



Town of Merrimac Multi-Hazard Mitigation Plan August 2021

Prepared by:



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Executive Summary

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This process results in a Multi-Hazard Mitigation Plan (HMP) that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term community vision. The Federal Disaster Mitigation Act of 2000 requires all municipalities to adopt a local HMP and update their plan every five years to be eligible for FEMA funding for hazard mitigation grants. Merrimac was previously included in the regional Merrimack Valley Multi-Hazard Mitigation Plan Update (2016), completed by the Merrimack Valley Planning Commission (MVPC), which expires in 2021.

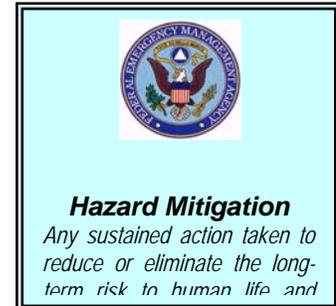
The Massachusetts Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) grant program helps communities assess local vulnerabilities to climate change and to develop appropriate action-oriented response strategies. The program provides technical support, guidance, and financial incentives for cities and towns to undertake community vulnerability self-assessments and prioritize projects and actions that can make a community more resilient and better prepared to mitigate long-term risks and adapt to climate change impacts. This planning process is very similar to that which is required to complete a local hazard mitigation plan. Merrimac became a designated MVP community in 2020.

In 2021, Merrimac began review of its yearly progress to advance the goals of its MVP Summary of Findings and decided to use this process as the starting point to update its expiring HMP. By incorporating the Town's updated MVP planning goals and actions, Merrimac is able to update its current HMP while incorporating resiliency to climate-related impacts. The result will be a more comprehensive tool for addressing risk to human life and property associated with hazards that will be exacerbated by climate change.

SECTION 1. INTRODUCTION

This section provides a general introduction to the updated **Merrimac Multi-Hazard Mitigation Plan** (hereinafter “Merrimac HMP”). It consists of the following four subsections:

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



1.1 Disaster Mitigation Act

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

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

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

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

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

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

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

1.2 Municipal Vulnerability Preparedness

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

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

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

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

In 2018, the Commonwealth of Massachusetts adopted the **State Hazard Mitigation and Climate Adaptation Plan (SHMCAP)**. The plan was the first of its kind to comprehensively integrate climate change impacts and adaptation strategies with hazard mitigation planning to comply with current federal requirements for state hazard mitigation plans under the Stafford Act. Following the State's example, cities and towns are eligible

for additional funding to combine the MVP Planning process with hazard mitigation planning. Merrimac became an MVP designated community in 2020 and will utilize the extensive planning process and outcomes to integrate, as the state has done, climate change impacts and adaptation strategies into their HMP update.

1.3 Background

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

The Merrimack Valley region is vulnerable to a wide array of natural hazards, including **floods, hurricanes, nor'easters, snow and ice storms, drought, wildfires**, and even **tornadoes** and **earthquakes**. These hazards threaten the safety of our residents and have the potential to damage or destroy public and private property, disrupt the local economy, and diminish the overall quality of life of those who live, work, and play in the region.

While we cannot eliminate natural hazards, there is much we can do to lessen their impacts on communities and citizens. By reducing a hazard's impact, we can decrease



the likelihood that such an event will result in a disaster. The concept and practice of reducing risks to people and property from known hazards is generally referred to as **hazard mitigation**. Also, by incorporating the best available scientific information on climate change, communities are better able to develop adaptation strategies to increase resilience.

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

Mitigation planning has the potential to produce long-term, recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-

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

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

1.4 Plan Purpose

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

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

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

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

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

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

As stated previously, to remain current, hazard mitigation plans must be updated and resubmitted to FEMA for approval every five years. Plan updates must demonstrate that progress has been made in fulfilling the commitments made in the previous plan. This requires a review and update of each section of the plan and a discussion of the progress made over the past five-year period. Merrimac was previously part of the regional Merrimack Valley Multi-Hazard Mitigation Plan which was approved in 2016. While the Merrimack Valley region has applied for Building Resilient Infrastructure Communities (BRIC) grant funding, Merrimac needs an updated plan on a faster timeline. Having recently completed the MVP Planning process, Merrimac took the opportunity when reporting on their progress with identified MVP goals, to begin planning for the HMP update. As a result, this updated Merrimac HMP describes occurrences of hazards included in the previous plan and assesses Merrimac's capacity to adapt to changing hazards and climate conditions in the future. The plan has also been updated to include changes in development patterns and changes in local and regional priorities. The goals contained in the prior plan have been reviewed and either reaffirmed or revised to reflect new information, priorities, and a changing climate.

1.5 Planning Project Vision Statement

Following the Community Resilience-Building workshop process used in MVP Planning, Merrimac seeks to develop an updated Hazard Mitigation Plan to substantially and sustainably improve its resilience to and preparedness for local and regional climate-related hazards. Merrimac seeks to achieve this by:

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

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

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

SECTION 2. PLANNING PROCESS & PUBLIC PARTICIPATION

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

2.1 Planning Process Summary

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

44 CFR Requirement

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

In late 2019, the Town of Merrimac engaged the Merrimack Valley Planning Commission, MVPC, as its certified MVP provider. MVPC also coordinated and completed the Merrimack Valley Multi-Hazard Mitigation Plan Update 2016-2021, in which Merrimac was included. To integrate climate change impacts and adaptation strategies with hazard mitigation planning, Merrimac determined it was logical to once again work with MVPC to facilitate the 2021 HMP update.

In 2020, Finance Director, Carol McLeod, supported by a Core Team, served as the lead for the MVP planning process. This team meets annually to review work completed during the prior year to advance resiliency and adaption goals and was a natural choice to lead the HMP update process.

Merrimac’s Core Team includes the following representation:

Carol	McLeod	Finance Director
Robert	Sinibaldi	Director of Public Works/Building Commissioner
Alyssa	Sexton	Inspectional Services Administrative Assistant
Eric	Shears	Police Chief
Larry	Fisher	Fire Chief
Ben	Beaulieu	Board of Selectmen
Chris	Manni	Board of Selectmen
Joel	Breen	Board of Selectmen
Kelly	Unsworth	Library Director

Jay	Smith	Conservation Agent
Tara	Ainello	Merrimac Light Department
Brienne	Walsh	Council on Aging Director
Sandra	Venner	Chair – Open Space, Planning Board, Housing
Denise	McClure	Consultant

In 2008, MVPC completed the Merrimack Valley region’s initial HMP. In 2015/16 MVPC completed the first update of that Plan. This update builds upon that planning initiative with Merrimac as the sole planning area focus. Updated data regarding natural hazard events, demographics, non-natural hazards, and critical infrastructure have been incorporated into the document as well as the outcomes of the Merrimac’s Municipal Vulnerability Preparedness Planning (2020) which further incorporates climate change into the existing plan. New information regarding changes in development patterns, progress in local mitigation efforts, and changes in local and regional priorities have been incorporated into the update as well.

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

2.2 Preparing for Plan Updating Process

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

MVPC is a certified MVP provider and staff leading the HMP update planning process are trained in workshops to provide technical assistance to communities in completing the assessment and resiliency plan using the [Community Resilience Building Framework \(CRB\)](#). Certified staff is well versed in relevant resources including climate change

projections for the Commonwealth and the region, found at the Climate Change Clearinghouse (resilientma.org). MVPC staff is also knowledgeable on how to incorporate nature-based solutions into the planning process, and how to integrate the MVP process with creating and/or updating a local Hazard Mitigation Plan.

Merrimac's Hazard Mitigation plan update included a review of Town and regional planning documents including the 2016 Update of the Merrimack Valley Natural Hazard Mitigation Plan, the 2019 Regional Housing Production Plan, Merrimac Master Plan (2002) and the Merrimac Open Space and Recreation Plan (2016-2023) as well as interviews with key staff within the Town.

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

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

2.3 Local HMP/MVP Core Team and Stakeholders

Project Announcement. The Merrimack Valley Regional Multi-Hazard Mitigation Plan is set to expire in May of 2021. To maintain its eligibility for future FEMA grant funding, Merrimac needs to have a current Hazard Mitigation Plan if awarded a grant. Merrimac engaged MVPC to assist with the update in early 2021. Merrimac announced the plan update at a Board of Selectmen's meeting (held virtually due to the Covid-19 pandemic) in April of 2021.

Core Team Meeting. The Town identified its MVP Core Team as possessing the integral group of community representatives to lead the HMP update. Per MVP Program requirements, the Core Team convenes annually to provide yearly progress on the Town's MVP Program. This year, the team met to review both the priority actions identified in Merrimac's 2016 Mitigation Action Plan as well as the priority actions identified in the 2020 Summary of Findings.

The Core team also reviewed natural hazards of greatest concern, existing inventories including those of critical facilities and infrastructure, dams, bridges, and flood-prone areas, as well as new developments and changes in land use. The resulting information was then used to compile the "Existing Protections Matrix" element of the Plan (see Section 5). Core Team members also provided valuable information to identify mitigation projects that have been completed or initiated since the prior Multi-Hazard Mitigation Plan was approved in 2016.

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

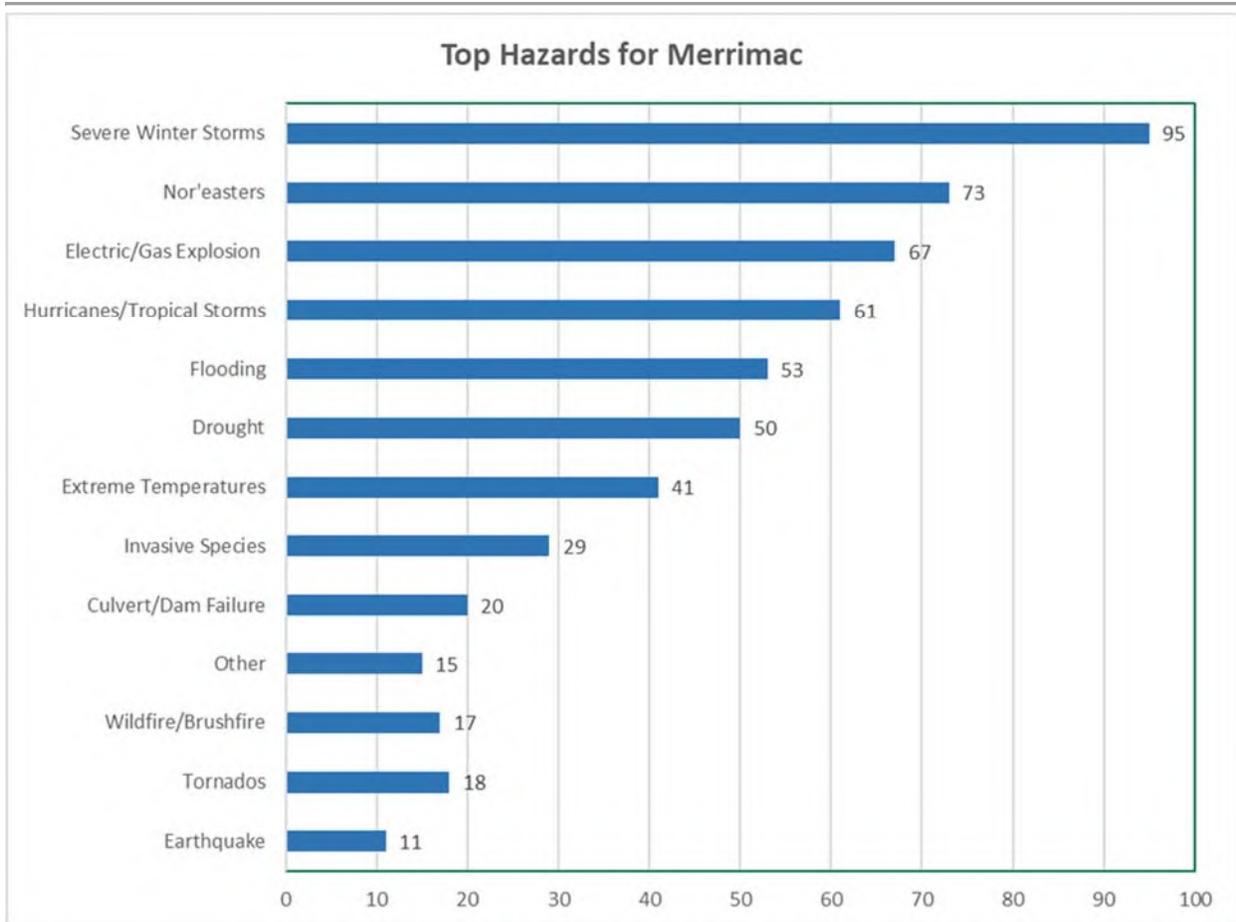
The Stakeholder representatives included:

Stakeholders

- ◆ Justin Bartholomew, Pentucket School Superintendent
- ◆ Maureen Lynch, Whittier Tech High School
- ◆ Eileen Stepanian, Town Nurse
- ◆ Nick Fiorello, Senior Center
- ◆ Laura Mailman, Senior Center
- ◆ Chris Gaudet, Chair – Commission on Disabilities
- ◆ Michelle Bibeau, Housing Authority
- ◆ Veronica Wolfe, Lake Attitash Association
- ◆ Greg MacLean, Retired
- ◆ Hilary Snook, EPA
- ◆ Cassandra Gove, Mayor, City of Amesbury
- ◆ Angus Jennings, Town Manager, West Newbury
- ◆ James Fiorentini, Mayor, City of Haverhill
- ◆ Christine Berry, Dept. of Conservation and Recreation (DCR), MA;
- ◆ Joseph Costanzo, MVRTA, Haverhill;
- ◆ Diana DiZoglio, State Senator, First Essex District;
- ◆ Margaret Duffy, Greenscapes Northshore, Salem;
- ◆ Joy Duperault, State NFIP Coordinator, Boston;
- ◆ Vanessa Johnson-Hall, Essex County Greenbelt, Essex;
- ◆ Lenny Mirra, State Representative, Second Essex District.
- ◆ Matthew Thorne, Merrimack River Watershed Council
- ◆ Kevin Hunt, Veterans Services
- ◆ Lori Timmerman, National Grid

Core Team and Stakeholder Survey. Prior to conducting community resilience workshops, the Merrimack project team conducted a survey asking the community to

identify the top four potential hazard events of most concern. Over two hundred community members responded to the survey which generated the following response levels to the following question:



Informed by the survey, the Merrimac residents characterized the top hazard concerns (additional survey results in Appendix B).

Town of Merrimac Primary Hazard Concerns Identified

	<p>Nor'easters/Severe Winter Storms</p> <p>Storms of heavy winds and rain along with severe winter storms are the most frequent naturally occurring hazard in Massachusetts. And with climate change, the intensity and frequency of these storms will rise. Nor'easters have caused major tree damage and infrastructure disruption to many Merrimack Valley Communities, memorably in March 2018 and Oct. 2017 when storms precipitated road closures and extended power outages.</p>
	<p>Flooding</p> <p>Approximately 11% of Merrimac's land area lies within either the designated flood zone areas with either a 1% (100-Year) or .2% (500-year) chance of occurrence. Risk of flooding events are heightened by the effects of climate change which portends higher precipitation levels in Winter/Spring seasons and more frequent, intense storms. In fact, parameters of the so-called 100-year storm are changing. In the 1960's, a 24-hour event that produced 6.5 inches of rain was categorized as a 100-year storm. By 2015, threshold for the 100-year storm (i.e. storm with 1% occurrence odds in any year) was 8.4 inches of rain over 24 hours.² Significant flood events occurred in Merrimac most recently in Spring 2010 and the Mother's Day Flood of 2006.</p>
	<p>Hurricanes/Tropical Storms</p> <p>A 2017 U.S. Climate Science Special Report noted that there has been an upward trend in North Atlantic hurricane activity since 1970. The report forecasts that future hurricanes formed in the North Atlantic will drop more rain and may have higher wind speeds. This is because a warmer atmosphere will hold more water, and hurricanes are efficient at wringing water out of the atmosphere and dumping it on land.³ Extreme tropical storms travel over inland areas and may release large quantities of precipitation causing rivers to overtop their banks flooding roads and damaging infrastructure.</p>
	<p>Aging Infrastructure</p> <p>The Sept. 2018 Gas Explosions underline heightened concern with infrastructure conditions in the Merrimack Valley. Bridges, culverts, dams, sewer, water and storm drain lines, power and communication networks, many installed in the first half of the 20th century or earlier are all vulnerable to extreme storm events.</p>

² https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html National Oceanic and Atmospheric Administration, Atlas 14 Precipitation Frequency Atlas of the United States & Technical Paper # 40, U.S. Dept. of Commerce.

³ <http://www.resilientma.org/resources/resource::2152> National Climate Science Center at the University of Massachusetts Amherst, Massachusetts Climate Change Projections, March 2018.

2.4 Community Resiliency Building Planning Process and Outcomes

In early 2020, the Town of Merrimac held two CRB Workshops. The workshops took place on January 28, 2020 and February 11, 2020. Agendas for the January 28 and February 11, 2020 workshops are attached as appendix C. Invitations were distributed to approximately 40 stakeholders with excellent participation of approximately 20 people per workshop.

Workshop participants included a broad representation of community groups, board and commission members, and staff from public works, building, planning, conservation, the Council on Aging, library, and other community departments. The workshops were facilitated by MVPC and were held at Sargents Hall at Merrimac Town Hall. The first workshop focused on characterizing the Town's top hazards followed by small table group discussions to identify community features most vulnerable to natural hazards exacerbated by climate change and define community assets that contribute to mitigating risk and aiding recovery. The second workshop centered on discussion of actions in the realms of infrastructure, society and environment the Town can undertake to build a more resilient Merrimac and better prepare for future emergencies.

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

<https://mvpc.maps.arcgis.com/apps/MapJournal/index.html?appid=89747a76fd554be58f4de62b510f303f>

As noted above, the first workshop included an opening presentation with summaries of the MVP Program and planning framework, climate change data and projections, and Merrimac's history of hazard events, all incorporated into the Storymap. Following the presentation, in small table discussions, participants identified and categorized as strengths and/or vulnerabilities critical community infrastructure, societal and environmental features. Individuals then voted on the most vulnerable infrastructure, societal and environmental features in the community. This information was recorded on a matrix for each category and is attached to this summary.

At the second workshop, participants focused table discussions on actions that either enhance community strengths or mitigate hazards that may be exacerbated by climate change. These actions were recorded in the matrices. Individual tables then reported out on all actions and a summary list was compiled.

In both workshops, lead facilitators from MVPC guided table discussions of 8-10 people aided by MVPC staff scribes. Each table delegated a volunteer to report out for the table in the large group discussion.

At the end of the second workshop, similar actions from each table were consolidated and participants voted for their three top recommended priority resilience projects for Merrimac in each of the designated categories (critical infrastructure, socio-economic, and environmental).

A draft Summary of Findings was posted to the Town of Merrimac website in March of 2020 and a public listening session was scheduled for March 16th. During that same month, the COVID-19 pandemic hit the country and state and local governments began working remotely. The listening session was cancelled and rescheduled to be held remotely on April 27, 2020. Over 30 people attended the remote session and additional comments were incorporated into the draft.

Merrimac was designated an MVP Community in the Spring of 2020 and was eligible for MVP Action Grant funding. As an MVP designated community, Merrimac must report annually on its work related to the MVP process and climate change resiliency in the community. This includes work the town has done to incorporate MVP outcomes in other planning efforts.

Similarly, following completion of the Regional Multi-Hazard Mitigation Plan in 2016, each community committed to annual review of the plan. The prior plan identified Merrimac's Local Hazard Mitigation Planning Team (LHMPT) to conduct the annual plan review. At this meeting, the local hazard mitigation team was charged with reviewing the hazard mitigation measures that had been implemented as of that date and determining if these measures have had an impact on mitigating the overall hazard risk(s). In the case of *structural* projects in particular, this review was to include site visits to locations where the measures have been implemented. Mitigation measures that have not been implemented were reviewed to determine if they would still minimize natural hazards or if they are no longer a viable option. Additionally, the hazard mitigation team would determine any new options to include in an update of the plan.

However, with the MVP Core Team now in place, Merrimac designated this group to oversee both the MVP and HMP review process. For Merrimac to become more disaster and climate-resilient and better equipped to respond to natural hazards, there must be a coordinated effort between elected officials, appointed bodies, municipal staff, regional and state agencies, other stakeholder groups, and the general public. Thus, monitoring, evaluating, and updating the hazard mitigation plan are critically important steps to maintaining a viable, effective plan.

On May 26, 2021, the Town of Merrimac coordinated a virtual meeting to review the outcomes of the MVP Planning process as well as consider additional vulnerabilities and actions to mitigate natural hazards including the impacts of climate change. A summary of the reviewed outcomes of Merrimac's recent MVP planning process are highlighted in the next section. Additional input from municipal officials and regional stakeholders will be incorporated throughout the plan. The invitation to the planning meeting, including workshop goals, is included in Appendix C. Over twenty people attended the public meeting/virtual workshop. Online polling via Poll Everywhere was used to review stakeholder support for the outcomes of the 2020 MVP Planning process. A summary of this polling can be found in Appendix B.

Merrimac Infrastructure Features

Vulnerabilities	Strengths
<ul style="list-style-type: none"> Culverts (Undersized) Lake Attitash (Flood Control) Lack of Emergency Shelter Locations Lack of Facilities with Backup Power (Ideally a clean energy source with storage) Drinking-Water Supply (Additional sources and water storage) Wastewater Treatment Plant Infrastructure DPW Facility on Cobblers Brook Stormwater Infrastructure 	<ul style="list-style-type: none"> Municipal Light Plant Requirement for Infiltration

Merrimac Societal Features

Vulnerabilities	Strengths
<ul style="list-style-type: none"> Vulnerable Populations - Seniors, Homebound, Mobile Home Park & Public Housing Complex Residents Residents in Flood-prone Areas (including Lake Attitash) Shelter Planning Lack of Communication on Emergency Planning Disease Vulnerability Mobility Issues for Seniors (lack of sidewalks and handicap accessibility) 	<ul style="list-style-type: none"> Senior Center Youth Population Faith Based/Civic Groups Mutual Aid Agreements Reverse 911 System

Merrimac Environmental Features

Vulnerabilities	Strengths
<ul style="list-style-type: none"> Water Supply/Water Quality Tree/Forest Health/Invasive Species Lack of Resiliency Planning/Inclusion in Local Bylaws/Regulations Stormwater Maintenance (Access Issues) Riverbank Erosion Cobblers Brook Under-designed Stormwater System Development in Flood-prone Areas 	<ul style="list-style-type: none"> Requirement for Infiltration (need for more with increasing storm intensity) Green Energy Program Open Space Subdivision Regulations

Recommendations for Hazard Mitigation and Climate Resiliency. At Merrimac's second workshop, participants identified actions focusing on infrastructural, societal, and environmental features and issues of most concern. Each table identified their priority actions. Participants came together at the end of the workshop to vote for their top three recommendations in each category. The top recommended priority resilience projects for Merrimac in each of the designated categories (critical infrastructure, socio-economic, and environmental) are listed below and the completed matrices are included in Appendix D of this plan.

High Priority Actions - Infrastructure

- Design and implement culverts where previous studies have been done. Fund a study of the remaining culverts to prioritize replacement to accommodate future stream flows. Studies should include existing and future land use development.
- Identify shelter locations and properly equip those shelters including backup green energy. Regional solutions should be considered.
- Conduct water & wastewater study including moving critical wastewater facilities out of areas that may be subject to flooding.
- Relocate DPW complex out of flood-prone area.
- Continue work with Green Communities and work on green energy generation and storage.

High Priority Actions – Society

- Establish emergency plan including strategies for communicating with vulnerable populations.
- Outreach and education for vulnerable populations (mobility issues, group homes) in emergency situations. Coordinate this outreach with faith based, community and other groups.
- Shelter planning with backup green energy.
- Improve access for emergency and everyday situations for those with mobility issues. Sidewalks were specifically mentioned.
- Emergency planning for flood-prone areas (Lake Attitash area may require regional solution).

High Priority Actions – Environmental

- Conduct forest management planning and implementation
- Conduct a comprehensive water study including storage (consider regional options)
- Conduct new watershed study of Cobbler's Brook including its mini watersheds
- Explore role for resiliency planner in local government. Find additional ways to continue resiliency planning including volunteers.

Other Priority Community Resilience Actions

- Comprehensive review of bylaws for stormwater
- Conduct an educational speaker series on resiliency topics

- Study and prioritize stormwater system improvements; develop maintenance plans for stormwater basins including provisions for access
- Bank restoration and management plan; education flyer on bank erosion
- Land preservation/restrictions for infiltration, flood protection and carbon sequestration
- Public education and outreach regarding resilient tree species
- Regional planning for Lake Attitash management
- Develop youth-based education program focusing on responsible land use, stewardship and eco-services
- Add street tree planting to subdivision bylaws with requirement for resilient species and guidance on placement
- Explore collaborative and strategic development plan for former farms and other large parcels that may be subject to development
- Explore and implement alternative management strategies for invasive species.

Additional Priority Actions Identified at the May 26, 2021 Planning Meeting

- Consider regional park systems to increase infiltration to aquifers, reduce flooding, and improve drainage
- Incorporate the Essex County Greenbelt Association priority parcel analysis into Merrimac’s mapping to identify parcels that can increase resiliency, provide cooling, enhance water supply protection, and protect priority agricultural lands
- Add the Regional School District to the Green Communities program to identify energy reduction strategies
- Improve water-supply planning for growing population
- Consider Stormwater Utility to assist with funding upgrades to stormwater infrastructure
- Continue to explore adding a town planner/resiliency coordinator municipal staff

This section summarizes the priorities of the Core Team and Stakeholders. The full list of action items can be found in the completed matrices in Appendix D of this plan. The resulting information was then used to update the “Existing Protections Matrix” element of the plan. These discussions allowed Town staff to identify gaps in their community’s natural disaster mitigation efforts, and to explore potential mitigation actions/projects. The MVP Planning process will serve to update the Hazard Mitigation Strategy developed in the 2016 Plan into the new 2021 Hazard Mitigation Strategy.

