

Merrimack Valley Region

Multi-Hazard Mitigation Plan Update 2015



Participating Communities

Town of Andover
Town of Boxford
Town of Georgetown
Town of Groveland
City of Haverhill
City of Lawrence
Town of Merrimac
City of Methuen
Town of Newbury
City of Newburyport
Town of North Andover
Town of Rowley
Town of Salisbury
Town of West Newbury

With Assistance of
Merrimack Valley Planning Commission
160 Main Street
Haverhill, Massachusetts 01830



November 2015

ACKNOWLEDGEMENTS

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- Chief Patrick Keefe, Andover Police Department
- John Dold, Public Works Director, Boxford
- Ross Povenmire, Planning and Conservation Director, Boxford
- Lt. Robert Hazelwood, Emergency Management Director, Boxford Police Department
- Chief Donald Cudmore, Georgetown Police Department
- Howard Snyder, Town Planner, Georgetown
- Deputy Chief and EMT Director Jeff Gillen, Groveland Police Department
- Nancy Lewandowski, Administrative Assistant, Groveland
- Andrew Herlihy, Community Development Director, Haverhill
- James Michitson, Emergency Management Director, Haverhill
- John Pettis, City Engineer, Haverhill
- Chief John Marsh, Lawrence Fire Department
- Dan McCarthy, City Planner, Lawrence
- Chief Brian Moriarty, Lawrence Fire Department
- Chief Ralph Spencer, Fire Department/EMD, Merrimac
- William Buckley, Community Development Director, Methuen
- Joseph Giarrusso, Conservation Officer, Methuen
- Captain Michael Buote, Methuen Fire Department
- Martha Taylor, Town Planner, Newbury
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- Jon-Eric White, City Engineer, Newburyport
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- Jean Enright, Assistant Director, Community Development, North Andover
- Brent Baeslack, Conservation Agent, Rowley
- James Broderick, Fire Chief/EMD, Rowley
- Deborah Eagan, Town Administrator, Rowley
- Lisa Pearson, Planning Director, Salisbury
- Lee Ann Delp, Emergency Management Director, West Newbury

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- Jennifer Hughes, Conservation Agent, North Andover
- Jerry Klima, Board of Selectmen and MVPC Delegate, Salisbury
- Michelle Rowden, Conservation Agent, Salisbury
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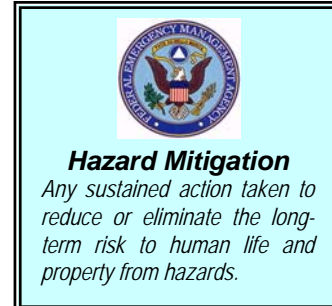
** Six (6) maps per community: "Population Density", "Potential Development", "Flood Zones", "Hurricanes and Tornadoes", "Earthquakes and Landslides", "Composite Natural Hazards"*

SECTION 1. INTRODUCTION

This section provides a general introduction to the updated **Merrimack Valley Region Multi-Hazard Mitigation Plan Update 2015** (hereinafter “Hazard Mitigation Plan” or “Plan”). 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 in order 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 in order 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, floodplain, and open space. Many of the strategies identified in hazard mitigation planning are implemented through land use planning tools and development regulations that can prevent or limit development in hazard-prone areas. Where development has already occurred in hazard-prone areas, buildings can be

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

retrofitted or modified to increase the chances of surviving a known hazard. Strict enforcement of the state building code is critically important in order to effectively minimize natural hazard losses. For example, studies have shown that inadequate code enforcement in Florida resulted in significant losses from Hurricane Andrew in 1992.

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 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.

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



While we cannot eliminate natural hazards, there is much we can do to lessen their impacts on our 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**.

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 local residents and businesses to reestablish 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 municipal master plan, economic revitalization plan, or open space preservation 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.

1.3 Plan Purpose

The purpose of this updated multi-jurisdictional **Merrimack Valley Region Multi-Hazard Mitigation Plan Update 2015** is to identify and characterize natural hazards that are common to the communities of the Merrimack Valley region; 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 plan *before* disaster strikes, our communities will be better able to prevent or minimize loss of life and property. Anticipated Plan benefits include:

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

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 a number of hazard mitigation grant programs to fund mitigation activities.

A number of 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 in order 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 in

order 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. This document represents the first full update to the region's 2008 Hazard Mitigation Plan. It describes occurrences of hazards included in the previous plan, as well as new occurrences of hazard events and changes in the region's vulnerability to such hazards. The plan has also been revised 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 and priorities.

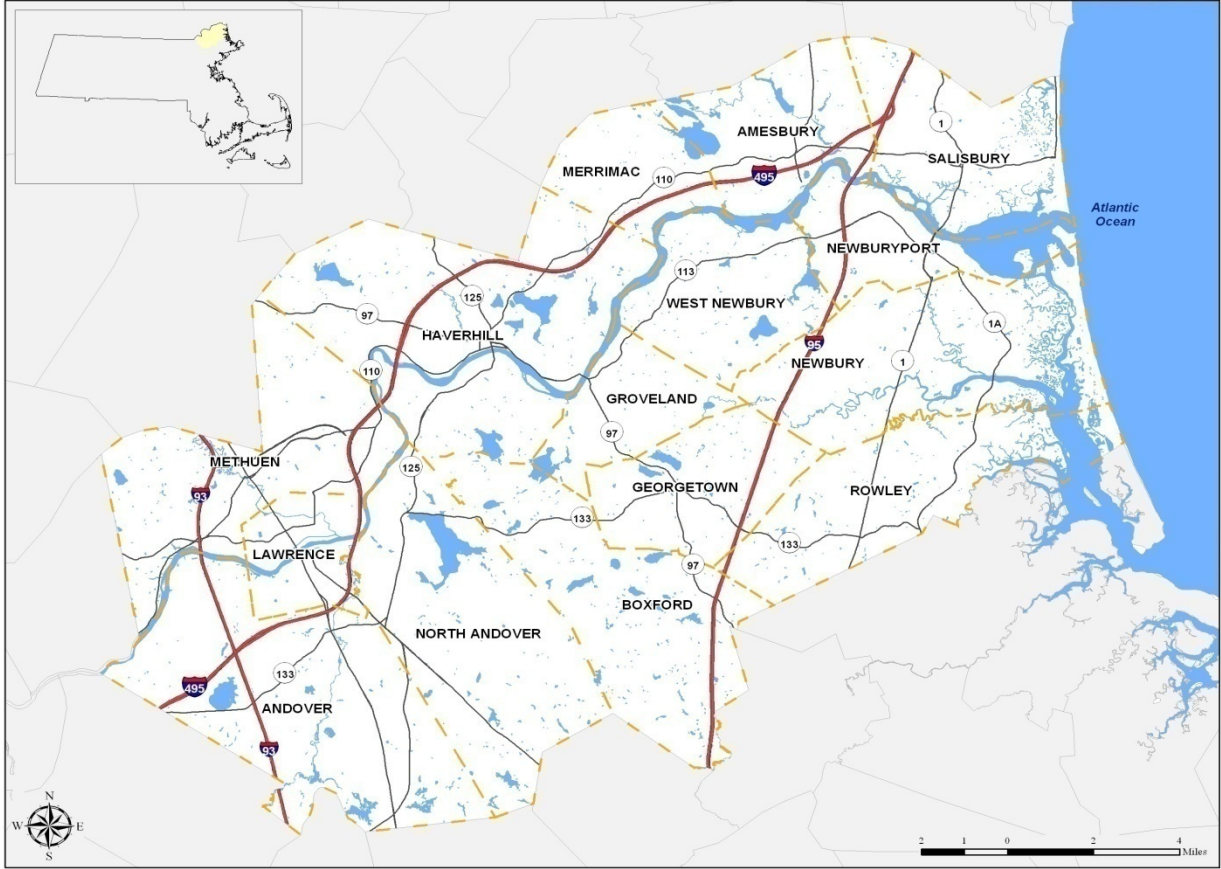
1.4 Geographic Scope

The geographic scope of this Plan is 14 of the 15 municipalities that comprise the Merrimack Valley Planning Region in northeastern Massachusetts (see **Figure 1-1**). The MVPC region as a whole covers 264 square miles and is home to a resident population of 333,748 (U.S. Census 2010). Part of the New England "Seaboard Lowland", the region has a variegated terrain that was scoured and shaped by Pleistocene Epoch glaciers thousands of years ago. Prominent landforms include drumlin hills, outwash terraces and plains, and broad coastal marsh. Major hydrographic features include the Merrimack, Ipswich, Parker, and Shawsheen Rivers and their tributaries, as well as Plum Island Sound and the Atlantic Ocean. The ocean forms the region's eastern boundary from the New Hampshire state line to the southern terminus of Plum Island, a coastline of approximately 10 miles. Elevations across the region range from sea level to 413 feet (Holt Hill in Andover), and average less than 100 feet mean sea level.

Although all fifteen of region's cities and towns participated in the Regional Hazard Mitigation Plan update planning process, fourteen (all but Amesbury which opted to undertake in 2014 its individual municipal plan) completed development of the regional plan update. These 14 communities are: Town of **Andover**, Town of **Boxford**, Town of **Georgetown**, Town of **Groveland**, City of **Haverhill**, City of **Lawrence**, Town of **Merrimac**, City of **Methuen**, Town of **Newbury**, City of **Newburyport**, Town of **North Andover**, Town of **Rowley**, Town of **Salisbury**, and Town of **West Newbury**.

One of the communities –Newburyport – did not participate in the original regional hazard mitigation plan ("Merrimack Valley Region Natural Hazards Pre-Disaster Mitigation Plan") prepared in 2008, but instead elected to prepare their own individual local plans. The Newburyport plan was adopted locally and approved by FEMA. With Newburyport part of the updated Regional Plan and collaboration on the part of Amesbury, there is seamless hazard mitigation planning coverage across the entire Merrimack Valley Planning District.

Figure 1-1. Merrimack Valley Region



SECTION 2. PLANNING PROCESS

This section of the Plan describes the plan updating process undertaken by the Merrimack Valley Planning Commission and its constituent communities and other stakeholders to develop the **Merrimack Valley Region Multi-Hazard Mitigation Plan Update 2015 Update**.

2.1 Coordinating Role of Regional Planning Agency

The Massachusetts Emergency Management Agency (MEMA) has encouraged the Commonwealth's 13 Regional Planning agencies to act as facilitators of local hazard mitigation planning efforts. The Merrimack Valley Planning Commission (MVPC) coordinated and facilitated the updating of the regional Hazard Mitigation Plan in partnership with the region's 15 member communities and with input from partner organizations and interested stakeholders. MVPC is a public, nonprofit Regional Planning Agency that provides comprehensive professional planning and technical services to municipalities, institutions, and businesses in northeastern Massachusetts.

Established in 1959 under Massachusetts General Laws Chapter 40B, MVPC's mission is to *"promote with the greatest efficiency and economy the coordinated and orderly development of the region's municipalities and the general welfare and prosperity of its citizens."* To accomplish this, the Commission maintains a policy board of elected and appointed officials from the 15 member communities as well as a full-time professional planning staff. Planning and technical services are offered in the areas of Environmental Planning; Economic Development Planning; Land Use and Community Development Planning; Transportation and Transit Planning; and Geographic Information Systems (GIS) Development and Applications. MVPC is the federally-designated Economic Development District for the Merrimack Valley region, as well as the state-designated GIS Regional Service Center. In addition, MVPC, through its subsidiary Merrimack Valley Economic Development Corporation (MVED), operates a successful \$1 million revolving loan fund that supports the growth and retention of commercial and industrial jobs in the Valley.

