or disapproving a site plan, the following issues are considered: landscaping, open space, signage, parking, utilities, outdoor lighting, screening, and overall compliance with the standards set forth in the zoning bylaw. Site plan approval lapses after one year from the approval date, if substantial use has not commenced, except for good cause.

In 2016, EPA and DEP issued a new MS4 Stormwater Permit for Massachusetts that went into effect on July 1, 2018. This permit requires the operators of a regulated small municipal separate storm sewer system (MS4), including Pepperell, to obtain National Pollutant Discharge Elimination System (NPDES) permit coverage. Under the permit, Pepperell will be required to develop and implement a storm water management program that includes six minimum control measures, and there are water quality testing, monitoring, mapping, maintenance and reporting requirements contained within the permit as well. Pepperell submitted its Notice of Intent (NOI) to EPA and MassDEP on October 1, 2018 outlining the BMPs that the Town planned to include in their stormwater management program in order to comply with the terms of the General Permit. The Town of Pepperell has established a Storm Water Enterprise Fund, which will function as a stormwater utility. Fees are assessed quarterly on each tax parcel.

The 2016 Pepperell Open Space and Recreation Plan Update stressed the importance of preserving open space, natural resources and outdoor recreational opportunities. Protecting farmland has been the focus of many land protection projects within Pepperell, and will continue into the future. Pepperell has continued to protect open space by working with state and non-profit partners and landowners. Over the past fifteen years, an additional sixty-one parcels totaling almost 985 acres have been protected, bringing the Town's total acreage of protected open space to over 3,074 acres, accounting for approximately 20% of the town's land area. Permanently protected lands include state lands and municipal properties subject to Article 97, a conservation restriction or other deed restriction, as well as private properties subject to a conservation restriction, agricultural preservation restriction, or a deed restriction.

As a result of a two-year planning process, Pepperell is wrapping up a major update to the Town's Master Plan. It is anticipated that the Planning Board will adopt the document within the next few months. The Master Plan recognizes that climate change planning in Pepperell

has been undertaken through multiple projects, including the recent preparation of the town's Municipal Vulnerability Preparedness Plan, the updating of the Hazard Mitigation Plan, completion of the most recent Open Space and Recreation Plan, and the town's Green Community activities. The Master Plan builds upon many of the recommendations and initiatives put forth as part of these programs. The document contains many strategies that are predicated on recognition of the fact that the climate change will continue to occur, and that municipal staff and boards, businesses, and residents will make major decisions today and in the future that will influence the town's vulnerabilities.

Building community resilience will require significant town government policy adjustments to address the root causes of climate change, as well as measures that increase social cohesion, localize food and energy systems, and advance public education and participation. Resilience requires that both the public and private sectors make structural shifts and capacity investments that support assessing and addressing the complex challenges of climate disruption.

Climate change and greenhouse gas emission reductions are addressed by recommendations throughout the Master Plan, rather than in a single section, and are summarized in the Implementation Chapter matrix of recommendations. The matrix specifically denotes those recommendations that will have a climate benefit for the community. Mixed-use, compact development that encourages walking and biking, use of alternative transportation modes, improved development practices, use of renewable energy systems, environmentally-friendly design guidelines, preservation of open space, water conservation measures, and enhanced stormwater management efforts are some of the strategies that help reduce greenhouse gas emissions, mitigate the impacts of climate change, mitigate natural hazards and reduce overall energy usage.

Administrative and Technical Capabilities

Administrative and Financial Capabilities

The Town Administrator oversees and coordinates Pepperell's day-to-day operations with the assistance of the Town Accountant, Tax Collector/Treasurer, and Assessor. Their work is supported and guided by several elected and appointed boards, including the Board of Selectmen, the Finance Committee, and the Board of Assessors. Each of these entities has a specialized and statutory role in financial and administrative policy.

The Town Accountant is appointed by the Board of Selectmen. It is the legal obligation of the Town Accountant to oversee all the financial activity of the Town, maintain all financial records, and review all bills, including payrolls, to ensure that they are within the budget and are not fraudulent or unlawful. The Town Accountant retains custody of all municipal contracts and prepares the financial reports for the municipality. Primarily working directly with other town departments, the accounting office has limited contact with the public. The Town Accountant also serves as an advisor to the Finance Committee.

In Pepperell, the duties of the treasurer and tax collector are combined into one office: Treasurer/Tax Collector. The Treasurer is responsible for the receipt, posting, classifying, depositing and investment of all money belonging to the Town. The Treasurer is also responsible for the administration of tax title and foreclosure accounts, debt service, trust funds, investments and bank account reconciliation. Using guidelines established by the Department of Revenue, the Tax Collector is responsible for the collection of all taxes, liens and fees associated with real and personal property, as well as other funds owed to the town, such as fees for permits, licenses, utilities, and services.

The Finance Committee consists of five members appointed by the Board of Selectmen for a three-year term. The Finance Committee reviews and analyzes the overall budget, and forecasts the Town's financial position for the future fiscal year based on prior trends. The Committee also identifies and recommends funding sources for proposed capital items, and reviews and makes recommendations on warrant articles. All Town Meeting articles that call for the expenditure of funds must be referred to the Finance Committee for its consideration. Each year the Finance Committee must review previous year expenditures and estimate budgetary requirements for the upcoming year and provide appropriation recommendations to Town Meeting.

Public Safety

The Pepperell Fire Department is a combination department with five full-time personnel and approximately 25 volunteers and paid-on-call firefighters. Twenty of these personnel are also emergency medical technicians. From 6 AM until 6 PM there is one firefighter/paramedic on duty as well as the chief. The Pepperell Department focuses on fire suppression, fire prevention, public education and emergency medical services

In addition to responding to fire and emergency medical calls, the fire department is also tasked with responding to other emergencies, such as a motor vehicle crash, building collapse, water and ice rescue, mass casualty incident, weather related emergency, or natural disasters. In addition, permits and inspections are issued or performed by the department. The Pepperell Fire Prevention program provides educational programs for children in pre-K to 8th grade.

The Pepperell Fire Department participates in an active mutual aid response system for fire, hazardous materials, and EMS operations. The Department is a member of Massachusetts Mutual Aid Fire District 6, as well as Border Area Mutual Aid (BAMA), a group of 30 Massachusetts and New Hampshire Fire Departments. Fire District 6 coordinates the mutual aid response of Massachusetts fire departments in the Greater Lowell area. The following services are available through these organizations:

- Centralized communications control center for mutual aid activities;

- Operation of multi-channel radio system for dispatch and coordination of firefighting apparatus and emergency medical units;
- Mobile command and communications vehicle for complex operations;
- Ten alarm running card system for coordination and deployment of apparatus, personnel and other resources;
- Regional hazardous materials response team (funded by the Massachusetts Department of Fire Services);
- Mobile air supply unit for refilling self-contained breathing apparatus at incidents;
- Evacuation and rehabilitation buses;
- Fire safety house trailer for fire prevention and training purposes; and
- Critical incident debriefing team.

The mission of the Pepperell Police Department is to: "Provide the highest level of protection and service to the citizens, business people, and visitors of Pepperell. Members of the Pepperell Police Department shall provide safety and security for the community by enforcing the bylaws of the Town of Pepperell, the laws of the Commonwealth of Massachusetts, and the Constitution of the United States of America. Members of the Pepperell Police Department shall be dedicated to provide the highest quality of public service with honesty, respect, and fairness." The Police Department goals are to do the following:

- "identify criminal activity, pursue and apprehend criminal offenders and proceed in the prosecution of known offenders,
- maintain a proactive patrol and investigation force and thus reduce the opportunity to commit crime;
- facilitate the safe movement of people and vehicles through analysis and commitment of selective traffic enforcement resources;
- perpetuate a sound managerial environment that focuses upon department goals and provides for career development; and
- instill public confidence in the agency by maintaining a high degree of professionalism, dedication and expertise in police service."

When fully staffed, the Police Department consists of 18 full-time sworn law enforcement personnel, an administrative assistant and a civilian clerk.

The Pepperell Police Department is a member of the North Eastern Massachusetts Law Enforcement Council (NEMLEC), a non-profit corporation and law enforcement council composed of a consortium of 60+ police and sheriff departments in Middlesex and Essex Counties. Member agencies operate pursuant to an interagency mutual aid and assistance agreement. NEMLEC is a professional organization focused on member needs and priorities, and governed by an elected Board. Member police chiefs actively participate in its operation

by serving in leadership roles on operational units and committees. NEMLEC manages all aspects of the organization through member meetings, open processes and a comprehensive intranet system.

NEMLEC units are composed of highly trained and skilled officers from member agencies under the command of a police chief. They are a primary source of assistance and support and are available to member police chiefs who activate them in accordance with written protocol. The available units include the following:

- Motorcycle Unit (MCU);
- Incident Management Assistance Team (IMAT);
- Regional Communications (RC);
- Regional Response Team (RRT);
- School Threat Assessment/Response System (STARS); and
- Special Weapons and Tactics (SWAT).

In Pepperell, the emergency communications center is operated as a separate department, rather than being tied to the police or fire departments. The Communications Department is responsible for the following tasks:

- Emergency and routine dispatching of Pepperell police, fire, ambulance, highway, water and sewer departments;
- Answering 911 calls and business calls for the above entities;
- Performing medical dispatch services;
- Operation of the National Crime Information Center (NCIC)/Law Enforcement Alerting Portal (LEAPS) computer to retrieve driver and criminal history through a national database;
- Chronologically documenting all incidents and calls;
- Coordinating civil defense personnel during times of emergency or disaster; and
- Using the Code Red notification system to alert the public.

The Communications Center is staffed with four full-time and two part-time dispatchers. Both the Director and Assistant Director are responsible for filling a shift in addition to their other duties. During the week, seven of the 21 shifts are staffed with two personnel, while on dispatcher is on duty during the remaining shifts. Groton serves as the alternate Public Safety Answering Point (PSAP) and as the back-up for Pepperell. Currently, the town is studying the possibility of regionalizing 911 dispatch services in partnership with the towns of Ashby and Townsend.

The primary function of the Animal Control officer is to enforce local by-laws and the Massachusetts General Laws as they relate to animal issues. In Pepperell, the Animal Control officer performs the following functions under the direction of the Board of Health:

- Maintains a record of complaints and investigates complaints;
- Educates the public relative to animal control regulations;
- Picks up, transports and holds lost, injured or dangerous animals;
- Seeks to return animals to their rightful owners;
- Responds to emergency calls;
- Destroys rabid animals;
- Removes dead animals from public ways with the assistance of the Highway Department;
- Investigates animal cruelty and neglect allegations;
- Investigates dog and cat bites; and
- Serves criminal or civil notices relative to the enforcement of animal control laws and bylaws.