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

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

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

The first session was held virtually on August 10, 2021. The public meeting was advertised on the Town Calendar and in the Events section of the Town website and was also promoted on the Town’s social media accounts. All Core Team members and Stakeholders were invited via email. The meeting was held virtually with 14 participants. Following a StoryMap presentation by MVPC, Merrimac’s Building Commission/Director of Public Works presented the priority actions identified during the planning process and facilitated discussion with the attendees.

The second listening session will be held once comments from MEMA and FEMA have been received and the plan is ready for presentation to the Board of Selectmen. Agendas for all meetings can be found in Appendix C and within the ArcGIS Storymap.

Date	Meeting	Attendees
January 28, 2020	MVP Stakeholder Workshop	20
February 7, 2020	MVP Stakeholder Workshop	20
April 27, 2020	Virtual Listening Session	30
May 26, 2021	Virtual HMP Planning Meeting	23
August 10, 2021	Virtual HMP Listening Session	14

2.6 Continuing Public Outreach

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

SECTION 3. COMMUNITY PROFILE

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

The Town of Merrimac is located in Essex County in the northeastern part of Massachusetts, on the banks of the Merrimack River and approximately 37 miles north of Boston. Merrimac is bounded by Amesbury, West Newbury, Haverhill and Newton, N.H.

The town has a total area of 8.6 square miles, of which 13.5% is wetlands or open water. The Town's southern border is the [Merrimack River](#). Lake Attitash, shared with the City of Amesbury, is in northeast Merrimac.

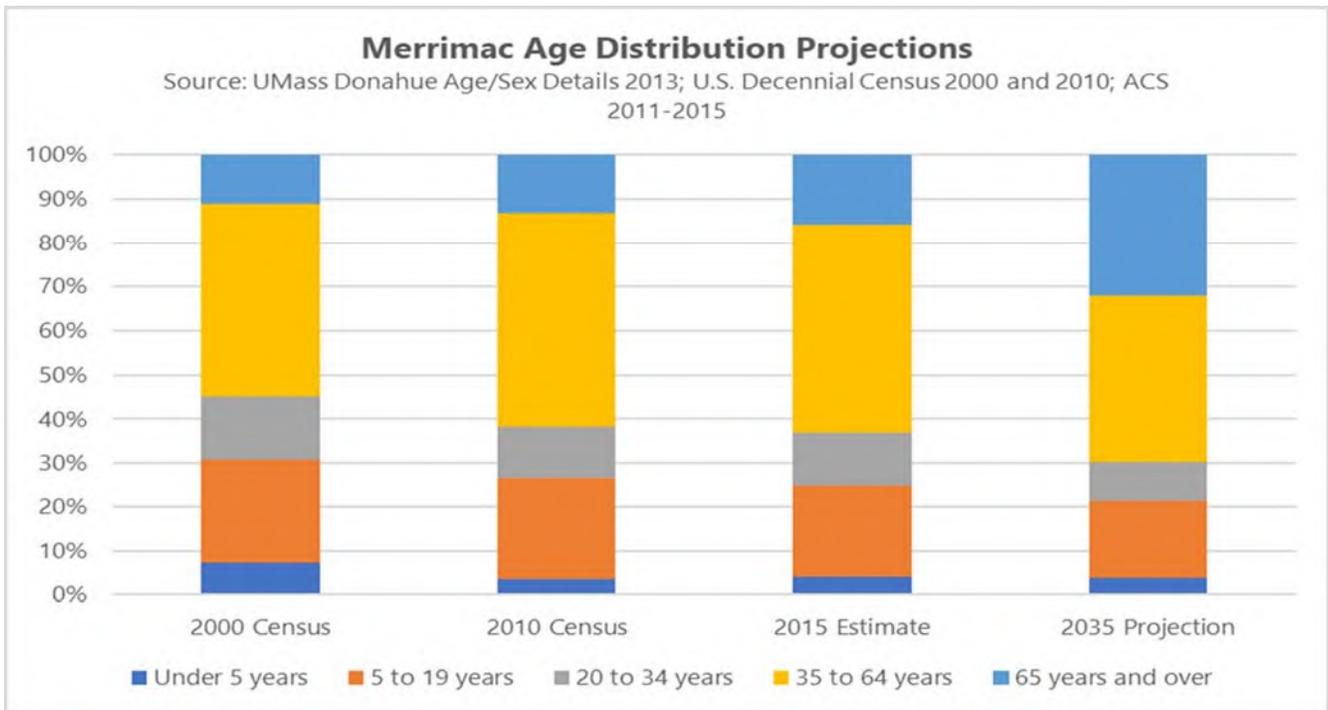
3.1 Current Population, Housing, and Employment

Population. Merrimac's estimated population per the 2019 American Community Survey (ACS) is 6,890 people – an increase of about 8.7 percent from 2010. The population of Massachusetts (state) and Essex County (county) increased about 5.2 percent and 5.6 percent respectively between 2010 and 2019.⁴ The estimated population of the region increased 6 percent in the same period.

Per the UMass Donahue projections, the age composition of Merrimac's population is anticipated to change with a 160 percent increase in the number of older adults (age 65 year and over), a 39 percent decrease in the number of school age children, a 59 percent decrease in the number of adults age 20 to 34 years, and a 40 percent decrease in the number of adults age 35 to 64. The median age in Merrimac was estimated to be 47.7 years in 2019, according to the ACS, which is higher than the county's median age of 40.6 years and the state's median age of 39.7 years.⁵

⁴ <https://data.census.gov/>

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



The U.S. Census Bureau, per the ACS, defines disability as including go-outside-home, employment, mental, physical, self-care, and sensory. Merrimac’s estimated disability rate (10.4 percent of total non-institutionalized population) is slightly lower than the region (11 percent), county (12 percent), and state (12 percent). The estimated percentage of children under 18 years with a disability in Merrimac (less than 1 percent) is lower than the region (5 percent), county (6 percent), and state (5 percent). The estimated percentage of adults age 18 to 64 years with a disability is the same (9 percent) as the estimated 9 percent of population in this age cohort in the region, county, and state.

However, there is still an estimated 30 percent (about 207) of older adults age 65 years and over with disabilities. Merrimac stakeholders identified senior populations and individuals with disabilities as more vulnerable to climate change and emergencies and disasters overall.

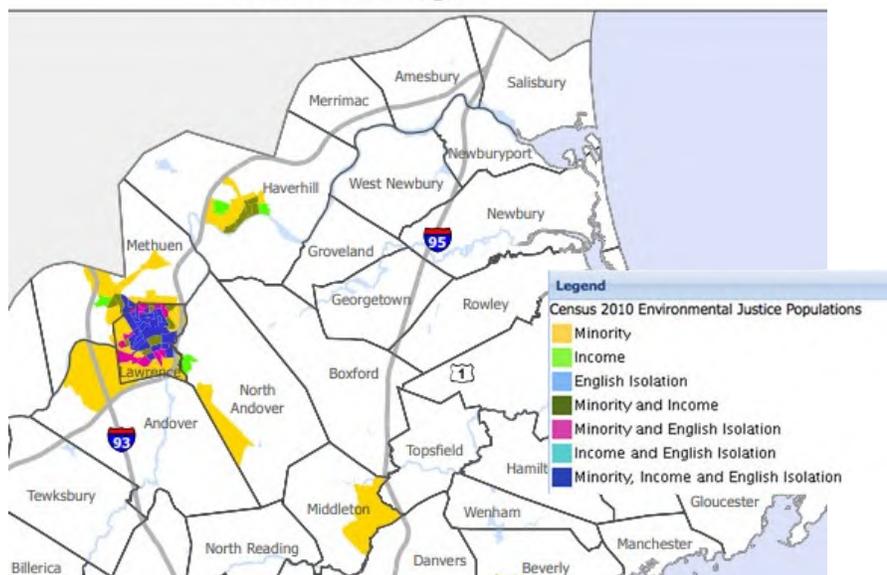
Environmental Justice. Since 2002, the Massachusetts Executive Office of Energy and Environmental Affairs has been implementing an Environmental Justice (EJ) Policy to help ensure that all Massachusetts residents experience equal protection and meaningful involvement concerning development, implementation, and enforcement of environmental laws, regulations, and policies, and the equitable distribution of environmental benefits. Historically, land-use decisions in Massachusetts caused lower-income people and communities of color to experience a disproportionate share of environmental burdens and often lacked environmental assets in their neighborhoods.⁶

⁶ Source: MA Executive Office of Energy and Environmental Affairs,

The state has identified Environmental Justice (EJ) neighborhoods that are comprised of EJ populations.⁷ Vulnerable populations such as EJ neighborhoods should be given special consideration when planning for current and future hazards. Merrimac has no environmental justice communities as defined by the Commonwealth.

The most significant racial/ethnic difference between Merrimac's population and the region's is the percentage of the population identifying ethnically as Hispanic or Latino. About 2 percent of Merrimac's population (of any race) identifies as having Hispanic/Latino ethnicity, whereas 25 percent of the region's population identifies as having Hispanic/Latino ethnicity. Despite lower reported ethnic diversity, language barriers were identified as needing consideration during the hazard mitigation planning process and actions to increase communication in multiple languages were recommended.

2010 Environmental Justice Populations Northeast Region



Economic. Roughly 45 percent of Merrimac's total labor force is employed in the industries of management, business, science and arts. About 25 percent is employed in sales or office occupations, and about 15 percent is employed in the service industry. The remaining employed population works in the fields of natural resources, construction, and maintenance and production, transportation, and material moving. In March of 2020, the COVID-19 pandemic shuttered many businesses, with the greatest losses seen in the leisure and hospitality industries. At that time, the unemployment rate in Merrimac was reported at 2.5 percent with the Lower Merrimack Valley being reported at 3.3 percent. In March of 2021, the Merrimac rate was reported 5 percent with the Lower Merrimack Valley Region at 7.9 percent⁸.

⁷ Environmental Justice (EJ) Populations are those segments of the population that the Massachusetts Executive Office of Energy and Environmental Affairs has determined to be most at risk of being unaware of or unable to participate in environmental decision-making or to gain access to state environmental resources. They are defined as neighborhoods (U.S. Census Bureau census block groups) that meet one or more of the following criteria: 1) The median annual household income is at or below 65 percent of the statewide median income for Massachusetts; or 2) 25% of the residents are minority; or 3) 25% of the residents are foreign born, or 4) 25% of the residents are lacking English language proficiency. Source: <https://www.mass.gov/doc/environmental-justice-policy6242021-update/download>

⁸ [Labor Market Information | Mass.gov](#)

Per the 2015 estimates, about 50 percent of Merrimac households have less than 30-minute travel time to work. This is lower than the estimated population in the region (57 percent), county (57 percent), and state (56 percent) that have less than 30-minute travel time to work. About 21 percent of Merrimac households commute over an hour, which is greater than in the region, county, and state.

In 2012, the US Economic Census reports that there were 94 firms in Merrimac. The number of firms compared to the number of jobs in the Town reveals that most local businesses are small employers or self-employed individuals. The sectors with the most employees in 2016 were construction and computer and scientific equipment manufacturing. While there are only a few farms, the continuation of these farms in agricultural uses is an important goal for the community. The largest employer is the Town of Merrimac. The Town is not zoned to attract large employers.⁹

Housing. The demand for housing in the Merrimack Valley has typically outpaced the available supply. The 2015 ACS estimated 2,582 housing units in Merrimac, with 2,528 year-round occupied units (98 percent) and an estimated 54 vacant units (2 percent of total housing units). The estimated rental vacancy rate in Merrimac was 1 percent and ownership vacancy rate was 1 percent. These vacancy rates indicate a need for both more rental and ownership units. The county and state had higher vacancy rates for both owner and rental housing.¹⁰

An estimated 85 percent of Merrimac total occupied housing units were owner occupied while 15 percent were renter occupied per the 2015 ACS estimates. In comparison, the region, county, and state had a greater percentage of renter-occupied units (37, 37, and 38 percent, respectively).

Although the rate of single-family residential growth has fluctuated with economic cycles, single-family development has generally been consistent over the past 30 years. While single-family development continues, there has been a recent shift to multi-family housing with 96 multi-family units constructed within the past year. This is a reflection of current consumer demand and may be preferable to the continued “sprawl” development occurring in the region’s suburban and semi-rural communities. From a natural disaster (especially *flooding*) perspective, the sprawl pattern of development has undesirable consequences, not the least of which are an accelerated loss of open space and natural flood storage capacity, increased impervious surface cover, and increased stormwater runoff. While recent progress has been made in the use of open space residential design (OSRD) as a means of “clustering” housing development and preserving a greater proportion of the natural landscape, this style of development is still less common and remains a small percentage of the total housing starts.

⁹ Merrimac Open Space & Recreation Plan, 2016

¹⁰ Town of Merrimac Housing Production Plan 2018-2022 prepared by Merrimack Valley Planning Commission with JM Goldson community preservation & planning

3.2 Land Use Characteristics and Trends

Merrimac has outstanding and irreplaceable natural assets that the Town needs to protect from potential adverse impacts of existing and future development, including the Merrimack River, a rolling landscape with vast tracts of agricultural land, large and still unaltered forests, along with an intricate system of wetlands, surface water and ground water resources. The location and extent of these resource areas have little relationship to the political boundaries that separate Merrimac from adjacent communities or the Commonwealth of Massachusetts from the State of New Hampshire. There are several habitat areas along the Merrimack River and north of Route 110, where large, contiguous tracts of undeveloped land serve as a buffer to riparian corridors and help to protect the quality of surface and ground water resources. For the most part, the open landscapes of northern Merrimac adjoin a simple frame of north-south byways that supported early colonial settlement patterns. Today, the same roads channel a significant amount of cut-through traffic between New Hampshire and I-495, a task for which they are poorly equipped by design and general condition.



Table 3.2.1 presents the most recent (FY2020) land use information available Merrimac. The information was developed based on assessment data/parcel land use codes. The table shows total acreage within each category as well as the percent cover of each category within the town. Also included is the percentage of land within the Zone A and Zone X Flood Areas per the FEMA Flood insurance rate maps. These areas are further defined in Chapter 4 (Natural Hazards section) of the plan.

Table 3.2.1 Merrimac Land Use FY20						
	Acres	Rounded Percent	Acres in Zone A	% in Zone A	Acres in Zone X	% in Zone X
Agriculture	91.53	1.6%	7.24	0.13%	0	0
Commercial	28.68	0.5%	0.155	0.003%	0.35	0.01%
Industrial	96.00	1.7%	0.131	0.002%	0	0
Institutional	318.85	5.6%	30.83	0.54%	0.014	0
Mixed Use	332.60	5.8%	6.43	0.11%	12.5	0.22%
Multi Family	274.92	4.8%	8.42	0.15%	2.45	0.04%
Open Space	625.66	11%	6.28	0.11%	59.2	1.04%
Single Family	2,328.82	41.6%	89.1	1.56%	8.8	0.15%
Vacant Commercial	163.66	2.9%	41.58	0.73%	0	0
Vacant Industrial	23.20	0.4%	0	0	0	0

Vacant Residential	748.39	13.1%	98.24	1.72%	38.62	0.68%
Water	223.87	3.9%	220.88	3.87%	0.08	0
ROWs & Rail ROWs	389.71	6.8%	2.91	0.05%	2.73	0.05%
Unknown Parcels	14.32	0.3%	1.37	0.02%	0.08	0
Total	5,700.21	100%	513.566	8.995%	124.824	2.19%

The largest category of developed land use in the Merrimack Valley region is residential. This includes all residential dwelling types, from large lot, single-family homes to multi-family apartments and condominiums. In Merrimac, assessment data shows that more than 75% of Town land currently supports development. Land that supports agriculture, open space, and recreation is less than 25%.

Of the undeveloped land that remains in Merrimac, the majority is zoned as residential (13.1%). Unprotected agricultural land could also be a source of developable land (1.6%) and was a point of discussion for many Merrimac stakeholders who expressed concerns about the loss of large pervious areas, scenic resources, and water supply. Two percent of vacant residential land lies within a floodplain area. Development in floodplain areas is regulated by the Merrimac Zoning Bylaw and the Merrimac Conservation Commission.

The Town of Merrimac Planning Board is the primary town agency responsible for regulating development in the town. The Merrimac Planning Board, through its staff, provided feedback during the local hazard planning team. In addition, Merrimac Valley Planning Commission, the Town's regional planning authority, works with all agencies that regulate development in its region, including the Towns and state agencies, such as Department of Conservation and Recreation and MassDOT. This continued involvement ensured that during the development of the Town of Merrimac Hazard Mitigation Plan, the operational policies and any mitigation strategies or identified hazards from these entities were incorporated.

Situated just east of Merrimac Square between Route 110 and I-495, **Merrimac's Route 110 Corridor** is designated a local priority development area in the Regional Growth Strategy (2015). It has convenient access to both major roads in town via Broad Street. This PDA consists of 159 acres divided into two zoning districts. The Highway Services district is set forth "to manage traffic flows on Broad Street between I-495 and Route 110 and provide goods and services that serve local and non-local customers." Permitted uses include retail/service and restaurants of 2,500 sq. ft or less; small grocery/convenient stores, and bakeries; plus, banks/real estate/insurance offices, and service establishments. Other uses including larger restaurants by special permit only. Prohibited uses include retail over 10,000 sq. ft. The permitted uses of the Office-Light Industrial district generally include professional offices and light manufacturing buildings, health clubs, recycling centers and the like. Residential is not permitted in this PDA.

Merrimac has one of the lowest commercial/industrial sectors among Merrimack Valley communities. As more land is developed, additional impervious surface is created, thereby decreasing the area available for flood storage and increasing the flood risk, Merrimac residents also expressed concerns for infiltration to recharge ground water supplies. As population and housing density increase, the potential for property damage and economic loss as a result of a natural disaster also increases.

3.3 Transportation Network

Merrimac and the surrounding region are accessed by three main modes of transportation: 1) major highways located within a few miles of Merrimac (State Route 110, and Interstate 495); 2) the Massachusetts Bay Transportation Authority (MBTA) commuter rail services (Haverhill and Newburyport stations), and bus service to the station and within Town provided by the Merrimack Valley Transit Authority; and 3) trails, paths and walkways providing pedestrian and bicycling opportunities. The closest airports are located in Manchester, NH and Boston.

Several major arterial, collector and local roadways comprise Merrimac's transportation network. Merrimac's regional highway, Routes 110, and major interstate highway, Routes 495, are important to the town's development and economy. Of Merrimac's 1,355 employed residents, 80% of them commute in single-occupant automobiles with an average commute time of under half an hour. Sidewalks are located principally in the downtown area. Pedestrians, cyclist, horses, cross-country skiers and snowmobilers use several local trails. Many of Merrimac's roads are winding, rural and lined with mature trees. New house lots, subdivisions and road widening, or straightening projects threaten the character of these streets.



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

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

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

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

Air Transportation. Aviation services in the Merrimack Valley region are offered at the Lawrence Municipal Airport in North Andover and two privately-owned airports in Methuen and Newburyport. Larger airports are located in Boston and Manchester NH.



Lawrence Municipal

3.4 Water Resources and Public Water Supplies

Water Resources. The communities in the region share many resources. The most significant is the 180-mile Merrimack River and its watershed. The Merrimack River watershed is New England’s fourth largest, covering 5,010 square miles and including more than 200 cities and towns. More than 300,000 people use surface water from the Merrimack River for drinking water. Other communities in the region rely on the



Merrimack’s groundwater resources. There are unconsolidated sand and gravel aquifers along the Merrimack River and its major tributaries that can sustain well yields of more than 300 gallons per minute (gpm).

In a regional context, all of Merrimac is located in the Merrimack River Watershed. Lake Attitash, located along Merrimac’s eastern boundary, doubles as a recreational and scenic resource for the region and a source of drinking water for neighboring Amesbury. The Town is crossed by many major and minor streams, such as Cobbler’s Brook, which runs through the center of town to the Merrimack River and the Back River that drains into Lake Attitash. Water quality is a major concern for Merrimac, in part because of past experience with polluted waters, but also because the Town cannot afford to lose one of its wells to ground water contamination. In fact, Merrimac’s water supplies are hard-pressed to meet existing demand and the Town lacks a workable, near-term solution to the problem.

Public Water Supply Water supply remains a significant challenge to Merrimac’s future development and is likely to be exacerbated by the increasing number of days without

precipitation. According to the Water Master Plan completed in November 2009, Merrimac obtains water from two well fields, the East Main Street well field and the Sargent Pit well field. The Town is registered to withdraw a total of 0.36 Million Gallons per Day (MGD) from these supply sources and is permitted to withdraw an additional 0.1 MGD for a total Water Management Act Authorized withdrawal of 0.46 MGD, or 167.9 MG/year.

The system provides municipal water to approximately 5,390 persons, or 80% of the town's total population and the average water use per person is 64 gallons per day. The Town anticipates that water demand will increase from current average daily flows of 0.396 Mgal/day to 0.422 Mgal/day in 2020, and 0.450 Mgal/day in 2030. Merrimac's efforts in promoting water conservation and aggressively correcting leaks when detected are very effective in managing a limited supply with few options for expansion.



Stream in Merrimac,
MVPC Photo

Merrimac's zoning bylaw provides for a water resource protection district (WRPD) that covers both groundwater resources (the area underneath the ground where the water is found) and surface water resources (the area of the aquifer that contributes water to the wells under the most severe pumping and recharge conditions that can be anticipated.) The district was developed because Merrimac and the city of Haverhill rely on Merrimac's groundwater resources for their drinking water supplies, and the town of Amesbury relies on surface water supplies in Merrimac

for its drinking water. The WRPD encompasses about 1,255 acres. Of these, the Merrimac only owns 154 acres and Haverhill owns 77.3 acres around its well fields. The remainder is privately-owned.¹¹

Water supply was a top concern of Merrimac stakeholders in the area of environmental vulnerabilities. The frequency and intensity of drought are 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. This may only exacerbate Merrimac's vulnerability. Workshop participants identified a need to undertake a study to identify additional drinking water sources which could include looking regionally. A need for greater water storage facilities was also identified.

Infiltration is important for recharging groundwater supplies. Merrimack stakeholders stressed the need to maintain and improve upon the town's bylaws that require infiltration on new development projects as well as protect and expand land protection initiatives and the water supply overlay district.

¹¹ Merrimac Open Space & Recreation Plan, 2016

3.5 Protected Open Space and Prime Farmland

Merrimac is blessed with an abundance of ecologically rich and visually stunning open space resources. This range includes an intricate tapestry of forests, fields, farms, and hilltops in both wetland and upland areas. Merrimac has about 625 acres of open space, of which the Town owns approximately 75% (about 468 acres).¹² Approximately one-eighth of the land in Merrimac is protected open space or currently in agricultural use.

Together, these rich resources provide outstanding and diverse:

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



Open Water – Merrimac, MVPC Photo

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

Prime Farmland

Historic agricultural vestiges such as outbuildings, barns, silos, stone walls and tilled fields



reinforce a Town's sense of place, as do its open spaces and scenic landscapes. Merrimac has many landscapes that retain their agricultural character and naturally scenic qualities. These sites have not been surveyed or fully documented as part of the Town's historic inventory. Most of the sites are unprotected, although two farms are protected by Agricultural Preservation Restrictions (APR). One of them, parts of Sargent Farm on Bear Hill Road, has been owned by the same family for at least seven generations and has been in operation for more than a century. The

second APR farm is located in the west side of Town on Birch Meadow Road and abutting the Town Forest.¹³

Currently, there are about 259.1 acres temporarily protected in the Chapter 61 programs. The largest holding (123 acres) is agricultural land that is owned by the Sargeant Family.

¹² Merrimac Open Space & Recreation Plan, 2016

¹³ Merrimac Open Space & Recreation Plan, 2016

Notably, all of the land that is enrolled in the Chapter 61 program is agricultural (61A). None is set aside for forestry or recreational uses. There are two Agricultural Preservations Restrictions in Merrimac, totaling 434.55 acres. This conflicts with the Land Use Table above with the reason being that the table is created using assessor's codes which do not always align with the Open Space and Recreation Plan's categories.

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

3.6 Historic and Cultural Resources

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

Despite the wealth of historic architecture around Merrimac Square and north of the Merrimack River, Merrimac has very little in place to protect its historic built assets. Town officials disagree about the merits of creating local historic districts or instituting demolition delay. The Zoning By-law requires a special permit for new construction in Merrimac Square and encourages building alterations that conform to the Secretary of the Interior's "Standards for Rehabilitation", but these are the only historic preservation tools in Merrimac today. It is hoped that new regulatory incentives to reuse older, obsolete buildings for a mix of uses, including multifamily housing, will dissuade property owners from resorting to demolition/rebuild projects.

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

CEMP and to promote education and cooperation in communities to enhance the protection of cultural resources from natural disasters.

3.7 Demographic Trends and Projections

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

UMass Donahue Institute population projections indicate an increase in Merrimac's population by about 486 people from 2010 to 2035. With associated household growth, this projection indicates a growing demand for housing units. Major development activity completed, in construction or planning since the 2016 plan update includes:

Project Name/Location	Project Type	Status	Completion Year	Total Housing Units/Sq.Ft.
Lakewoods Drive	Residential Subdivision – single family	Constructed	2013	14
Madison Way	Residential Subdivision – single family	Constructed	2015	14
Nancy Ann Lane	55+ Residential Subdivision-single family	Constructed	2017	26
Freedom Way	55+ Residential Subdivision–condominium	Constructed	2017	36
Chart Holding – Broad Street	Medical/Office	Constructed	2018	3,150 s.f.
Quail Ridge Road	Residential Subdivision – single family	Constructed	2018	11
Poplar Hill	OSRD Residential Subdivision-single family	Constructed	2018	15
Cormier Way	Residential Subdivision - condominium	Constructed	2019	13
Olde Glory Way	55+ Residential Subdivision-condominium	Constructed	2020	10
Regency Village Way	Apartment Complex - Building #1 – Rental	Constructed	2019	48
Regency Village Way	Apartment Complex – Building #2 - Rental	Constructed	2020	48
Regency Village Commercial Building	Commercial	Office Building Completed	2020	3,500 s.f.
Abbey Road	Open Space Residential Subdivision – single family	Under Construction	2022	13
Coastal Metals – Little's Court	Residential – affordable housing	Projected	Unknown	30
School Street	Local Initiative Program (LIP) Residential	Planning	2023	
Merrimac Crossing – 118 East Main Street	Residential	Permitted	2023	16

In order to characterize any change in Merrimac's vulnerability associated with new developments as shown above, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map. The analysis shows that the Lakewoods Drive subdivision and the proposed Merrimac Crossing subdivision are the only ones within the 100-year flood hazard area (all structures are outside of the area). Merrimac's Floodplain Zoning restricts development in the 100-year floodplain. With an increase in extreme storm events and changes in precipitation patterns, areas previously not prone to flooding may be susceptible to inundation.