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.*

MVPC completed the region's initial Hazard Mitigation Plan in 2008, and this update builds upon that planning initiative. Updated data regarding natural hazard events, demographics, non-natural hazards, and critical infrastructure have been incorporated into the document. Recently developed plans, including comprehensive community plans and master plans, open space and recreation plans, economic development plans, housing production plans and emergency management plans have been consulted. The *Merrimack Valley Priority Growth Strategy*, the *Merrimack Valley Comprehensive Economic Development Strategy*, and the *Merrimack Valley Regional Transportation Plan* have also been considered in formulating the updated document. 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 development of the Merrimack Valley Region Multi-Hazard Mitigation Plan Update 2015, MVPC and local staff have taken numerous steps to coordinate all aspects of emergency management planning. Each municipality has a Comprehensive Emergency Management Plan (CEMP), and a Regional Homeland Security Plan is also in place. Each of these emergency management plans has a slightly different focus, but many of the components within each are common, such as the inventory of critical facilities, roles and responsibilities, and protocols for response. The intent of this Multi-Hazard Mitigation Plan is to reflect existing conditions, as cited in previous work, and to complement and augment efforts already undertaken. Accordingly, this Hazard Mitigation Plan update includes goals and objectives that meet local needs and complement local and regional goals established in the CEMPs and Homeland Security Plan.

2.2 Preparing for Plan Updating Process

In preparation for the Plan update, MVPC staff conferred with Massachusetts Emergency Management Agency (MEMA) and Department of Conservation and Recreation (DCR) staff, consulted with other regional planning commissions, attended FEMA- and MEMA-sponsored hazard mitigation planning conferences, and reviewed state and federal guidance documents pertaining to the development of an updated multi-hazard mitigation plan. MVPC utilized the multi-jurisdictional planning process recommended by the Federal Emergency Management Agency (FEMA Publication Series 386), as well as 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 documents, “Local Mitigation Planning Handbook” (March 2013); and “Local Mitigation Plan Review Guide” (October 1, 2011). 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.

2.3 Project Start-up and Planning Team Meetings

Project Announcement. On February 8, 2012, MVPC issued a notification to local public officials and other interested community stakeholders throughout the Merrimack valley region, announcing the planning project’s start-up and encouraging the reestablishment and reconvening of each community’s Local Hazard Mitigation Planning Team (LHMPT). A copy of this announcement is provided in Appendix A of this plan.

Regional “Kick-off” Workshop. On March 21, 2012, MVPC hosted a regional “kick-off” workshop at Northern Essex Community College in Haverhill to officially launch the plan updating project. The workshop was broadly advertized via the MVPC website (www.mvpc.org), a notice to prominent area newspapers (*Lawrence Eagle-Tribune* and *Newburyport Daily News*), and several direct mailings and email “blasts”. A total of 49

individuals attended, including numerous local emergency management personnel (police, fire, public works), city and town planners, health and conservation agents, municipal engineers, and building inspectors. Also attending were MEMA and COSTEP-MA as well as representatives of several community nonprofit and environmental organizations, including the Eight Towns and the Great Marsh Committee.

The purpose of the workshop was to introduce local and regional hazard mitigation team members and other interested parties to the plan updating process and plan contents. The session began with a PowerPoint presentation by MVPC that described the Disaster Mitigation Act of 2000 and the need for communities to have an approved updated plan in place. Other topics included the types of natural hazards common to the region, the inventorying and mapping of critical facilities and infrastructure, and the development of updated hazard mitigation goals, strategies, and actions. MEMA staff followed with a PowerPoint presentation on hazard mitigation funding programs, and offered several case studies of successful local mitigation projects. COSTEP-MA staff concluded the session with a PowerPoint presentation on preserving cultural resources in times of disaster. A sample workshop notice, the list of workshop attendees, and the MVPC, MEMA, and COSTEP-MA PowerPoint presentations are provided in Appendix A, along with three MEMA-prepared hazard mitigation “best practices” summaries that were provided as handouts.

Formation of Regional Hazard Mitigation Planning Team. A Regional Hazard Mitigation Planning Team (RHMPT) was formed and input was solicited from the RHMPT, local officials and residents, the business community, and nonprofit and environmental organizations. RHMPT members served as MVPC’s primary points of contact and liaison between the MVPC planning staff and the local hazard mitigation planning teams. Each community’s appointed delegate to MVPC’s governing board was also invited to participate, as the Commission’s monthly meetings served as the principal public forum for selected RHMPT deliberations, including the review and discussion of draft plan materials and regular project updates. The Commission delegates are elected and appointed officials from various municipal boards and serve as MVPC’s primary liaison to other local boards and committees. The meetings are open to the public and are widely advertised via the MVPC website, notices to area newspapers, public postings in city and town halls, and direct e-mailings to numerous partner organizations and stakeholder groups.

The regional team representatives included:

RHMPT Members

- ◆ Rob Desmarais, Public Works Director, Amesbury;
- ◆ Robert Lavoie, City Councilor and MVPC Delegate, Amesbury;
- ◆ Tom Carbone, Public Health Director, Andover;
- ◆ Joan Duff, Planning Board and MVPC Delegate, Andover (to 2014);
- ◆ Chief Patrick Keefe, Andover Police Dept./Emergency Management Director
- ◆ Executive Officer Charles Heseltine, Andover Police Dept./Asst. Emergency Management Director
- ◆ Lt. Robert Hazelwood, Boxford Police Dept./EMD
- ◆ Ross Povenmire, Planning and Conservation Director, Boxford;
- ◆ Chief Donald Cudmore, Chief of Police, Georgetown;
- ◆ Peter Durkee, Highway Surveyor, Georgetown;
- ◆ Howard Snyder, Town Planner and MVPC Delegate, Georgetown;
- ◆ Nancy Lewandowski, Administrative Assistant, Groveland (to 2014);
- ◆ Jeff Gillen, Deputy Chief, Groveland Police Department;
- ◆ Robert O'Hanley, Board of Health and MVPC Delegate, Groveland;
- ◆ James Michitson, Emergency Management, Haverhill;
- ◆ Robert Driscoll, Planning Board and MVPC Delegate, Haverhill;
- ◆ John Pettis, Chief Engineer, Haverhill;
- ◆ Dan McCarthy, City Planner and MVPC Delegate, Lawrence;
- ◆ Chief John Marsh, Lawrence Fire Department (retired 2015)
- ◆ Chief Brian Moriarty, Lawrence Fire Department (as of March 2015)
- ◆ Ralph Spencer, Fire Chief/EMD, Merrimac;
- ◆ Chief Steve Buote, Methuen Fire Dept. (to 2015)
- ◆ William Buckley, Community Development Director, Methuen;
- ◆ Joseph Giarrusso, Conservation Officer, Methuen;
- ◆ Martha Taylor, Town Planner, Newbury;
- ◆ David Powell, Planning Board and MVPC Delegate, Newbury (to 2014);
- ◆ Marshal Thomas Howard, Newburyport Police Dept. (to 2015);
- ◆ Jon-Eric White, City Engineer, Newburyport;
- ◆ Ed Ramsdell, Newburyport Planning Board and MVPC Delegate;
- ◆ Jeff Coco, Emergency Management Director, North Andover;
- ◆ Curt Bellavance, Community Development Director, North Andover (to 2014);
- ◆ Jean Enright, Community Development, Assistant Director
- ◆ Brent Baeslack, Rowley Conservation Agent
- ◆ James Broderick, Fire Chief/EMD, Rowley;
- ◆ Robert Snow, Selectman and MVPC Delegate, Rowley;
- ◆ Lisa Pearson, Planning Director, Salisbury;
- ◆ Jerry Klima, Selectman and MVPC Delegate, Salisbury;
- ◆ Lee Ann Delp, Emergency Management Director, West Newbury;
- ◆ Brian Murphy, Planning Board and MVPC Delegate, West Newbury

The regional meetings were held at the MVPC Offices in Haverhill to report on and discuss the planning process and the development and review of plan contents. Topics including the kick-off workshop and subsequent public forums, as well as updating of

regional profile information, natural hazard occurrences and risks, critical facilities inventorying and mapping, plan goals, potential disaster mitigation strategies, and plan implementation and maintenance procedures. The MVPC staff also used the meetings as a forum for providing information and guidance to local municipalities relative to the preparation and development of the individual, community-specific sections of the plan. The regional team met March 6th, 2015 at MVPC offices in Haverhill and endorsed the preliminary draft of the Regional Multi-Hazard Mitigation Plan. The Merrimack Valley Planning Commission Board of Directors also voted preliminary endorsement at its March 19th, 2015 meeting. Meeting notes with comments, Regional meeting notices, agendas, and attendance lists are provided in Appendix B.

Municipal Meetings. Following the initial kick-off workshop, a series of individual meetings were held with the communities' reestablished Local Hazard Mitigation Planning Teams (LHMPTs). A minimum of two meetings per community were held. All meetings were posted at least two weeks in advance by the respective city and town clerks and were open to the public. LHMPT members, through their own personal contacts, also invited the participation of other stakeholders, such as local historical commission, school department, and open space committee representatives. At these meetings, draft community base maps with flooding related hazards and critical facility locations were presented for review and discussion. In addition, existing protection measures and potential mitigation strategies for individual communities were identified and discussed. The LHMPT members, local meeting notices/agendas, and meeting attendance lists are provided in Appendix C.

MVPC staff contacted each of the communities by phone and/or e-mail. Together with the RHMPT designees, the LHMPT members were the primary contacts for the planning process. The LHMPTs included a broad range of municipal boards and staff including, where possible: the community development director/planner, city/town engineer, public works director, emergency management director, conservation agent, health agent, police and fire chiefs, building inspector, and other interested parties. These meetings were useful in explaining and facilitating the local natural disaster mitigation planning process. MVPC staff met with LHMPT members (or their representative) alone when other members were unable to attend. Overall, these "hands-on" local meetings generally formed the heart of the planning process, as they were instrumental in assembling much of information needed for the plan update and in engaging many of the individuals who will be responsible for the updated plan's implementation.

In addition to updating and correcting the draft hazard area and critical facilities maps, the local meetings were used to circulate a questionnaire on each community's existing protection measures and initiatives. The resulting information was then used to compile the "Existing Protections Matrix" element of the plan. These discussions afforded an opportunity for city/town staff to identify gaps in their community's natural disaster mitigation efforts, and to explore potential mitigation actions/projects. The local meetings also provided an opportunity to identify mitigation projects that have been completed or initiated since the original plan was approved in 2008.

Local teams in each of the 14 participating communities held public meetings in March 2015 to review action plans and community self assessments. Comments and edits were received by MVPC and incorporated into the plan document by MVPC with local

planning team coordinator reviews. FEMA comments on the draft plan were received in July 2015 and responses from local planning teams with MVPC were incorporated into the final plan draft.