State law requires that all animal control officers receive formal training. Training enables the officers to be more effective at protecting themselves, the animals, and the public.

Pepperell also has an Animal Inspector whose primary duty involves rabies control in the domestic animal population. The Animal Inspector works under the supervision of the Board of Selectmen and is also responsible for barn inspections. The inspector may also be called upon to assist with domestic animal quarantines in the event of a disease outbreak

Pepperell's Emergency Management Director (EMD) and Emergency Management program ensure that effective emergency services are in place during large-scale emergencies or disasters as outlined within the Town's Comprehensive Emergency Management Plan (CEMP). The CEMP is developed by the Local Emergency Planning Committee (LEPC), which is chaired by the EMD, and approved by the Town Administrator and Board of Selectmen. The EMD is responsible for maintaining the CEMP and for activating and managing the Emergency Operations Center. The LEPC meets quarterly to discuss public safety issues. There are also twenty-seven volunteers that support emergency services.

On a day to day basis, the EMD works with the heads of Police, Fire, Emergency Medical Services, Communications, Board of Health, DPW and Council on Aging to coordinate major emergency event planning for the Town. This effort includes public awareness and education, community outreach, resource management, manpower deployment, mutual aid agreements and coordination with the Massachusetts Emergency Management Agency (MEMA), the American Red Cross and other statewide resources. MEMA coordinates state level emergency operations and can assist the Town in the event of a disaster. MEMA also serves as a conduit for resources from other jurisdictions and the Federal Emergency Management Agency (FEMA).

Pepperell's Emergency Management director also oversees four other programs:

- Emergency Shelter Operations;
- The Auxiliary Police;
- The Community Emergency Response Team (CERT); and
- The Radio Amateur Civil Emergency Services (RACES)

The Inspection Department enforces State and local laws, by-laws, and regulations. The Department issues permits for all types of construction, including all public and private buildings. It also issues permits for additions and alterations of buildings, installation of pools, sheds, and garages, and other improvements to properties. The Building Inspector is required to perform periodic inspections for businesses and buildings that must obtain a Certificate of Inspection. The Plumbing and Wiring Inspectors also work out of this department.

Public Works

The Department of Public Works (DPW) consists of the Highway Division, Sewer Division, Water Division, and Transfer Station. The Pepperell Director of Public Works also serves as the Town Engineer. The Department provides technical and engineering services on matters related to municipal operations and land use, including assistance to town departments, boards and committees. The Town Engineer reviews subdivision plans and participates on the Signs and Safety Committee.

The Highway Division maintains and repairs the town's roadways, street signs, sidewalks and subsurface drainage systems to provide for safe vehicle and pedestrian travel. It removes snow, salts and sands, re-seeds grass in the roadway rights-of-way, and trims and removes trees. In addition, it also maintains DPW vehicles and equipment in-house.

The Sewer Division is responsible for operating and maintaining the wastewater treatment facility that serves the towns of Pepperell and Groton. The Sewer Division employs six licensed operators who regularly inspect the plant and eight pumping stations. Seasonal inspections and monitoring of the collection system and its infrastructure is an ongoing process. Inspections are performed utilizing the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) guidelines.

The Water Division operates and maintains the public drinking water system for Pepperell in accordance with the Federal Safe Water Drinking Act and Massachusetts Department of Environmental Protection (MassDEP) regulations.

Planning and Development

The Planning Board, Zoning Board of Appeals, Conservation Commission, Board of Health and Historical Commission carry out community planning and development review in Pepperell with the assistance and support of Town staff.

The Planning Board consists of five elected members and one appointed associate member, and is responsible for reviewing proposed subdivisions and site plans, and issuing special permits. All zoning bylaw revisions must go through the Planning Board. The duties and powers of the Planning Board are outlined in Chapters 40A and 40 of the Massachusetts General Laws. The Planning Board is supported and advised by a part-time professional planning consultant.

The Zoning Board of Appeals is appointed by the Board of Selectmen, serves as the special permit granting authority for some special permits, exercises statutory jurisdiction over variances and comprehensive permits, and hears appeals on the decisions of the Building Inspector. The Board consists of three members and two alternates. The Zoning Board of Appeals is authorized under Chapters 40A and 40B of the General Laws of the Commonwealth of Massachusetts as well as the Pepperell Zoning Bylaw.

The Conservation Commission administers the Massachusetts Wetlands Protection Act, MGL c.131 § 40 and the Pepperell Wetlands Protection Bylaw, has responsibility for protecting natural resources, and manages the Town's conservation properties. Each building permit application is reviewed by the Conservation Commission to determine whether a project falls under its jurisdiction. The Commission has partnered with the Nashua River Watershed Association to address the control of aquatic invasive plants on the Nashua River via the implementation of a five-year treatment plan. The Commission also coordinates volunteer activities for trail monitoring, cleanup and maintenance. The Conservation Commission is supported by the town's Conservation Agent.

The Pepperell Board of Health is composed of three elected members; its mission is to protect public health through the enforcement of health codes and regulations, and promote a healthy community. The Board adopts and modifies regulations to address various public health issues, such as the sale of tobacco and fill importation. Through assistance from the Nashoba Associated Boards of Health, the Board provides inspection services regarding food safety, safe and sanitary housing, and Title V, and conducts nuisance complaint investigations. The Nashoba Associated Boards of Health also provides community nursing services, such as immunizations, chronic disease management, and health screenings for Pepperell residents.

The Pepperell Historical Commission is charged with "the preservation and development of the historical and archaeological assets" of the town, in accordance with MGL Chapter 40, section 8D, and seeks to identify and promote the town's historical resources. The five members of the Commission are appointed by the Board of Selectmen for three-year terms. Historical Commission researches places of historic or archeological value, cooperates with the state archeologist in conducting research, and may advertise, prepare, print and distribute books, maps, charts, plans and pamphlets which it deems necessary for its work.

For the purpose of protecting and preserving historic resources, the Commission may make recommendations to the selectmen and to the Massachusetts Historical Commission that locations be certified as historical or archeological landmarks, and that procedures be implemented that preserve historic resources in town. The Commission is required to report to the State Archaeologist the existence of any archeological, paleontological or historical site or object discovered.

The Affordable Housing Committee consists of seven members: three residents at large plus one representative each from the Planning Board, Zoning Board of Appeals, Board of Selectmen, and Finance Committee. The Committee is appointed by the Board of Selectmen to oversee the development of the Housing Production Plan (HPP) and to promote affordable housing opportunities. The HPP remains in effect for five years and serves as a "blueprint" for the community in developing affordable housing units to address the 10% affordable housing goal established by the state's Department of Housing and Community Development (DHCD). The Affordable Housing Committee helps implement the HPP by promoting affordable housing projects that address the housing needs of the community, while meeting the community standards.

Human Services

The Pepperell Council on Aging (COA) supplies or coordinates most of the services that directly benefit senior citizens. The COA staff relies on volunteers to assist in providing support services, information, and referrals relative to housing, fuel and food assistance, home care, guidance on Social Security, insurance counseling, lending of medical equipment, grief support, home visits, wellness checks, tax preparation services, Meals on Wheels, and transportation services. In addition, the Senior Center offers a number of educational programs, fitness classes, entertainment, and social opportunities. The Center also provides a daily lunch for approximately 180 people each week.

The Town's Veterans Agent helps veterans and their dependents with financial, medical or burial benefits. Pepperell has a part-time Veteran's Services Officer who has office hours at Town Hall each Wednesday afternoon. The Department of Veterans' Services oversees a state assistance program based on need, which provides financial, medical, educational and service benefits to veterans and their dependents. The Veteran's Services Officer administers the Program's main financial and medical assistance components, and offers assistance and referrals in the areas of federal compensation and pensions, fuel assistance, state and federal educational benefits, tax exemptions, annuities, home loans, counseling and job training. Approximately 300 Pepperell veterans are served annually.

The Pepperell Housing Authority Board consists of four members elected by Pepperell voters plus a fifth member appointed by the Governor. The Housing Authority manages low- and moderate-income public housing units. Currently, Pepperell has 70 units: 57 one-bedroom

apartments for senior or disabled citizens; six units are bedrooms within congregate apartment housing for mentally challenged elderly or disabled citizens, and are staffed 24 hours/day; seven units are for families and of these, six are two-bedroom apartments and one is a 3-bedroom unit.

Financial Capabilities

Financial resources available to the Town for funding mitigation activities include the town's general fund. The Town's FY 2019 revenues totaled $27,350,321, with approximately 60% of the Town's FY 2019 budget was dedicated to education expenses. The Town's bond rating from Moody's is Aa3, and in FY 2019 the Town had $ 1,186,349 in certified free cash.[1] The most recent projections estimate that the Town's budget will increase to $30,793,581 by FY 2024. Pepperell's property taxes are 24% lower than in similar communities and 61% of the state average for all municipalities.[2] Pepperell received $1,691,088 in State Aid in FY 2019, and relies heavily on local property taxes to meet its needs.

In addition to the general fund, Pepperell has a sewer enterprise fund, water enterprise fund and a transfer station enterprise fund. The Town has also established a stormwater enterprise fund, and began issuing a Storm Water Utility fee in February 2019. The fee is assessed quarterly on all tax parcels and is collected through the water and sewer billing system.

The Town of Pepperell has successfully leveraged state and federal grants for projects that benefit natural hazard mitigation, and it is expected that the town will continue to apply for competitive grants through the Green Communities program, the Hazard Mitigation grant program, the Culvert Replacement Municipal Assistance program, and other available state and federal grant programs. Pepperell has received $622,014 in Green Community grants since 2018. Most recently, the Town received a grant from the Massachusetts Division of Ecological Restoration for the removal of a dam and the replacement of a culvert on Sucker Brook.

The Town has partnered with a number of non-profit and community organizations to leverage the resources needed to successfully complete many projects. For example, the Town worked with Trout Unlimited to install three-sided or bottomless culverts and on the removal of the Turner Dam on Hollis Street. Much of the land along the Nissitissit River has been protected by the Division of Fish and Wildlife, working with the Nissitissit River Land Trust, the Nashua River Watershed Association, and the Town of Pepperell Conservation

[1] Massachusetts Department of Revenue
[2] ClearGov.com

Commission. The Town will continue to foster and grow these partnerships in the implementation of the recommendations outlined in the Hazard Mitigation Plan.