Land use changes in neighboring communities also have the ability to increase Merrimac's vulnerability. There is currently a proposed development on the Haverhill/Merrimac border which would take a piece of existing farmland and convert it into 55+ housing. The increased traffic from that development will impact Merrimac's roadways- specifically River Road which will be utilized by new residents as a scenic cut through to Amesbury & Newburyport. A portion of River Road remains closed due to road collapse resulting from riverbank failure following the 2006 Mother's Day Storm.

In addition, the Town is in the process of design and construction on two vital culvert projects which are located in hazard prone areas. The first is the Bear Hill Culvert project which received funding through FEMA. The project will replace the culverts that have deteriorated and crumbled into the river. This project is nearing construction. The second is the Mill Street culvert over Cobbler Brook, which received design funding through the Division of Ecological Restoration. The design of a new culvert, which eroded into the brook due to the severely deteriorated condition of a portion of the concrete culvert and the associated wingwall/retaining wall on the downstream end of the culvert, is currently underway. Both of these projects will alleviate flooding in these areas and decrease the vulnerability of development in the community.

3.8 Critical Infrastructure

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

Table 3.8.1 Merrimac Critical Infrastructure

Name	Type	FEMA Flood Zone (100/500)	Facility has Backup Generator
Merrimac Post Office	POST OFFICE	N	
Merrimac Town Hall	TOWN OFFICES	N	*
Helen R Donaghue School	SCHOOL - Middle	N	N
Dr Frederick N Sweetsir	SCHOOL - Elementary	N	N
Merrimac Police Dept	POLICE STATION	N	Y
Merrimac Public Library - Thomas Hoyt Memorial Library	LIBRARY	N	N
Merrimac Fire Department – Headquarters	FIRE STATION	N	Y
Merrimac Highway Department	HIGHWAY	N	Y
Salt Shed	HIGHWAY	N	N
Merrimac Board of Health	PUBLIC HEALTH OFFICE	N	N
Harbor Schools	RESIDENTIAL CARE	N	*
Little People’s Preschool	SCHOOL	N	*
Merrimac Senior Center	TOWN OFFICES	N	N
Water Treatment Plant	WATER TREATMENT	N	Y
Merrimac Wastewater Treatment Plant	SEWAGE PUMPING STATION	N	Y
Bear Hill Pump Station/Lakewoods Drive	SEWAGE PUMPING STATION	N	N
East Main Street Pump Station	SEWAGE PUMPING STATION	N	Y
Attitash Avenue Lift Station	SEWAGE LIFT STATION	N	Y
Middle Road Sewer Lift Station (0 River Road)	SEWAGE LIFT STATION	Y	Y
Little Pond Road Lift Station	SEWAGE LIFT STATION	N	Y

Spring Hill Road Lift Station/Little Pond Road	SEWAGE LIFT STATION	N	Y
Orchard Street Lift Station	SEWAGE LIFT STATION	N	Y
Willowdale Lift Station	SEWAGE LIFT STATION	N	N
Burnside Lane Lift Station	SEWAGE LIFT STATION	N	N
Alnette Road Lift Station	SEWAGE LIFT STATION	N	N
Birchmeadow Road Lift Station	SEWAGE LIFT STATION	N	Y
River Road Lift Station	SEWAGE LIFT STATION	N	N
Red Oak Acres	SEWAGE LIFT STATION	N	N
Bear Hill Road Storage Tank	WATER STORAGE	N	N
West Main Street Storage Tank	WATER STORAGE	N	N
Union Street Booster Station	WATER BOOSTER STATION	N	Y
Attitash Avenue Booster Station	WATER BOOSTER STATION	N	Y
Town Well Fields	WELL FIELDS	N	Y
Light Department Offices	LIGHT DEPARTMENT	N	N
Light Department Substation (Burnside Ln)	LIGHT DEPARTMENT	N	N
Light Department Substation (Mill Street)	LIGHT DEPARTMENT	N	N
Light Department Garage	LIGHT DEPARTMENT	N	Y
Historical Museum	HISTORICAL	N	N

* Unknown

SECTION 4. NATURAL HAZARDS IDENTIFICATION

A. Natural Hazards Inventory

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

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

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

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

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

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

44 CFR Requirement

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

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

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

Through a community survey, the Merrimac Core Team and Stakeholders identified Severe Winter Storms/Nor'easters, Inland Flooding, Hurricanes/Tropical Storms, and Drought as the top four natural hazards of concern. Following natural gas explosions in the Merrimack Valley communities of Andover, North Andover, and Lawrence, Merrimac residents rated electric/natural gas explosions related to aging infrastructure high on the list of hazards of concern. Non-natural hazards will also be addressed as part of this plan.

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

4.1 Flood-Related Hazards

As is the case nationally and throughout New England, floods are the Merrimack Valley region's most frequent and costly natural disaster in terms of human hardship and economic loss. Flooding is generally the direct result of moderate to severe weather events such as coastal storms ("nor'easters"), heavy rainstorms, and hurricanes. Total annual precipitation at the century's end is projected to increase by as much as 18% above the 1971-2000 baseline of 45", with most high precipitation events concentrated in the winter and spring months. Increased frequency of high-intensity events, the Northeast experiencing a 71% increase in precipitation during storms¹⁴. With extreme rainfall events becoming more frequent, the severe impacts from flooding are also likely to increase.

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

The most significant flood in the recorded history of the Merrimack River was in March 1936, when rain, melting snow and ice swelled the Merrimack in Lowell to 68.4 feet

¹⁴ <http://www.resilientma.org/resources/resource::2152> National Climate Science Center at the University of Massachusetts Amherst, Massachusetts Climate Change Projections, March 2018

(20.8 m), 10 feet (3 m) higher than the 2006 flood. Upstream in Methuen, Lawrence, North Andover, Haverhill, and other riverfront communities, densely developed downtown centers and riverfront neighborhoods were devastated by the floodwaters. In addition to the 1936 flood, the 1852 flood, the Mother's Day Flood of 2006, the New England Hurricane of 1938, and the Patriots Day Flood of April 2007 are among the region's most serious flood events. Most recently, from March 14 through 21, 2010, a major rain event caused several local rivers and streams to reach or exceed flood stage. Table 4.1.1 below lists all flood events in Essex County between 1958 and 2019.

Table 4.1.1 Merrimack Valley Flood Events 1998 - 2019

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

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

LYNN COMMON	ESSEX CO.	09/02/2019	0	0	0.50K
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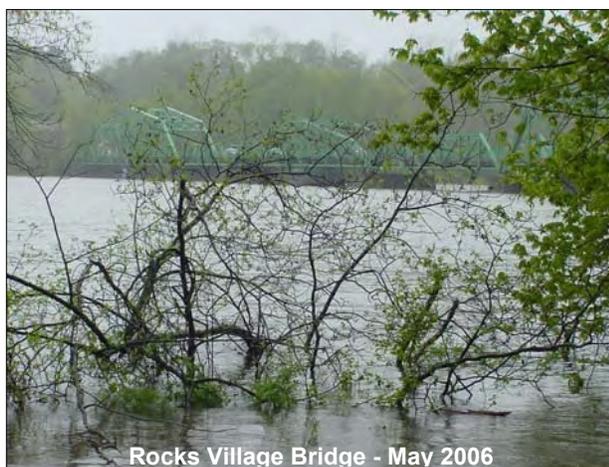
Riverine floods are most likely to occur in Spring. They result from the “overbanking” of swollen rivers and streams and are typically caused by a large-scale weather event that generates an unusual amount of precipitation or by rapid snowmelt. *Coastal floods* commonly occur during the winter months and are the result of storm surges spawned by northeast coastal storms (Nor’easters). Packing sustained wind speeds of up to 40 miles per hour and wind gusts of up to 70 mph, these storms cause repeated wave and erosion-induced damage to structures and natural resources, such as beaches and dunes. Although the Merrimack River is still tidal in Merrimac, this type of flooding is not typically a concern. Other communities in the Merrimack Valley region are especially vulnerable. *Urban (stormwater) floods* may occur year-round and are caused by inadequate stormwater drainage in areas with a high percentage of impervious surface (rooftops, roads, parking lots, etc.) that prevents groundwater infiltration. Flooded roadways and basements often result from this type of flood event.

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

Methodology

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

The methodology for assessing the hazard presented by flooding involved mapping the FEMA Flood Insurance Rate Maps as an overlay to Merrimac’s critical infrastructure. Additionally, repetitive loss structures were identified based on records from the National Flood Insurance Program (NFIP). Vulnerable critical facilities and infrastructure, including dams and



bridges, were then mapped in relation to their proximity to rivers, streams, and flood-prone areas. Definitions of the various flood hazard areas/zones are as follows:

Zone A - Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic

analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

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

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

National Flood Insurance Program

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

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

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

In 2010, and again in 2012 and 2014, new FEMA floodplain maps were released for the communities located in the Merrimack Valley region. The most current FIRM maps for Merrimac are dated July 19, 2018.

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

Community Rating System

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

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

NFIP and Repetitive Loss Structures

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

According to the most recent data provided by the Massachusetts Flood Hazard Management Program (FHMP), Merrimac has 21 policies in force, insuring over \$5.75 million in property. Over the years, flood damage to these structures has resulted in the payment of over \$15,571 in insurance claims under the National Flood Insurance Program (NFIP). According to FEMA and the NFIP, Repetitive Loss Properties are properties that have received flood insurance claim payments greater than \$1,000 twice in any 10-year period years since 1978. There are currently no repetitive loss structures

in Merrimac.

Flooding was one of the top 5 hazards of concern in the survey of Merrimac residents and according to the State Hazard Mitigation and Climate Adaptation Plan, the Commonwealth experiences a substantial flood event once every three years.

Flood Prone Areas

Merrimac has a number of rivers, streams, ponds, and wetlands. All lie within the Merrimack River watershed, and many of these are subject to periodic flooding. The most prominent of these is the **Merrimack River**, which runs along the entire southern edge of town and forms the town boundary with West Newbury. Numerous tributary streams and brooks can be found throughout Merrimac. The largest of these are East Meadow River, Cobbler Brook, and the Back River.



Significant parts of the Town of Merrimac lie within the floodplains of the Merrimack River, Cobbler's Brook and Lake Attitash. A GIS analysis of the town's FIRM flood hazard areas by MVPC has determined that a total of 513.6 acres (0.8 sq. mi.) of land area in Merrimac is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 124.8 acres (0.2 sq. mi.) lies within the 500-Year floodplain. Together, these two flood zones constitute 11.2% of the total area of the community which is a large proportion of land in town located in a flood hazard area. The 100-year floodplain extends the distance of the Merrimack River riparian corridor and includes the shoreline of Lake Attitash. The City of Amesbury controls the height of the surface water in Lake Attitash in accordance with the public water supply management plan. Other large flood hazard areas in Merrimac include the Cobbler Brook riparian corridor and the associated wetlands located to the east of the corridor.

Undersized culverts can act as choke points restricting stream flow causing flooding of local roadways preventing access to these major routes. Extreme storm events with higher precipitation amounts will exacerbate this flooding. The Merrimac Core Team and Stakeholders identified several culverts of concern including those on Bear Hill Road, Mill Street, Church Street and Harriman Road. Culverts on Bear Hill Road and Mill Street have been evaluated and need funding for final design, permitting and construction. Other culverts were identified for study and prioritization.

Special Flooding Concerns

The prior MVHMP identified several areas of special concern. The following figure from the 2016 MVHMP has been updated to include progress made on these issues since 2016.

Special Flooding Concerns

Merrimac public works and public safety officials cite ten recurring flooding problem areas that are of particular concern and are at various stages of investigation and mitigation in order to better protect public safety and property. These areas are listed below.

- **Bear Hill Road.** Deteriorating road culverts have resulted in frequent flooding of Bear Hill Road, FEMA funding was obtained to reconstruct these culverts. The project is out to bid and Construction is anticipated in fall of 2021.
- **Bisson Lane.** This road floods during heavy rains, affecting several homes in the area. The existing drainage swale needs to be re-configured and enlarged to relieve the chronic water ponding.
- **Mill Street Bridge.** The bridge is currently closed. The Massachusetts Department of Ecological Restoration has been for feasibility and design of a new structure. The Town is seeking funding through the BRIC program for construction.
- **Willowdale @ Church Street.** An undersized culvert causes chronic stream backups during heavy rains, resulting in road flooding and closures, and the flooding of two residential properties.
- **Donovan's Stream.** This area's outmoded and undersized drainage system cannot handle the heavy flows during large storms. As a result, numerous streets experience flood flooding, including Vendome Street, Lincoln Street, Summer Street, and Prospect Street.
- **Harriman Road.** The existing undersized culvert cannot handle heavy rains, resulting in periodic road flooding and closures.
- **Winter Street.** The existing undersized culvert cannot handle heavy rains, resulting in periodic road flooding and closures.
- **Locust Street.** The existing makeshift drop inlet structure cannot handle runoff from the hill during heavy rains, causing water to pond on the road and, in winter, creating dangerous icing conditions.
- **River Road.** Part of River Road, an important connector road to neighboring Haverhill and Amesbury, is still closed to traffic due to serious damage from the May 2006 and April 2007 floods. The bridge at the intersection of River Road

Merrimac's MVP stakeholders also identified the Lake Attitash area as prone to flooding. The Town recognizes that addressing flooding in this area will require a regional response as the City of Amesbury controls the height of the Lake. Planning stakeholders identified regional planning for Lake Attitash Management as an important action item



Merrimac's Department of Public Works is located immediately adjacent to Cobbler Brook. While not in the FEMA identified Flood Hazard Area, the property has experienced flooding events. Cobbler Brook is a 3.7-mile perennial stream that originates between Highlands Hill and Red Oak Hill. It runs north-south through central Merrimac, passing just east of the town square before emptying into the Merrimack River. Much of the shoreline has been disturbed and extensively developed with residential uses, light manufacturing, agricultural uses, road crossings and culverts, and the former municipal landfill all of which have increased flooding events. The Cobbler Brook watershed was specifically identified by the Core Team and stakeholders as vulnerable to the pressures of increased precipitation and severe storm events. A watershed study of this area including the mini watersheds that contribute to flooding in Merrimac was a high priority. The riparian corridor of this brook is not an ideal location for the DPW facility and the many operations that it supports.

Merrimac stakeholders identified several farms and other areas potentially subject to developed that should be preserved for their flood storage capacity. Land preservation was also encouraged by several workshop participants for its ability to sequester carbon and provide increased infiltration.

Land Use

With a growing population and continued pressure for additional housing, vacant land is scarce in Merrimac. Vacant residential parcels make up just 5% of land in Merrimac. As discussed above, nearly 1/3 of that land lies within a designated FEMA Flood Hazard Area (100 or 500-year floodplain). Of vacant commercial and industrial land, less than 5% is within a Flood Hazard Area. Merrimac regulates development in the Floodplain through the Merrimac Zoning Bylaw which creates a Floodplain District (Article 13) requiring compliance with the following regulations:

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

(1) Section of the Massachusetts State Building Code which addresses floodplain and coastal high-hazard areas (currently 780 CMR 120G);

- (2) Wetlands Protection Regulations, Department of Environmental Protection (DEP) (currently 310 CMR 10.00);
- (3) Inland Wetlands Restriction, DEP (currently 310 CMR 13.00);
- (4) Minimum Requirements for the Subsurface Disposal of Sanitary Sewage, DEP (currently 310 CMR 15, Title 5);

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

Further analysis of vacant residential parcels (Land Use Codes 130 Developable land and 131 Potentially developable lands) shows that over 137 acres contain land in some portion of the floodplain as shown on FIRM maps. In the survey of Merrimac residents, People (Loss of life and other injuries) were determined to be the most vulnerable to natural hazards. As the frequency and intensity of rainfall events increases, flooding is likely to increase. Development of residential structures and redevelopment should be prioritized outside of designated Flood Hazard Areas to protect Merrimac residents.

Commercial and Industrial properties are also vulnerable to flooding. Commercial and industrial properties are not only subject to possible loss of property and revenue during flood events but also the valuable services, products, and jobs they provide to the community and region. Less than 1% of existing commercial and industrial property in Merrimac is within a Flood Hazard Area with an additional 9% of commercial and land in these zones.

Flooding and Critical Infrastructure

Critical Infrastructure identified by the Merrimac Core Team was identified on maps used in the workshop process. These mapped facilities were overlaid with the FEMA Flood Insurance Rate maps to identify what critical infrastructure might be vulnerable to flood events. Of nearly 40 facilities, only the following facility is in a Flood Hazard Area:

Table 4.1.2 Merrimac Critical Facilities in Flood Hazard Areas		
Facilities in 100-Year Floodplain		
Facility Name	Parcel ID / Street Location	2020 Buildings Valuation
Sewer Lift Station Building Middle Rd	35-1-4.C	\$73,100.00
Facilities in 500-Year Floodplain		
Facility Name	Parcel ID / Street Location	2020 Buildings Valuation
None		

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

Bridges

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

Currently, three federally inspected highway bridges in Merrimac have AASHTO ratings ranging from the 84 to 96 and are not considered structurally deficient. Non are located over waterways. There are two Massachusetts DOT listed concrete culverts on the non-federally inspected list that have ratings below 50. Both structures carry Cobblers Brook, one under Interstate 495 and the other under Broad Street. The Interstate 495 culvert is on a high priority list for replacement.

Locally, there are three structures listed as deficient. The first is on River Road and carries Cobblers Brook under the road and into the Merrimack River. This structure was most recently upgraded in 2010. River Road has been closed since the Mother's Day storm of 2006. The bridge is not the cause of the road closure, but the structure is listed as high priority for replacement. The second structure is a bridge/culvert (definition varies between agencies) on Mill Street. The bridge is currently closed however, funding has been acquired for feasibility and design. The final deficient municipal structure is on Bear Hill Road. Replacement of this structure has been designed and permitted and the project is out to bid with construction anticipated for September or October of 2021.

A final structure listed on Merrimac's inventory of bridges includes an abandoned railroad bridge over Harriman Road. This concrete slab structure built in 1850 has been removed and is now a wooden bridge for foot traffic only. All structures listed as passing over waterways were described as having a "slight chance of overtopping bridge deck and roadway approaches."

Dams

A *dam* is an artificial barrier that can impound water, wastewater, or any liquid for the purpose of storage or control. Dam failure can be defined as a catastrophic failure

characterized by the sudden, rapid, and uncontrolled release of impounded water. Dams can fail for several reasons:

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

Dam failures are potentially the worst of flood events. Typically, a dam failure is the result of neglect, poor design, or structural damage caused by a major event such as an earthquake. When a dam fails, huge volumes of water are often released, causing widespread destruction and potential loss of life. Although infrequent, floods due to dam failures have occurred in New England in the past. On May 16, 1874, in Williamsburg, Massachusetts, a landslide destroyed a 43-foot dam on Mill Creek, a tributary of the Connecticut River, resulting in the deaths of 144 people.

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

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

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

evacuate residents in the inundation area. The EAP must be filed with local and state emergency agencies.

According to DCR Office of Dam safety records, as of May 2020, there are no High Hazard dams located in Merrimac. A table showing all of the Dams in Merrimac and their current status per the Office of Dam safety can be found in **Table 4.1.3** below.

Table 4.1.3 Merrimac Dams			
Dam Name	Impoundment Name	Hazard Classification	Date of Most Recent Inspection
Cobbler Brook Dam at East Main Street	Cobbler Brook	N/A	Not required
Cobbler Brook Dam #1	Cobbler Brook	N/A	Not required
Cobbler Brook Dam #	Cobbler Brook	N/A	Not required
Cobbler Brook Dam #3	Cobbler Brook	N/A	Not required

All three dams are located on Cobbler Brook and are owned by the Town. The state records indicate that two of the dams – Cobbler Brook Dams #1 and #2 – have been breached and no longer impound water. The third dam (Cobbler Brook Dam #3) lacks control boards and has only a low impoundment capacity of 2-acre feet when operational. However, it too currently has no impoundment area. Since none of the three dams is classified as either a “high hazard” or a “significant hazard” dam, the overall risk rating of dam failure to downstream property or public safety is considered low. Members of Merrimac’s Core Team spoke to the need for a study of the Cobbler Brook watershed. The status and future of these dams has been added to that action item. Review of the “Dams (by Hazard Code)” layer on MassGIS does not show any High Hazard dams in neighboring communities that might potentially impact Merrimac.

4.2 Wind-Related Hazards

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

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

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

Hurricanes

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

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

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

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



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

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

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

Figure 4.2.1 Hurricane Categories

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

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

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

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

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

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

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



While there have been relatively few direct hits from hurricanes in New England, peripheral effects from offshore hurricanes and tropical storms that track inland are not uncommon. In the period of time that records have been kept for hurricanes, Massachusetts has experienced 45 wind-related occurrences associated with hurricanes. Of those, six have had a direct impact and 39 have had an indirect impact. The most recent hurricane to affect the region was Hurricane Bob, which passed through in 1991. **Table 4.2.1** provides a summary of hurricanes that have affected New England since 1938.

Table 4.2.1 New England Hurricanes and Tropical Storms (1938-Present)					
Date	Storm Event	Description	Deaths	Injuries	Property Damage
9/21/1938	New England Hurricane	Highest sustained winds-121 mph. Forward motion in excess of 50 mph. 17 inches of rain; extensive flooding.	564	1700+	9,000 homes and businesses destroyed, 15,000 damaged.
9/15/1944	Great Atlantic Hurricane	Forward motion in excess of 40 mph.	390	NA	\$925 million
9/12/1950	Hurricane Dog	Center passed offshore Cape Cod. 4.42 inches of rain in 24 hours.	0	0	\$2 million
9/07/1953	Hurricane Carol	Moved through the Bay of Fundy with only minor damage.	0	0	
8/31/1954	Hurricane Carol	First of three devastating hurricanes of 1954. Forward motion in excess of 50 mph. Category 3. Extensive flooding and damage.	60	NA	\$438 million
9/11/1954	Hurricane Edna	Over 7 inches of rainfall. Extensive flooding.	29	NA	\$40.5 million
10/15/1954	Hurricane Hazel	Forward motion over 50 mph.	600	NA	\$350 million
8/00/1955	Hurricane Connie	Extensive flooding with 4-6 inches of rainfall	43	NA	\$40 million
8/18/1955	Tropical Storm Diane	20 inches of rainfall caused devastating floods	184	NA	\$832 million
8/29/1958	Hurricane Daisy	New England felt only periphery gales.	0	0	NA

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

Date	Storm Event	Description	Deaths	Injuries	Property Damage
9/12/1960	Hurricane Donna	Category 2. Forward motion of 39 mph.	133	NA	\$387 million
9/21-25/1961	Hurricane Esther	Did unusual loop-de-loop southeast of Cape Cod. 7-8 inches of rainfall. Forward motion slowed approaching New England.	0	NA	NA
10/10/1961	Hurricane Frances	Category 3 storm, 110 mph winds. Some wind damage in New England	NA	NA	NA
8/29/1962	Hurricane Alma	Minor damage only.	NA	NA	NA
10/6-7/1962	Hurricane Daisy	14.25 inches of rainfall over 48 hours in Wakefield, MA. Significant flooding occurred throughout New England. Set record for 24-hour precipitation which remained unbroken until Hurricane Bob in 1991.	24	NA	NA
10/29/1963	Hurricane Ginny	Famous snow hurricane in Maine with up 18 inches falling in the Maine mountains.	0	0	\$300,000
9/14/1964	Hurricane Dora	Moderate rainfall.	3	NA	\$200 million
9/24/1964	Hurricane Gladys	Moderate to heavy precipitation.	2	NA	\$6.7 million
6/13/1966	Hurricane Alma	Minor damage.	5	NA	\$1.5 million
9/9/1969	Hurricane Gerda	Center passed directly over Nantucket with gusts to 140 mph.	NA	NA	NA
8/28/1971	Tropical Storm Doria	Wind gusts to 80 mph. Heavy rains, flooding.	3	NA	NA
9/14/1971	Tropical Storm Heidi	Moderate rainfall, little damage.	0	0	NA
9/3-4/1972	Tropical Storm Carrie	Hurricane-force wind gusts. Heavy rainfall	1	NA	\$1.2 million
7/27/1975	Hurricane Blanche	Most heavy weather remained offshore	0	NA	NA
8/9-10/1976	Hurricane Belle	Category 1. Forward motion 32 mph. Heavy rainfall causes some flooding.	3	3	NA
9/6/1979	Tropical Storm David	Minor effects	1,100 Virgin Islands	NA	\$60 million
9/25/1985	Tropical Storm Henri	Minor effects	0	0	NA
9/27/1985	Hurricane Gloria	Category 2. Forward motion of 72 mph. Gusts to 80 mph.	NA	3	\$1 billion
8/7/1988	Tropical Storm Alberto	Winds of 50 mph.	31	NA	\$500 million
8/19/1991	Hurricane Bob	Category 2. Forward motion of 51 mph. Wind speeds of up to 60 mph. Set new 24- hour precipitation record. Major flooding and power outages	18	NA	\$1.5 billion
10/30-11/01/1991	Unnamed "Halloween" storm	Huge storm surge caused extensive damage along the coast	12	NA	\$210 million
7/13/1996	Hurricane Bertha	Forward motion of 48 mph. Very heavy rainfall and strong gusty winds. Spawned one tornado in Massachusetts	12	NA	\$275 million
9/02/1996	Hurricane Edouard	Left 40,000 residents without power, 3 inches of rain fell	0	0	\$3.5 million
7/25/1997	Tropical Storm Danny	Dropped 3-5 inches of rain	0	0	
9/16-17/1999	Tropical Storm Floyd	Forward motion of 56 mph. No significant damage in Massachusetts.	0	0	\$4.5 billion
9-3-2010	Hurricane Earl	Tropical Storm passed 98 miles east of New England with winds of 40+ mph	1	0	NA

Table 4.2.1 New England Hurricanes and Tropical Storms (1938-Present)					
Date	Storm Event	Description	Deaths	Injuries	Property Damage
		producing high surf, heavy rain, and coastal flooding			
8/21/11	Tropical Storm Irene	Hurricane Irene became a tropical storm as it moved inland over NY, CT, MA, NH, and ME	42	NA	7-10 billion (est.)
10/29-30/2012	Hurricane Sandy	Category 1. Schools and public transportation closed in many communities.	285		75 billion (est.)