Public and municipal department comments received in local team planning meetings included the following-

Andover:

- Update status/schedule regarding Shawsheen dam removal process. Center for EcoSystem Restoration, Tom Ardido is project manager. *(project update included in Section 5.1)*
- Reinforce need for designation of regional shelter *(added to regional action plan)*

Boxford:

- Comment that comfort station space is available at both town fire stations (each 50 capacity with kitchens and emergency generators) and at police stations (30 capacity) with kitchen & generator. *(Added to Section 5.2)*
- Committee wanted to emphasize concern re. condition at Lowe Pond Dam. Add wording Town regards this dam in its current condition as highest priority dam for repair and capacity improvement. Flood conditions in 2006 and 2010 required installation of sandbags at the dam. *(Added to Section 5.2)*
- Table 5.2-2 Note Stiles Pond Dam was replaced in 1996 and major repair in 2014 *(Noted).*
- Add Middleton Road culvert project. Project identified through culvert assessment work of Trout Unlimited with Boxford Lakes, Ponds & Streams Committee. *(Done, included in Section 9-2 Action Plan)*

Georgetown:

- Local planning team should meet twice a year to document progress/evaluate plan (Chief Cudmore)
- Concern regarding timing of plan adoption process to access HMGP funding. *(Note legitimate concern; staff will work to expedite and coordinate with MEMA/FEMA.)*

Groveland:

- Team confirmed Bagnall School is primary shelter. Secondary site is Pentucket gym. Add warming stations available at Housing Authority Senior Community Center Room, capacity of 50 with feeding, generator; Also warming station at Fire Station: capacity 50, with generator, feeding; and additional warming station center at Town Hall meeting room capacity 100; feeding and generator available.
- Bob Arakelian, Highway Supt. confirmed that dam most in need of repair is Johnson's Creek Dam. Town has conceptual plan of improvements and has hired engineering firms to undertake design/permitting. Dam repair project to be added to action plan. Cost estimate will be developed, but according to DPW is expected to be high cost initiative.

- Add Drainage Improvements including outfall replacement at Main/School Street area. Cost estimate is \$150k...Project is high priority (*Added to Action Plan*).

Haverhill

- Bridges-add information regarding ongoing reconstruction of MBTA rail bridge over Merrimack River, \$100 million project multi-year being done with state and federal TIGER monies. (*Done*)
- Add new projects to Action Plan for bank repair/stabilization at Kenoza Lake. Area has been subject of severe erosion with silt impact to the City's Kenoza Lake water supply. City DPW has capital funding request in current budget of \$70k for design/permit. Construction funding is estimated to be \$350,000. (*Projects added*)
- Question raised about DCR FireWise program. Deputy Chief Laliberty indicated City had looked into but no action & not resource priority to participate. (*Noted in plan*)

Lawrence

- Reclassify Housing Shelters and Add Emergency shelters: Lawrence High School, Arlington School and South Lawrence East Elementary School...All have emergency generators and cafeterias. (*Done*)
- Table 5.6-2...Note replacement value of Engine 7 Fire Station well exceeds \$434,700 and according to Chief would be at least \$3-4 million.
- Check status of Daisy Street Bridge; team notes flooding problem at Spicket with bridge acting as dam. (*Daisy Street Bridge is classified by MassDOT as functionally obsolete and is federal aid eligible. Info added Section 5-6*)
- Action Plan—Suggest new projects (*Projects added Action Plan*):
 - Upgrade sewer lift stations with generators and pumps. Highest priority at Pembroke Drive and Pilgrim Road. Estimated cost \$1 million per lift station.
 - Install generators at Park Street and Howard St. fire stations as well as City Hall. Cost estimate \$300k
 - Upgrade 20+year generator at Police Station--\$100k
 - Design and construct upgrades at South Broadway Fire Station which has structural issues/concerns. Cost estimate moderate/high

Merrimac

- Discussion as to whether Town Hall to be considered as secondary EOC. Chief Spencer and Chief Shears indicated w/o generator facility not suitable for EOC and wouldn't be used. Consensus to delete listing of Town hall as secondary EOC at this time. (*Done Section 5-7*)
- Special Flooding Concerns: Add as highest priority Bear Hill Road. Area of Back River near state line has been subject to recent flooding. Existing corrugated steel culvert is undersized and deteriorating. Estimated cost need is \$40k for engineering and \$200k for construction.

Also to be highlighted is culvert crossing on Route 110 in area of Police/Fire/DPW facility. Existing culvert is undersized which results in localized flooding. During May Day Flood 2006, flooding here led to temporary closing of Route 110.....a critical site area given access to the Police/Fire EOC and DPW. Construction estimate is approx. \$100k, according to DPW. River Road—given repetitive flood damage, State discontinued River Road in 2013.

Mythical Street---Culvert replacement completed in 2009 by DPW.

(Included in Section 5-7)

Add Projects:

- Town needs upgrades to shelters/warming stations including addition of generators at Sweetsir School and Council on Aging, as well as at Town Hall so the latter could be used as backup EOC.
- Specific Culvert Capacity Replacement/Repair Program highlighting highest priorities at Bear Hill Road and Route 110/downtown.
(Both projects added Action Plan Section 9-7)

Methuen

- Quinn Building now confirmed as Emergency Operation Center (no longer Searles Building...at which there have been problems with generator) – *(Noted in Plan Section 5-8)*
- Add National Guard Armory---has been offered by National Guard for use as local backup Ops Center according to Chief Solomon. Issue has been location...access to it can be restricted from City center in the event of Merrimack River flooding leads to closure of Route 110 as happened in 2006. But facility has capacity, maps, generators and can be activated for local use.
- Shelter---Confirmed that Timony Middle School is the designated shelter...also designated and available as regional shelter.
- Add Senior Housing facilities---Park Gardens, Methuen Village, Edgewood, Cedar Homes, 20 Calumet Road, Mystic Street.
- Expand listing of problem flood areas to include:
 - Area of Lowell Street/ route 110 at Bartlett Brook (by Jewels restaurant)
 - Tobey Street/ Grandview—drainage capacity/localized flooding
 - Joy Terrace/Newport Street—waterway maintenance/localized flooding
 - Frye Road –Baremeadow tributary-waterway maintenance
 - Cross Street/Hampshire Road—Spicket River
 - Area of Broadway bridge over Spicket---span flow capacity, during floodwaters, fire equipment,trucks not allowed to use; Limits access to lower Broadway/Arlington Neighborhood area
- Add Methuen DPW Water Maintenance Facility, 124 Cross Street—Critical Facility in Flood Hazard Area.

- Question raised about condition of Osgood Street bridge over Spicket---(Bridge is now classified by MassDOT as structurally deficient. Information added Section 5-8)
- Searles Pond Dam—Last inspection date was May 2014. (Info added)
- Website upgrade in development and to be launched in 2015. (Info added)

Newbury

- Table 5.9-1 Note Newburyport EOC is backup center for Newbury Emergency Operations; According to Chief, Triton is designated as mass inoculation center for health emergencies; Governor's Academy has been offered for use as shelter and is available; Newbury Town Hall is available for use as warming station. Add also as warming station, Plum Island Taxpayers Hall (PITA), capacity of 50 with kitchen, generator. (Table updated)
- Note in Special Flood Hazard Concerns, add reference to flooding at bridge & dam (done)
- Add in Section 6 reference to Newbury/Newburyport/Salisbury partnership in the Merrimack River Beach Alliance....Through this partnership, communities have coordinated planning and implementation including beach replenishment 150 cubic yards on Plum Island in 2009; South Jetty repair in 2014; and planned North Jetty repair in 2015; and through the Army Corps of Engineers Section 103 Program ongoing sand replenishment and embankment stabilization.(done)
- Update Action Plan to incorporate hazard mitigation projects that provide capacity to reduce long-term risk inc. implementation of 2010 Larkin Dam study. Note need for coordination with Newburyport on Little River watershed study(Mitigation projects identified Action Plan matrix Section 9-9)

Newburyport

- Smart Growth 40R district advancing...change wording to read in effect...City in early 2015 is in process of establishing; (Noted)
- AMR is now Atlantic/Cataldo (Noted)
- Add Atria Assisted Living Facility (done)
- Generator at Salvation Army is installed. (Noted)
- Chief LeClaire confirms Bresnahan School is shelter
- Add information regarding National Grid Substation and sewer pump stations as critical facilities (done)
- Need to highlight South jetty repair completed 2014 and North jetty repair project in Salisbury out to bid---both should assist in controlling erosion impact (done)
- Reference work of Merrimack River Beach Alliance..local org that meet throughout year on regular basis and partners in setting priorities, communication on issues re beach erosion with leadership that includes Jerry Klima of Salisbury/ Senator Bruce Tarr. (Noted)

- Problem flooding areas in Section 5 should highlight prioritized sections including Industry Park, Downtown, Plum Island. *(Noted and revised in Special Flood Hazard Concerns table in Section 5.10.)*
- Repair work done on Artichoke Dam 2014. *(Noted)*
- Bridges- add Whittier Bridge reference. *(noted)*
- Add Action Plan project Extend T1 hardwire communications between municipal communications system and DPS building and Plum Island Hall (PITA) *(done Section 9-10)*

North Andover

- Boston Hill Senior Housing is now named **Brightview Senior Care**. *(Update done Section 5-11)*
- Units planned at Osgood Landing total 530 (not 600)
- Table 5.11-1 Critical Facility updates *(Info added/edited)*
 - Fire Station to be completed and operations Fall 2015. Will have an emergency generator.
 - Add Fire Station #2/9 Salem Street
 - Address for new Police Station constructed in 2011 is 1475 Osgood St.
 - Heritage House is now Ashland Farms
 - Add Brightview North Andover, 1275 Turnpike St.
- Keep emergency shelters as listed. North Andover High School not currently suited as shelter because no emergency power for heat. *(noted)*
- Flood Prone Areas...Add fourth area, per Jeff Coco, EM Director, of 90 Sutton St. area at confluence of Shawsheen & Merrimack rivers. *(done)*
- Add info regarding efforts to fund structural solution upgrades to the recurring surcharge problems at Rae's Pond and Winter Street lift stations near the town's Lake Cochichewick water supply. Conditions here with pump station operations have posed high risk of a public health threat with sewage contamination during possible flood events. *(done)*
- Table 5.11-2. Add in 100-year Floodplain Glenwood St. sewer lift Station; Raes Pond Sewer Lift station *(done)*
- Lake Cochichewick outlet dam built in 1837 had some repair work done in 2007. *(noted)*
- Action Plan Projects: *(New projects added Section 9-11)*
 - Add as new project—Generator/wiring upgrade to provide emergency heat that would make this facility suitable for shelter use. High Priority/ Cost estimate \$3k to \$5k
 - Add Flats Bridge Culvert Replacment at Great Pond Road by Rae's Pond pump Station . High priority, 100% designed; \$348k cost estimate
 - Add Rae's Pond pumping station capacity upgrade

- o Work completed 2010 sewer manholes at Raes Pond and Winter St.

Rowley

- Add comments regarding new development (*done* - Planner Kirk Baker memo-3/23/2015)
- Health Dept. review & concurrence (3/23/2015)

Salisbury

- Concerns regarding Beach Road and Ferry Road. Both of these have low elevations and are very big concerns regarding evacuation in that area.
- Interest raised by town officials/residents in seeking FEMA/MEMA funding for raising elevation of homes.

West Newbury

- Update with deletion of references to Dunn Well land Andreas Well as that well expansion project not advanced (*done Section 5-14*)
- Add critical facility generator capacity project. (*done Section 9-14*)

2.4 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 comprehensive public involvement process was utilized to encourage governmental entities, local residents, business sector, and nonprofit organization participation in the planning process.

MVPC staff met and consulted with representatives of a variety of stakeholder groups to gather regional and local profile information for the plan update, to solicit input on the region's hazards and possible mitigation actions, and to review draft plan materials. Among the stakeholders consulted were the region's Comprehensive Economic Development Strategy (CEDS) Committee, the Merrimack Valley Metropolitan Planning Organization (MVMPO), the Merrimack Valley Mayors & Managers Coalition (MVMCMC), volunteer-based environmental organizations: Eight Towns & The Great Marsh (8TGM) and Storm Surge of Greater Newburyport, and the community advocacy organization Groundwork Lawrence, Inc. (GWL). A description of MVPC's outreach to these and other stakeholders follows.