Education and Outreach

Pepperell uses the CodeRED emergency notification service to reach residents and businesses by telephone, mobile phone, text message, or email regarding time-sensitive emergencies. The Town also distributes information via the town website and through Pepperell Community Media, the local cable access channel. Pepperell Community Media, Inc. produces public access programming and cablecasting for cable customers over three channels: 191, 192, and 194. Programming includes educational and government programs for the Town, as well as an extensive video library available on *Video On Demand.* Community events, municipal meetings, and all types of local video content are available to view online. with new videos added regularly.

The Pepperell Fire Prevention program provides educational programs on fire prevention and safety for children in pre-K to 8th grade. The Water Division, Sewer Division and Conservation Commission provide educational materials to homeowners and businesses on conservation, pollution prevention, best management practices and changes in regulations.

Under its MS4 permit, the Town is required to broadly distribute educational materials on stormwater within the community, as part of a formal public education program for specific target audiences.

Tighe&Bond
Engineers | Environmental Specialists

APPENDIX E

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

Pepperell's Priority Assets					Actions to Address Pepperell's Top Hazards					
Name	**Location**	**Ownership (Town, State, Federal, Private)**	**V or S**	**Workshop**	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	**Priority** **H - M - L**	**Time** **S**hort **L**ong **O**ngoing
Infrastructural										
Main St. Dam	Main Street	Private - PowerCo	V	1	Assess feasibility of microgrid to mitigate downstream properties,monitor ice conditions on river/assess conditions for ice jams		Address flashboards, regular dam inspections, get AEP from Eagle Creek, analyze dam and how to minimize risks/impact of dam removal or chose to improve dams	Monitor conditions	M	O
Main St. Bridge	Main Street	Public	S	1	Plowing/sanding	Structural analysis of bridges and flooding impacts/remediation of major roadways	Sandbagging, adjust flashboards, update floodplain bylaw	Inspect expansion joints	M/L	O
Route 119 Bridge	Route 119	State	V/S	1	Plowing/sanding	Structural analysis of bridges and flooding impacts/remediation of major roadways	Sandbagging, adjust flashboards, update floodplain bylaw	Inspect expansion joints	M/L	O
Route 113 Bridge	Route 113	State	V/S	1	Plowing/sanding	Structural analysis of bridges and flooding impacts/remediation of major roadways	Sandbagging, adjust flashboards, update floodplain bylaw	Inspect expansion joints	M/L	O
Groton Street Bridge	Groton Street	Town	V/S	1	Plowing/sanding	Structural analysis of bridges and flooding impacts/remediation of major roadways	Sandbagging, adjust flashboards, update floodplain bylaw	Inspect expansion joints	M/L	O
Hollis Street Bridge	Hollis Street	Town	V/S	1	Plowing/sanding	Structural analysis of bridges and flooding impacts/remediation of major roadways	Sandbagging, adjust flashboards, update floodplain bylaw	Inspect expansion joints	M/L	O
Mill Street Bridge	Mill Street	Town	V/S	1	Plowing/sanding	Structural analysis of bridges and flooding impacts/remediation of major roadways	Sandbagging, adjust flashboards, update floodplain bylaw	Inspect expansion joints	M/L	O
Covered Bridge	Groton Street	Town	S	1					L	L
Sewer Main/Pump Station	Townwide	Town	V/S	1					M	O
Major Traffic Arteries	Route 111, 113. and 119	State	S	1	Old plows need to be replaced	Assess feasibility of raising road and/or Town acquire and reconstruct bridge properties. Investigate raising Route 119 and culvert replacements.	Watershed stormwater retrofit assessment, floodplain bylaw, raise Route 119 with coordination from MassDOT,		H	L
Public Safety Communications	Main Street	Town	V/S	1	Evaluate potential enhanced safety complex design and construction; generator and building maintenance	Explore backup redundant system/wireless/relocation		Mold-leaky roof	H	O
SCADA System	Townwide	Town	V/S	1		Replace/upgrade to wireless			H	S
Pepperell Police Department	Main Street	Town	S	1	Resilient communcication/redundant communications system				H	O
Pepperell Fire Department	Park Street	Town	S	1	Resilient communcication/redundant communications system;				H	O
Public Wells and Water Systems	Townwide	Town	V/S	1	Replace water mains to prevent breaks, generator education for private well owners, evaluate ways to minimize risks, isolate tanks to provide clean water, have backup source of water; resiliency improvements study	Wellhead protection and water system master plan; zoning and bylaw updates for private systems	Restore original streamflow at Bemis Well;analyze vulnerability of Nashua Road wells to contamination from flooding; generators	Water bans; continuous monitoring of well levels, public education on water conservation	M	L
Wastewater Treatment Plant and Pump Stations	Lomar Park	Town	V/S	1	Runoff management/stormwater BMPs, evaluate how to minimize impact of flooding; Resiliency improvements- road access study	Study of improved resilience of WWTP and/or expansion to serve additional areas	Floodplain analysis on impact to plant; pump stations- elevate utilities	Study of covering clarifiers, monitor for succifient flow into plant	H	S/L
Power Utilities	Groton Street, Lowell Str	Private	V/S	1	Tree trimming; hazard tree removal, education on proper generator installation	Tree trimming; hazard tree removal	Ongoing natural gas replacement to address leaks; vulnerable substation on river- push utility for flood proofing	Educate homeowners	H	O
Culverts	Townwide	Town/State	V	1	In depth analysis and evaluation of all culverts including capacity analysis, engineering, design, and construction of Town's most vulnerable culverts				H	S
Culverts	Townwide	Town/State	V	1	Enhanced maintenance equipment					
Schools	Townwide	Town/Private	S	1	Evaluate use of schools as a shelter during emergencies	Emergency prepardness plan and shelter assessment		Outreach and communication of available resources	M	S
Medical Center	Main Street	Private	S	1	Immediate care- protect access/power				M	O
Town DPW	Main Street	Town	V/S	2						
Power Grid	Townwide	Private	V/S	2	Study impacts of climate change				H	S
Societal										

Senior Center	Nashua Road	Town	S	1	Prone to flooding- flood-proof building/add shower facilities to serve as shelter/replace generator				H	L
Varnum School		Town/Regional	S	1					L	L
SNMC		Private	S	1					L	L
Veterinary Hospitals		Private	S	1					L	S
Town Library	Main Street	Town	S	1	Investigate use as shelter; generator	Investigate use as shelter; evaluate remodeling as full shelter			H	S/L
Pepperell Airport	Nashua Road	Private	S/V	1	Airport should be maintained as source of supplies and evacuation		Floodplain		L	L
Schools	Townwide	Town/Private	V/S	1	Snow removal from roofs, evaluate design weight loads for roofs, Survey of population, emergency response plan with NGOS on needs, shelter, capacity with community input	Structural assessments for vulerabilities		Confirm airconditioning for schools	M	O
Vulnerable Population	Townwide		V	1	Educate the vulnerable population for preparing for an event, power management, Survey of population, emergency response plan with NGOS on needs, shelter, capacity with community input	Leveraging the CERT Program	Educate the vulnerable population for preparing for an event, power management	Educate the vulnerable population for preparing for an event, power management	M	O
Child Care	Hollis Street	Private	V	1						
Nursing Homes/Elderly Housing	Townwide	Town/Private/State	V/S	1	Maintaining transportation access and ensuring doors are always accessible for emergencies, Create database of senior notifications and develop a contingency plan for evacuation with senior center, public education and preparedness	Maintaining transportation access and ensuring doors are always accessible for emergencies		Install air conditioning systems	M	S
Food Pantry	Hollis Street	Private	V/S	1	Generator; transportation plan to deliver food				M	S
Churches	Townwide	Private	S	1	Public education/outreach- help them be prepared				M	S
Pepperell Fire Department	Park Street	Town	S	1	Feasibility and design for new public safety complex				M	L
PACH Outreach	Hollis Street	Private	S	1	Communication				M	S
Historical Places	Townwide	Town/Private	V/S	2	Inventory and BC guidelines development following NFIP guidelines					
Emergency Shelters	Townwide		V/S	2	Power redundancies for shelters				H	S
RV/Trailers	Townwide	Private	V	2	Survey of population, emergency response plan with NGOS on needs, shelter, capacity with community input				H	S
Environmental										
Farms	Townwide	Private	S	1	Purchase lands in floodplain and open space/zoning bylaws to maintain OS		Increase water holding capacity		L	O
Town Forest	Townwide	Public	V	1				Implement/update management plan	M	O
Ch. 61 Lands	Townwide	Private	V	1				Public education of valve and BMPs to mitifate for other infrastructure	L	S
Conservation Lands	Townwide	Town/State/Land Trust	V	1			Land acquisition to mitigate flooding, snow, property protection		L	S
Gulf Brook	Oak Hill Street			1			Restore original streamflow at Bemis Well		H	S
Trails	Nashua River Trail	State	V/S	1	Manage tree canopy				L	L
Open Space	Townwide	Town/Private	V/S	1					L	L
Transfer Station	Boynton Street	Town	V/S	1	Debris management plan				L	S
Rail Trail	Townwide	State	V/S	1	Not accessible in the winter- purchase snowmobile; rail trail can be used as emergency access				M	S/O