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

The National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center provides a searchable database that allows one to query hurricane records dating back to as early as 1851. Query results show historical storm tracks by storm intensity within a specified radius of a site. Query results for this region for hurricanes of Category 1 or above, passing within a 75-mile radius, show eight Category 1-5 hurricanes, as depicted in **Figure 4.2.2** According to NOAA’s Historical Hurricane Tracker, 39 hurricane or tropical storm events have occurred in the vicinity of Massachusetts between 1842 and 2019. Within this period the Commonwealth was not impacted by any Category 4 or 5 hurricanes, however, the state was impacted by three Category 3 hurricanes, four Category 2 hurricanes, ten Category 1 hurricanes, and 25 tropical storms. Also, within this time a total of 31 tropical depressions and extratropical events impacted the Commonwealth.¹⁵



Figure 4.2.2 Historical Hurricane Tracks over Massachusetts

¹⁵ Commonwealth of Massachusetts Tropical Cyclone Profile, July 2020

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

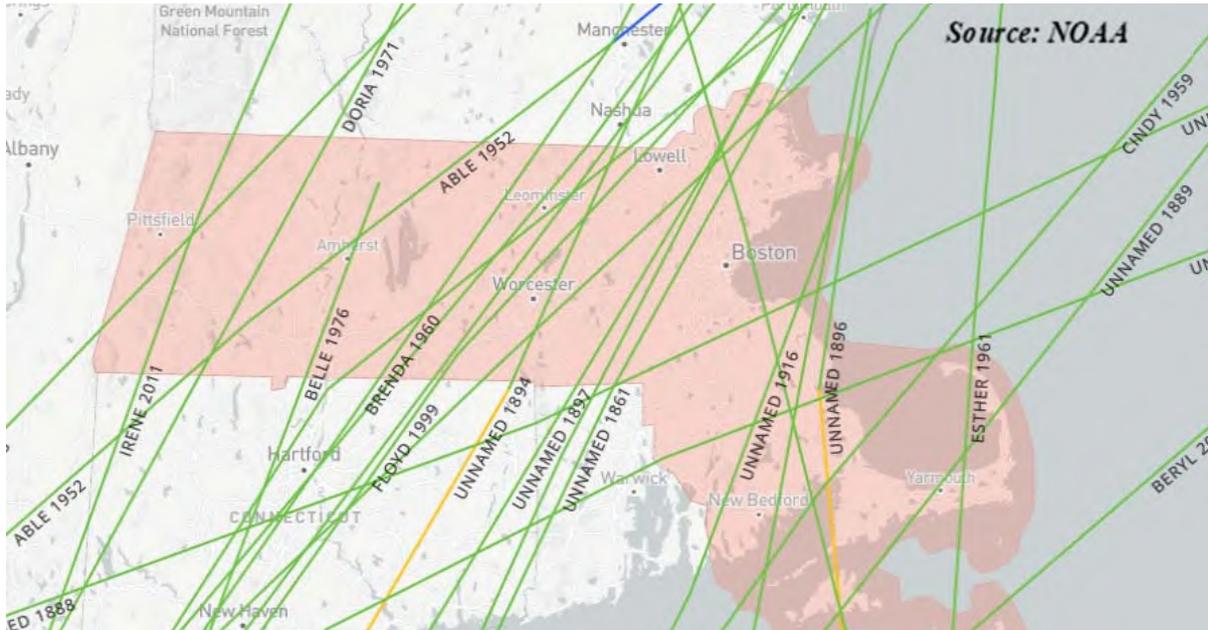


Figure 4.2.3 Tropical Storm Tracks over Massachusetts (1851-2019)

Hurricanes in Merrimac are considered a Medium frequency event. As defined by the 2018 Massachusetts State Hazard Mitigation and Adaptation Plan, this hazard occurs more frequently than once in 5 years (a greater than 20% chance per year). Hurricanes and tropical storms will impact the planning area equally although it was noted by Merrimac stakeholders that some areas of town, including mobile home parks, may be more vulnerable from downed hazardous trees. Vulnerable populations, especially the elderly and disabled, are often left without access to vital services during these outages. Hurricanes and tropical storms may also bring heavy rains and associated inland flooding. Areas identified in the prior section as flood-prone may experience inundation during these events requiring evacuations and/or road closures.

Tornadoes

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

Tornadoes can appear from any direction, but most move from southwest to northeast, or west to east. Tornadoes can last from several seconds to more than an hour. Most last less than ten minutes. Over 80% of tornadoes strike between noon and midnight. “Tornado season” is generally from March through August, although a tornado may occur any time of the year. Some ingredients for tornado formation include:



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

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

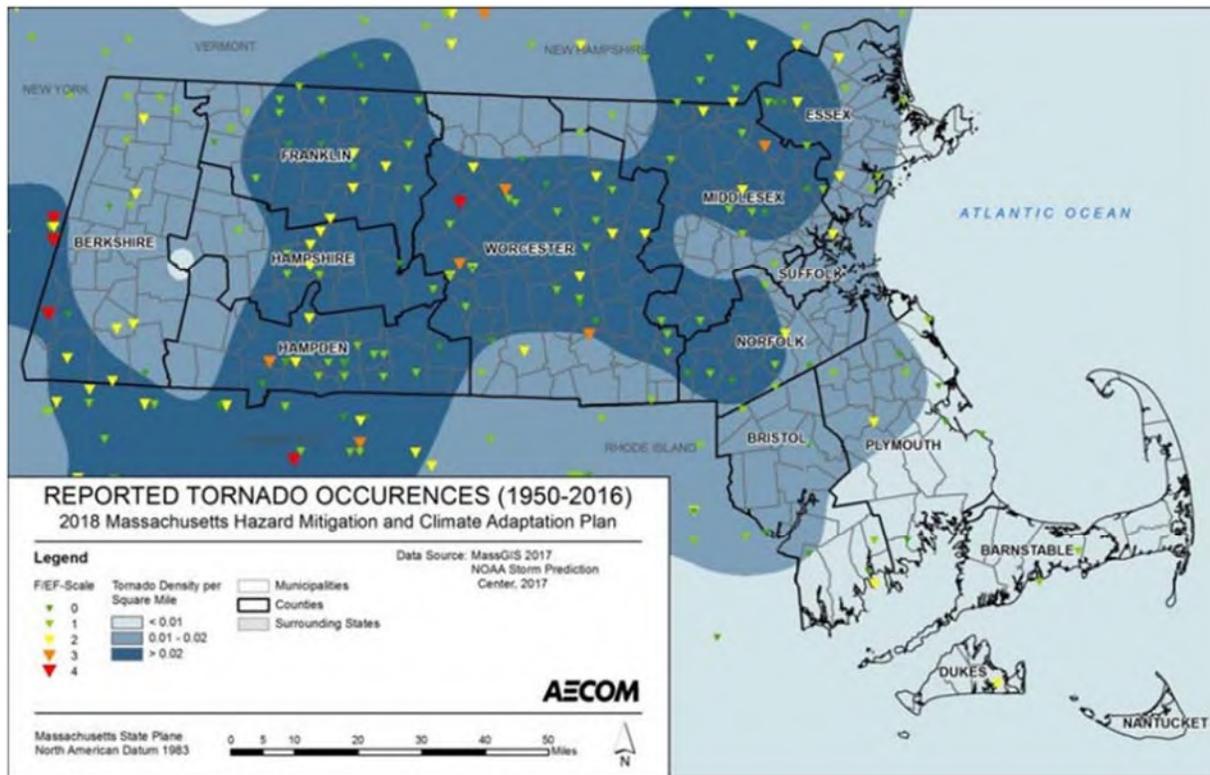
Table 4.2.2 Tornadoes in the Merrimack Valley Region (1951- Present)					
Year	Date	Tornadoes	Category	Injuries	Fatalities
1951	8-21-51	1	F2	0	0
1956	6-13-56	1	F1	0	0
1956	11-21-56	1	F2	0	0
1960	7-13-60	1	F0	0	0
1964	5-19-64	1	F0	0	0
1971	7-1-71	1	F1	1	0
1991	8-15-91	1	F1	0	0

Source: www.tornadohistoryproject.com

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

across the Commonwealth as documented in the NOAA NCDC Storm Events Database.¹⁶ The following Figure 4.2.4 shows the area of the state at greatest risk runs from central to northeastern Massachusetts including a portion of the Merrimack Valley region just outside of Merrimac.

Figure 4.2.4 Tornado Density per Square Mile



Source: NOAA Storm Prediction Center (SPC)

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

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale). It is considerably more complicated than the original F-scale, and it allows surveyors to create more precise assessments of tornado severity. **Tables 4.2.3** and **4.2.4** illustrate the EF-scale and the damage indicators. Its uses three-second gusts

¹⁶ Massachusetts SHMCAP, September 2018

estimated at the point of damage as judged by eight levels of damage to the 28 indicators listed in Table 4.2.4. These estimates vary with height and exposure.

Table 4.2.3 The Enhanced F-Scale						
F Number	Fastest ¼ mile (mph)	3-second gust (mph)¹	Derived		Operational EF Scale	
			EF Number	3-second gust (mph)	EF Number	3-second gusts (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over -200

Source: www.noaa.gov

Table 4.2.4 Enhanced F-Scale Damage Indicators

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

Source: www.noaa.gov

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

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

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

Severe Thunderstorms

The National Weather Service considers a thunderstorm to be severe if it produces hail at least 3/4 inch in diameter, has winds of 58 mph or higher, or has the potential to produce a tornado. Lightning accompanies all thunderstorms and can cause death, injury, and property damage. Straight-line winds can exceed 100 mph and are responsible for most thunderstorm wind damage. A downburst, a small area of rapidly descending air beneath a thunderstorm, can reach speeds equal to that of a strong tornado.

Three basic ingredients are required for a thunderstorm to form: moisture, rising unstable air (air that keeps rising when given a nudge), and a lifting mechanism to provide the impetus. The sun heats the surface of the earth, which warms the air above it. When this warm surface air begins to rise, such as in areas with hills or mountains, or areas where warm/cold or wet/dry air bump together, it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (a process known as convection). The water vapor in the air begins to cool, releases heat, and condenses into a cloud. The cloud eventually expands upward into areas where the temperature is below freezing. Some of the water vapor turns to ice, and some of it turns into water droplets. Both ice particles and water droplets have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up, they are eventually discharged in a bolt of lightning, which causes the sound waves we hear as thunder.



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

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

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

According to the NOAA Storm Events Database, Essex County, including the town of Merrimac, experienced 19 days of Thunderstorm Wind events causing nearly \$712 thousand in property damage since 2015. This includes an event on July 8, 2016, which began in Methuen and ended in Haverhill which resulted in over \$100 thousand in recorded property damage. Highest winds were reported at 80 mph. Additional events were reported in Merrimac on February 25, 2016, and May 18, 2017, with narratives citing multiple trees down and \$6 thousand and \$15 thousand reported.

4.3 Winter-Related Hazards

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



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

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

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

The most significant annual snowfall years in the region, as recorded in Newburyport, occurred in 1956 (120.5"), 2005 (110"), and 1969 (102.3"). Most recently, the October 2011 snowstorm left 640,000 Massachusetts homes and residents without power, according to MEMA. Merrimac residents will not soon forget the winter storms of March 2018 when downed trees resulted in power outages lasting several days throughout the Merrimack Valley. The NOAA Storm Events Database states that from eight to twenty-two inches of snow fell on Eastern Essex County. Numerous trees and wires were reported down.

Property damage throughout Essex County, estimated at \$120 thousand (\$37k Western Essex and \$83k Eastern Essex), was reported during the March 7 and 13, 2018 events. The March 13, 2018 event resulted in a FEMA Major Disaster declared on Jul 19, 2018.



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

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

Date of Event	Deaths	Injuries	Property Damage (\$)
1/7/2017	0	0	0
2/9/2017	0	0	0
2/12/2017	0	0	0
4/1/2017	0	0	0
12/9/2017	0	0	0
1/4/2018	0	0	2,000
2/17/2018	0	0	0
3/7/2018	0	0	55,000
3/13/2018	0	0	65,000
1/19/2019	0	0	0
3/3/2019	0	0	0

Northeasters/Nor'easters

Nor'easters occur in New England more frequently than hurricanes and typically have a longer duration than hurricanes. A Nor'easter is a large New England storm formed from a weather system traveling from South to North, passing along or near the seacoast. The Nor'easter derives its name from the northeasterly direction of its counterclockwise cyclonic winds. It is not unusual for the sustained winds of a Nor'easter to meet or exceed hurricane force. The duration of a Nor'easter may outlast a hurricane event by many hours or even days. High winds associated with a Nor'easter can last from 12 hours to 3 days, while the duration of a hurricane rarely exceeds 12 hours.



Nor'easters pose a threat to infrastructure, including critical facilities. During the height of a storm, blizzard conditions present a hazard to driving or any other outdoor activity. A blizzard is defined as a storm with winds in excess of 35 mph, with falling and blowing snow reducing visibility to less than ¼ mile for at least three hours. Heavy snow disrupts transportation and may impede the passage of emergency vehicles. Heavy snow may also bring down power lines and trees, and lead to roof collapses. The Blizzard of 1978 dumped 24-48 inches of snow on eastern Massachusetts and paralyzed the region for many days. Most recent blizzard events in Essex County include January 26, 2015 (31.4”

reported in nearby Methuen) and March 14, 2017, when heavy snow and strong winds combined to create blizzard conditions.

The Merrimack Valley region experienced a significant Nor'easter on March 5-7, 2001, that resulted in a Presidential Disaster Declaration on April 10, 2001. Two feet of snow fell over three days (March 5-7). Wind gusts up to 64 miles per hour were reported in some areas. The combination of heavy wet snow and high winds resulted in broken tree limbs that blocked roadways and downed power lines. More than 16,000 people in the Merrimack Valley were left without power on March 6, 2001. This late-season snow also



2017 Storm Damage (MVPC Photo)

set the stage for flooding. Two subsequent rainstorms, on March 20-22 and 29-30, 2001, resulted in the flooding of more than 10,000 residences and businesses in northeastern Massachusetts. Most of the damage due to flooding occurred along smaller rivers and tributary streams rather than the larger mainstems such as the Merrimack River. Other major Nor'easters occurred in the Merrimack Valley region in April of 2007, October 2011, March 2013, October 2017, and March 2018.

On October 29-30, 2011, the region experienced a significant Nor'easter, known as the Halloween Nor'easter. This storm produced a snowfall over 30 inches in some parts of the state, and, due to the amount of foliage still on the trees, resulted in power outages for hundreds of thousands of electrical customers for up to seven days. (The National Weather Service estimated that approximately 3 million electrical customers were without power at the height of the event). As a result of the storm, a Presidential disaster declaration was approved on November 1, 2011.

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

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

northeast snowstorms can have on the rest of the country in terms of transportation and economics.

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

Table 4.3.2 The Northeast Snowfall Impact Scale (NESIS)		
Category	NESIS	Value Description
1	1 – 2.499	Notable
2	2.5 – 3.99	Significant
3	4 – 5.99	Major
4	6 – 9.99	Crippling
5	10.0+	Extreme

Source: Paul Kocin and Louis Uccellini

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

Table 4.3.3 NESIS Data for Massachusetts (1953-2012)					
Rank	Year	Date	NESIS	Category	Description
1	1993	March 12-14	13.20	5	Extreme
2	1996	January 6-8	11.78	5	Extreme
3	2003	February 15-18	8.91	4	Crippling
4	1960	March 2-5	8.77	4	Crippling
5	1961	February 2-5	7.06	4	Crippling
6	1964	January 11-14	6.91	4	Crippling
7	2005	January 21-24	6.80	4	Crippling
8	1978	January 19-21	6.53	4	Crippling
9	1969	December 25-28	6.29	4	Crippling
10	1958	February 14-17	6.25	4	Crippling
11	1983	February 10-12	6.25	4	Crippling
12	1966	January 29-31	5.93	3	Major
13	1978	February 5-7	5.78	3	Major
14	2007	February 12-15	5.63	3	Major
15	2010	February 23-28	5.46	3	Major
16	1987	January 21-23	5.40	3	Major
17	1994	February 8-12	5.39	3	Major
18	2011	January 9-13	5.31	3	Major
19	2011	February 1-3	5.30	3	Major
20	2010	December 24-28	4.92	3	Major
21	1972	February 18-20	4.77	3	Major
22	1979	February 17-19	4.77	3	Major
23	1960	December 11-13	4.53	3	Major

24	2010	February 22-28	4.29	3	Major
25	1969	February 22-28	4.29	3	Major
26	2010	February 9-11	4.10	3	Major
27	2006	February 12-13	4.10	3	Major
28	1961	January 18-21	4.04	3	Major
29	2009	December 18-21	4.03	3	Major
30	1966	December 23-25	3.81	2	Significant
31	1958	March 18-21	3.51	2	Significant
32	1969	February 8-10	3.51	2	Significant
33	1967	February 5-7	3.50	2	Significant
34	1982	April 6-7	3.35	2	Significant
35	2007	March 15-18	2.55	2	Significant
36	2000	January 24-26	2.52	2	Significant
37	2000	December 30-31	2.37	1	Notable
38	1997	March 31- April 1	2.29	1	Notable
39	2011	January 26-27	2.17	1	Notable
40	1956	March 18-19	1.87	1	Notable

Source: Massachusetts State Hazard Mitigation Plan (2013)

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

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

Ice Storms

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

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

The December 2008 ice storm in New England and the Merrimack Valley region storm resulted in one fatality and left over one million people without power, some for as long as two weeks. Damage from the storm was measured in millions of dollars in property damage, lost business, and cleanup costs. Many of the expenses incurred were related to the clearing and disposal of downed trees and tree limbs. Given the magnitude of damage, the storm resulted in a Presidential Disaster Declaration.



More recently, the Halloween Nor'easter in 2011, caused billions of dollars in damage along the Eastern Seaboard. In Massachusetts, the ice storm accompanied by wind gusts up to 69 mph was responsible for six deaths and 420,000 power outages. (*Associated Press report 11/1/2011*)

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

Ice Jams

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

4.4 Fire Related Hazards

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

Wildfires

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



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

The Massachusetts Department of Fire Services/Division of Fire Safety maintains a comprehensive database of all reported fire incidents in the Commonwealth, including wildfires and brush fires. According to statistics compiled by the Massachusetts Fire Incident Reporting System (MFIRS), during the five years from 2014 to 2018, there were 5,245 fires classified as “other fires” in Essex County (i.e., non-structure and non-vehicle fires), the vast majority of which were local brush fires. MFIRS reports 80 “other fires” for Merrimac during that period.

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

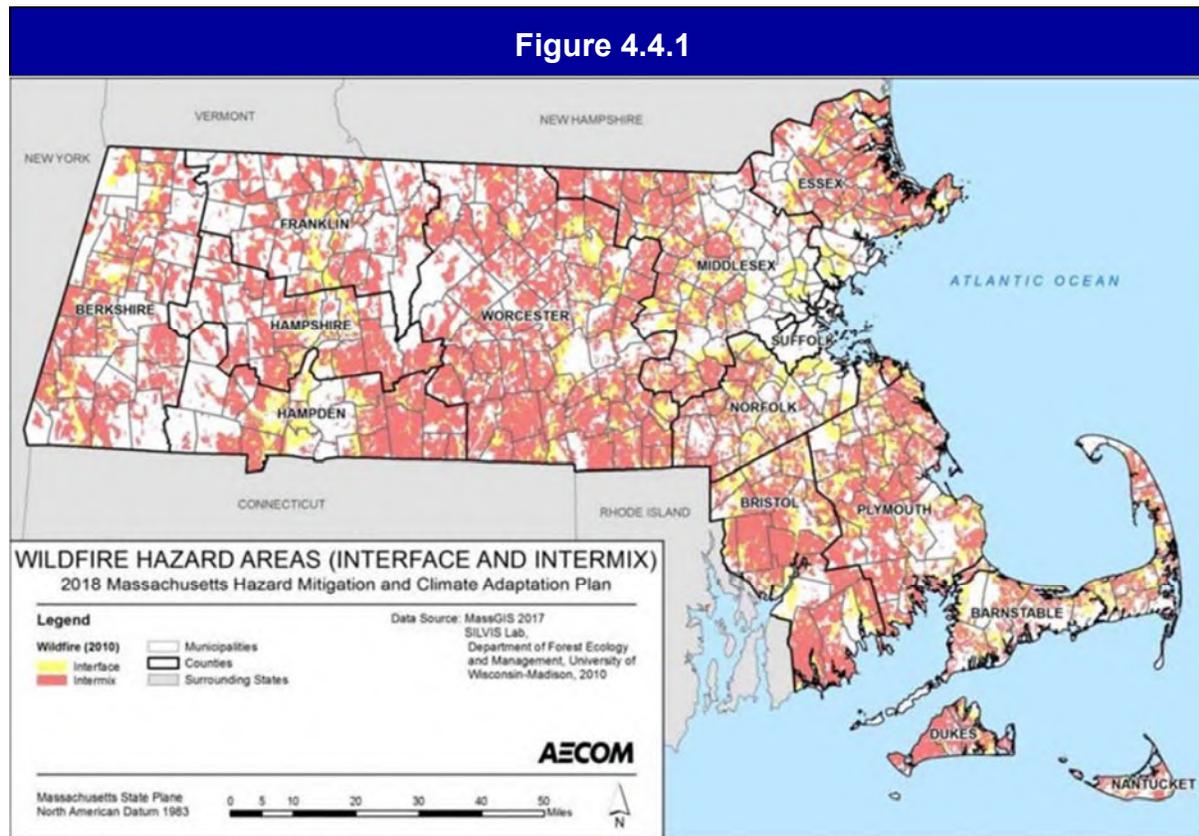
Wildland/Urban Interface

Wildland/urban interface areas exist wherever homes and businesses are built among trees and other combustible vegetation. Such areas are becoming increasingly prevalent throughout the Merrimack Valley region and Merrimac, as development continues to encroach into forest land. The wildland/urban interface problem stems from two different sources of fire and their impact on the community. Fire can move from forest, brush, or pastureland into the community or from the community into adjacent wild areas. In temperate areas, vegetative decay is a slow process, and logs, leave, and evergreen

needles pile up on the forest floor. This accumulation of fuel increases the probability of large fires that are difficult to control. Ignitions are more frequent in the wildland/urban interface because of the increased presence of people. Carelessness, recreation use, damaged power lines, and industrial activity all are potential ignition sources.

Wildland/urban interface fires can cause large economic losses and severe social impacts. The impact to residents can include the loss of, or damage to, homes and irreplaceable items, and even death or serious injury. Financial costs include building and infrastructure damage and loss, business disruption, and fire suppression and evacuation costs. While Merrimac responds to several brush fires annually, none have resulted in significant property damage or death. During planning workshops, stakeholders identified a lack of forest management as a concern including many dead and dying trees which might serve as fuel for future fires.

The following map taken from the 2018 SHMCAP depicts wildlife hazard as “interface” or “intermix.”



4.5 Geologic Hazards

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

Earthquakes

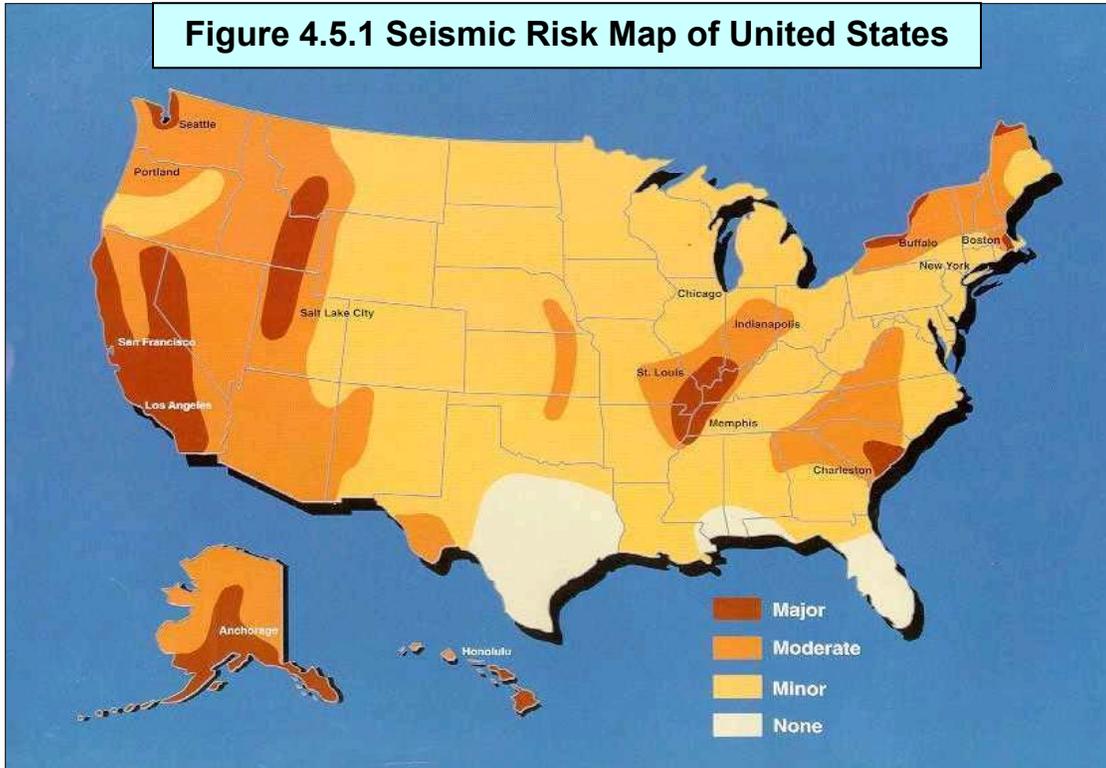
In the Northeast, earthquakes are not associated with specific known faults, as they are in California. In New England, the immediate cause of most earthquakes is the sudden release of stress along a fault or fracture in the earth's crust. Much of the research on earthquakes in the northeast has involved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

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

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

An area's vulnerability to a devastating earthquake is based primarily on two elements: the density of the population in the region, and the age of the region's buildings, and the lack of earthquake-proof design. Additionally, seismic waves travel further in the eastern U.S. than in other parts of the country. Seismologists have determined that the likelihood of an earthquake with a magnitude of 5.0 or greater in the New England area is 41-56% by the year 2043.