Merrimack Valley CEDS Committee. The CEDS Committee is a coalition of local and regional economic development stakeholders who guide the development of the region's Comprehensive Economic Development Strategy (CEDS). Members include local community development directors and development organizations (e.g., the Merrimack Valley Workforce Investment Board and the Merrimack Valley Economic Development Council), as well as representatives of area chambers of commerce,

educational institutions (Merrimack College and Northern Essex Community College), and real estate firms and banks. Consultations with CEDS Committee representatives helped to inform the planning process by providing input on the region's economy and future growth prospects.

Merrimack Valley Planning Directors Network Meetings. MVPC organized and hosted three meetings of the region's local planning directors and city/town planners – on January 1, April 23, and September 26, 2012 – in order to solicit information and advice for preparing the updated Hazard Mitigation Plan. A range of topics were presented and discussed, including plan goals, local critical facilities and infrastructure, existing mitigation measures, development activity occurring since the 2008 Plan, and mitigation action strategies. Copies of the meeting agendas and lists of attendees are provided in Appendix B.

Merrimack Valley Metropolitan Planning Organization. The MVMPO was created by the Governor of Massachusetts in 1972. Under federal transportation legislation, MPOs are assigned the important task of completing the planning and programming of all federally-funded transportation projects and programs in their respective urbanized area. Membership includes the MA Department of Transportation (MADOT), the Merrimack Valley Regional Transit Authority (MVRTA), MVPC, and local delegates from the region's cities and towns. On April 4, 2013, MVPC hosted a meeting of the MVMPO during which various elements of the regional Hazard Mitigation Plan were presented and discussed. Under the topic of "Climate Change and Livability", the group discussed integrating transportation system issues and information into the Plan update and local stormwater management plans. Throughout the planning process, representatives of the MPO provided helpful information on the region's evacuation routes, structurally-deficient bridges over water, and transportation accidents. A copy of the MVMPO meeting agenda and list of attendees is provided in Appendix B.

Merrimack Valley DPW Directors Network. The Merrimack Valley DPW Directors Network is a coalition of public works and highway department directors from around the Merrimack Valley region. They meet approximately monthly to discuss public works issues of common interest and concern, and to pursue joint initiatives such as collective purchasing of DPW equipment and services. On May 1, 2013, MVPC hosted a meeting of the DPW Directors Network during which MVPC staff and the Horsley Witten Group led a discussion on current local and regional stormwater management needs and best management practices, projected climate change/sea level rise impacts, and local flooding concerns – and how these topics can be integrated into the communities' NPDES Phase II Stormwater Management Programs and the multi-jurisdictional Hazard Mitigation Plan. Input from the meeting was used to inform the hazard mitigation plan development process. A copy of the meeting agenda and list of attendees is provided in Appendix B.

Merrimack Valley Mayors & Managers Coalition. The MVMMC is a coalition of the mayors from the region's five cities (Amesbury, Haverhill, Lawrence, Methuen, Newburyport) and the town managers from the four communities which have a strong town manager form of government (Amesbury, Andover, North Andover, Salisbury). The MVMMC meets on approximately a monthly basis to discuss matters of common interest and concern, and to explore and launch joint ventures that will improve the cost-efficiency and effectiveness of local government. Based on the success of the DPW

Directors meeting described above, MVPC hosted a similar meeting the MVMMC members on June 12, 2013. The same topics were presented and discussed, albeit from the perspective of the region's chief executive officials. Information from this meeting was helpful in informing the planning process.

Great Marsh Symposium: Helping Communities Prepare for Sea Level Rise. On November 8, 2012 and annually each November thereafter, MVPC and its coastal partner organizations (CZM, MassBays Program, Great Marsh Coalition, Essex County Greenbelt Association among others) co-sponsored a major regional symposium on sea level rise vulnerability and adaptation in the North Shore region. Held at the Crane Estate in Ipswich, over 100 local officials and staff, scientists, educators, and nonprofit and business community representatives attended from throughout the Merrimack Valley, North Shore, and NH seacoast regions. Topics included: an overview of the State's coastal climate change adaptation strategies, coastal inundation vulnerability and risk assessment, inundation mapping techniques and resources, and adaptation case studies. MVPC staff gave a PowerPoint presentation on infrastructure impacts to Great Marsh's coastal and estuarine communities, and participated in a lively panel and audience discussion on local concerns and initiatives regarding sea level rise as well as next steps in helping communities achieve climate change resiliency. Information presented at and gleaned from this symposium helped to inform the hazard mitigation planning process. A copy of the symposium notice and agenda, together with MVPC's PowerPoint slides, are provided in Appendix B.

PIE Rivers Restoration Partnership Conference: Roads, Runoff, and Water Management in Northeastern Massachusetts. MVPC, as part of the Parker-Ipswich-Essex Rivers Restoration Partnership and the Great Marsh Coalition, helped to promote and participated in this major regional conference held on April 11, 2013. Over 100 participants from the Merrimack Valley and North Shore regions attended the event, which was designed to educate and assist local public works, conservation, and planning department personnel in matters involving stormwater management, water resources conservation, and protection of vulnerable road-stream crossings from flooding. Information and comments from the conference helped to inform the planning process. A copy of the conference notice, agenda, and list of attendees is provided in Appendix B.

Greater Newburyport Sea Level Rise Education & Outreach, Storm Surge. MVPC helped to promote and participated in the April 18, 2013 meeting of the Greater Newburyport Sea Level Rise Group, held at MA Audubon's Joppa Flats Education Center in Newbury. The Greater Newburyport SLR Group is comprised of local public officials, regional planners, coastal scientists, business leaders, and members of the general public, who have begun to meet periodically to better understand the area's coastal storm flooding and sea level rise inundation threats and solutions. The purpose of the April 18 meeting was, among other things, to: 1) share information and perspectives on coastal resilience-building priorities and options for the Greater Newburyport area, 2) identify key areas for collaboration, and 3) explore and decide next steps. As part of the general discussion, MVPC staff presented an overview of the hazard mitigation planning process underway, including an outline of the plan goals, mapping of critical facilities and infrastructure, and mitigation action plan strategies under consideration. The group also discussed MVPC's emerging role, as the Regional GIS Service Center, of assisting the communities in mapping inundation zones and

impacted municipal infrastructure (and natural resources) under varying SLR scenarios. Information and comments delivered during the meeting helped to inform the planning process. A copy of the meeting agenda and attendance list are provided in Appendix B.

Merrimack Valley Annual Regional Planning Days. In June 2012 and 2013, MVPC hosted two half-day “Regional Planning Day” sessions at Northern Essex Community College in Haverhill to apprise local public officials, partner organizations, area educators, the business community, and the general public about several of the key regional planning initiatives underway. As part of these sessions, MVPC’s environmental staff manned an exhibit on hazard mitigation planning, and fielded attendees’ questions and comments related to the plan update. Handouts were provided on successful municipal hazard mitigation case studies , as well as CZM’s StormSmart Coasts fact sheet series.

All told, more than 45 public meetings and other public forums were held in order to solicit information, generate discussion, and develop and review draft plan materials for the updated multi-jurisdictional hazard mitigation plan.

2.5 Other Regional Planning Initiatives

In 2009, MVPC, in partnership with its 15 member communities, completed the ***Merrimack Valley Priority Growth Strategy (MVPGS)***, the regional land use plan for the Merrimack Valley Planning District. **The regional plan was updated in 2015.** The MVPGS guides MVPC and member communities in planning for future development initiatives and for the preservation of open space and natural resources. The plan focuses on smart growth and sustainable development principles and practices that promote compact development in those areas with available infrastructure, and fosters the protection and preservation of the region’s most vulnerable and valuable environmental and cultural resources. A number of the goals outlined in the Priority Growth Strategy are beneficial in mitigating natural hazards and addressing climate change, including the following:

- Use land efficiently and protect sensitive resource areas by directing growth to priority development areas and locations with adequate infrastructure;
- Support the transformation of key underutilized lands, such as brownfields, to productive uses that complement the community and enhance existing neighborhoods;
- Minimize the environmental impact of future development by encouraging mixed-use and compact development patterns, and by promoting the use of low impact development techniques;
- Care for the natural environment by protecting and restoring natural systems, conserving habitat, improving water quality, and reducing air pollution, thereby ensuring that all residents, regardless of social and economic status, live in a healthy environment;
- Promote the use of innovative, environmentally sensitive development practices, including design, materials, construction, and on-going maintenance;
- Encourage the use of low impact development techniques and other best management practices (BMPs) for managing stormwater;

- Preserve, protect and enhance the region's remaining agricultural lands;
- Preserve significant historic, visual and cultural resources, including public views, landmarks, archaeological sites, historic and cultural landscapes and areas of special character; and
- Promote the production and use of clean, alternative energy.

The ***Merrimack Valley Regional Transportation Plan*** incorporates hazard mitigation planning in that it addresses stormwater management, climate change and reductions in greenhouse gas emissions, air quality, and transportation safety and traffic management along evacuation routes. The regional transportation plan is updated every four years.

2.6 Hazard Identification and Assessment Process

MVPC staff, Planning team members, and other local personnel developed a natural hazards inventory for the region and grouped the hazards in a format consistent with the State Natural Hazard Mitigation Plan. For each natural hazard grouping, a discussion of each individual hazard has been provided, as well as an assessment and history of the occurrence of the hazard in the region, and an evaluation of the likelihood of future occurrence. Whenever possible, experts were consulted to supplement information gathered from the State Hazard Mitigation Plan and other sources, such as the Federal Emergency Management Agency.

Comprehensive hazard maps were developed using the best available data for each of the participating local jurisdictions. 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, including repetitive loss structures, and form the basis for estimating the probable losses from potential natural disasters, such as severe flooding.

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.

Part of the risk assessment consisted of the development of loss estimates and area vulnerability assessments. MVPC staff, through input from the local communities and the RMHCPT, concluded that flooding was the most prevalent natural disaster impacting the region. Furthermore, potential flooding impacts can be identified and predicted within flood zones such as the 100-year event floodplain, for which maps are readily available. The most recent tax assessor's data was evaluated to estimate the value of structures located within the 100-year floodplain. Those figures were utilized to estimate losses resulting from a severe flood event. The methodology is described in more detail in Section 7 of this document.

2.7 Updating the Existing Protections Matrix

The existing protections matrix is a summary of measures, programs, and projects that have been implemented locally to mitigate natural hazards. The matrix is essentially a

listing of the items already in place which work toward solving hazard problems or preventing future losses, as outlined in Step 3 of the Massachusetts Community Planning Guide (*Natural Hazards Mitigation Planning: A Community Guide, January 2003*). In order to accomplish this task, MVPC distributed a detailed questionnaire among municipal personnel in each of the participating communities. The questionnaire was organized by topic area and by municipal department in order to facilitate its completion by the appropriate local staff. A copy of the questionnaire is provided in Appendix D.

The questionnaire was used as a tool to facilitate each community's examination of the adequacy of its programs, policies, bylaws, and regulations relative to natural hazards mitigation. The questionnaire was circulated and discussed at the individual local hazard mitigation planning team meetings and with other local municipal staff, as appropriate. The information derived from the questionnaires and the meeting discussions was used to compile the communities' Existing Protections Matrix.