Nashua and Nississit Rivers	Townwide	NRWA	V/S	1	Address private dam issue, provide public education		Provide public education on flood risk to abutters, WQ studyof sources of contamination from septics, update BOH requirements and inspections, land acquisition and education on best practices for land management in light of climate change		M	O
Sensitive Habitats	Townwide		V/S	2		Invasive species removal, conditions survey, public education			M	O
Forests and Woodlands	Townwide	Town/Private	V/S	2	Develop forest management plans for resiliency	Acquisition and BMPs, Invasive species removal			H	S/O
Recharge from Septics	Townwide	Private	V/S	2	Comprehensive Wastewater Management Plan					
Properties with Floodplain	Townwide	Public/Private	V	2		Bylaw revisions to address floodplains			H	S/O
Well Contribution Areas	Townwide	Public/Private	V	2		Review and update aquifer protection bylaw and overlay distribution bylaw and public education on BMPs; strengthen bylaws for enforcement			M	S
Major Wetlands, Vernal Pools, and Waterbodies	Townwide	Public/Private	V/S	1			Mosquito management	Monitor water quality for toxic algae	M	S
Economy										
Gas Heating Oil Co.		Private	S/V	1	Emergency plan, generator, and Memo of Agreement to ensure public safety can continue, notify first responders				H	S
Tree Removal Services	Townwide	Private	S	1	Create an emergency services agreement, public education and outreach				H	S
Pharmacies	Townwide	Private	S	1	Access to emergency supplies/prescriptions, public education and outreach				H	S
Donelan's Supermarket	Main Street	Private	S	1	Public education, outreach; fuels have leaked, coordinate eddects of NGOS	Impliment inspection standards as part of annual inspection/licensing			L	L
Industrial Park	Lomar Park	Private	V/S	1	Public education, outreach; Utility resilience- target public education to business owners about utility resiliency and staying open and safe in a storm		Floodplain awareness/education, encourage road maintenance, flood-proofing to keep operations active		M	S
Oil Delivery	Groton Street, Hollis Stre	Private	V/S	1	Public education, outreach, notify first responders					
Hardware Stores	Main Street	Private	S	1	Public education, outreach					
Farms	Townwide	Private	V/S	1	Manure management regulations, tick and mosquito management, best management practices, ask DEP for cheap water- more incentives to grow	Allow alternative energy- solar wind farm, subsidize to address loss from floods and droughts, plan regional storage and distribution food hub- equity issue to seniors and VP (schoops	Emergency evacuation for livestock in floods, BMPs to address climate change		M	O
Gas Stations	Townwide	Private	S/V	1	Public education, outreach, notify first responders				M	S
Medical Center	Main Street	Private	S	1	Public education, community engagement, understanding their capacity				M	S
Funeral Homes	Main Street, Pleasant Str	Private	S	1	Public education, outreach					
Kimball Fruit Farm	Hollis Street	Private	S	1	Public education, outreach				L	L
Banks	Townwide	Private	S/V	1	Public education, outreach					
Recreational Areas	Townwide	Town	S	2	Look for local sites to restore and remove invasive species				M	O
Railroad Square	East Main Street	Town	S/V	2	Plant trees for cooling/shade area				M	S
Main Street Businesses	Main Street	Private	S	2	Utility resilience- target public education to business owners about utility resiliency and staying open and safe in a storm				S	L
Skydiving Park	Nashua Road	Private	S	2						
Veterinary Hospital	River Road	Private	S	1					L	L

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Engineers | Environmental Specialists

APPENDIX E

THURSDAY, MAY 21, 2020 – 7PM to 8:30PM

HAZARD MITIGATION & CLIMATE ADAPTATION

LISTENING SESSION

(COVID-19 VIRTUAL GATHERING)





Join us to hear about Pepperell's HAZARD MITIGATION & CLIMATE ADAPTATION process.

We look forward to hearing your experiences and ideas.

Please reach out if you have any questions or barriers to participate.

Lisa Davis, Town of Pepperell Planning Consultant

ldavis@town.pepperell.ma.us

The meeting can be accessed by using this link:
https://global.gotomeeting.com/join/929720389
You can also dial in using your phone.
United States: +1 (646) 749-3122
Access Code: 929-720-389

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PEPPERELL'S HAZARD MITIGATION AND MUNICIPAL VULNERABILITY PREPAREDNESS PLANNING

Listening Session **May 21, 2020**

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WELCOME



Pepperell awarded $37.5K grant for

- Municipal Vulnerability Preparedness (MVP) Community Resilience Building (CRB) Workshop Process; and
- Draft Hazard Mitigation Plan (HMP) Update

First step in unlocking additional funding opportunities for Pepperell from FEMA/MEMA and Commonwealth of Massachusetts

A BRIEF THANKS TO PEPPERELL'S HAZARD MITIGATION PLAN AND MVP CORE TEAM AND ADVISORY GROUP

CORE TEAM

- Lisa Davis*
- David Querze
- Beverly Woods*
- Brynn Montesanti
- Paula Terrasi*
- Ken Kalinowski
- Andrew MacLean
- Kalene Gendron*



ADVISORY GROUP

- Walter Richards
- Denise Pigeon
- Tony Beattie
- Casey Campetti
- Kalene Gendron
- Jim Scarsdale
- David Querze
- Kat Belliveau

*Also a member of the Advisory Group

MVP/HMP GRANT AND CRB PROCESS

1. Establish Core Team
2. Complete Evaluation/Assessment
   - Natural Hazard Risks
   - Community Assets
   - Multi-Hazard Vulnerability Assessment
   - Capabilities Assessment
   - Mitigation Strategies
3. Hold two workshops
4. Draft MVP Report
5. Hold Public Meeting
6. Draft Hazard Mitigation Plan Update
7. Hold Listening Session
8. Final MVP Report



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PURPOSE OF LISTENING SESSION

- Required to comply with MVP guidance and contract with EEA
- Present Information on the Hazard Mitigation and Municipal Vulnerability Planning Processes and on work completed to date
- Provide an opportunity for feedback and comments

BACKGROUND ON MVP PROGRAM

EXECUTIVE ORDER 569 9.16.16



ENVIRONMENTAL BOND BILL 8.21.18



- $2.4 billion bond bill with focus on climate change resiliency
- Over $200 million authorized for climate change adaptation
- **Codifies EO 569, including the MVP Program**

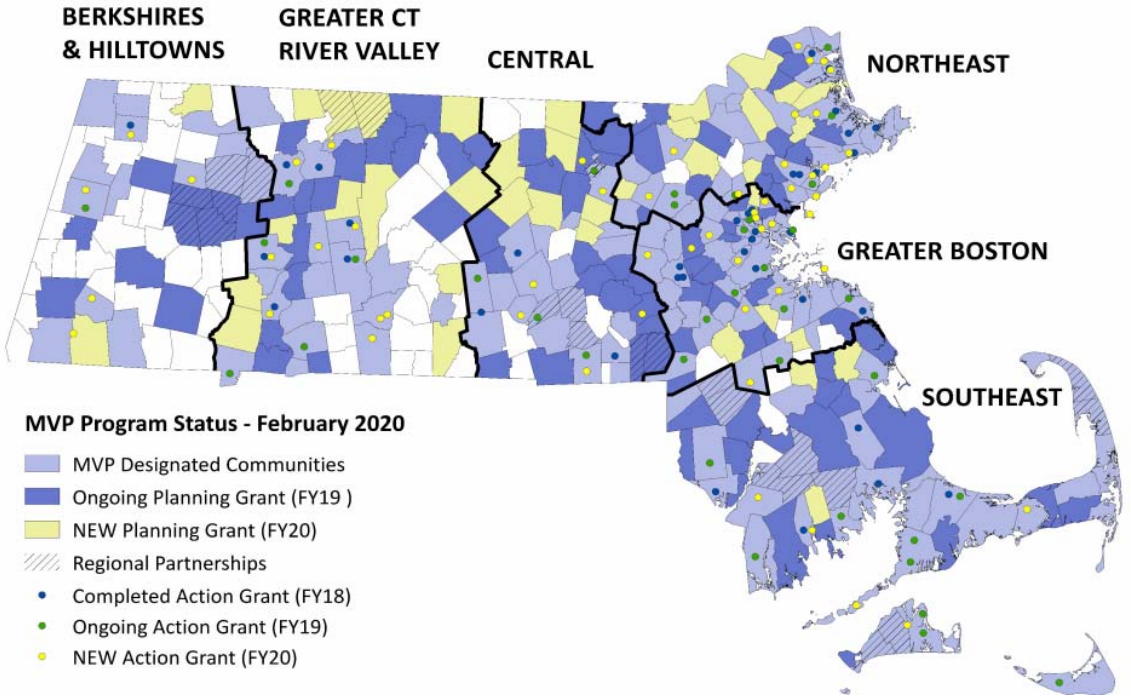
WHO HAS PARTICIPATED IN MVP PROGRAM?

Three Years of MVP

MVP Designations
82% of the Commonwealth
287 communities

Action Grant Projects
FY 18: 37
FY 19: 36
FY 20: 54

Total Awards
$33M+ in planning and action grants to date

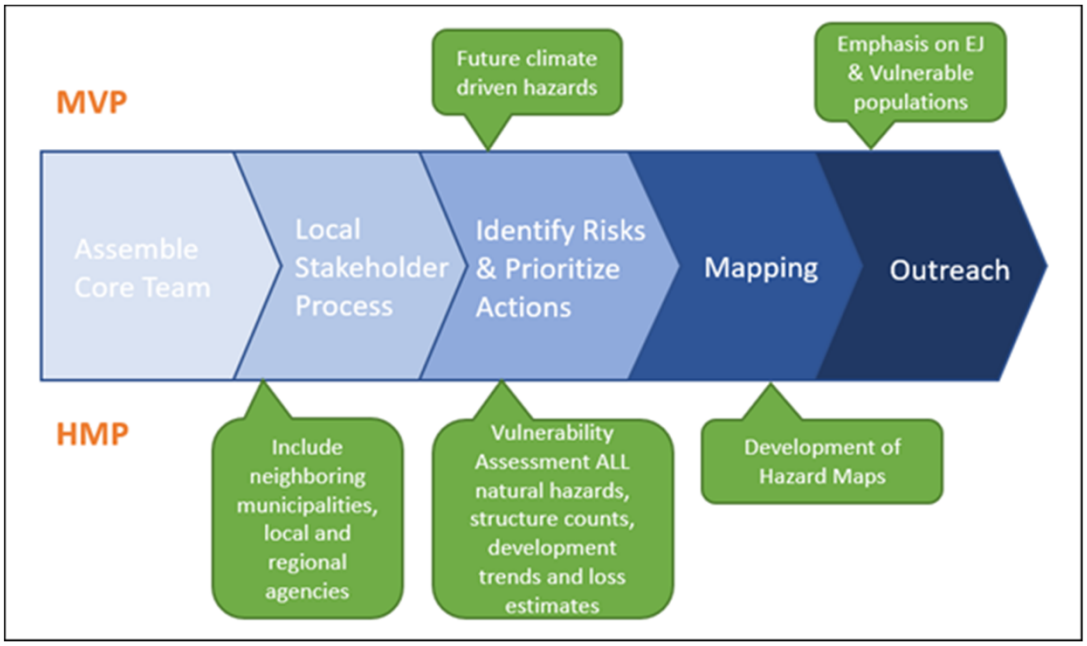


BACKGROUND ON HAZARD MITIGATION PLANNING

- **FEMA Requirements:**
  - Disaster Mitigation Act of 2000, 44 CRF Part 201.6
  - *FEMA Local Mitigation Plan Review Guidance, October 2011*
  - *FEMA Local Mitigation Planning Handbook, March 2013*
- **Pepperell included in Northern Middlesex Regional Hazard Mitigation Plan, approved August 2015.**
  http://www.nmcog.org/Websites/nmcog/images/Hazard_Mitigation_Plan_FEMA_approved_8_15.pdf
- **To maintain eligibility for FEMA/MEMA funding, must update plan every 5 years**
- **Commonwealth of Massachusetts State Hazard Mitigation & Climate Adaptation Plan 2018 must be considered in update**

HOW DO THE MVP AND HMP PROCESSES OVERLAP?