Figure 4.5.1 Seismic Risk Map of United States



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

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

Based on records, the maximum experienced earthquake intensities on the Mercalli Scale in Essex County have been in the range of VI (where there is damage to objects indoors, the tremor is felt by all people indoors and outdoors, movement is unsteady, moderately heavy furniture moves, and pictures fall off walls) to VII (where there is damage to

architecture, the tremors are frightening, it is difficult to stand, cracks occur in chimneys and plaster, bricks may fall, and stream banks may cave in).

Figure 4.5.2 New England Earthquake Probability

Source: Weston Observatory, Boston College

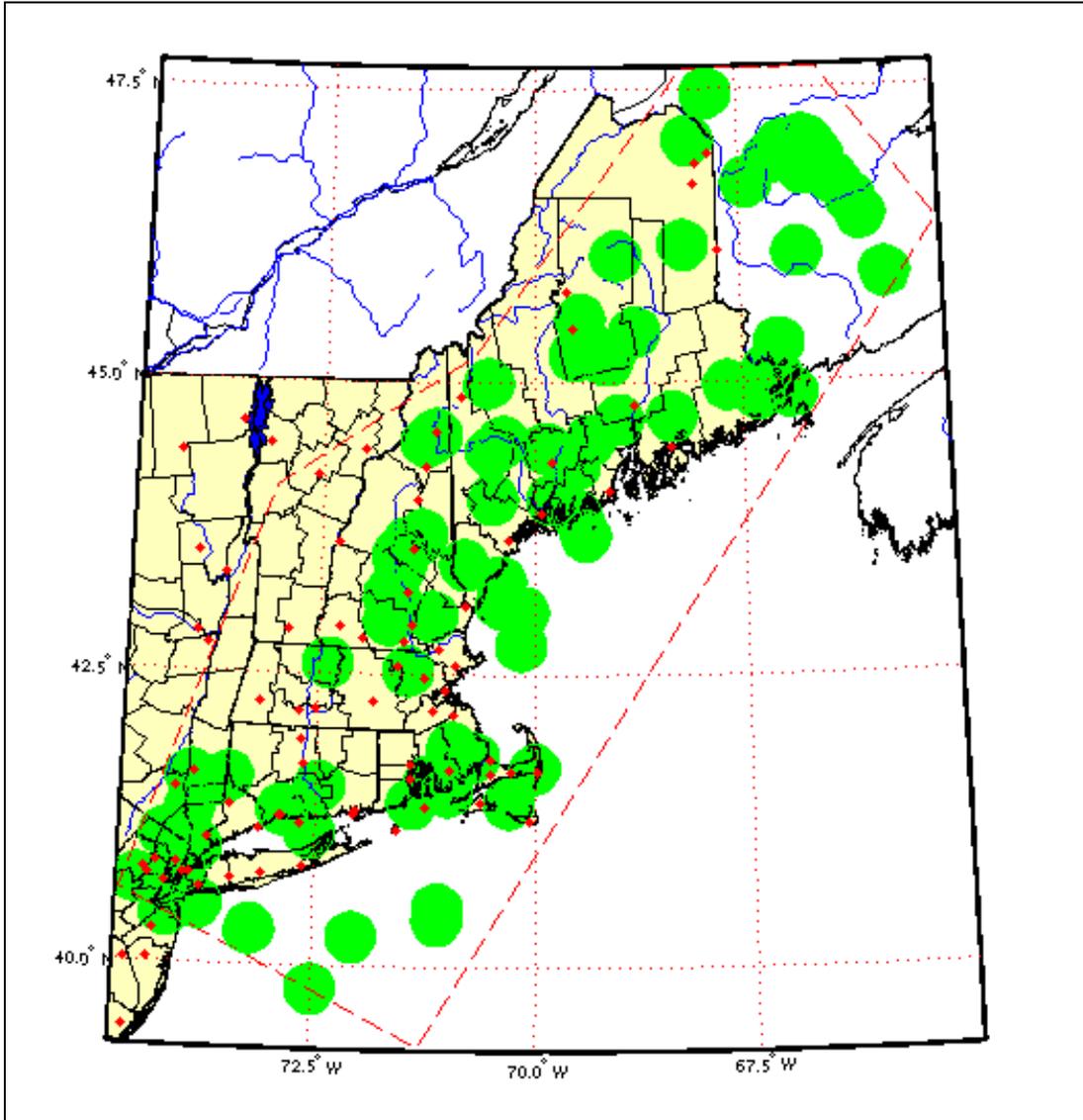


Figure 4.5.2 above shows the results of an earthquake probability analysis conducted by the Weston Observatory at Boston College. The study examined earthquake activity of magnitude greater than 2.7 between 1975 and 1998. According to the analysis, there is a 66% chance that the next earthquake of magnitude greater than 2.7 will occur in the green areas shown on the map above. A record of all seismic activity in the Northeast can be found at the following link on the Weston Observatory website: [Latest New England Earthquakes \(bc.edu\)](http://www.westonobservatory.org/earthquake/).

Failure to design structures with earthquakes in mind will also affect the potential damage caused by an earthquake. Regulations that require buildings and structures to meet some minimum seismic criteria were only recently put in place. Merrimac complies with the most recent version of the state Building Code.

Landslides

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

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

Table 4.5.1 2010 Population in Unstable Slope Areas

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

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

4.6 Heat Waves/Extreme Heat

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

Heat kills by pushing the human body beyond its limits. Most heat disorders occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. The most severe heat-induced illnesses are heat



exhaustion and heatstroke. If left untreated, heat exhaustion can progress to heatstroke and possible death. Young children, the elderly, and those with existing illnesses are more likely to become victims. Other conditions that can cause heat-related illness include stagnant atmospheric conditions and poor air quality.

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

Drought

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

The first evidence of drought is usually seen in rainfall records. Within a short period, soil moisture can begin to decrease. The effects on stream and river flow, or water levels in lakes and reservoirs, may not be noticed for several weeks or months. Water levels in wells may not be impacted for a year or more after a drought begins.

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

A serious drought occurred in Massachusetts during the spring and summer of 1999. Cumulative precipitation deficits reached 8-12 inches below normal over one year. Stream flows routinely fell below the 25th percentile of historical flows for the month. Groundwater levels were also below normal throughout the summer over nearly the entire state. During this period, the Massachusetts Emergency Management Agency developed a Massachusetts Drought Management Plan. The Plan includes groundwater data, surface water data, reservoir data, precipitation data,



and streamflow conditions, as well as a report on fire danger and agricultural conditions. The Drought Management Plan provides specific action items to be implemented during a drought watch, drought warning, or drought emergency. A drought emergency is one in which state-mandated water restrictions or the use of emergency supplies is necessary. The Plan underwent minor updates and was formally adopted in 2013.

In the subsequent 2016/2017 Drought, the most severe in Massachusetts since the 1960s, the 2013 Plan was implemented but was followed by an in-depth review of the previously developed indices by the Drought Management Task Force. This review resulted in a substantial update to the Plan. This included a change in methodology for calculating the indices and for calculating the thresholds for drought levels as well as the introduction of new and substantially updated actions for local and state government.¹⁷ Unlike most droughts, which are slow-developing and long-lasting, the drought of 2016-2017, developed rapidly with conditions declining quickly from one month to the next which resulted in a new concept of “flash drought”.

Massachusetts has experienced multi-year drought episodes in 1879-1873, 1908-1912, 1929-1932, 1939-1944, 1961-1969, and 1980-1983. Recently, in September of 2020, all seven regions of the Commonwealth were in Level 2 – Significant Drought status. While drought conditions eased over the winter, as of April 2021, Merrimac is under a Level 1 water use restriction including restrictions on non-essential outdoor water use.

TOWN OF MERRIMAC WATER DEPARTMENT
PUBLIC NOTICE
EFFECTIVE APRIL 15TH 2021

Voluntary Restrictions on Non-Essential Water Use

4.7 Climate Change

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

Severe Winter Storms and Nor’easters

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

¹⁷ Drought Management Plan 2019, Executive Office of Energy and Environmental Affairs & Massachusetts Emergency Management Agency, 2019.

The frequency and intensity of heavy precipitation events in Merrimac and the Merrimack Valley are projected to continue to increase throughout the 21st century. The northern United States, including New England, is projected to receive more intense precipitation in the winter and spring, while parts of the southwestern United States are projected to receive less precipitation in those seasons. Winter precipitation (generally in the form of rain) is expected to increase by 12% to 30%, while the number of snow events is expected to decrease.¹⁸ While more winter precipitation is likely to fall as rain than snow, historical data show that the frequency of extreme snowstorms in the U.S. doubled between the first half of the 20th century and the second.¹⁹ Consequences of more extreme storm events include infrastructure failures, disruptions to local economies, and increased public safety risks with more demands on local government and first responder capacity.



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

Inland Flooding

The risk of flooding events is heightened by the effects of climate change which portends higher precipitation levels in winter/spring seasons and more frequent, intense storms. Between 1958 and 2012, the Northeast saw more than a 70% increase in the amount of rainfall measured during heavy precipitation events, more than in any other region in the United States. The parameters of the so-called 100-year storm are changing. In the 1960s, a 24-hour event that produced 6.5 inches of rain was categorized as a 100-year storm. By 2015, the threshold for the 100-year storm (i.e. storm with 1% occurrence odds in any year) was 8.4 inches of rain over 24 hours.²⁰ Significant flood



Merrimack River – MVPC Photo

¹⁸ Massachusetts Climate Adaptation Report, Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, September 2011.

¹⁹ Massachusetts SHMCAP, September 2018

²⁰ https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html National Oceanic and Atmospheric Administration, Atlas 14 Precipitation Frequency Atlas of the United States & Technical Paper # 40, U.S. Dept. of Commerce.

events occurred in Merrimac most recently in Spring 2010 and the Mother's Day Flood of 2006.

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

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

Extreme Temperatures

Massachusetts' climate is changing – nineteen of the 20 warmest years all have occurred since 2001, according to the NASA climate change website. Average global temperatures have risen steadily in the last 50 years.²¹ Ambient temperature has increased by approximately 1.8°F from 1970 through the first decade of the 21st century and sea surface temperature has increased by 2.3° F. These warming trends have also been associated with more frequent days with temperatures above 90°F, reduced snowpack, and earlier snowmelt and spring peak flows.²² The Intergovernmental Panel on Climate Change predicts that, by the end of the century, Massachusetts will experience a 5° to 10°F increase in average ambient temperature, with several more days of extreme heat during the summer months. From 1971 to 2000, the Merrimack Valley annually had an average of seven days with temperatures above 90 °F. By the end of the century, Merrimac and the region are projected to have fourteen (14) to as many as fifty-six (56) more days per year with temperatures rising above 90 degrees.

Higher temperatures will have a negative effect on air quality and human health. Increased rates of respiratory illness, worsening of allergies and asthma, increased vector-borne diseases, and degraded water quality are expected. With higher temperatures, electricity demand in Massachusetts could increase by 40% in 2030. Total heating degree days will be 15-37% lower, but cooling degree days are projected to triple by the century's end, requiring significant investment in peak load capacity and energy efficiency measures.²³

²¹ <https://climate.nasa.gov/vital-signs/global-temperature/>

²² Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser and D.J. Wuebbles, 2006. Climate Change in the U.S. Northeast: A Report of the Northeast Climate Change Impacts Assessments, Union of Concerned Scientists, Cambridge, MA.

²³ Ibid.

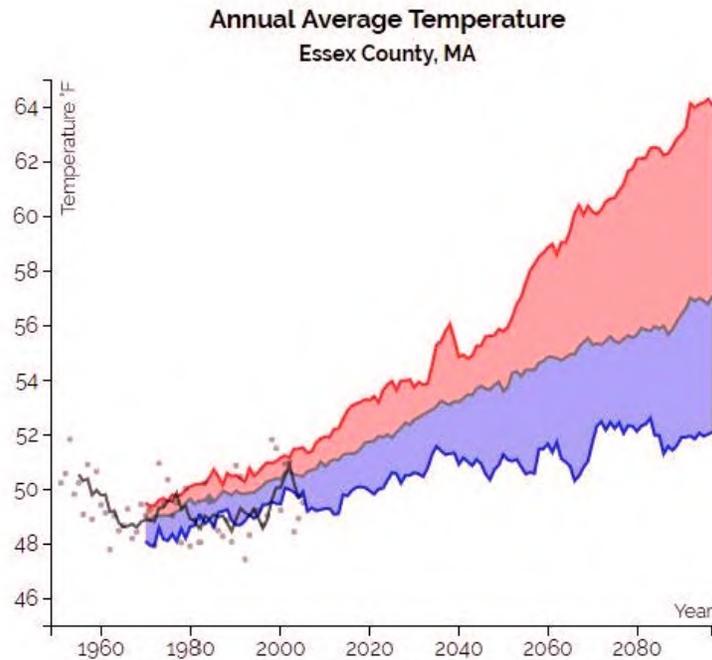


Figure 4.7.1 Northeast Climate Adaptation Science Center

Drought

Higher summer temperatures, less summer precipitation, and an increase in drought frequency will impact water quality and quantity. Intermittent streams will cease flowing earlier in the season and some cold-water habitat will be replaced with warm water habitat. As discussed above, average summer and fall temperatures in the Merrimack River Basin could increase 12° F by the century's end. The annual number of extreme heat days greater than 90°F is expected to increase by as much as 32 more days in 2050.²⁴ Extended heat waves could significantly impact public health as well as infrastructure, economic systems including agriculture and ecosystems of forests and wetlands. As higher temperatures lead to greater evaporation and earlier snowmelt, the frequency and intensity of droughts are predicted to increase in summer and fall in the Northeast.²⁵

Also, for summer and fall seasons, data projections are showing variable precipitation levels with the potential for a moderate change in the number of consecutive dry days (less than 1 mm precipitation). The 1971 to 2000 baseline is 17 on average annual consecutive dry days and that is projected to increase by 3 days by the end of this century.²⁶ Less winter snowpack, the result of more winter precipitation falling as rain, combined with earlier spring melt, may fail to adequately recharge groundwater aquifers.

²⁴ <http://www.resilientma.org/resources/resource::2152> National Climate Science Center at the University of Massachusetts Amherst, Massachusetts Climate Change Projections, March 2018.

²⁵ <https://www.mass.gov/files/documents/2018/09/17/SHMCAP-September2018-Chapter4.pdf>

²⁶ Ibid.

Summary

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

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

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

B. Risk Analysis

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

Frequency

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

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

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

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

Table 4.B. Merrimac Natural Hazards Risk Assessment		
Hazard	Frequency	Severity
Winter Storms (blizzard/snow/ice)	High	Minor to Extensive
Nor'easters	High	Minor to Extensive
Extreme Temperatures	High	Minor to Serious
Hurricanes	Medium	Serious to Catastrophic
Tornados	Medium	Minor to Extensive
Drought	Medium	Minor to Serious
Forest/Brush Fires	Medium	Minor to Serious
Earthquakes	Low	Minor to Extensive
Dam Failure	Low	Minor to Catastrophic
Landslides	Low	Minor

C. Non-Natural Hazards

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

Each municipality, including Merrimac, has a Comprehensive Emergency Management Plan (CEMP) in place. The CEMP combines the four phases of emergency management:

mitigation, preparedness, response, and recovery. In the interest of holistically addressing mitigation and its interrelationship with emergency management overall, this Hazard Mitigation Plan provides an overview of several hazards that are non-natural and pose a threat to the state, the region, and the Town of Merrimac.

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

4.8 Public Health Emergencies and Hazards

Merrimac and the world are currently battling COVID-19, a new strain of coronavirus (similar to the H1N1 virus of 2009) that was first discovered in Wuhan, China in December of 2019 and first recognized in the United States in January of 2020. This virus, unlike any other since the 1918 flu pandemic, is overwhelming public health systems. Infectious disease emergencies are extremely rare - while previously the Massachusetts Department of Public Health (MDPH) received 10,000 case reports annually, as of June 2021, there are over 660,000 cases of COVID-19 with over 17,000 deaths. While generally, health care providers, local boards of health, and the MDPH handle most infectious diseases routinely, this outbreak has presented unprecedented challenges including a state "stay at home" order in the spring of 2020.

Worldwide travel and the re-emergence of infectious diseases in more virulent forms may increase the rate of public health infectious disease emergencies in the future. The Massachusetts Department of Public Health is the primary agency responsible for the study, planning, isolation/quarantine and actions, surveillance, and reporting for all public health emergencies. Any cluster or outbreak of any unusual disease or illness must be reported to the local board of health (or to MDPH if the local board of health is not available). Vaccines are now available to battle the current coronavirus outbreak, and nearly 4 million people in the state have been vaccinated. However, the country, state, and individual communities still have much work to do to bring this virus under control.

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

Government at all levels must also be prepared for bioterrorism, or the intentional use of (or threat to use) biological agents including but not limited to anthrax, botulism,

brucellosis, cholera, pandemic influenza, plague, ricin, smallpox, tularemia, and viral hemorrhagic fevers.

4.9 Infrastructure Failure

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

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

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



The explosions and fires ignited by natural gas-fueled appliances damaged 131 structures in the three communities. Leonel Rondon, an 18-year-old Lawrence resident, was killed when a house chimney collapsed onto his parked car in a building explosion on Chickering Road in Lawrence. At least 21 people received treatment at area hospitals for injuries.²⁷ The three municipal Fire Departments responded to initial calls and required mutual aid from departments throughout eastern Massachusetts, New Hampshire, and Maine.

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

On September 14, 2018, in response to the severity of the situation, Governor Baker made a State of Emergency declaration. In Andover, officials on short notice set up an

²⁷ NTSB Preliminary Report PLD13MR003 10/11/2018 and Safety Recommendation Report PSR-18/02, 12/6/2018

overnight shelter at the Senior Center. Schools were closed, and Merrimack College temporarily evacuated its buildings. Before power could be restored and people allowed to return to their homes and businesses in the days and weeks following, teams of inspectors would enter each building to conduct safety checks and ensure no concentrations of trapped gas were present.

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

The Columbia Gas explosions emergency reinforced the importance of community engagement and planning on how to effectively respond and mobilize resources to protect and inform the public and shelter and provide for those displaced, especially the most vulnerable. The occurrence of these events in communities close to Merrimac heightened residents' awareness to infrastructure related disaster and may be the reason it was given priority in Merrimac's MVP process. Subsequent recovery efforts to bolster businesses that lost revenue during the disaster provided important lessons which, tragically are being experienced again, and more severely, as a result of the COVID-19 pandemic.

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

SECTION 5. EXISTING PROTECTIONS MATRIX



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

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

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

Examples of Local Hazard Mitigation Measures



Local Wetlands Protection Regulation



Regular Street Sweeping



Tree-pruning to Protect Utility Lines

Table 5.1 TOWN OF MERRIMAC Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness/ Improvements Needed	Hazard
Town participation in the National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	Flooding
Floodplain Zoning District	Requires all development, including structural and non-structural activities, be in compliance with state building code requirements for construction in floodplains	FEMA flood zones	Generally effective for new construction but some older structures pre-date bylaw/ Updates needed to conform with Mass 2020 Model Floodplain Bylaw	Flooding
Local Wetlands Protection Bylaw and Regulations	Regulates building on: - Wetland Resource Areas - 100-ft buffer zones - 200-ft riverfront protection area	Town-wide	Effective – review/updates needed	Flooding
Stormwater Management Bylaw and Regulations	Regulates development activity encompassing one acre or more within Urban Areas, consistent with National Pollutant Discharge Elimination System permit program	Urbanized Areas of Merrimac as identified by U.S. Census	Effective - review/updates needed	Flooding
Subdivision Rules & Regulations, (Stormwater)	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Effective with use of engineering consultant to assist with LID and implementation – review/updates needed	Flooding
Local Open Space & Recreation Plan	Proactive plan to preserve and protect Town's open space and natural resources, but does not focus on flood hazard areas specifically	Town-wide	Effective – updated in 2016, expires 2023. Updated should give increased attention to preserving undeveloped	

			flood-prone parcels	
Town Zoning Bylaw (Last update 4/24/2017)	Promotes the health, safety, and welfare of Town residents. Cited sections detail the requirements relating to lot size, setbacks, contiguous buildable area, site plan review, and lot/slope requirements	Town-wide	Effective – actively enforced	Flooding, Geologic
Master Plan (2002)	Guide for community growth and preservation of open space and natural resources	Town-wide	Moderately effective – In need of update	Flooding, drought
Municipal drainage system maintenance and repair program	Town strives to keep municipal drainage facilities (storm drains swales, culverts, stream channels, etc.) open and in good working condition	Town-wide	Moderately effective - More public works personnel and funds would increase overall effectiveness of program	Flooding
State Building Code	Town enforces the Mass State building code	Town-Wide	Effective	Multi-hazard
Street sweeping and catch basin cleaning program	Streets and catch basins cleaned on a schedule per EPA MS4 Permit requirements	Town-wide	Effective	Flooding
Comprehensive Emergency Management Plan	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective - Maintain CEMP and upgrade as needed to ensure its applicability	Multi-hazard
CodeRed Community Notification System	Emergency notification system for residents	Town-wide	Effective	Multi-hazard
Phase II Stormwater Management Program/MS4 - Stormwater Management Plan (SWMP)	Policies, procedures, and best management practices, including public education, to reduce urban runoff generation and	Town-wide	Effective – updated yearly as required by MS4 Permit	Flooding

	nonpoint source pollution			
Water Supply Protection District Bylaw	Regulates development activity and uses in public water supply areas	Aquifer recharge areas for Town wells	Effective	Flooding/Drought
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs in collaboration with power company and by property owner notification	Town-wide	Generally effective – need additional resources	Wind Related
Mutual Aid Agreements	Agreements with neighboring municipalities for emergency response	Town-wide	Effective	Multi-hazard
Town Participates in Mosquito Control District	Detect and prevent spread of vector-borne diseases	Town-wide	Effective	Flooding

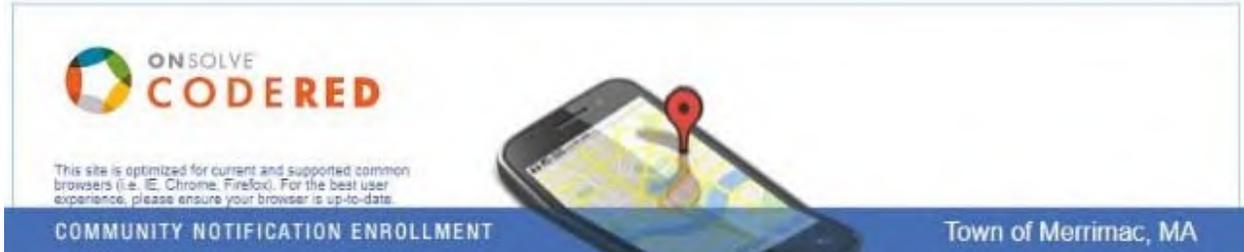
SECTION 6. 2016 MITIGATION MEASURES UPDATE

6.1 Implementation Progress from 2016 Plan

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

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

- Significant drainage system improvements to prevent flooding including implementation of Bear Hill culvert project (fall 2021) and feasibility and design of the Mill Street bridge/culvert.
- Updates to municipal wastewater infrastructure including program to eliminate infiltration and inflow.
- Town Bylaw update to require stormwater infiltration on new development projects.
- Implemented Code Red and E-Notify alert systems.



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

- The Town of Merrimac utilized the 2016 Hazard Mitigation Plan when it developed goals and strategies in the Town's Master Plan and in its Open Space and Recreation Plan.
- In addition, Merrimac incorporated elements from the 2016 Hazard Mitigation Plan when it underwent its risk assessment process through the Commonwealth's MVP Program.
- Finally, the Town has taken steps to implement findings from its 2016 Hazard Mitigation Plan into a Transportation Improvement Project (TIP) for the reconstruction of Bear Hill Road and the Complete Streets Program.