2.8 Development of Hazard Mitigation Strategies and Actions

The Regional and Local Planning Team members and MVPC staff worked together to develop the plan's hazard mitigation goals, strategies, and actions. In the regional meetings, RMHCPT members generated valuable suggestions on broader *regional* goals and actions. In the local meetings, municipal personnel focused primarily on identifying *community-specific* projects, programs, and measures that would become part of each community's local mitigation plans. However, these meetings also served to stimulate additional discussion on the regional mitigation actions that were subsequently incorporated into the plan.

SECTION 3. REGIONAL PROFILE

This section of the Plan provides an overview of the Merrimack Valley region, and includes updated information on the region'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 which follow later in the Plan.

3.1 Current Population, Housing, and Employment

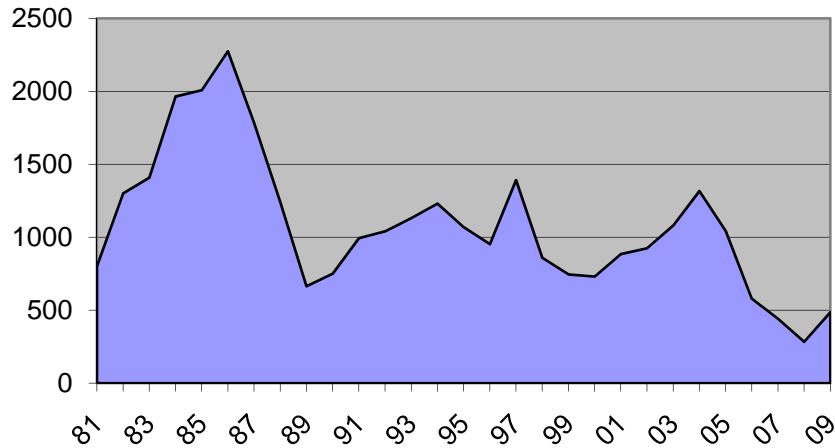
Population. The Merrimack Valley region's 15 cities and towns cover 264 square miles and have a resident (year-round) population of 333,748 (U.S. Census 2010). During the summer months, the population swells considerably as vacationers and tourists flock to the seaside resorts of Salisbury Beach, downtown Newburyport, and Plum Island. The population density (persons per square mile) in the region ranges from 285 in semi-rural Newbury to over 11,000 in densely-developed Lawrence, and averages a little over 1,200 region-wide. Together, the two central cities of Haverhill and Lawrence account for over 40% of the region's total population.

In 2002, the Merrimack Valley Planning Commission conducted a "buildout" analysis for each of the 15 communities. (Buildout is a calculation of a community's maximum land development potential under current zoning.) Based on these analyses, MVPC projects a *maximum regional population of 406,149* if all remaining residential building sites are developed. This represents a 21.7% increase over the current (2010) population.

Housing. The demand for housing in the Merrimack Valley has typically outpaced the available supply. **Figure 3.1-1** on the following page depicts the total number of dwelling units permitted in the MVPC region by year for the 30-year period of 1981-2010. Housing permit activity experienced a sharp increase during the mid-1980s (1983-1987), and an even sharper decline after 1987 as the national and regional recession took hold. Development regained its strength during the mid-1990s, although with less fervor than the previous decade. A total of 2,275 dwelling units were permitted in the region in 1987, but this figure dropped to only 665 units in 1990. This figure then rose to a high of 1,392 in 1998 before plunging to a Great Recession low of 284 in 2009.

Although the rate of single-family residential growth has fluctuated some in accordance with economic cycles, single-family development has generally been strong and consistent over the past 30 years, and continues to be the principal mode of development. This is a reflection of current consumer demand, and accounts for the continued "sprawl" development occurring in the region's suburban and semi-rural communities. From a natural disaster (especially *flooding*) perspective, this pattern of development has a number of 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. Although recent progress has been made in the use of open space residential design (OSRD) as a means of "clustering" home sites and preserving a greater proportion of the natural landscape, this style of development is still in its relative infancy in the Valley and remains a small percentage of the total housing starts.

Figure 3.1-1. Merrimack Valley Dwelling Units Permitted 1981-2010



Employment. The Merrimack Valley region has a long history of adapting to structural changes in the economy that impact employment and development patterns. In general, the region has experienced three such changes. Before the industrial revolution, the City of Newburyport was famous among maritime nations as a shipbuilding port, and Amesbury was a prominent early manufacturer of horse-drawn carriages. Yet these were exceptions to the region's predominantly agrarian economy.

At the beginning of the 19th century, however, the Merrimack Valley rapidly developed into one of New England's earliest and most important industrial regions. By the end of the century, the Cities of Lawrence and Haverhill had become world centers of the woolen worsted and footwear industries. Several of the region's smaller communities developed satellite industries, serving as suppliers of textile machinery or ancillary leather products to the major producers.

The postwar demise of the New England textile and footwear industries is well documented. Between 1947 and 1956, the Merrimack Valley experienced a net loss of nearly 18,000 manufacturing jobs and a 17% reduction in total employment. From 1940 to 1960, Lawrence alone lost nearly 25,000 jobs in the textile industry. The region's leather and footwear industries, which still employed 12,000 workers in 1950, shrunk to less than 4,200 by 1975.

During the economic boom period of the 1960s and early 1970s, the region experienced employment growth in high tech industries supported largely by defense procurement. But sharp reductions in military spending during the mid-70s and the national recession

of 1974-1975 combined to produce regional unemployment rates approaching 16% during the spring and summer of 1975. Recovery from that recession was led by a renewed expansion of the high technology industries located along the Greater Boston, Route 128 beltway, fueled by the growth of non defense-related markets for high tech applications. The Town of Andover, situated at the crossroads of Interstates 495 and 93, became a prime new location for high tech research and development facilities. Numerous parcels of land along the region's major highways sprouted industrial parks.

By the mid-1980s, the region was benefiting from the Massachusetts economic boom, partly due to its proximity to Boston. As the state unemployment rate dropped to 3.6%, regional unemployment fell to 4.0%. The Lawrence-Haverhill PMSA was the only one in the state to have a simultaneous increase in its labor force and a decrease in its unemployment rate. During the latter half of the 1980s, construction was the fastest growing industry in New England, as it responded to the growing demand for housing and modern office space. When mini-computer manufacturing peaked in 1985, the construction industry and its financial servicing carried the economy for the remainder of the decade.

A recession in the early 1990s hit Massachusetts and the Merrimack Valley earlier and harder than the rest of the nation, but the state and regional economies rebounded and economic growth continued for the rest of the decade. From 1991 to 2000, employment in the Merrimack Valley grew from 133,931 to 154,482 – an increase of over 20,000 jobs. As with the country as a whole, the Valley took a major hit during the Great Recession of the late 2000s, but today the region's economy is better positioned to weather future downturns in any particular

A summary of current (2010) population, housing, and employment data for the region and its 15 constituent communities is presented in **Table 3.1-2** on the following page.

Table 3.1-2. Merrimack Valley Population, Housing, and Employment (2010)

Community	Land Area (sq. mi.)	Population	Population Density (persons/sq. mi.)	Total Households	Employment
Amesbury	12.3	16,283	1,328	6,642	9,025
Andover	30.8	33,201	1,076	11,851	15,584
Boxford	23.6	7,965	338	2,688	3,916
Georgetown	12.9	8,183	636	2,937	4,113
Groveland	8.9	6,459	727	2,346	3,003
Haverhill	33.0	60,879	1,846	24,150	30,782
Lawrence	6.9	76,377	11,028	25,181	31,057
Merrimac	8.5	6,338	749	2,417	3,437
Methuen	22.2	47,255	2,124	17,529	22,847
Newbury	23.4	6,666	285	2,594	3,510
Newburyport	8.3	17,416	2,086	7,622	9,292
North Andover	26.3	28,352	1,078	10,516	13,843
Rowley	18.2	5,856	322	2,155	3,069
Salisbury	15.4	8,283	537	3,441	4,650
West Newbury	13.5	4,235	315	1,508	2,142
MVPC Region	264.1	333,748	1,264	123,577	160,270

The occupations of employed persons living in the Valley region in 2010 are shown in **Table 3.1-3**. Forty-one percent (66,397) were Management and Professional; 23.6 percent (37,838) Sales and Office; 15.8 percent (25,390) Service; 12.0 percent (19,187) Production, Transportation and Material Moving; and 7.1 percent (11,458) Construction, Extraction and Maintenance

Table 3.1-3. Number of Employed Persons by Occupation (2010)

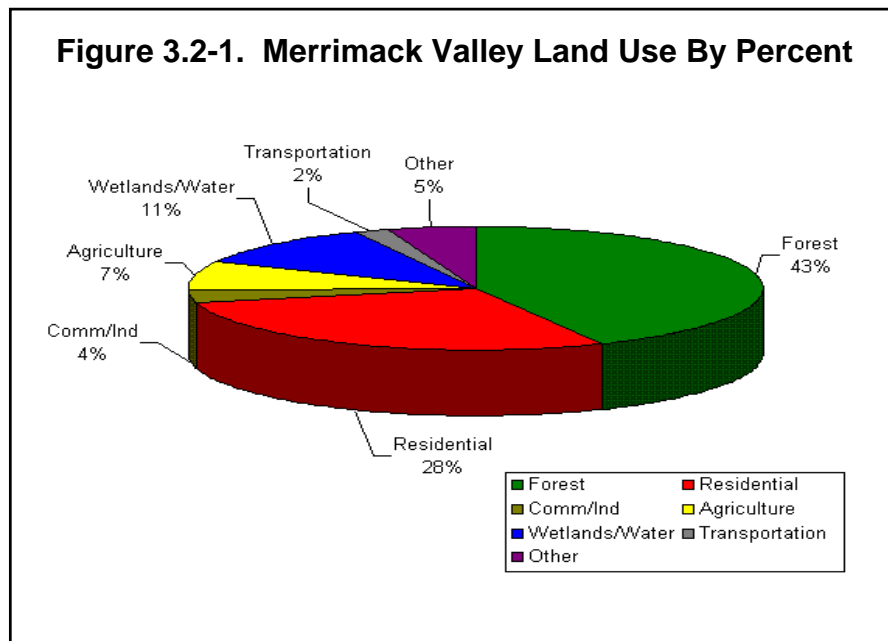
Employed Civilian Population 16 Years and Over						
Area	Employed Civilians 16 Years and Over	Management & Professional	Service	Sales and Office	Natural Resources Construction, & Maintenance	Production, Transportation, and Material Moving
Amesbury	9,025	4,012	1,050	2,414	794	755
Andover	15,584	10,453	1,223	2,959	385	564
Boxford	3,916	2,353	370	812	210	171
Georgetown	4,113	2,002	538	930	368	275
Groveland	3,003	1,302	318	667	319	397
Haverhill	30,782	11,621	5,469	7,959	2,638	3,095
Lawrence	31,057	6,019	7,600	6,530	2,397	8,511
Merrimac	3,437	1,533	464	607	322	511
Methuen	22,847	8,891	3,317	6,062	1,918	2,659
Newbury	3,510	1,768	334	734	349	325
Newburyport	9,292	5,005	1,195	2,377	253	462
North Andover	13,843	7,365	1,866	3,296	631	685
Rowley	3,069	1,155	524	745	426	219
Salisbury	4,650	1,596	889	1,299	382	484
West Newbury	2,142	1,322	233	447	66	74
MVPC Region	160,270	66,397	25,390	37,838	11,458	19,187
Massachusetts	3,271,535	1,400,638	541,505	790,915	241,318	297,159
Essex County	366,590	149,204	59,753	92,855	26,642	38,136

3.2 Land Use Characteristics and Trends

The Merrimack Valley encompasses 264 square miles of land area, slightly more than half of what formerly was Essex County. The region is predominantly coastal lowland and substantial portions of its eastern borders are tidal marsh, estuary, and barrier beach. Some agricultural uses remain in the more rural communities of the region – principally dairy, horse, and truck farming – but the overwhelming majority of the region’s area (43%) is forest. Another 28% is devoted to residential uses. Commercial and industrial uses together constitute less than 4% of the land in the region.