The MVP effort supplements the HMP process by providing a statewide and major watershed specific climate change data to use in the natural hazard risk assessment and a consistent methodology for public engagement through the Community Resilience Building (CRB) workshops.



WHY DO THIS PLANNING?

Help Pepperell Build Resilience and Preparedness:

Climate change is a challenge that will affect every government agency and every community across the Commonwealth, and our coordination in addressing this challenge will help protect Massachusetts residents, infrastructure and natural resources while improving quality of life year-round

Governor Charlie Baker

WHY DO THIS PLANNING?

Help Pepperell Build Resilience and Preparedness:

- Build on the Town's existing emergency management capabilities
- Plan for more frequent and intense weather events that are linked to climate change
- Engage multiple stakeholders in the planning process
- Improve access to funding for mitigation and adaptation





COMMUNITY ASSET INVENTORY

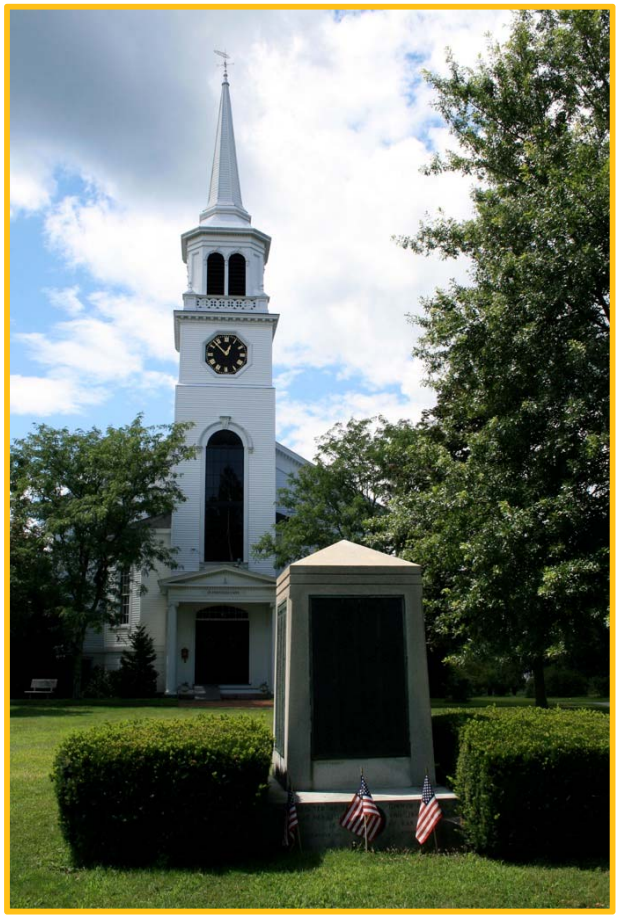
COMMUNITY ASSET CATEGORIES

FEMA defines a community asset as anything that is important to the character and function of a community.

FEMA Community Asset Categories	Critical Sectors	Characteristics of Community Assets
People	Schools, Vulnerable Populations, Cultural Facilities	Areas of greater population density, or population with unique vulnerabilities or less able to respond and recover during a disaster.
Built Environment	Critical Municipal Facilities, Water, Wastewater, Energy, Stormwater, Transportation, Cultural Resources	Critical facilities necessary for a community's response to and recovery from emergencies, infrastructure critical for public health and safety, economic viability, or needed for critical facilities to operate.
Economy	Marinas, Business and Industry	Major employers, primary economic sectors and commercial centers where loss or inoperability would have severe impact on the community and ability to recover from a disaster.
Natural Environment	Natural Resources	Areas that provide protective function to reduce magnitude of hazard impact and increase resiliency. Areas of sensitive habitat that are vulnerable to hazard events, protection of areas that are important to community objectives, such as the protection of sensitive habitat, provide socio-economic benefits, etc.

PEOPLE – SOCIETAL ASSETS

- Child Care on Hollis Street
- Churches
- Emergency shelters
- Food Pantry
- Historical Places
- Nursing Homes/elderly housing
- Pepperell Airport
- PACH outreach
- Senior Center
- RV/Trailers
- Southern NH Medical Center
- Schools
- Town Library
- Veterinary hospitals



BUILT ENVIRONMENT – INFRASTRUCTURE ASSETS

- Bridges (Main Street, Route 119, Route 113, Groton Street, Hollis Street, Mill Street)
- Culverts (town-wide)
- Department of Public Works facilities
- Fire and Police facilities
- Main Street Dam (private)
- Major traffic arteries
- Power grid
- Private medical center on Main Street
- Public safety communications
- Public wells and water facilities
- Schools/town shelters
- Wastewater treatment plant and pump stations



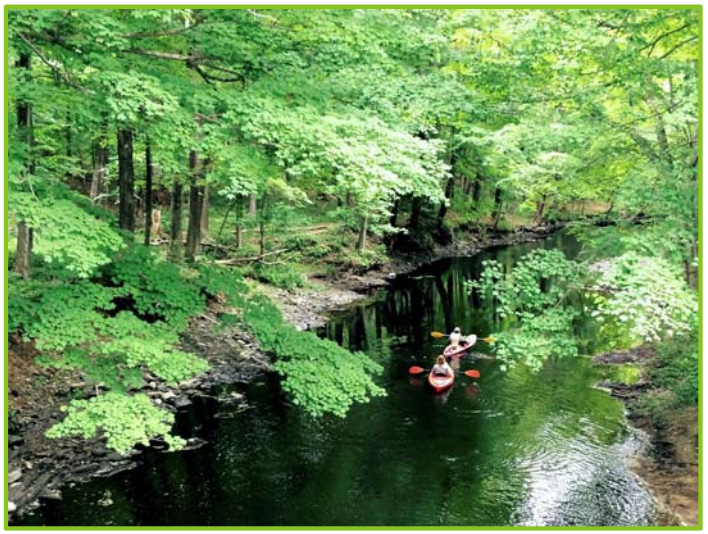
ECONOMIC ASSETS

- Banks
- Donelan's Supermarket (Main Street)
- Farms
- Funeral Homes (Main Street, Pleasant Street)
- Gas Heating Oil Company
- Gas Stations
- Hardware Store (Main Street)
- Industrial Park (Lomar Park)
- Kimball Fruit Farm (Hollis Street)
- Main Street Businesses
- Medical Center (Main Street)
- Oil Delivery (Groton Street, Hollis Street)
- Pharmacies
- Railroad Square (East Main Street)
- Recreational Areas
- Skydiving Park (Nashua Road)
- Tree removal services
- Veterinary Hospital (River Road)



ENVIRONMENTAL ASSETS

- Conservation lands and open space
- Major Wetlands and Waterbodies (e.g., Nashua and Nissitissit Rivers, Gulf Brook)
- Habitat (including vernal pools)
- Trails (Nashua River Trail)
- Well contribution areas





NATURAL HAZARD RISK AND VULNERABILITY ASSESSMENT

WHAT ARE NATURAL HAZARDS?


Inland Flooding


Tsunami


Severe Winter Storm

Blizzards
Snow
Ice Storms


Drought


Average/Extreme Temperatures


Tornadoes


Landslide


Wildfires


Other Severe Weather

Nor'easters
High Wind
Heavy Precipitation
Microbursts


Hurricanes/Tropical Storms


Invasive Species


Earthquake

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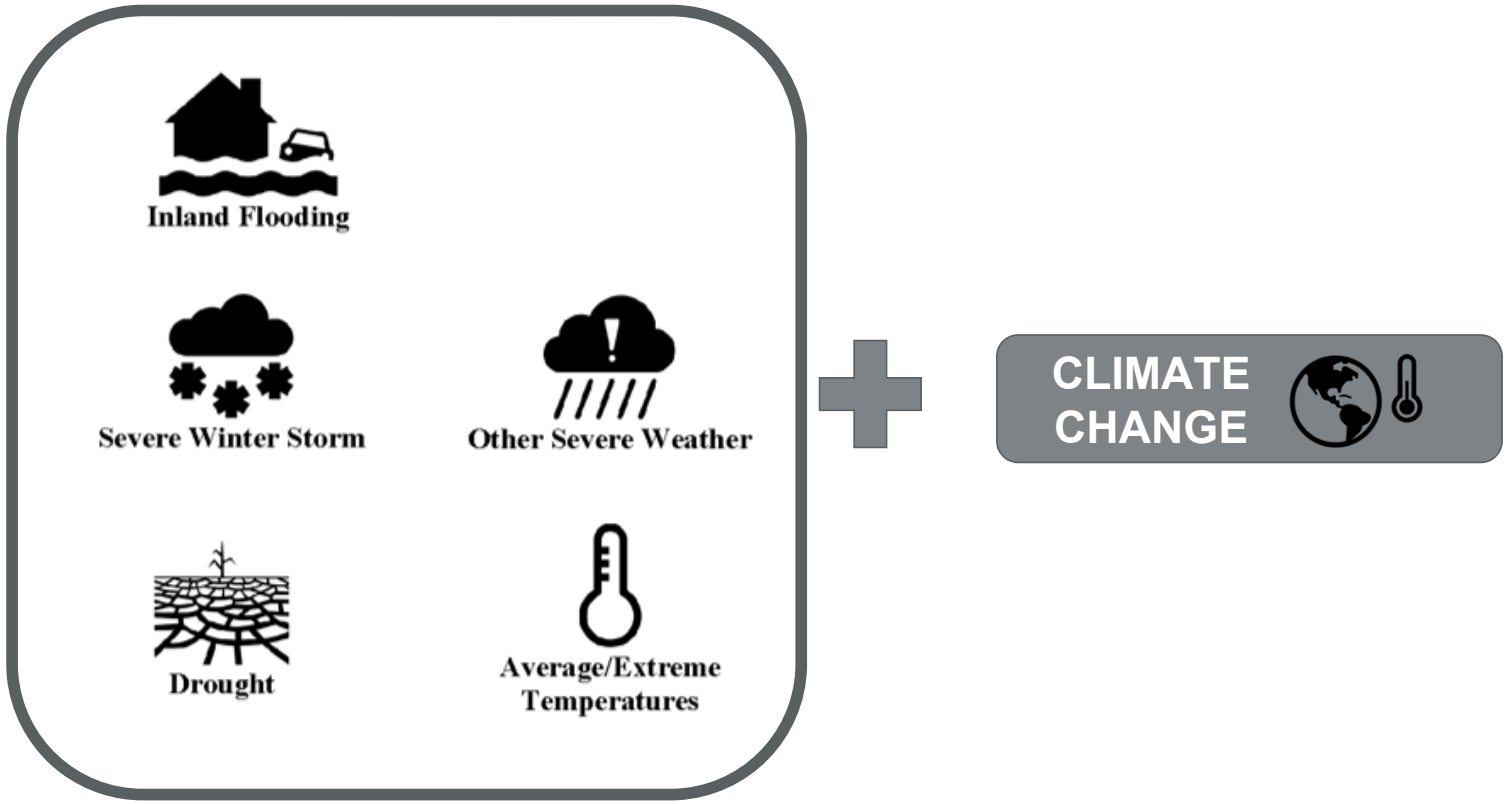
HISTORICAL EVENTS IN PEPPERELL