Table 6.1.1 MERRIMAC 2016 Mitigation Action Plan

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority in 2016	2021 Status (completed, in progress, not completed)	Include in 2021 Update?
Structural/Prevention	<p>Prioritize/engineer drainage system improvement needs in areas subject to chronic flooding and institute appropriate mitigation/remediation measures:</p> <ul style="list-style-type: none"> • Highest priority is replacing undersized corrugated steel culvert on Bear Hill Road at Back River by State Line/ Cost estimate is \$40k for engineering; \$200k for construction • Replace undersized culvert Route 110 downtown area by Public Safety/DPW facilities at Cobbler's Brook. DPW construction estimate is \$100k. • Reconfigure & enlarge drainage swale at Bisson Lane; • Replace undersized culvert at Willowdale/Church St. • Increase drainage system capacity at Donovan's Stream area; • Replace undersized culvert at Harriman Road; • Replace undersized culvert at Winter Street; • Reconfigure bridge crossing at Mill Street for flow capacity; • Reconfigure inlet structure at Locust Street; • Drainage improvement study needed at Birch Meadow Road Loop 	Flooding	Town Department of Public Works	Long-term/High	<p>Highest priority culvert on Bear Hill Road will be replaced in September/October 2021</p> <p>Feasibility and design for Mill Street structure in progress</p>	Yes – remainder of culverts/crossings will remain on plan
Prevention	Incorporate hazard mitigation in local policies, plans and programs (e.g. Capital Improvement Program, Master Plan, Open Space & Recreation Plan; MS4 Stormwater Management Program Plan)	All Hazards	DPW, Planning Board, Conservation Commission, Selectmen	Long-term/Medium	In progress – OSRP and SWMP updated	Yes

Table 6.1.1 MERRIMAC 2016 Mitigation Action Plan

Prevention	Consistent with the NPDES MS4 permit for Massachusetts, prepare Stormwater Management Plan and implement to ensure regular inspection, cleaning and maintenance of municipal stormwater facilities and waterways	Flooding	Town DPW	Long-term/Medium	In progress – Town continues to update SWMP as permit requires	Yes
Prevention	Study feasibility of implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Brushfires	Fire Department	Long-term/Low-Medium	Continue to discuss with DCR	Yes
Prevention/Natural Resource Protection	As opportunities arise, acquire, and protect private undeveloped open space in flood hazard areas	All Hazards	Conservation Commission, Open Space & Recreation Committee	Long-term/Medium	Ongoing as parcels become available	Yes
Public Education and Awareness	To reduce public risks from all natural hazards, establish and maintain Town web page describing safety “tips and techniques” for hazard preparedness, mitigation, and response, with direct links to MEMA and FEMA hazard mitigation websites	All Hazards	Emergency Management Director	Long-term/Medium	In Progress – Town implemented Code Red and E-Notify systems	Yes
Emergency Services Protection	Capacity upgrades to critical facility shelters/warming stations including addition of generators at Sweetsir School and Council on Aging, as well as Town Hall so the latter facility can be used as backup EOC	Flooding	Town DPW, School Department, Council on Aging	Medium-term/High	Not completed – funding not identified	Yes

Success/Lesson Learned Stories:

The Town of Merrimac has successfully received funding through FEMA’s Hazard Mitigation Grant Program to replace an undersized culvert on Bear Hill Road. The undersized culvert was prone to flooding and is on a crucial cut through road connecting Route 108 in Newton, NH to Route 110 in Merrimac, MA. Merrimac hopes to complete this work in the Fall of 2021.

The Town applied for funding through FEMA’s new Building Resilient Infrastructure and Communities grant for another culvert in town on Mill Street. This culvert, which has currently failed has resulted in road closure. The project was not selected, and the town is awaiting feedback from FEMA/MEMA to strength the application for refileing. This road closure directly impacts the Town’s Wastewater Treatment Facility, Merrimac Light Department Garage & Station, the Highway Department’s Salt Shed, and National Grid’s high pressure gas main running directly underneath the failed culvert.

SECTION 7. VULNERABILITY/RISK ASSESSMENT

7.1 Overview of Natural Hazards Vulnerability

Previous sections of this Multi-Hazard Mitigation Plan identify and describe the natural hazards that have occurred, or are most likely to occur, in Merrimac and the Merrimack Valley region. Since 1991, there have been 26 Presidential disaster declarations that included Essex County, as summarized in **Table 7-1**. Since 2014, when the region's last Hazard Mitigation Plan was prepared, there have been three additional Presidential disaster declarations in Essex County, two of which were the result of severe winter storms with flooding and the third being the ongoing COVID-19 pandemic. The vulnerability and risk assessment for Merrimac has been based on the frequency of disasters, data provided in the *2018 Massachusetts SHMCAP*, and the Hazard Assessment outlined in Sections 4 of this document.

TABLE 7.1.1 DISASTER DECLARATIONS FOR ESSEX COUNTY (1991 – 2020)		
DISASTER NAME (DATE OF EVENT)	DISASTER NUMBER (TYPE OF ASSISTANCE)	DECLARED AREAS
Hurricane Bob (August 1991)	FEMA-914 (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)
Severe Coastal Storm (October 1991)	FEMA-920-DR-MA (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	FEMA-920-DR-MA (IMA)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	FEMA-920-DR-MA (HMGP)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
Blizzard (March 1993)	FEMA-3103-EM (PA)	All 14 Massachusetts counties
Blizzard (January 1996)	FEMA-1090-EM (PA) (Public)	All 14 Massachusetts counties
Severe Storms and Flooding (October 1996)	FEMA-1142-DR-MA (PA)	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk
	FEMA-1142-DR-MA (IFG)	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk
	FEMA-1142-DR-MA (HMGP) and FY1997 CDBG	Counties of Essex, Middlesex, Norfolk, and Plymouth, Suffolk (36 projects)
Heavy Rain and Flooding (June 1998)	FEMA-1224-DR-MA (IFG)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	FEMA-1124-DR-MA (HMGP) and FY1998 CDBG	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Severe Storms and Flooding (March 2001)	FEMA-1364-DR-MA (IFG)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	FEMA-1364-DR-MA (HMGP)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)

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

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

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

DISASTER NAME (DATE OF EVENT)	DISASTER NUMBER (TYPE OF ASSISTANCE)	DECLARED AREAS
<p>Key:</p> <p>PA-Public Assistance Project Grants: Supplemental disaster assistance to states, local governments, certain private non-profit organizations resulting from declared major disasters or emergencies.</p> <p>HMGP – Hazard Mitigation Grant Program: Project grants to prevent future loss of life or property due to disaster. A presidential declaration of a major disaster or emergency is needed to designate HMGP assistance.</p> <p>IHP – Individual Household Program: Formerly named IFG, this program provides grants and loans to individual disaster victims to address serious needs and necessary expenses, under the FEMA Disaster Housing, State IFG Program, and/or SBA Home and Business Loan Programs.</p> <p>CDBG – Community Development Block Grant: Project grants for community development-type activities to assist with long-term recovery needs related to both residential and commercial buildings.</p>		

7.2 Vulnerabilities Identified

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

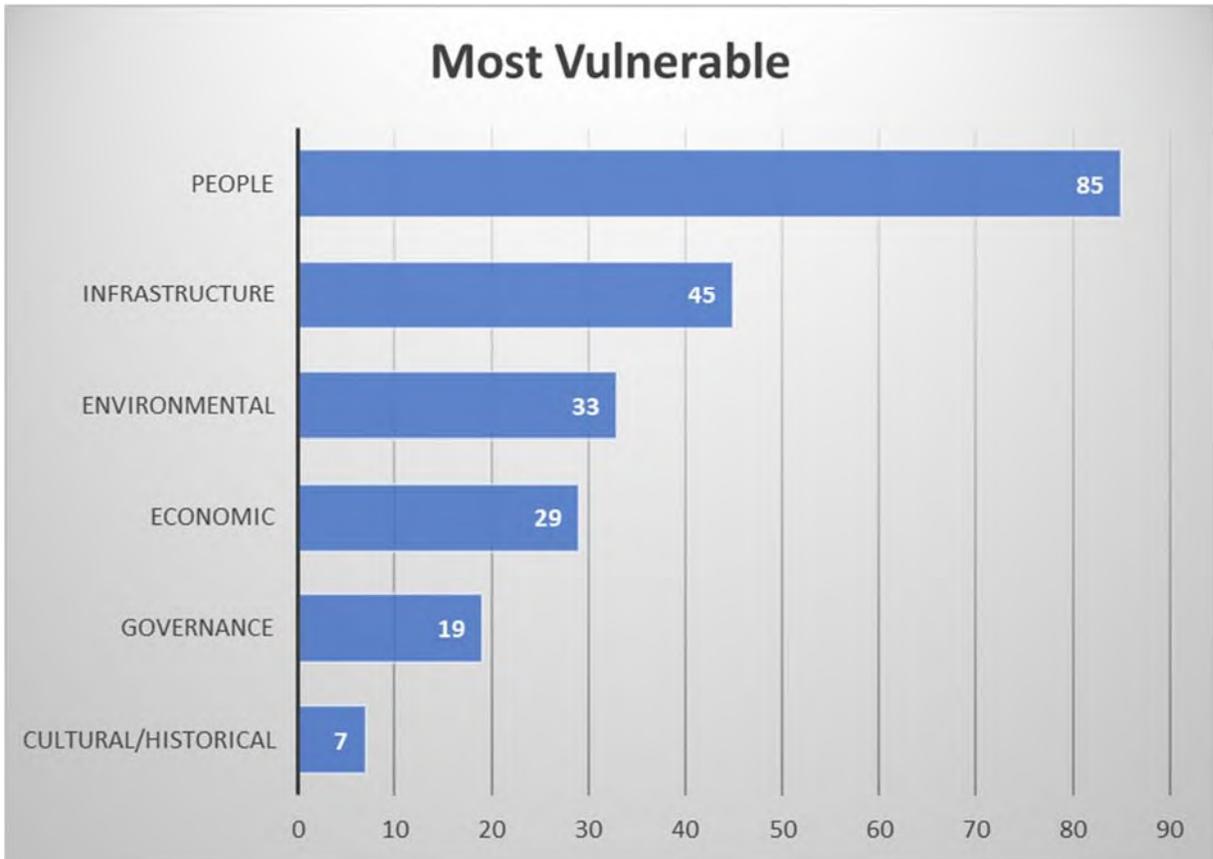


Figure 7.2.1 “Most Vulnerable” Stakeholder Survey Response

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

Merrimac Societal Features – Vulnerabilities Identified

Emergency Planning: The age composition of Merrimac’s population is changing with a substantially greater number of older adults (over 65) with approximately 30 percent of which identified themselves as having a disability.²⁸ Workshop participants stressed the need for outreach and education to vulnerable populations on emergency

²⁸ Town of Merrimac Housing Production Plan 2018-2022 prepared by Merrimack Valley Planning Commission with JM Goldson community preservation & planning

planning and recommended coordination with faith-based, community and veterans' groups. Other actions included establishing an emergency plan including communication to vulnerable populations. A contact list was suggested. Emergency planning for flood-prone areas was also stressed as residents in these areas are often cut off from emergency services during storm events the frequency and intensity of which is already increasing. Residents of the Lake Attitash area were mentioned specifically. Stakeholders also raised the concern that some vulnerable populations are not identified in the community including those living in illegal apartments and those with mobility issues.

Other populations identified as vulnerable in Merrimac and to be considered in emergency planning included residents of one of the town's two mobile home parks and residents of the public housing complex Merri Village.

Participants agreed that there is a need for the community to enhance its current efforts to educate and communicate about climate-related hazards including ways to prepare and plan for these hazards, both now and in the future.

Shelter Planning: Workshop attendees again identified the lack of shelters and shelter planning as a vulnerability requiring action. The need for backup energy at shelters was also raised. Green solutions for backup power were prioritized.

Access Issues: Merrimac stakeholders recognized that in emergency and in everyday situations that town sidewalks and other facilities are not accessible for those with mobility issues. Of the estimated disabilities in Merrimac, the most reported was ambulatory (36 percent of reported disabilities)⁷. Funding and implementation of the Town's transition plan was a recommended action to be certain all populations can access emergency services especially in hazard situations. Since the MVP stakeholder meetings, Merrimac staff provided an update that the Town is in the process of completing an ADA Self-Evaluation and Transition Plan project. The project is expected to be completed in September or October of 2021.

Other: Workshop attendees also identified developing youth-based education programs around stewardship, responsible land use, and eco-services as a way to address vulnerabilities related to climate change. Other suggested actions included education and outreach on resilient tree species and development of maintenance plans for stormwater infrastructure.

Merrimac Infrastructure Features – Vulnerabilities Identified

Culverts: Workshop participants identified several culverts of concern including those on Bear Hill Road, Mill Street, Church Street and Harriman Road. As presented earlier, construction on the Bear Hill Road culvert will begin this fall and the culvert/bridge on Mill Street has been funded for feasibility and design. Other culverts were identified for study and prioritization.

Emergency Shelters: Merrimac stakeholders were concerned about the lack of shelter locations in the community. Currently Merrimac does not have any identified shelter locations, only Emergency Operation Centers (Merrimac HMP 2016). Identifying shelter locations and properly equipping these locations was another high priority. Regional collaboration for sheltering was also identified as was the need to have backup power. Merrimac acknowledged that a clean energy source with storage capacity would be the ideal solution and an action the town should pursue.

Water, Sewer, and Stormwater Infrastructure: Merrimac's water, sewer and drainage infrastructure are vulnerable because of age and condition in some areas but is also serves as a strength in mitigating hazards and protecting public health in others.

Water supply remains a significant challenge to Merrimac's future development and is likely to be exacerbated by the increasing number of days without precipitation. According to the Water Master Plan completed in November 2009, Merrimac obtains water from two well fields, the East Main Street well field and the Sargent Pit well field. The Town is registered to withdraw a total of 0.36 Million Gallons per Day (MGD) from these supply sources and is permitted to withdraw an additional 0.1 MGD for a total Water Management Act Authorized withdrawal of 0.46 MGD, or 167.9 MG/year. The system provides municipal water to approximately 5,390 persons, or 80% of the town's total population and the average water use per person is 64 gallons per day. The Town anticipates that water demand will increase from current average daily flows of 0.396 Mgal/day to 0.422 Mgal/day in 2020, and 0.450 Mgal/day in 2030. Merrimac's efforts in promoting water conservation and aggressively correcting leaks when detected are very effective in managing a limited supply with few options for expansion. Workshop participants identified a need to undertake a study to identify additional drinking water sources which could include looking regionally. A need for greater water storage facilities was also identified.

Except for a few small isolated rural sections, most of Merrimac is part of the **public wastewater system**. The Merrimac Wastewater Treatment Facility (WWTF) was upgraded in 2005. It has a discharge license that limits its total discharge flow rate to 450,000 gallons per day calculated on a 12-month running average. This flow rate was exceeded from May to September 2006 due to severe storms that exposed the vulnerability of the system to infiltration and inflow into the collection system. The town has since been aggressive in eliminating infiltration/inflow to seep into the system. These efforts have been successful in reversing the increase in the 12-month running average to its current level of approximately 326,300 gallons per day. While the town does have a meaningful reserve that can be used to support continued but controlled growth in the community, a study is needed and was identified by workshop participants as a priority. Moving critical wastewater treatment plant infrastructure (including lift stations and main lines) farther from the Merrimack River and other sources of potential flooding was also an identified action item.

Merrimac maintains many **stormwater structures** including catch basins and outfalls as well as a variety of basins and swales. In 2016, the U.S. EPA and MassDEP

updated the permit regulating municipal management of separate storm sewer systems (MS4s). It went into effect in 2018 and requires that urbanized Massachusetts communities, including Merrimac, take proactive steps to implement tracking systems to guard against illicit discharges that could pollute waterways. The permit also prescribes maintenance of stormwater infrastructure and mandates promotion of low impact development techniques including nature-based stormwater treatment systems. Merrimac prioritized a need to inventory and prioritize maintenance of stormwater basins to be certain they will function as needed in larger more frequent storm events.

Merrimac identified a need to review its traditional and open space subdivision bylaws and regulations to improve maintenance access to **stormwater infrastructure**. This increased maintenance and oversight could be a strength as the community works to improve the quality of its waterways. However, it has led Merrimac to identify the need to review its stormwater bylaws and regulations to be sure they are addressing future climate related concerns including increased rainfall and more frequent severe storm events.

Municipal Facilities & Resources: Workshop participants identified the DPW Facility located on East Main Street as a top concern. The facility is located on Cobbler’s Brook and is subject to flooding. Cobbler’s Brook is a 3.7-mile perennial stream that originates between Highlands Hill and Red Oak Hill. It runs north-south through central Merrimac, passing just east of the town square before emptying into the Merrimack River. Much of the shoreline has been disturbed and extensively developed with residential uses, light manufacturing, agricultural uses, road crossings and culverts, and the former municipal landfill all of which have increased flooding events. The riparian corridor of this brook is not an ideal location for the DPW facility and the many operations that it supports.



Town of Merrimac Website Photo

Merrimac Environmental Features – Vulnerabilities Identified

Water Supply: Water supply was again a top concern of Merrimac stakeholders in the area of environmental vulnerabilities. The frequency and intensity of drought are 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. This may only exacerbate Merrimac’s vulnerability.

Tree/Forest Health: Merrimac stakeholders identified tree and forest health as a vulnerability. Wild/brushfires as well as downed trees due to severe storm events elevated concerns among workshop participants.

Invasive species were another concern of Merrimac stakeholders and finding alternative management techniques was an action item. Street tree planting was a lower priority action suggested to improve resiliency to higher temperatures and improve infiltration of larger storm events. Participants emphasized the need to consider resilient tree species as the local climate changes. Workshop participants suggested a review of the subdivision regulations to add street trees requirements.

Planning: Many participants identified a need to continue resiliency planning beyond the workshop process. A lack of climate change considerations in local bylaws, especially for stormwater management and larger more frequent storm events, was highlighted by stakeholders. A specific need to review the traditional and open space subdivision regulations was cited by several participants.



Lake Attitash, Merrimac

Watersheds: The Cobbler's Brook watershed was specifically identified by stakeholders as vulnerable to the pressures of increased precipitation and severe storm events.

Bank Erosion: Prior storm events have eroded banks and closed roads in Merrimac. Areas of bank erosion include Lake Attitash, the Merrimack River and Cobbler's Brook. The Historic Commission was mentioned as a source of old photos to compare historic and existing conditions.

Flood Prone Areas: Merrimac stakeholders identified several farms and other areas potentially subject to development that should be preserved for their flood storage capacity. Land preservation was also encouraged by several workshop participants for its ability to sequester carbon and provide increased infiltration.

Potential Flood Damage as a Measure of Vulnerability

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



Merrimack River Mother's Day 2006 (MVPC Photo)

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

From this intersection of floodplain and building location data layers, MVPC was able to determine both the total number of buildings in Merrimac's 100-year floodplain *and* their corresponding assessed values. This information was organized and recorded by land use category – i.e., residential (all types), commercial, industrial, and institutional – and is presented in **Table 7.2.1**

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

Table 7.2.1 Assessed Value of Buildings in the 100-Year Floodplain						
City/Town	Number of Buildings	Assessed Building Value by Land Use Type				Total Assessed Value in 100-Yr
		Residential	Commercial	Industrial	Institutional	
MERRIMAC	75	\$10,786,700	\$0	\$0	\$0	\$10,786,700.00

Source: MVPC digital imagery and local assessor records

The total assessed value of all buildings in Merrimac is \$10,789,700 to provide context for the above. While the table figures provide an estimate of the building values, they do not include the estimated cost of replacing building contents. It is also important to note that loss of property does not reflect the entire cost of a region-wide flood event. There may also be added personnel (overtime) costs, rescue and evacuation costs, infrastructure repair/replacement costs, sediment and debris cleanup costs, and economic costs related to business closures.

7.3 Vulnerability to Future Natural Hazards

Based on the identification and profile of the natural hazards that have occurred throughout the region over time, a vulnerability matrix has been developed. The matrix,

adapted from the 2010 Massachusetts Hazard Mitigation Plan developed by MEMA, was used to categorize each hazard based on frequency, severity, extent of impact, and area of occurrence. Historical data were utilized, as well as the best available scientific assessments, published literature, and input from subject area experts. The criteria were formulated based on the hazard identification profile and from the prior assessment performed for the region. There have been no significant changes in the region’s vulnerability since the completion of the 2016 Regional Multi-hazard Mitigation Plan.

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

Table 7.3.1 Merrimac’s Potential Vulnerability to Natural Hazards														
HAZARD	FREQUENCY				SEVERITY				AREA OF IMPACT			AREA OF OCCURRENCE		
	VERY LOW	LOW	MODERATE	HIGH	MINOR	SERIOUS	EXTENSIVE	CATASTROPHIC	ISOLATED	LOCAL/MUNICIPAL	REGIONAL	ISOLATED	LOCAL/MUNICIPAL	REGIONAL
FLOOD				X		X				X	X		X	X
DAM FAILURE		X				X				X			X	
HURRICANE			X			X					X			X
TORNADO			X				X			X	X		X	X
THUNDERSTORM				X	X						X			X
NOR'EASTER				X		X					X			X
SNOWSTORM/ BLIZZARD				X		X					X			X
ICE STORM			X			X					X			X
ICE JAM		X			X			X	X				X	
DROUGHT			X		X						X			X
WILDFIRE			X			X				X			X	
EARTHQUAKE		X				X					X			X
LANDSLIDES	X				X				X	X		X	X	
CLIMATE CHANGE				X			X				X			X

KEY:

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

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

AREA OF IMPACT:

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

AREA OF OCCURRENCE:

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

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

Table 7.3.2 Secondary Impacts from Primary Natural Hazards

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

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

SECTION 8. MITIGATION STRATEGY

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

44 CFR Requirement

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

8.1 Mitigation Goals

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

The overarching goal of the current plan is as follows:

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

Complementing Goal #1 are the following additional goals:

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

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

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

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

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

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

8.2 Mitigation Measures

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

1. Prevention

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

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

2. Property Protection

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

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection

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

3. Natural Resource Protection

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

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

4. Structural Projects

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

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

5. Emergency Services Protection

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

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

6. Public Education and Awareness

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

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

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

8.3 Mitigation Measures for Regional and Inter-Community Issues

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

- The City of Amesbury - workshop participants recognized that addressing flooding in the Lake Attitash area will require a regional response as the City of Amesbury controls the height of the Lake. Workshop participants identified regional planning for Lake Attitash Management as an important action item.
- The City of Amesbury, like Merrimac, needs to address shoreline erosion along the Merrimac River. Both communities have important infrastructure, including closed roads, which would benefit from a regional response.
- Essex County Greenbelt Association – Assist with open space acquisition and protection at a regional level. ECGA also has a priority parcel analysis that can assist communities with protecting land that promotes resiliency.
- Other communities with connected infrastructure and/or mutual aid agreements – Amesbury, Groveland - Participants in the HMP Planning workshop identified the need to work with neighboring communities to identify additional water supply sources. Shelter planning, a top Merrimac priority, would also benefit from regional planning with neighboring communities.
- Merrimack River Watershed Council (MRWC) – Merrimac participates in Merrimack River related meetings

8.4 Mitigation Measures and New Development and Infrastructure

As discussed in Chapter 3, by 2030, MVPC forecasts the Merrimac population to increase by 486 people between 2010 and 2035. The age composition of Merrimac's population is also anticipated to change with a 160 percent increase in the number of older adults (age 65 year and over). Hazard Mitigation Planning must consider this growth and change in population characteristics in light of any additional hazards that may occur. New development can increase existing vulnerabilities to infrastructure including water, sewer, and stormwater. New development and redevelopment must adhere to the Massachusetts State Building Code but must also consider local zoning, wetlands, and stormwater bylaws and regulations. To reduce flooding, increase groundwater recharge, and promote cooling, Merrimac must prioritize Low Impact Development and green infrastructure as the community expands.

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

SECTION 9. MITIGATION ACTION PLAN

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

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

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

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

44 CFR Requirement

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

- Protect critical public facilities and services from damage due to natural hazards;
- Develop a mitigation strategy that considers the needs of area businesses and protects the economic vitality of the region;
- Update and maintain the Plan as resources permit;
- Provide information concerning hazard mitigation funding opportunities, and assist the Town in the identification and development of specific mitigation projects; and
- Increase Merrimac’s capacity for responding to a natural hazard event by promoting the adequate provision of emergency services.

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

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

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

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

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

This Mitigation Action Plan is an update of the 2016 Action Plan. It is organized in a series of matrices. The matrices note whether each particular action was included in the 2016 Plan or if it is a new action resulting from this planning process. The implementation status of prior projects is noted in Chapter 6. Several of the actions contained in the 2016 Plan remain in the updated plan and continue to be a priority for Merrimac. The actions put forth in this current Hazard Mitigation Plan will be implemented as resources are made available.