Table 3.2-1 presents the most recent (2005) land use information available for the 15 cities and towns in the Valley. The information was developed based on aerial photography interpreted by the University of Massachusetts Department of Forest Resources. The data are organized in seven use categories as follows: Forest, Residential, Commercial & Industrial, Agricultural, Wetlands & Water, Transportation, and Other. The same use categories are illustrated in **Figure 3.2-1** below. In addition to the forest and residential uses, which combined constitute about 70% the region, a relatively high proportion (11%) of the region is comprised of wetlands and water. This is due in large part to the expansive "Great Marsh" salt marsh that occupies much of the region’s coastal zone. In fact, wetlands and water constitute over one-third (33.7%) of the total area of Newbury, almost 28% of the area of Salisbury, and over 22% of the area of Rowley.



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. Recent development across the region has been largely in the form of large lot, single family subdivisions, although there have been several multi-family projects constructed under Chapter 40B and several open space residential design (OSRD) projects. The OSRD projects use clustering of houses on smaller lots in order to preserve open space, in some cases keeping open as much as 50% or more of the total subdivision area. By way of example, several successful OSRD projects have been constructed in the Town of Newbury in recent years. However, region-wide, these projects remain the exception and not the rule.



A significant amount of undeveloped land remains, although it is not evenly distributed throughout the region. This undeveloped land includes land that is vacant and developable, as well as land that may be classified as undevelopable due to various development constraints, such as wetlands. Land consumption will likely continue at an alarming rate as long as large lot zoning remains the norm in the region's suburbs. Commercial development continues to be dispersed beyond traditional municipal centers to locations along state numbered routes and major travel corridors, such as Route 114 in Lawrence and North Andover, and Route 110 in Amesbury and Salisbury. The greatest concentration of newer industrial areas tends to be in technology parks built near highway interchanges and along major corridors, such as Route 93 in Andover. Such industrial parks are often built in a campus-like setting with large areas of paved parking, resulting in higher land consumption rates than would occur in a traditional urban or compact development setting where higher floor area ratios are typically allowed.

The trend toward urbanization/suburbanization of the region has implications for natural hazard planning. As more land is developed, additional impervious surface is created, thereby decreasing the area available for flood storage and increasing the flood risk. As population and housing density increases, the potential for property damage and economic loss as a result of a natural disaster also increases.

Table 3.2-1. Merrimack Valley Land Use (2005)

Community	Forest		Residential		Commercial & Industrial		Agricultural		Wetlands & Water		Transportation		Other		Total
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Amesbury	3161	39.3	2169	27.0	355	4.4	1101	13.7	687	8.5	217	2.7	436	5.4	8036
Andover	7901	40.8	7365	38.0	1257	6.5	500	2.6	1191	6.1	469	2.4	684	3.5	19367
Boxford	9404	61.4	3825	25.0	26	<1	705	4.6	859	5.6	231	1.5	257	1.7	15307
Georgetown	4597	56.6	2181	26.9	158	1.9	229	2.8	582	7.2	153	1.9	218	2.7	8119
Groveland	2918	50.9	1613	28.1	78	1.4	300	5.2	427	7.4	0	0	396	6.9	5732
Haverhill	8180	39.7	6504	32.0	597	2.9	2156	10.5	1227	6.0	570	2.8	1379	6.7	20613
Lawrence	308	7.5	2243	54.3	1116	27.0	7	<1	18	<1	161	3.9	279	6.8	4132
Merrimac	2844	51.7	1457	26.5	64	1.2	575	10.5	266	4.8	116	2.1	179	3.3	5501
Methuen	4187	30.5	5931	43.2	689	5.0	593	4.3	943	6.9	421	3.1	975	7.1	13739
Newbury	5073	33.7	2086	13.8	69	<1	1538	10.2	5076	33.7	202	1.3	1028	6.8	15072
Newburyport	1182	23.0	1756	34.1	549	10.7	705	13.7	342	6.6	176	3.4	436	8.5	5146
North Andover	8571	49.8	4946	28.7	722	4.2	1050	6.1	1044	6.1	303	1.8	577	3.4	17213
Rowley	5659	48.7	1844	15.9	189	1.6	777	6.7	2630	22.6	38	<1	485	4.2	11622
Salisbury	3675	37.8	1619	16.6	370	3.8	544	5.6	2689	27.6	171	1.8	665	6.8	9733
West Newbury	4282	49.8	1896	22.1	5	<1	1559	18.1	576	6.7	40	<1	240	2.8	8598
MVPC Region	71942	42.8	47436	28.2	6244	3.7	12339	7.3	18557	11.1	3268	1.9	8234	4.9	167,930

3.3 Transportation Network

Highways. The region's 15 cities and towns are well served by an excellent highway network that includes over 1,400 miles of roadway. Interstate highways I-93, I-95, and I-495 all traverse the region, providing convenient vehicular access to points north, south, and west. Both I-93 and I-495 link the region with Boston. I-93 extends north to Salem, Manchester, and Concord, New Hampshire. I-495 is a circumferential roadway that crosses every major highway in eastern Massachusetts, including the Massachusetts Turnpike running west to New York State. I-95 passes through every major East Coast city from Maine to Florida. At least one of these three interstates passes through 14 of the region's 15 communities.



While the interstate highways serve the highest numbers of vehicles, state-numbered arterial routes are the most extensive. U.S. Route 1 and Routes 1A, 28, 97, 110, 113, 114, 125, 133, and 213 are of vital importance because they link the major activity centers of each community with other communities in the region. In addition, local roads, which make up approximately 62% of the region's highway network, are important to communities because they serve as access to residences and businesses.

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. The Merrimack Valley region receives a wide array of 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.

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 at two privately-owned airports in Methuen and Newburyport. The Lawrence Airport, located on Sutton Street in North Andover, is the largest airport in the region, with 60 hangars and 145 tie-downs, and a capacity of 259 aircraft. There are currently 202 aircraft (196 planes, 6 helicopters) based at this airport, the majority of which are small, single engine private planes. For the year ending October 1, 2011 there were 66,000 takeoffs and landings.

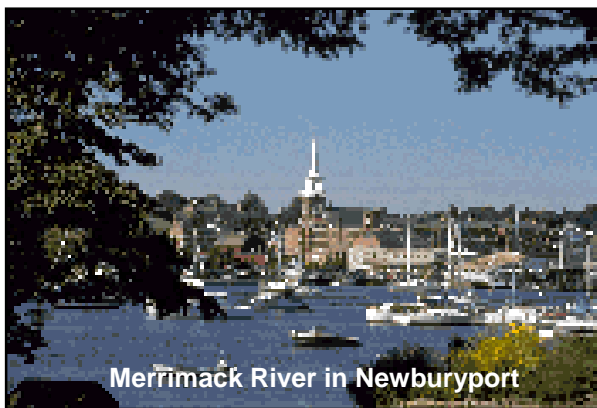


The Methuen Airport is a seaplane base and is located on the Merrimack River adjacent to Lowell Street. The Newburyport Airport is located along the Plum Island Turnpike in the eastern end of Newburyport and neighboring Newbury. These two airports are small facilities with 8-month operating seasons, and are used primarily for pleasure aircraft.

3.4 Water Resources and Public Water Supplies

Water Resources

The Merrimack Valley region contains abundant freshwater and saltwater resources, ranging from the Merrimack River – one of the largest river systems in New England



– to numerous smaller rivers and streams, lakes, ponds, wetlands, and tidal creeks. The Atlantic Ocean forms the region’s eastern border in the four coastal communities of Salisbury, Newburyport, Newbury, and Rowley. Prominent estuarine waterways include Newburyport Harbor and Plum Island Sound.

The region encompasses parts of five major watersheds (as defined by the

Executive Office of Environmental Affairs): ***Ipswich River***, ***Merrimack River***, ***North Coastal***, ***Parker River***, and ***Shawsheen River***. These five watershed areas are

shown in **Figure 3.4-1**. The Merrimack watershed area is by far the largest, encompassing 147 square miles, or 55% of the region. This is only a small fraction of the entire Merrimack River drainage basin, which begins in the White Mountains of New Hampshire and covers over 5,000 square miles. The Merrimack River has an average daily flow of 7,500 cubic feet per second (cfs), as recorded at Lowell, MA. This is greater than the average flow of all other eastern Massachusetts rivers combined. The highest flow of record, which occurred during the infamous Flood of 1936, is estimated to have exceeded **173,000 cfs**.

Figure 3.4-1. Merrimack Valley Major Watersheds

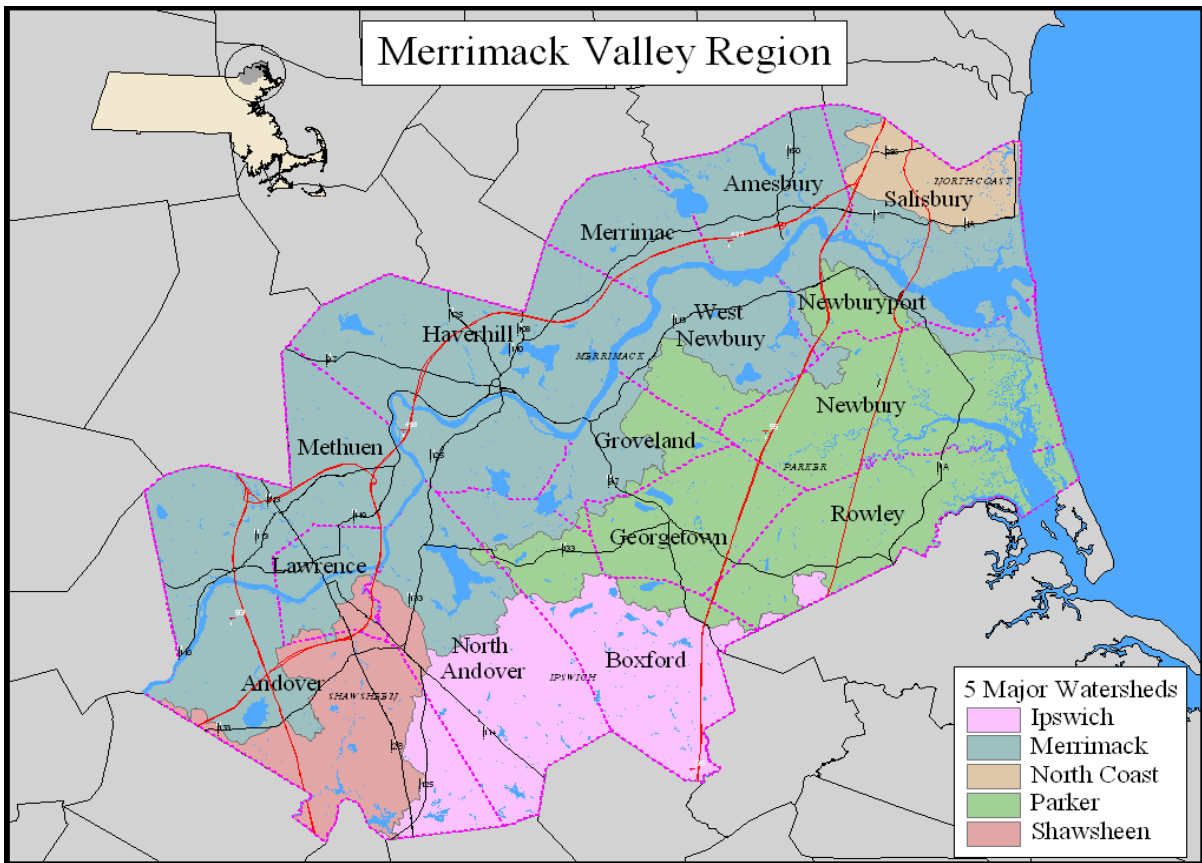


Table 3.4-1 on the following page gives a breakdown of each community's major watershed areas.