- **August 1948 Highest Temperature Recorded**
  Temperature of 105 degrees recorded in Pepperell
- **January 1957 Lowest Temperature Recorded**
  Temperature of -29 degrees recorded in Pepperell
- **March 1968 Ice Jam**
  Ice jam on the Nashua River
- **1987 Major Flooding of Nashua River**
  Road closures, school closed
- **July 2002 Thunderstorm Wind**
  Winds recorded over 70 mph
- **March 2010 Nashua River Flooding**
  Flooding of the Nashua River leads to closure of Route 111 and Route 119
- **August 2011 Hurricane Irene**
  Devastating flooding, wind damage
- **October 2011 Halloween Storm**
  Power out for seven days
- **March 2018 Nor'easter**
  Pepperell received 20 inches of snow from a winter nor'easter

NATURAL HAZARD RISK INDEX

Type of Natural Hazard	History of Occurrence in Pepperell	Hazard Probability	Hazard Frequency	Geographic Extent	Severity of Impact	Hazard Risk Ranking
Inland Flooding	Yes	3	3	2	3	11
Severe Winter-Storm/Nor'easter	Yes	3	3	3	2	11
Drought	Yes	3	3	2	2	10
Extreme Temperature	Yes	3	3	3	1	10
Tropical Storms/ Hurricanes	Yes	3	2	3	2	10
Severe Weather-Strong Wind and High Precipitation	Yes	3	3	3	1	10
Invasive Species	Yes	4	3	2	1	10
Microburst	Yes	3	3	1	1	8
Earthquake	Yes	1	0	3	3	7
Wildfires	Yes	3	1	1	1	6
Tornadoes	No	1	0	1	3	5
Landslide	No	1	0	1	1	3

PEPPERELL'S TOP NATURAL HAZARDS





CLIMATE CHANGE

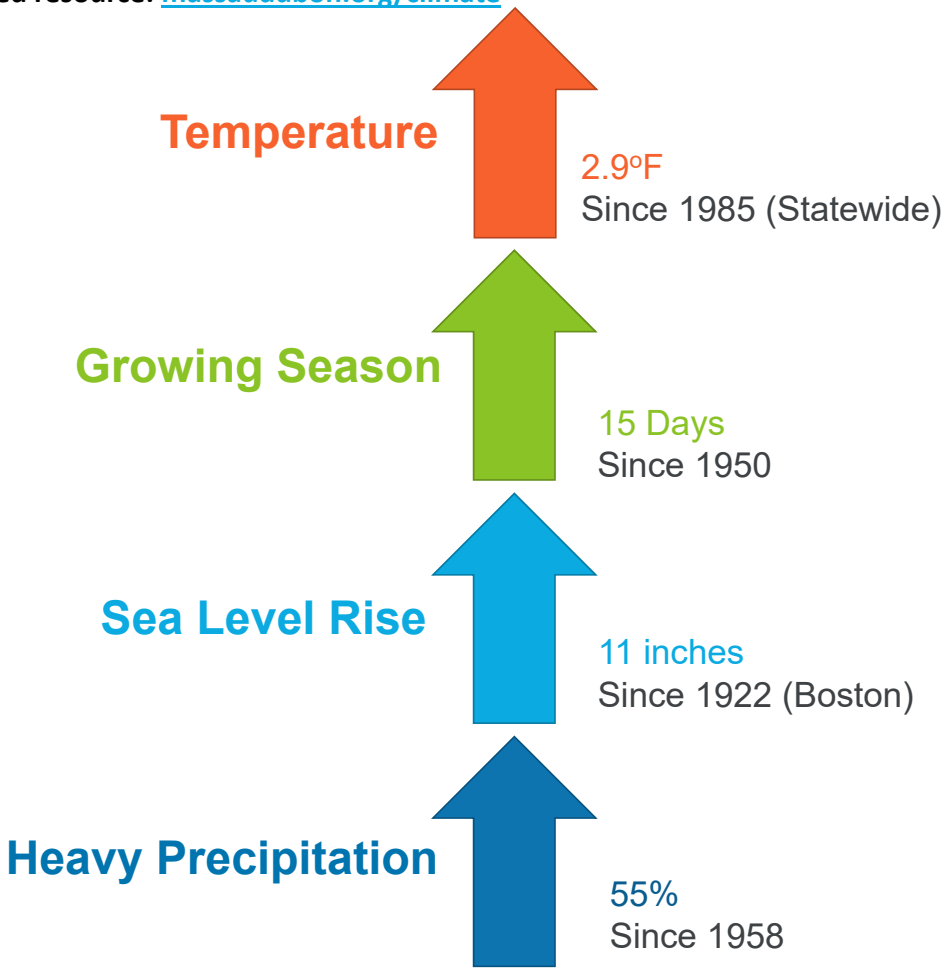
CLIMATE CHANGE REFERENCES FOR MVP PROCESS

- **Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan, September 2018**
  - https://www.mass.gov/service-details/massachusetts-integrated-state-hazard-mitigation-and-climate-adaptation-plan
- **Massachusetts Climate Clearinghouse**
  - https://resilientma.org/
- **Statewide and Major Watershed (Basin) Climate Change Projections**
  - https://www.mass.gov/files/ma-statewide-and-majorbasins-climate-projections-final.pdf

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MASSACHUSETTS OBSERVED CLIMATE CHANGES

Recommended resource: massaudubon.org/climate



MASSACHUSETTS CLIMATE PROJECTIONS

By end of century:

Changes in precipitation

- 18% increase in consecutive dry days
- 57% increase in days with > 1 in. rainfall
- 7.3 inches additional annual rainfall

Rising temperatures

- 10.8°F increase in average annual temperature
- 42% decrease in days/year with min. temperatures < 32* F
- 1,280% increase in 90-degree days/year

Sea level rise

- 4-10.5 feet along the MA coast

Extreme weather

- Increase in frequency and magnitude



CLIMATE CHANGE THREATENS PUBLIC HEALTH



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CHANGES IN PRECIPITATION

Nashua Basin		Observed Baseline 1971-2000 (Inches)	Projected Change in 2030s (Inches)	Mid-Century Projected Change in 2050s (Inches)	Projected Change in 2070s (Inches)	End of Century Projected Change in 2090s (Inches)
Total Precipitation	Annual	45.9	+0.4 to +4.9	+1.2 to +6.3	+2.3 to +7.9	+1.3 to +8.4
	Winter	11.0	-0.3 to +1.9	+0.2 to +2.5	+0.4 to +3.3	+0.6 to +4.3
	Spring	11.8	-0.0 to +2.2	+0.1 to +2.0	+0.5 to +3.0	+0.1 to +2.9
	Summer	11.3	-0.3 to +1.5	-0.3 to +2.2	-0.6 to +2.2	-1.1 to +2.2
	Fall	11.8	-1.1 to +1.1	-1.2 to +1.8	-1.6 to +1.7	-1.4 to +1.5

IMPACTS OF CHANGING PRECIPITATION

- Episodic droughts
- Concerns over food production and drinking water supply
- Stress on ecosystems
- Flooding

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EXTREME STORMS

Blizzards

- There have been more than 5 in Massachusetts since 2011

Nor'easters and Hurricanes

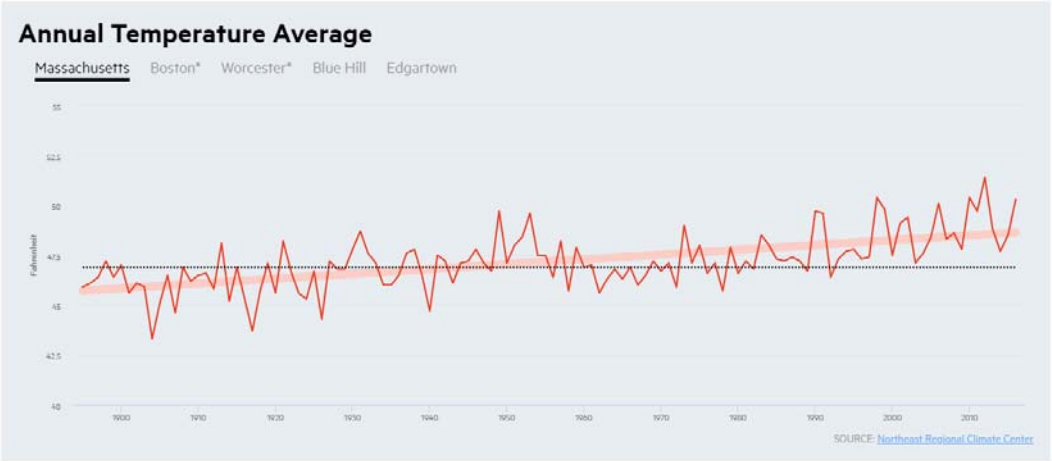
- Upward trend since the 1970s



IMPACTS OF EXTREME STORMS:

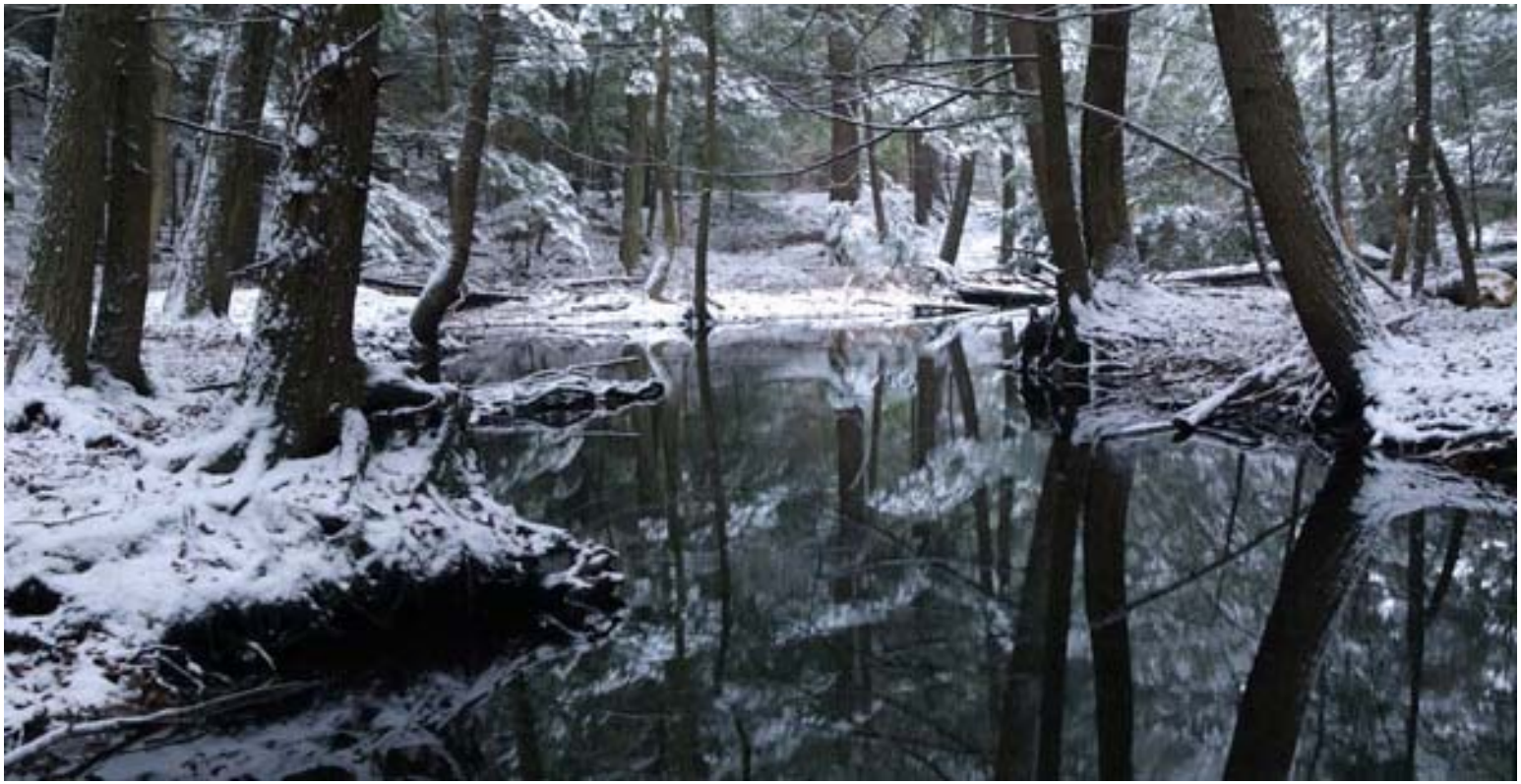
- **Public safety concerns, including increased injuries and mortality**
- **Economic damages and business disruption**
- **Property and infrastructure damage**
- **Natural resources**

RISING TEMPERATURE



IMPACTS OF RISING TEMPERATURE:

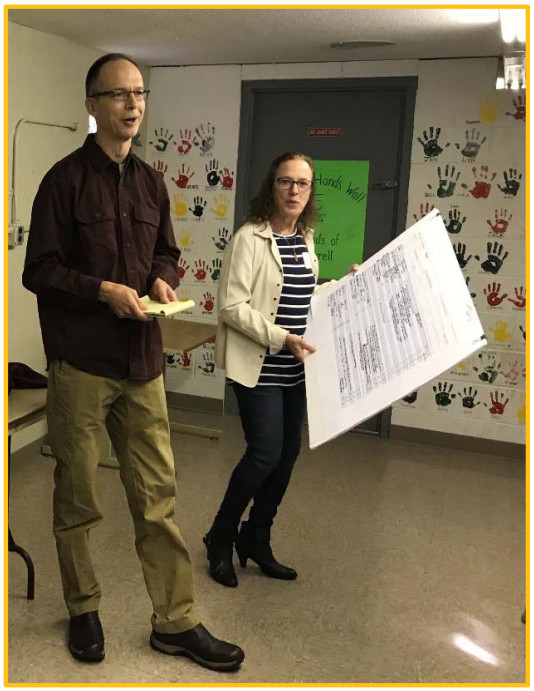
- Heat-related illnesses
- Vector borne-diseases
- Health of plants, animals, ecosystems
- Reduced crop production
- Larger energy demand
- Droughts and wildfires



MVP WORKSHOPS

WORKSHOP OBJECTIVES

- Hear from stakeholders who can help evaluate our community's strengths and vulnerabilities of residents, infrastructure, and natural resources
- Understand connections between natural hazards and local planning/mitigation efforts
- Develop and prioritize resiliency actions for the municipality, organizations, businesses, neighborhoods, and community groups
- Identify opportunities to advance actions that reduce the impact of hazards and increase resiliency in the community



Overview of the Process (Steps & Tasks)

DURING WORKSHOP

A Prepare for the Workshop
1. Establish a core team with goals.
2. Engage stakeholders.
3. Prepare materials for workshop.
4. Decide on participant arrangements.

B Characterize Hazards
1. Identify past, current, and future impacts.
2. Determine the highest-priority hazards.

C Identify Community Vulnerabilities and Strengths
1. Identify infrastructural vulnerabilities and strengths.
2. Identify societal vulnerabilities and strengths.
3. Identify environmental vulnerabilities and strengths.

D Identify and Prioritize Community Actions
1. Identify and prioritize infrastructural actions.
2. Identify and prioritize societal actions.
3. Identify and prioritize environmental actions.

E Determine the Overall Priority Actions
1. Identify highest-priority actions.
2. Further define urgency and timing.

F Put It All Together
1. Generate final workshop products.

G Move Forward
1. Continue community outreach and engagement.
2. Secure additional data and information.
3. Inform existing planning and project activities.

Community Components



Infrastructural



Societal



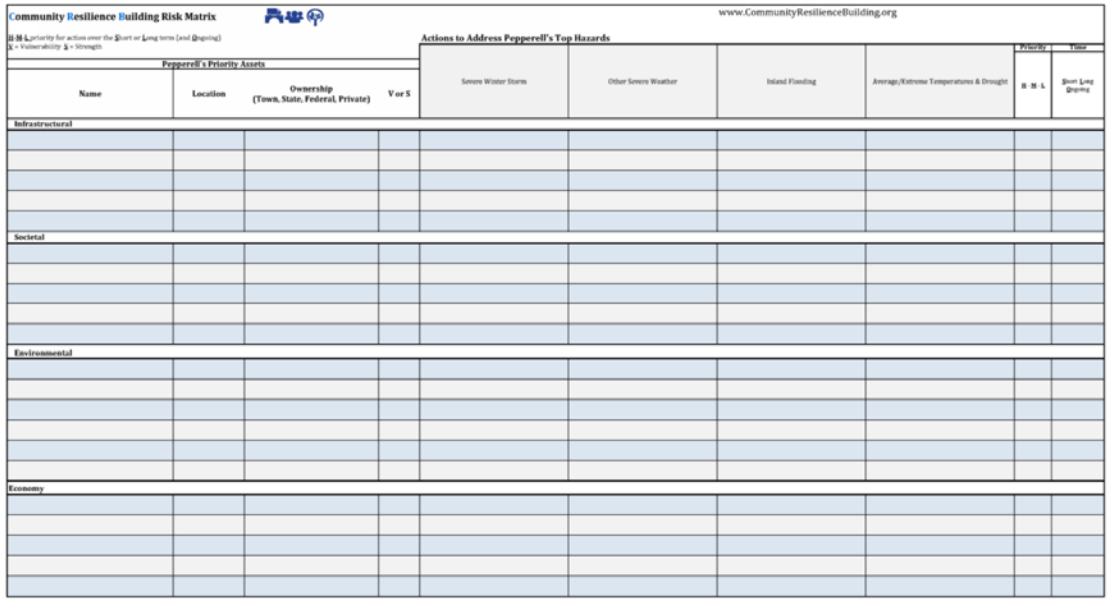
Environmental

https://www.communityresiliencebuilding.com/

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COMMUNITY RESILIENCE BUILDING RISK MATRIX

- **Series of small and large group discussions to fill out CRB Risk Matrix:**
  1. Identify important community assets and the vulnerability to top hazards
  2. Determine mitigation actions to address vulnerabilities and protect strengths
  3. Prioritize and schedule mitigation actions



Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

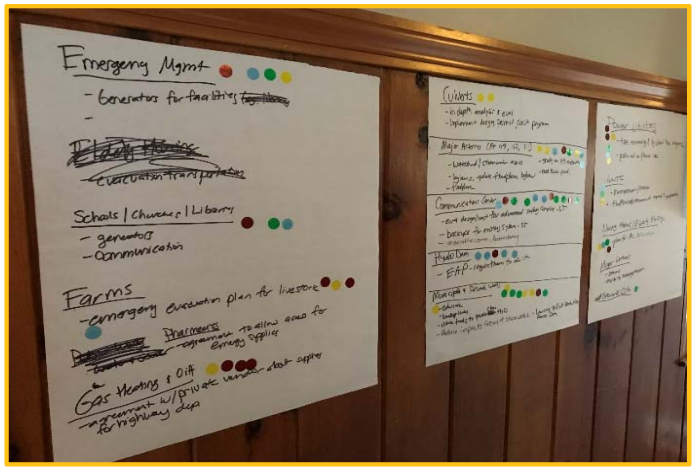
H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Pepperell's Priority Assets				Actions to Address Pepperell's Top Hazards				Priority	Time
Name	Location	Ownership (Town, State, Federal, Private)	V or S	Severe Winter Storm	Other Severe Weather	Inland Flooding	Average/Extreme Temperatures & Drought	H - M - L	Short Long Ongoing
Infrastructural									
Societal									
Environmental									
Economy									

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WORKSHOP RESULTS

- Groups reported top risks and strengths and mitigation actions based on prioritization and scheduling
- Mitigation actions then reviewed by Core Team
- MVP Findings Report Draft has been developed







MITIGATION STRATEGIES

TYPES OF MITIGATION ACTIONS

1. Prevention
2. Property Protection
3. Public Education and Awareness
4. Natural Resource Protection and Green Infrastructure
5. Structural Projects
6. Emergency Services Protection

EXAMPLE MITIGATION ACTIONS IN PEPPERELL

- **Prevention**
  - Update Town floodplain, zoning, and stormwater bylaws
- **Natural Resource Protection**
  - Conduct a town-wide watershed/stormwater assessment
- **Structural Projects**
  - Conduct a capacity planning study for culverts to analyze design, permit, and construction
- **Emergency Services Protection**
  - Evaluate and identify backups for the existing communications system and define alternative communications
  - Study inventory and conduct an evaluation on emergency generators
  - Conduct an agreement with a private vendor regarding gas/oil supplies for the highway department in the event of an emergency

Full list available in draft MVP Report on website

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WHAT'S NEXT?