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

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

Cost. Costs are estimated using the following criteria:

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

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

The **Merrimac Mitigation Action Plan** is presented in **Tables 9.1.1**

Table 9.1.1 MERRIMAC Mitigation Action Plan

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Cost	Benefit	Resources/ Funding	In Prior Plan? New?
Structural Project/Prevention	Prioritize/design drainage system improvements in areas subject to chronic flooding. Institute appropriate mitigation/remediation measures (see "Special Flooding Concerns" in Chapter 4).	Flooding	Town Department of Public Works (DPW)	Long-term/High	High	High	FEMA, MEMA, MVP, Town	Prior
Structural Project	Design and implement culvert upgrades where previous studies have been done. Fund a study of the remaining culverts to prioritize replacement to accommodate future stream flows. Studies should include existing and future land use development.	Flooding	DPW	Long-term/High	High	High	FEMA, MEMA, DER, MVP, Town	New
Structural Project	Merrimack River riverbank restoration plan	Flooding	Town/Regional	Short-term/High	Medium	High	FEMA, MEMA, CZM, MVP	New
Emergency Services	Identify shelter locations and properly equip those shelters including backup green energy. Regional solutions should be considered.	All Hazards	Emergency Management, Police and Fire Departments/Regional	Long-term/High	High	Medium	Town, FEMA, MEMA	New
Structural Project	Conduct wastewater study to understand impacts of community growth and impacts of climate change. Move infrastructure out of areas that may be subject to flooding.	Flooding	DPW, Town	Long-term/Medium-High	High	Medium	FEMA, MEMA, MVP	New
Structural Project	Move Public Works complex out Cobbler Brook flood prone area.	Flooding	DPW, Town	Long-term/Medium-High	High	Medium	Town	New
Prevention	Continue work with Green Communities to reduce municipal energy use. Study green energy generation and storage.	All Hazards	Public Works, Emergency Management, Town	Long-term/Medium	Medium	Medium	Town, DOER (Green Communities Program)	New
Prevention	Consistent with EPA MS4 Program requirements, develop and implement drainage system maintenance plan to ensure regular inspection, cleaning, and maintenance of municipal stormwater facilities and waterways	Flooding	DPW	Immediate/Medium	Medium	Medium	Town, Regional Stormwater Collaborative	Prior
Emergency Services	Increase sign-up and information updates of Code Red alert system especially with seniors and other vulnerable populations. Establish emergency plan for communicating with vulnerable populations.	All Hazards	Senior Center, Emergency Management, Police and Fire Departments	Short-term/Medium	Low	Medium	Town	New
Public Education and Awareness	Conduct education and outreach for vulnerable populations in emergency situations. Coordinate this outreach with community groups and faith-based organizations.	All Hazards	Town Administration, Senior Center, Emergency Management	Immediate/Low	Low	Medium	Town	New
Emergency Services	Improve access for emergency and everyday situations for those with mobility issues. Sidewalks were specifically mentioned. – Town is completing ADA self-evaluation/Transition Plan – Fall 2021	All Hazards	Town	In process/High	Low	Medium	Town	New

Table 9.1.1 MERRIMAC Mitigation Action Plan

Emergency Services	Conduct emergency planning for flood-prone areas – include regional discussions for Lake Attitash area	Flooding	Town Administration, Emergency Management, DPW	Short-term/High	Low	High	Town	New
Natural Resource Protection	Conduct forest management planning and implement	Wind/Brush Fire	DPW/Conservation	Short-term/High	Medium	Medium	Town	New
Natural Resource Protection	Conduct Cobbler Brook watershed study	Flooding	Town	Short-term/High	Medium	Medium	Town, MassDEP, MVP	New
Natural Resource Protection/Structural Project	Conduct a comprehensive water study, including storage. Consider regional options for additional water supply sources.	Drought	Water Department	Long-Term/High	Medium	High	Town and Regional Communities	New
Property Protection/Natural Resources Protection	Prioritize land acquisitions to protect water supply, provide infiltration, carbon sequestration, and flood mitigation	Drought/Climate Change	Open Space Committee, Town, Regional Partners (ECGA)	Long-Term/Medium	High	Medium	DCR, MVP	New
Prevention	Incorporate hazard mitigation in local policies, plans and programs (Capital Improvement Program, Master Plan, Open Space & Recreation Plan; MS4 Stormwater Management Program Plan).	All Hazards	Town Departments	Annual/Medium	Low	Medium	Town, MVP	Prior
Prevention	Explore role for resiliency planner in local government. Find additional ways to continue resiliency planning including volunteers.	All Hazards	Town	Short-term/High	Medium	Medium	Town	New
Prevention	Conduct comprehensive review of stormwater bylaw	Flooding, Climate Change	DPW, Planning and Conservation	Short-term/Medium-High	Low	Medium	Town	New
Prevention	Strictly enforce and, as appropriate, upgrade Town zoning bylaw, subdivision rules & regulations, and wetlands regulation to minimize incidence and impacts of flooding and other natural hazards.	All Hazards	Planning, Zoning, Conservation	Annual/High	Low	Medium	Town	Prior & New
Prevention	Update local Subdivision Rules and Regulations (traditional and open space) to require Low Impact Development techniques in all new and redevelopment.	Flooding	Planning Board	Long-term/Medium	Medium	Medium	Town, MVP	Prior & New
Prevention	Continue to participate in NFIP and strictly enforce local floodplain regulations, building code, and other bylaws and regulations designed to minimize the impact of flooding and other natural hazards on public safety, property and the environment; participate in NFIP training sessions offered by the state and/or FEMA that address flood hazard planning and management.	Flooding	Town Departments	Annual/High	Low	High	Town	Prior
Natural Resource Protection	Explore and implement alternative management strategies for invasive species control	Climate Change	Conservation/Open Space	Long-term/High	Medium	Medium	Town	New

Table 9.1.1 MERRIMAC Mitigation Action Plan

Prevention	Maintain & update Comprehensive Emergency Management Plan (CEMP) and local Natural Hazards PDM Plan to ensure completeness and relevance in disaster prevention, mitigation, and response	All Hazard	Town Departments	Annual/High	Low	High	Town	Prior
Prevention	To mitigate against damage and disruption from high winds, promote to the maximum extent practicable, the use of underground utilities in all new development and redevelopment.	Power Outages/Wind	Town Departments and Private Developers	Long-term/High	High	High	Town/Private	Prior
Prevention	To reduce public risks from all natural hazards, establish and maintain Town web page describing safety “tips and techniques” for hazard preparedness, mitigation, and response, with direct links to online resources	All Hazards	Town Departments	Short-term/Medium	Low	Medium	Town	Prior

SECTION 10. PLAN ADOPTION AND MAINTENANCE

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

10.1 Plan Adoption

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

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

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

10.2 Plan Maintenance

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

44 CFR Requirement

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

Accordingly, the Core Team will meet annually to review the plan. At this meeting, the Core Team will review the hazard mitigation measures that have been implemented as of that date and determine if these measures have had an impact on mitigating the overall

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

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

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

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

SECTION 11. PLAN IMPLEMENTATION

11.1 Pivotal Role of Local Government

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

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

Of note in Merrimac is the small staff that wears many hats in day-to-day municipal operations. Staff are integral in accomplishing mitigation goals but are challenged to manage large projects and several grants on top of their everyday responsibilities. Merrimac has successfully contracted some work to outside partners/consultants, but funding additional full-time positions has proved challenging.

11.2 Broad Integration of Plan

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

44 CFR Requirement

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

Table 11.1.1 Role of Local Boards and Departments in Plan Implementation

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

SECTION 12. FUNDING SOURCES

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

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

Table 12.1 FEMA and Other Funding Programs				
FEMA Program	Type of Assistance	Availability	Managing Agency	Funding Source
National Flood Insurance Program (NFIP)	Pre-Disaster Insurance	Any time (pre and post-disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA
Severe Repetitive Loss (SRL) (Part of the NFIP)	Grants to state emergency management offices to reduce damage to insured severe RLPs	Varies	MEMA	Up to 90% FEMA/ 10% state government
Repetitive Flood Claims Program (RFC) (Part of the NFIP)	Grants to states and municipalities to reduce damage to insured RLPs	Any time	FEMA	100% FEMA
Community Rating System (CRS) (Part of the NFIP)	Disaster Insurance Discounts	Any time (pre and post-disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA
Flood Mitigation Assistance (FMA) Program	Cost-share grants for pre-disaster planning and projects	Annual pre-disaster grant program	DCR & MEMA	75% FEMA/25% local government or organization
Hazard Mitigation Grant Program (HMGP)	Post-disaster Cost-Share Grants	Post disaster program	DCR & MEMA	75% FEMA/25% local government or organization
Building Resilient Infrastructure and Communities (formerly the Pre-Disaster Mitigation Program)	National, competitive grant program for multiple hazard mitigation projects and "all hazards"	Annual pre-disaster mitigation program	DCR & MEMA	75% FEMA/25% local government or organization
Small Business Administration (SBA) Mitigation Loans	Pre- and Post-disaster loans to qualified businesses	Ongoing	MEMA	Small Business Administration
Infrastructure Support Program (formerly Public Assistance)	Post-disaster aid to state and local governments	Post Disaster	MEMA	FEMA
Municipal Vulnerability Preparedness Action Grans	Funding for designated MVP Communities to advance priority climate adaptation actions to address climate change	Annually	EOEEA	State of Massachusetts

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

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

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

National Flood Insurance Program (NFIP)

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

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

Communities participating in the NFIP must:

- Adopt the Flood Insurance Rate Maps as an overlay regulatory district;
- Require that all new construction or substantial improvement to existing structures in

- the flood hazard area will be elevated; and
- Require design techniques to minimize flood damage for structures being built in high hazard areas, such as floodways or velocity zones.

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

Severe Repetitive Loss Program

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

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

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

Repetitive Flood Claims Program (RFC)

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

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

Community Rating System (CRS)

A voluntary initiative of the NFIP, the Community Rating System (CRS) encourages communities to undertake activities that exceed the minimum NFIP floodplain management standards. Communities participating in CRS can reduce flood insurance premiums paid by policyholders in that community by performing such activities as maintaining records of floodplain development, publicizing the flood hazard, improving flood data, and maintaining open space. Communities can gain additional credit under CRS by developing a flood mitigation plan.

Flood Hazard Mitigation Program

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

Hazard Mitigation Grant Program (HMGP)

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

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

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

Pre-Disaster Mitigation (PDM) Program now BRIC

The Pre-Disaster Mitigation (PDM) Program was authorized by §203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 USC, as amended by §102 of the Disaster Mitigation Act of 2000. As a result of amendments by the Disaster Relief and Recovery Act of 2018, the Pre-Disaster Mitigation program is being replaced with the new [Building Resilient Infrastructure and Communities \(BRIC\)](#) program. The BRIC program aims to shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience. All applicants must be participating in the National Flood Insurance Program (NFIP) if they have been identified through the NFIP as having a Special Flood Hazard

Area (a Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM) has been issued). Also, the community must not be suspended or on probation from the NFIP. Applicants must also have an up to date HMP.

Small Business Administration Mitigation Loans

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

Public Assistance Program

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

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

Typical federal/state aid can include:

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

Special Appropriations Following State Disasters

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

State Revolving Fund

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

Massachusetts Land and Water Conservation Fund

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

Major Flood Control Projects

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

Municipal Vulnerability Preparedness (MVP) Action Grants

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

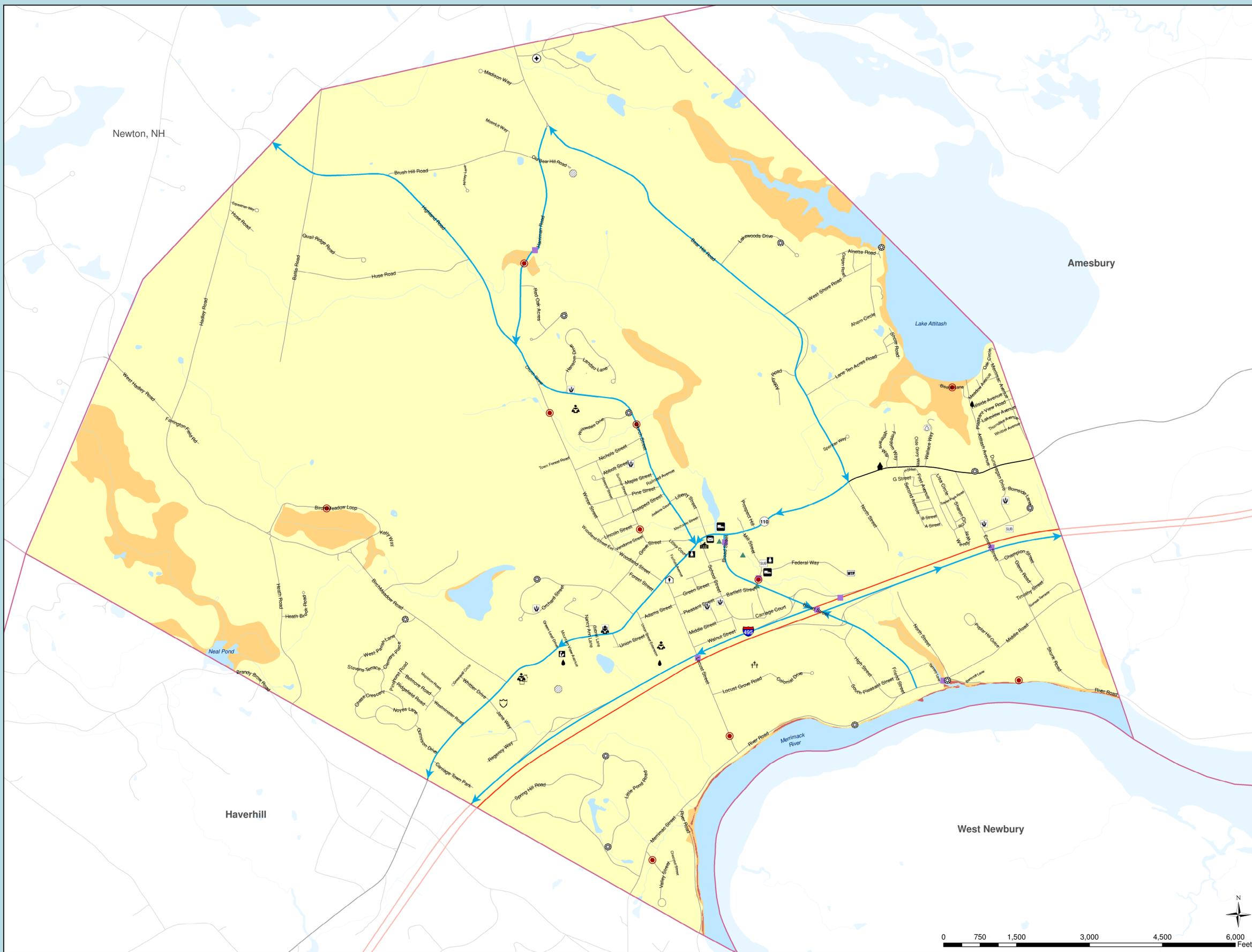
Appendix A

Composite Hazards Map

Merrimack Valley Multi-Hazard Mitigation Plan

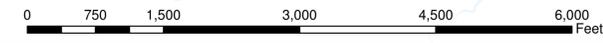
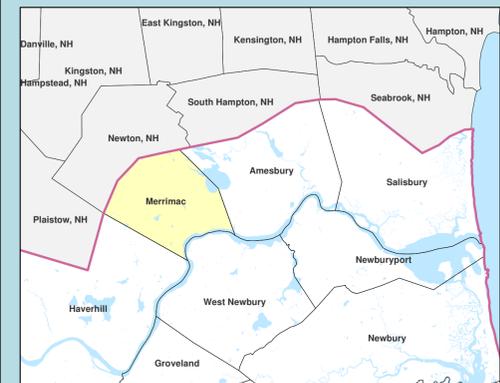
2021

MERRIMAC, MA Composite Hazards



Legend

Chronic Flooding Locations	Town Boundary
Very Low (1 Hazard)	Hydrographic Features
Low (2 Hazards)	Interstate
Moderate (3 Hazards)	Major Roads
High (4 Hazards)	Local Roads
	Rail Lines



Critical Facilities and Infrastructure

- | | | | | | | | |
|-------------------|---------------------|-------------------|------------------|----------------------|-----------------------------|-----------------------|---------|
| Cemetery | Electric Substation | Museum | Public Library | Senior Center | Waste Water Treatment Plant | Water Treatment Plant | Bridges |
| DPW Yard | Fire Station | Police Department | Residential Care | Sewer Infrastructure | Water Booster Station | Well Fields | Dams |
| Day Care Facility | Light Department | Post Office | School | Town Hall | Water Storage Tank | Evacuation Routes | |

Preparation of this Plan was funded by grant # HMGP 1895-45 from the Massachusetts Emergency Management Agency (MEMA) in cooperation with the Department of Homeland Security-Federal Emergency Management Agency (FEMA). Matching funds were provided by MVPC.

Data Sources: The data for this map was supplied by the Merrimack Valley Planning Commission, the Massachusetts Department of Conservation and Recreation, the Executive Office of Environmental Affairs/MassGIS (EOEA/MassGIS), and the municipality. The information depicted on this map is for planning purposes only. It may not be adequate for legal boundary definition or regulatory interpretation.

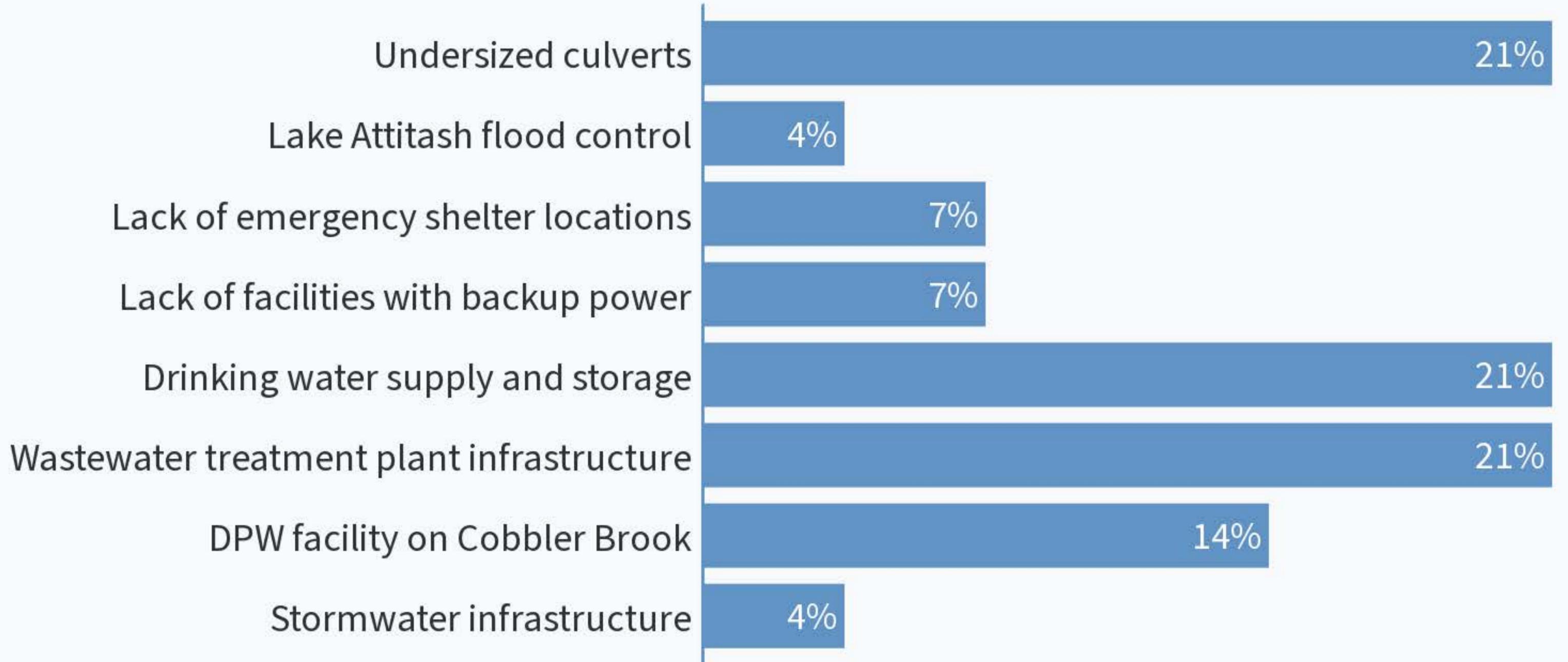
A State Designated Regional Service Center
"Mapping the Crossroads of New England"
Merrimack Valley Planning Commission (MVPC)
160 Main Street Haverhill MA, 01830

E:\ArcGIS\Merrimac\2021\EMMA_CompHazards.mxd June 2021 MM

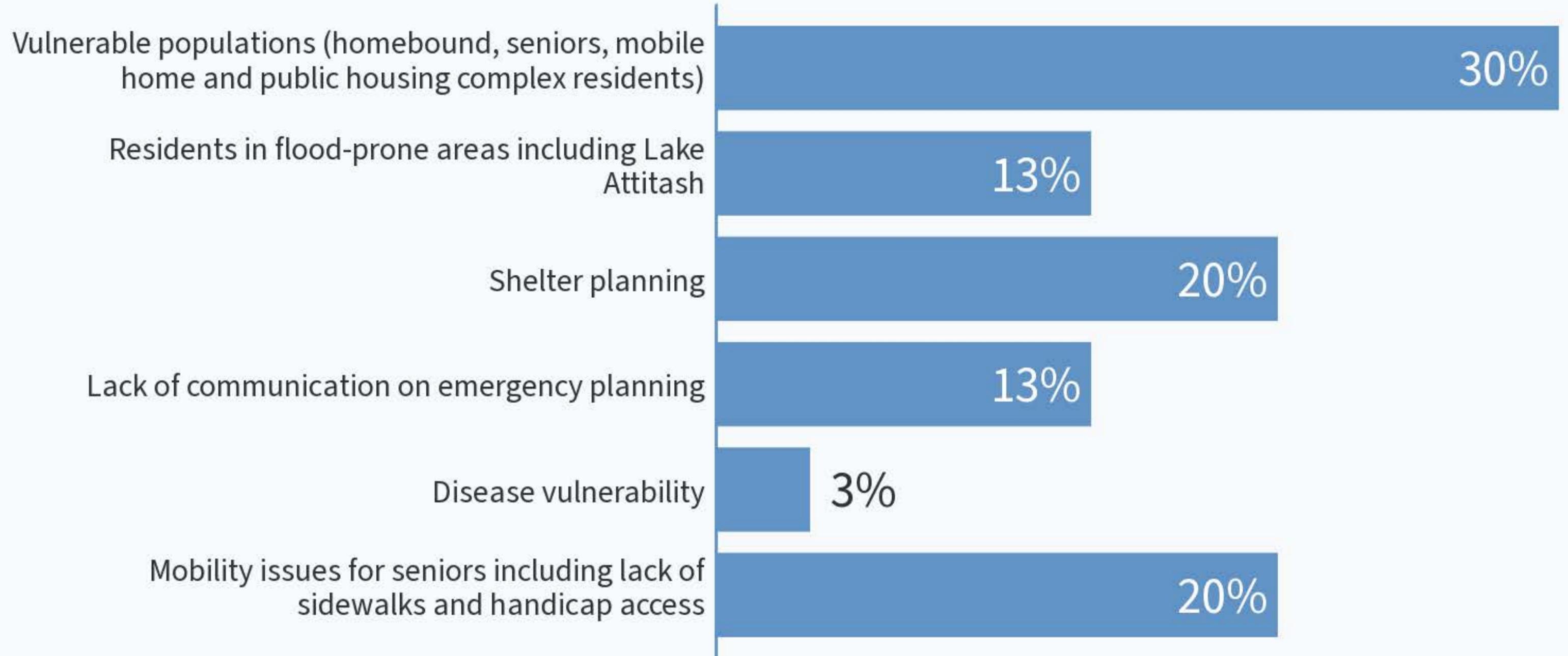
Appendix B

Survey Results

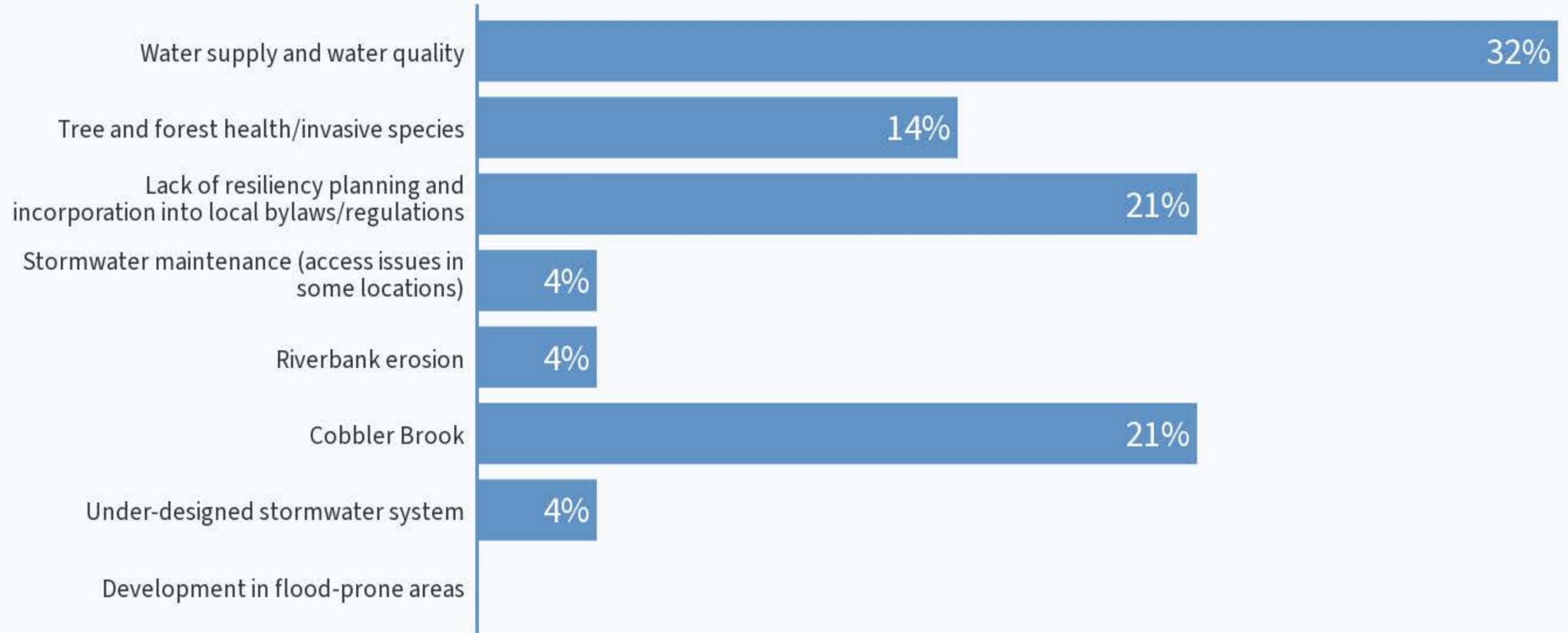
Merrimac Infrastructure Vulnerabilities (Select Top 3)



Merrimac Societal Vulnerabilities (Select Top 3)



Merrimac Environmental Vulnerabilities (Select Top 3)



Are there other vulnerabilities that should be added? You can vote on the ideas submitted.