Table 3.4-1. Merrimack Valley Watershed Areas By Community

Community	Area (Acres)	Major Watershed	Watershed Area Per Community		% of Community
			Acres	Sq. Miles	
Amesbury	8783.26	Merrimack	8779.31	13.72	99.96
		North Coastal	3.95	0.01	0.04
Andover	20562.86	Ipswich	3476.12	5.43	16.90
		Merrimack	6815.73	10.65	33.15
		Shawsheen	10271.01	16.05	49.95
Boxford	15603.55	Ipswich	9868.52	15.42	63.25
		Merrimack	2067.24	3.23	13.25
		Parker	3667.78	5.73	23.51
Georgetown	8414.97	Ipswich	6.68	0.01	0.08
		Merrimack	130.39	0.20	1.55
		Parker	8277.91	12.93	98.37
Groveland	6014.06	Merrimack	3802.10	5.94	63.22
		Parker	2211.96	3.46	36.78
Haverhill	22827.64	Merrimack	22827.64	35.67	100.00
Lawrence	4753.37	Merrimack	3805.26	5.95	80.05
		Shawsheen	948.11	1.48	19.95
Merrimac	5688.02	Merrimack	5688.02	8.89	100.00
Methuen	14705.78	Merrimack	14705.78	22.98	100.00
Newbury	16488.41	Merrimack	2050.32	3.20	12.43
		Parker	14438.09	22.56	87.57
Newburyport	6961.36	Merrimack	4521.69	7.07	64.95
		Parker	2439.67	3.81	35.05
North Andover	17735.20	Ipswich	10495.86	16.40	59.18
		Merrimack	5798.65	9.06	32.70
		Parker	155.42	0.24	0.88
		Shawsheen	1285.27	2.01	7.25
Rowley	12763.63	Ipswich	513.73	0.80	4.02
		Parker	12249.89	19.14	95.98
Salisbury	10993.03	Merrimack	5804.43	9.07	52.80
		North Coastal	5188.60	8.11	47.20
West Newbury	9424.01	Merrimack	7124.72	11.13	75.60
		Parker	2299.29	3.59	24.40

Public Water Supplies

The Merrimack Valley region has a wide variety of municipal water supply sources. These range from the Merrimack River, which supplies all of the drinking water to the cities of Lawrence and Methuen, to smaller tributary rivers and streams, surface water reservoirs, and groundwater aquifers.



Together, these sources meet the daily water supply needs of residents, institutions, and businesses throughout the Valley region, and are critically important to the region's present and future growth and prosperity. Thus, it is essential that we protect both the quantity and quality of our existing and potential water supply sources through effective land use controls. Toward this end, most communities have adopted water supply protection district regulations consistent

with Massachusetts DEP drinking water source protection requirements. These regulations prohibit high-risk commercial and industrial uses, such as gasoline stations and dry-cleaning establishments, and in some cases impose limited residential restrictions, such as amount of impervious surface cover.

Table 3.4-2 provides a community-by-community breakdown of the region's primary water supply lands (Zone A and Zone II), as classified and mapped by the Water Supply Division of the Massachusetts Department of Environmental Protection. **Zone A** lands are lands that are hydrologically connected with and contribute recharge to *surface water* supplies. They consist of: (a) the land area between the surface water source and the upper boundary of the bank; (b) the land area within a 400 foot lateral distance from the upper boundary of the bank; and c) the land area within a 200 foot lateral distance from the upper boundary of the bank of a tributary stream or associated surface water body.

Zone II lands are hydrologically-connected with and contribute recharge to *groundwater* supplies. They include the areas of an aquifer which contribute water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (i.e., 180 days of pumping at a DEP-approved yield without benefit of recharge from precipitation). Zone IIs are bounded by the groundwater divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In some cases, streams or lakes act as recharge boundaries. In all cases, the Zone II extends upgradient to its point of intersection with prevailing hydrogeologic boundaries (for example, a groundwater flow divide, a contact with till or bedrock, or a recharge boundary).

As the acreage figures in the table indicate, only about one-third (1/3) of the region's total Zone A and Zone II land area is currently considered "permanently protected" – that is, preserved from development in a largely natural state by virtue of fee simple ownership or conservation/deed restriction by a government entity or nonprofit land trust. The remaining two-thirds (2/3), although regulated, is still potentially vulnerable

to impacts from some level of land disturbance and/or development activity. While strict enforcement of these regulations can (and often does) go a long way toward protecting the water supplies from inappropriate land uses, the regulations are not a substitute for the communities' acquiring and managing these sensitive watershed and aquifer areas in a natural, undisturbed state.

Table 3.4-2. Municipal Drinking Water Supplies – Primary Protection Zones				
	Water Supply Zone	Total Acres	Protected Acres	% Protected
Amesbury	Zone A	641.3	111.1	17.3
	Zone II	510.5	139.8	27.4
Andover	Zone A	796.4	225.0	28.3
	Zone II	1,595.9	477.1	29.9
Boxford	Zone A	18.9	0.1	0.5
	Zone II	2,357.7	376.7	16.0
Georgetown	Zone A	0.0	0.0	0.0
	Zone II	1,731.3	975.6	56.4
Groveland	Zone A	0.0	0.0	0.0
	Zone II	1,574.6	554.9	35.2
Haverhill	Zone A	1,504.1	899.5	59.8
	Zone II	0.0	0.0	0.0
Lawrence*	Zone A	0.0	0.0	0.0
	Zone II	0.0	0.0	0.0
Merrimac	Zone A	565.8	70.2	12.4
	Zone II	160.4	103.0	64.2
Methuen*	Zone A	0.0	0.0	0.0
	Zone II	0.0	0.0	0.0
Newbury	Zone A	1.3	0.2	15.4
	Zone II	757.4	237.5	31.4
Newburyport	Zone A	127.0	46.4	36.5
	Zone II	227.4	105.5	46.4
North Andover	Zone A	1,311.5	328.9	25.1
	Zone II	0.0	0.0	0.0
Rowley	Zone A	1.2	0.0	0.0
	Zone II	1,277.8	651.4	51.0
Salisbury	Zone A	0.0	0.0	0.0
	Zone II	528.7	75.4	14.3
West Newbury	Zone A	924.4	254.8	27.6
	Zone II	51.3	18.9	36.8
MVPC REGION	Zone A	5,891.9	1,936.2	32.9
	Zone II	10,772.5	3,715.8	34.5

*The cities of Lawrence and Methuen derive their municipal drinking water solely from the Merrimack River, for which the MA DEP has not designated or mapped any Zone A surface water protection areas.

3.5 Protected Open Space and Prime Farmland

The Merrimack Valley region is blessed with an abundance of ecologically rich and visually stunning open space resources. These range from vast, interconnected salt marsh, barrier beaches, and inter-tidal zones along the coast to an intricate tapestry of forests, fields, farms, and hilltops in bordering and upland areas.

Together, these rich resources provide outstanding and diverse:

- **habitat and migration corridors** for numerous wildlife species, birds, fish and shellfish, and plants;
- **surface and ground water sources** for drinking water supply, irrigation, hydropower generation, wastewater assimilation, and recreation;
- **productive soils** for agriculture, horticulture, and tree farming; and
- **natural buffers** for protection against flooding, high winds, coastal storm surges, and sea level rise.



They also serve as a major draw for tourists and vacationers, attracting thousands of visitors each year to enjoy beachcombing, swimming and boating, hiking, nature observation, and sight-seeing. Regardless of their geographic setting or function, the Merrimack Valley's prime open space resources are critically important to the overall character, economic vitality, and quality of life in the Merrimack Valley region, and as such warrant vigilant protection and sustainable use.

Toward this end, the Merrimack Valley Planning Commission has worked closely with member communities and partner organizations (open space committees, watershed associations, land trusts) through the years to help identify, map, and protect some of the region's most important land and water resources. The Merrimack Valley Priority Growth Strategy recognizes the need to continue this important work and presents a series of strategies to help accomplish this. The goal is not to slow or stop growth, nor to preserve all remaining open space, but rather to help direct new development toward those areas best able to accommodate it, in the process protecting the region's most critical natural resources.

Existing Protected Open Space

As part of its collaborative efforts with communities to preserve vital open areas, MVPC has mapped the region's existing protected open space using data derived from both the MassGIS Office and from municipal sources, including local open space and recreation plans and conversations with knowledgeable conservation officials. These existing protected lands range from several large, multi-community federal and state wildlife management areas, to non-profit land trust holdings, to individual town forests, watershed areas, and conservation lands. A description of

some of the most prominent and noteworthy of these protected areas follows. While this list is by no means exhaustive, it reveals the diversity and richness of the Merrimack Valley region's natural resources.

- ***Parker River National Wildlife Refuge.*** The federally-protected Parker River National Wildlife Refuge is the region's largest and most ecologically-rich natural area. Spanning parts of Newburyport, Newbury, Rowley, and Ipswich, it was established in 1942 and is managed by the U.S. Fish and Wildlife Service. The Refuge occupies the southern three-fourths of Plum Island, an 8-mile barrier beach, and contains 4,662 acres of scenic tidal marsh, fresh water impoundments, bogs, and sand dunes. It is one of the few barrier beach-dune-salt marsh complexes remaining in the Northeast. The Refuge is home to over 800 species of plants and animals, and is considered one of the top ten bird-watching sanctuaries in the United States.
- ***Martin H. Burns Wildlife Management Area.*** This state-protected wildlife management area spans the towns of Newbury and West Newbury. It consists of 1,555 acres of small rocky hills, forest, meadows, and low-lying wetlands. Historically this area was clear-cut, but a second growth forest composed primarily of pole sized hardwoods has returned. A series of openings connected by smaller openings or trails have been cut and are maintained to increase habitat diversity. Except for three small fire ponds, there is little standing water on the area, although much of the lower terrain is poorly drained and seasonally wet. The Little River, a major tributary of the Parker River, has its headwaters within this area.
- ***Old Town Hill Reservation.*** This scenic 531-acre "half-upland, half-marine" landscape is owned and managed by The Trustees of Reservations, the oldest private non-profit land trust in the nation. Old Town Hill is a glacial drumlin that rises prominently from the surrounding lowland and tidal marsh. The Reservation's upland consists of second growth forest and fields that provide habitat for nesting birds and hunting grounds for hawks and owls. The bordering salt marsh and tidal creeks are home to a variety of estuarine invertebrates, such as mussels and snails, that provide food for egrets and other wading birds. Old Town Hill features 3 miles of hiking trails, and is a vital link in Metro-Boston's circumferential Bay Circuit Trail and Greenway.
- ***William Forward Wildlife Management Area.*** This state-protected wildlife management area spans the towns of Newbury and Rowley. It consists of 2,083 acres of scenic salt marsh and upland habitat. The uplands are predominantly mixed oak and white pine woodlands. There are approximately 60 acres of open fields that are maintained under cooperative agreements with local farmers, and another 20 acres are maintained in an early successional stage for purposes of wildlife diversity. Portions of the Parker River and two of its major tributaries – the Little River and the Mill River – run through or border this area. Public trails provide access to two of the area's most prominent landforms: Kent's Island and Ox Pasture Hill.