NEXT STEPS BEFORE JUNE 30, 2020

- Complete draft Hazard Mitigation Plan for Town staff and public review
- Selectmen vote to submit Hazard Mitigation Plan to FEMA
- Submit documents to EEA and FEMA



MVP ACTION GRANT OPPORTUNITIES

MVP ACTION GRANTS

Project Types

- Planning, Assessments, and Regulatory Updates
- Nature-based Solutions for Ecological and Public Health
- Resilient Redesigns and Retrofits for Critical Facilities and Infrastructure

MVP ACTION GRANTS

- Detailed Vulnerability and Risk Assessment*
- Community Outreach and Education
- Local Bylaws, Ordinances, Plans, and Other Management Measures**
- Redesigns and Retrofits***
- Nature-Based Flood Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques
- Nature-Based, Infrastructure and Technology Solutions to Reduce Vulnerability to Extreme Heat and Poor Air Quality



* Most common project type

** Second-most common project type

***Third-most common project type

MVP ACTION GRANTS (CONT)



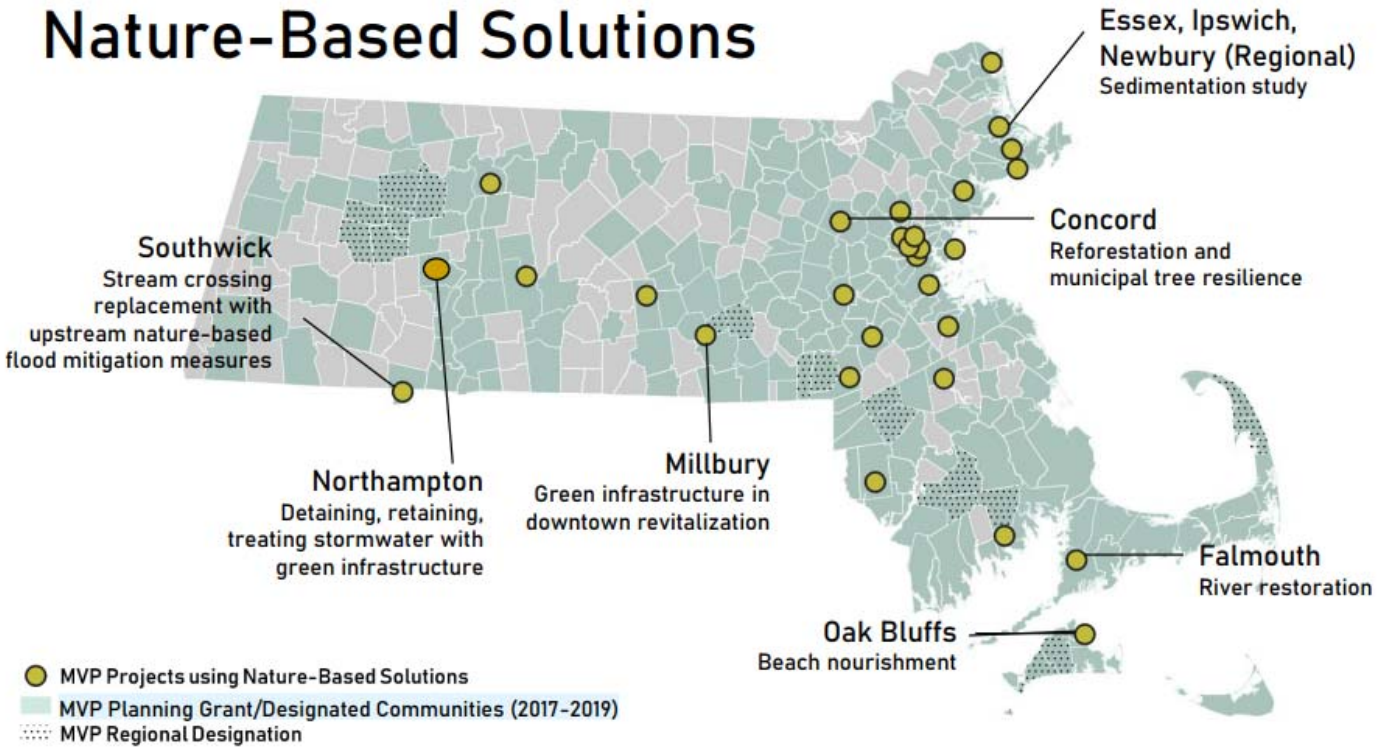
- Nature-Based Solutions to Reduce Vulnerability to other Climate Change Impacts
- Ecological Restoration and Habitat Management to Increase Resiliency

NEW IN 2019

- Energy Resilience
- Chemical Safety
- Land Acquisition for Resilience
- Subsidized Low-Income Housing Resilience Strategies

\+ Expanded eligibility of project location

Nature-Based Solutions



Statistics From Last Round

- 111 applications
- Over $30 million requested
- 54 funded projects
- Total funding $10.5 million
- Average grant size: ~$195,000

EMPHASIS OF FY21

New Public Involvement & Community Engagement Requirements

- New attachment with best practices for community engagement
- Includes menu of options for print, digital, and in-person strategies with an emphasis on strategies that will increase engagement with EJ and Climate Vulnerable Populations that you could tailor to your project
- Opportunity to also create your own innovative strategies
- Application question will ask you to fill out a matrix with your proposed strategies and include details in a narrative and in the scope/budget document







COMPETITIVE EVALUATION CRITERIA

- Project Description, Rationale, and Climate Data
- Nature-Based Solutions and Environmental Benefits
- Environmental Justice and Public/Regional Benefits
- Public Involvement and Community Engagement
- Project Transferability, Measurement of Success, and Maintenance
- Need for Financial Assistance
- Project Feasibility & Management
- Timeline, Scope, and Budget
- Overall Project Quality

THINKING ABOUT ADAPTATION STRATEGIES

- For the three Town-owned community assets most at risk, the Core Team has begun to explore specific adaptation strategies tailored to site.
- Considering specific actions to adapt to natural hazards and climate change.
- Can be structural changes, flood proofing, elevation of critical equipment, on-site plantings or stormwater management.

ADAPTATION STRATEGIES BEING EXPLORED

- **Public Safety Complex**
  - Siting and natural hazard preparedness considerations

- **Water and wastewater facilities**
  - Site-specific climate resiliency plans

FOR MORE INFORMATION



Lisa Davis, AICP
LDavis@town.pepperell.ma.us

Janet Moonan, PE, Project Manager
JSMoonan@tighebond.com
(781) 708-9826

Information on Town's website at:
https://town.pepperell.ma.us/668/MVP-Grant-Information

AND NOW FOR QUESTIONS AND ANSWERS



NEWS > LOCAL NEWS

Town hosts listening session for MVP certification

Public input valid for use of potential grant money and new hazard mitigation plan

By JON WINKLER | jwinkler@nashobavalleyvoice.com | Nashoba Valley Voice

PUBLISHED: May 31, 2020 at 6:05 p.m. | UPDATED: June 1, 2020 at 8:50 a.m.

PEPPERELL — Town officials furthered the process to achieve municipal vulnerability preparedness certification from the state by holding a virtual listening session on May 21.

Planning Board Adviser Lisa Davis said last month that the open public session was meant to gain community input on what the grant money should be put toward in terms of preserving the town's environment and making the community more resilient to climate change. Davis said the listening session "went well" and the town will likely have the entire report prepared before the deadline of June 30.

According to the Massachusetts Executive Office of Energy and Environmental Affairs, the MVP program awards local towns with grants to fund vulnerability assessments and the development of action-oriented resiliency plans. Before getting those funds, towns have to complete the MVP program and be certified by the state.

Davis said Pepperell first applied for the MVP planning grant last May and received the planning grant in July. Davis said the town has a final draft MVP report, which was discussed during the listening session. Members of the Tighe & Bond consulting firm and Beverly Woods, executive director of the Northern Middlesex Council of Governments, hosted the session. The report has to be finalized and then deemed official before being submitted to the state for certification no later than June 30.

“The biggest hazard we’ve identified is flooding and how to deal with it,” Davis said. “I think the MVP grant could be used to develop a floodplain bylaw to regulate activity within local floodplains. It could also update culverts, provide wetland restoration, go to vulnerable dams in town and emergency services. There’s a laundry list of mitigation strategies.”

On top of going through the MVP process, Davis said the town is also in the midst of establishing its own Hazard Mitigation Plan. The plan, overseen by the Federal Emergency Management Agency, is similar to the purpose of the MVP program in that it educates officials and prepares long-term strategies for communities in case of any kind of natural disaster. If the HMP is certified by FEMA, communities are eligible to receive certain forms of nonemergency disaster assistance. Pepperell originally operated under a North Middlesex HMP, but now state officials want towns to establish their own HMP.

“It’s been a convoluted process so now the state wants us to do a community-exclusive HMP,” she said.

Davis said the HMP is still awaiting approval from the Board of Selectmen, which she expects to be completed by July.

Tags: **Pepperell**



Jon Winkler | Multimedia journalist

Jon Winkler is a 25-year-old reporter covering government, education and human interest in Ayer, Groton, Pepperell, Shirley and Townsend for the Nashoba Valley Voice. He previously covered education and local government in East Hampton and Southampton, New York. Jon is a New England original, born in Nashua and raised in Merrimack, New Hampshire.

jwinkler@nashobavalleyvoice.com

Follow Jon Winkler @MrJW595

Elodie Ring