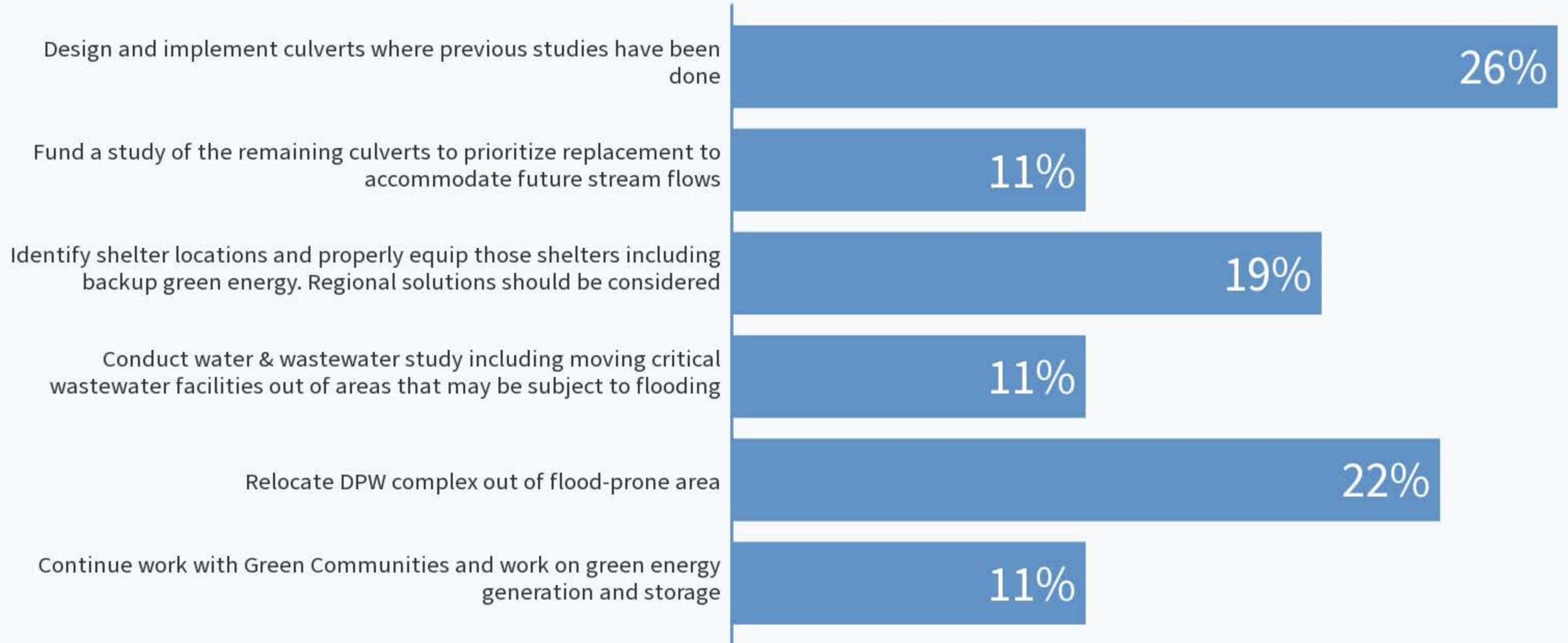
Top

2

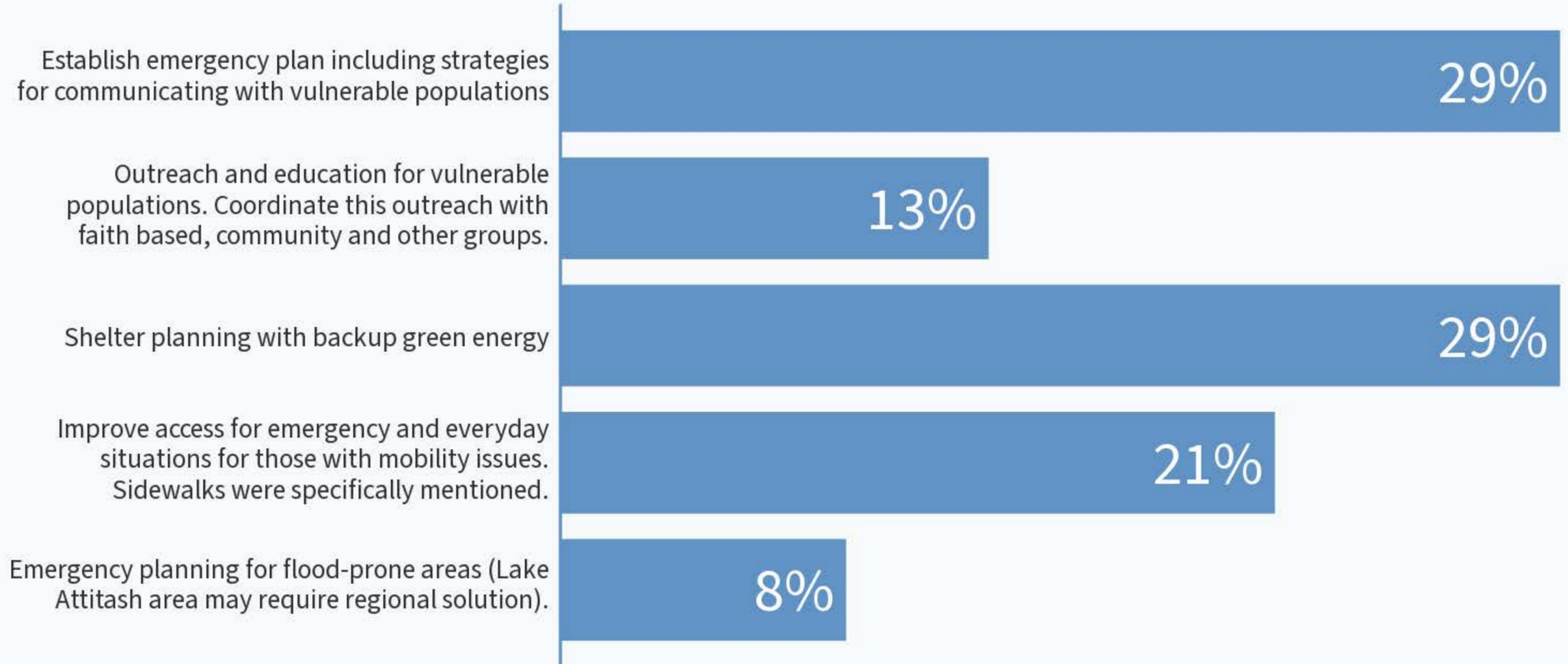


Development in areas that are identified as important for climate resilience - i.e. in areas that protect drinking water, that protect ecological resilience, t...

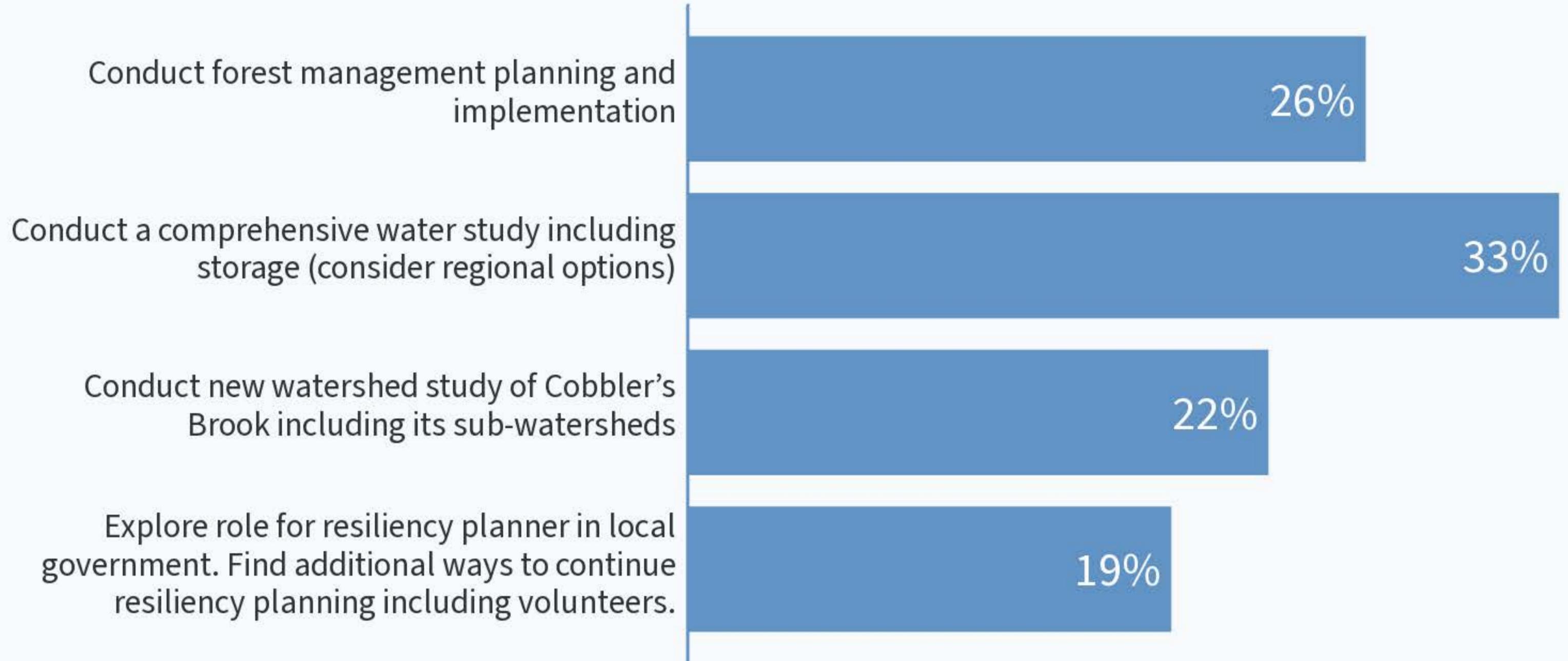
High Priority Actions Infrastructure (Select Top 3)



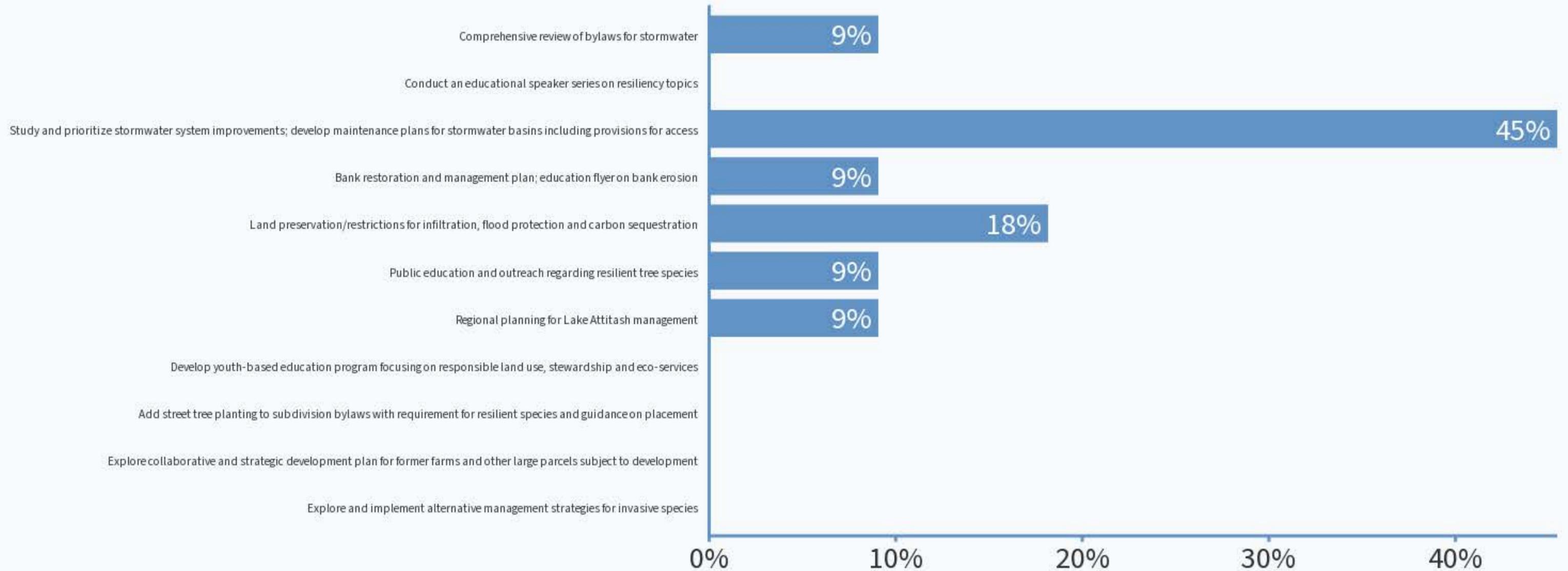
Merrimac High Priority Actions - Society (Select Top 3)



High Priority Environmental Actions (Select Top 3)



Other Priority Actions (Should any of the following be listed as higher priority - select 1)

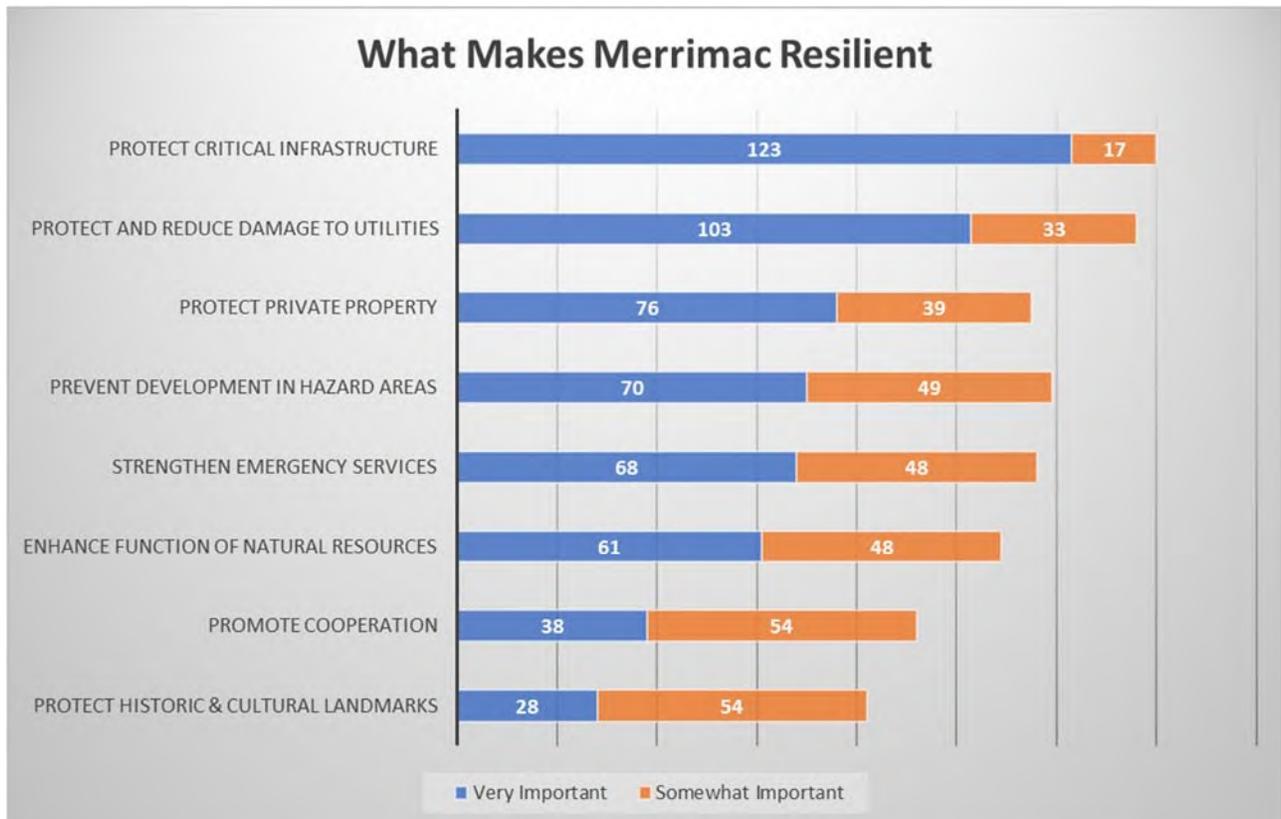
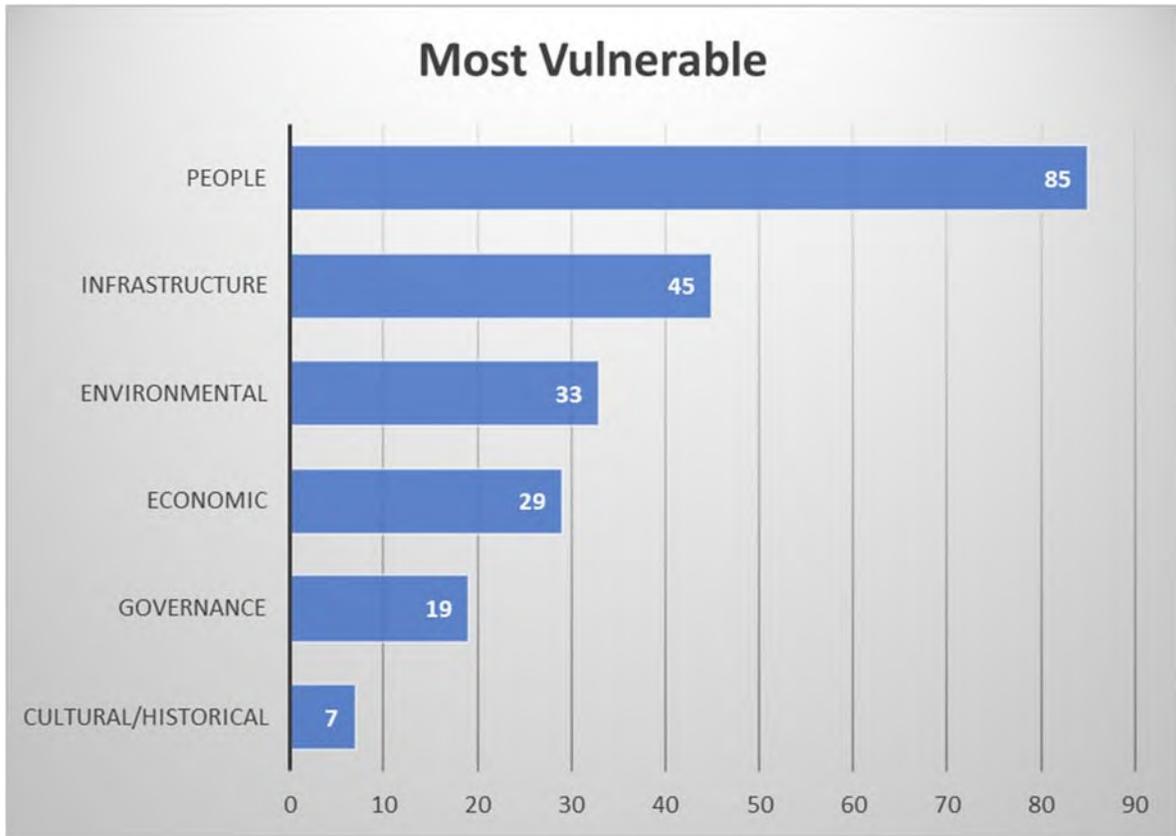


Are there any other hazard mitigation or resiliency actions Merrimac should consider (local or regional)?

Top

No responses received yet. They will appear here...

Merrimac – Additional Survey Questions



Appendix C

Meeting Agendas



May 18, 2021

Dear Merrimac Stakeholder:

The Town of Merrimac is convening a group of municipal officials and key stakeholders to participate in a workshop to review the Town's resilience strategies from its 2020 Municipal Vulnerability Preparedness planning process as it prepares to update its 2016 Multi-Hazard Mitigation Plan. The workshop goals are to:

- Build connections within Merrimac among stakeholders on local and regional planning and hazard mitigation efforts;
- Evaluate and update the identified strengths and vulnerabilities of the Town's neighborhoods, infrastructure and natural resources;
- Review and update resilience actions for the Town, businesses, institutions, neighborhoods, and community groups; and
- Use this information to inform and update Merrimac's Multi-Hazard Mitigation Plan.

To promote safety and increase attendance at this resiliency and hazard mitigation planning event, the workshop will be held remotely on Wednesday, May 26, 2021, at 11 a.m. Please join the meeting using the Zoom meeting link.

If you have any questions, please contact Alyssa Sexton in Inspectional Services (asexton@townofmerrimac.com or 978-346-0525). We appreciate your time and participation. We look forward to reviewing Merrimac's strengths and vulnerabilities in the face of climate change and prioritizing actions to build a more resilient Merrimac.

Sincerely,

Robert Sinibaldi

Building Commissioner/DPW Director

Municipal Vulnerability Preparedness for Merrimac

Working Session #1

Merrimac Town Hall

January 28, 2020

8:30 A.M.

AGENDA

I.	Welcome/Introductions
II.	MVP Overview, Working Session Objectives & Summary of Community Survey
III.	Hazards Overview & Resources Presentation
IV.	Instructions for Small Team Breakouts
V.	Small Team Breakouts – Community Identification and Assessment of Strengths & Vulnerabilities A. Infrastructure & Critical Facilities B. Social/Economic Features C. Environment/Natural Resources
VI.	Large Group Wrap-Up: Report Outs from Tables
VII.	Vote on Top Vulnerabilities & Strengths
	For reference, the Story Map presentation can be accessed at this link: http://bit.do/MerrimacMVP
	Workshop #2: Prioritizing Actions for Merrimac Resiliency Tuesday, February 11, 2020 - 8:30 A.M. at Merrimac Town Hall (Snow Date February 12)

Municipal Vulnerability Preparedness for Merrimac

Working Session #2

Merrimac Town Hall

February 11, 2020 8:30 A.M.

AGENDA

I.	Welcome/Introductions
II.	Recap of Workshop #1: Top Hazards, Strengths and Vulnerabilities
III.	Presentation of types of MVP Resiliency Projects and Action Grant Funding
IV.	Instructions for Small Team Breakouts
V.	Small Team Breakouts – Identify and Prioritize Actions <ul style="list-style-type: none">A. Infrastructure & Critical FacilitiesB. Social/Economic FeaturesC. Environment/Natural Resources
VI.	Large Group Wrap-Up: Report Outs from Tables
VII.	Vote on Highest Priority Actions
	For reference, the Story Map presentation can be accessed at this link: http://bit.do/MerrimacMVP
	Next Meeting: Community Listening Session on Workshop Findings – Spring 2020

Appendix D

Community Resilience Building Matrices

Appendix E

Plan Approval Documents & Plan Review Tool



CERTIFICATE OF ADOPTION
Town of Merrimac, Massachusetts

A RESOLUTION ADOPTING THE MERRIMAC MULTI-HAZARD MITIGATION PLAN
(MONTH) 2021

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

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

WHEREAS, duly noticed workshops and public meetings were held by the Town of Merrimac on May 26, 2020 (workshop) and on July __, 2021 and Month __, 2021 (Listening Sessions) as part of the process of updating the Hazard Mitigation Plan; and

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

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

NOW, THEREFORE BE IT RESOLVED by the Town of Merrimac Board of Selectmen adopts the ***Town of Merrimac Multi-Hazard Mitigation Plan 2021*** in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Merrimac.

ADOPTED AND SIGNED this day, the _____ of _____, 2021

By:

Name(s):

Title(s):

Signature(s):

ATTEST: IN WITNESS WHEREOF, the undersigned has affixed his/her signature and corporate seal of the Town of Merrimac.

APPENDIX A: LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA’s evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan’s strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction:	Title of Plan:	Date of Plan:
Local Point of Contact:		Address:
Title:		
Agency:		
Phone Number:		
		E-Mail:

State Reviewer:	Title:	Date:

FEMA Reviewer:	Title:	Date:
Date Received in FEMA Region (insert #)		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

**SECTION 1:
REGULATION CHECKLIST**

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been ‘Met’ or ‘Not Met.’ The ‘Required Revisions’ summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is ‘Not Met.’ Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST	Location in Plan		Not
Regulation (44 CFR 201.6 Local Mitigation Plans)	(section and/or page number)	Met	Met
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))			
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))			
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))			
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))			
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))			
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))			
ELEMENT A: REQUIRED REVISIONS			

1. REGULATION CHECKLIST		Location in Plan (section and/or page number)	Met	Not Met
Regulation (44 CFR 201.6 Local Mitigation Plans)				
1. REGULATION CHECKLIST				
Regulation (44 CFR 201.6 Local Mitigation Plans)				
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))				
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))				
B3. Is there a description of each identified hazard’s impact on the community as well as an overall summary of the community’s vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))				
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))				
<u>ELEMENT B: REQUIRED REVISIONS</u>				
ELEMENT C. MITIGATION STRATEGY				
C1. Does the plan document each jurisdiction’s existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))				
C2. Does the Plan address each jurisdiction’s participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))				
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))				
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))				
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))				
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))				
<u>ELEMENT C: REQUIRED REVISIONS</u>				

1. REGULATION CHECKLIST		Location in Plan (section and/or page number)	Met	Not Met
Regulation (44 CFR 201.6 Local Mitigation Plans)				
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)				
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))				
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))				
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))				
<u>ELEMENT D: REQUIRED REVISIONS</u>				
ELEMENT E. PLAN ADOPTION				
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))				
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))				
<u>ELEMENT E: REQUIRED REVISIONS</u>				
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)				
F1.				
F2.				
<u>ELEMENT F: REQUIRED REVISIONS</u>				

SECTION 2: PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to:

- *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);*
- *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);*
- *Diverse methods of participation (meetings, surveys, online, etc.); and*
- *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of:

- 1) *A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;*
- 2) *The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and*
- 3) *A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.*

How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:

- *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;*
- *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);*
- *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;*
- *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and*
- *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to:

- *Key problems identified in, and linkages to, the vulnerability assessment;*
- *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;*
- *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;*
- *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);*
- *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;*
- *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and*
- *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (Plan Updates Only)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to:

- *Status of previously recommended mitigation actions;*
- *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;*
- *Documentation of annual reviews and committee involvement;*
- *Identification of a lead person to take ownership of, and champion the Plan;*
- *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;*
- *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);*
- *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and*
- *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

**SECTION 3:
MULTI-JURISDICTION SUMMARY SHEET (OPTIONAL)**

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were ‘Met’ or ‘Not Met,’ and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI JURISDICTION SUMMARY SHEET												
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Requirements
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