- **Georgetown-Rowley State Forest.** This large, 1,112-acre state forest spans the towns of Georgetown and Rowley to the west and east of Route I-95. It contains a mix of dense woodland, wetlands, and streams, and is a key headwater for Penn Brook, Mill River, and Muddy Brook. Miles of multi-use trails traverse the area, which support a variety of year-round public recreation activities including hiking, horseback riding, cross-country skiing, and nature observation.
- **Crane Pond Wildlife Management Area.** This 2,123-acre state wildlife area spans the towns of Groveland, Georgetown, Newbury, and West Newbury. It consists of a series of low rolling hills and marshland varying approximately 120 feet in elevation. The hills were once cleared for use as pasture, but the fields were abandoned some 60 years ago, and pines and mixed hardwoods have since reclaimed the land. A series of openings have been maintained by forestry operations, and a high-tension line provides additional open cover and easy access for hunters and hikers. The Parker River, a stocked trout water, flows through the southern portion of the area.
- **Harold Parker State Forest & Wildlife Management Area.** This 3,000-acre natural area spans the towns of Andover, North Andover, North Reading, and Middleton. It consists of mixed hardwood-hemlock-white pine forest, and features over 35 miles of logging roads and trails. Recreational opportunities abound here, and include hiking, mountain biking, horseback riding, fishing, hunting, non-motorized boating, picnicking, and camping. There are 11 ponds within the area, including scenic Berry Pond which sports a sandy beach and is stocked with trout. The remaining ponds are shallow, warm water impoundments constructed by the Civilian Conservation Corps during the 1930s.
- **Charles Ward Reservation.** The 695-acre Ward Reservation is owned and managed by the Trustees of Reservation. This visually-stunning property represents the union of more than 40 separate parcels of farm and pasture land whose stone walls, when combined, extend more than 17 miles. These parcels encompass all or parts of three hills – Shrub Hill, Boston Hill, and Holt Hill – and are connected by many miles of recreational trails, segments of which are part of the Bay Circuit Trail. The focal point of the Ward Reservation is Holt Hill, whose 420-foot summit is the highest point in Essex County. From this summit, visitors can view the Boston skyline and the Blue Hills to the south. At the foot of Holt Hill lies Pine Hole Bog, a rare “quaking” bog that features concentric rings of distinct vegetation resulting from different growing conditions.

Together, the above-listed properties comprise almost 14,700 acres of protected open space, or about 40% of all of the protected open space in the Merrimack Valley region. The remaining protected open space acreage is divided among numerous smaller parcels that are dispersed throughout the region. A breakdown of each community’s current protected open space acreage follows.

Table 3.5-1. Protected Open Space By Community

Municipality	Total Area (Acres)	Protected Open Space	
		Acreage	Percent of Community
Amesbury	8,784	1,075	12.2
Andover	20,578	4,268	20.7
Boxford	15,619	2,531	16.2
Georgetown	8,415	2,211	26.3
Groveland	6,014	1,909	31.8
Haverhill	22,852	2,556	11.2
Lawrence	4,753	291	6.1
Merrimac	5,692	764	13.4
Methuen	14,717	972	6.6
Newbury	16,529	7,020	42.5
Newburyport	6,966	1,402	20.1
North Andover	17,739	3,939	22.2
Rowley	12,783	3,227	25.2
Salisbury	11,007	1,945	17.7
West Newbury	9,424	1,847	19.6
MVPC REGION	181,872	35,957	19.8

Sources: MassGIS, MVPC Regional GIS Service Center, Municipal Conservation Commissions

Prime Farmland

A number of the region’s prominent farm lands – such as the Colby Farm in Newbury and the Pleasant Valley area farms in Methuen – are proximate to rivers, streams, and other water bodies. In addition to the abundant crops they produce, the farms’ broad alluvial soils provide important stormwater infiltration/retention and flood storage functions. Future development of these lands for more intensive residential and commercial uses would result in the loss or diminution of these functions.

Since its heyday in the 19th century, farming in the Merrimack Valley and throughout Essex County has steadily declined as a business and a way-of-life. According to the U.S. Department of Agriculture, in 1870, **47%** (151,809 acres) of all land in Essex County was in agriculture. By 1950, this figure had fallen to **31.2%** (99,840 acres). Nevertheless, nearly one-third of County land was still being farmed. However, in the high growth decades following 1950, the loss of farmland – much of it to low-density sprawl development – greatly accelerated. By 2007, the total number of farms in the County had declined from 2,288 to 531 (-77%), and total farm acreage decreased from 99,840 acres to 27,834 acres (-72%). As a result, only **8.7%** of Essex County land has remained in agricultural use. In the Merrimack Valley region, just over



13,000 acres was being farmed when the last statewide land use survey was conducted in 1999. This represented a 1,900-acre (-12.6%) decline in only eight years since the previous survey in 1991.

The Valley's shrinking farmland continues to be imperiled. 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. If the Merrimack Valley is to preserve its agricultural heritage, and the critical natural resource functions these open lands provide, a collaborative effort is needed 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 in order 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. **Table 3.6-1** on the following page provides a listing of Merrimack Valley local historic districts, as recorded in the *State Register of Historic Places 2012* prepared by the Massachusetts Historical Commission.

COSTEP-MA (Coordinated Statewide Emergency Preparedness in Massachusetts) 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 and 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.

Table 3-6.1. Local Historic Districts in the Merrimack Valley Region

<p>Amesbury</p> <ul style="list-style-type: none"> - Amesbury and Salisbury Mills Village Historic District 	<p>Methuen</p> <ul style="list-style-type: none"> - Arlington Mills Historic District - Methuen Multiple Resource Area - Pleasant - High Street Historic District - Searles, Tenney, Nevins Historic District - Spicket Falls Historic District
<p>Andover</p> <ul style="list-style-type: none"> - Academy Hill Historic District - Andover Multiple Resource Area - Andover Village Industrial District - Ballardvale Historic District - Central Street Historic District - Shawsheen Village Historic District - West Parish Center Historic District 	<p>Newbury</p> <ul style="list-style-type: none"> - Newbury Historic District
<p>Boxford</p> <ul style="list-style-type: none"> - Boxford Village Historic District - Howe Village Historic District 	<p>Newburyport</p> <ul style="list-style-type: none"> - Central Waterfront Archaeological District - Fruit Street Local Historic District - Market Square Historic District - Newburyport Historic District
<p>Georgetown – No Listings</p>	<p>North Andover</p> <ul style="list-style-type: none"> - Machine Shop Village Historic District - North Andover Center Historic District - North Andover Historic District - Tavern Acres Historic District
<p>Groveland – No Listings</p>	<p>Rowley</p> <ul style="list-style-type: none"> - Glen Mills Historic District - Rowley Center Historic District
<p>Haverhill</p> <ul style="list-style-type: none"> - Bradford Common Historic District - Hamel Leather Company Historic District - Haverhill Historical Society Historic District - Main Street Historic District - Rocks Village Historic District - Washington Street Shoe District 	<p>Salisbury – No Listings</p>
<p>Lawrence</p> <ul style="list-style-type: none"> - American Woolen Mill Housing District - Arlington Mills Historic District - Downtown Lawrence Historic District - Jackson Terrace Historic District - Mechanics Block Historic District - North Canal Historic District - North Common Local Historic District - Prospect Hill Local Historic District 	<p>West Newbury – No Listings</p>
<p>Merrimac – No Listings</p>	

Source: State Register of Historic Places 2012, Massachusetts Historical Commission, January 2013

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, additional impervious surface is created increasing the flood risk and decreasing available flood storage area. The population, household, and employment projections for the Merrimack Valley region were developed utilizing a methodology developed by the Massachusetts Department of Transportation (MassDOT). Over the past ten years, the region has continued to grow, albeit less dramatically than in past decades. Based upon population projections developed by MassDOT with input from MVPC, the region is expected to grow by an additional 14,252 residents (4.27%) between 2010 and 2020 and by another 27,000 residents (7.75%) between 2020 and 2035. The region, as a whole, is projected to grow by 12.36% between 2010 and 2035, which represents a much greater growth rate than that experienced between 2000 and 2010 (4.76%). The data summarized in **Table 3.7-1** reflects anticipated population trends over the next two decades.

Table 3.7-1. Current and Projected Population in the Merrimack Valley Region					
Community	2010	2020	2025	2030	2035
Amesbury	16,283	17,000	17,450	17,900	18,200
Andover	33,201	34,650	35,500	36,500	37,400
Boxford	7,965	8,850	9,350	9,900	10,600
Georgetown	8,183	8,700	9,100	9,600	10,000
Groveland	6,459	7,100	7,500	7,900	8,200
Haverhill	60,879	64,400	66,400	68,550	70,500
Lawrence	76,377	77,200	77,600	77,900	78,000
Merrimac	6,338	6,600	6,800	7,100	7,500
Methuen	47,255	48,850	49,750	50,500	51,500
Newbury	6,666	7,300	7,850	8,250	8,600
Newburyport	17,416	17,750	17,850	17,950	18,000
North Andover	28,352	30,000	31,200	32,200	33,500
Rowley	5,856	6,100	6,450	6,900	7,500
Salisbury	8,283	8,900	9,300	9,700	10,100
West Newbury	4,235	4,600	4,900	5,150	5,400
Total	333,748	348,000	357,000	366,000	375,000

Source: U.S. Census for 2010; MassDOT projections in consultation with MVPC

Between 2010 and 2035, the seven semi-rural towns of Boxford (33.1%), Newbury (29.0%), Rowley (28.1%), West Newbury (27.5%), Groveland (26.9%), Georgetown (22.2%), and Salisbury (21.9%) are all expected to experience substantial percentage increases in their total population. For those communities that are more developed, such as Amesbury, Andover, and Methuen, less dramatic population growth is expected over the next 25 years. The two communities that are expected to experience the smallest percentage increases are the cities of Lawrence (2.12%) and Newburyport (3.35%), both of which are largely built out and have few remaining buildable parcels.

Notwithstanding the current housing slump, the number of households in the region is projected to increase from 123,577 in 2010 to 143,300 households in 2035, an increase of 15.9%. From a percentage perspective, the principal areas of household growth are expected to be in the semi-rural communities of Boxford (37.6%), Newbury (35.7%), West Newbury (35.3%), Rowley (34.6%), and Groveland (33.0%), as outlined in **Table 3.7-2** below. The more developed communities, such as the cities of Lawrence (3.5%), Newburyport (4.9%), and Methuen (11.7%) will experience more restrained household growth between 2010 and 2035.

Table 3.7-2. Current and Projected Households in the Merrimack Valley Region					
Community	2010	2020	2025	2030	2035
Amesbury	6,642	6,900	7,300	7,540	7,680
Andover	11,851	12,300	12,930	13,370	13,750
Boxford	2,688	2,850	3,220	3,450	3,700
Georgetown	2,937	3,100	3,370	3,610	3,770
Groveland	2,346	2,550	2,820	3,000	3,120
Haverhill	24,150	25,400	26,880	27,920	28,700
Lawrence	25,181	25,500	25,850	26,000	26,050
Merrimac	2,417	2,510	2,660	2,810	3,000
Methuen	17,529	18,050	18,730	19,080	19,580
Newbury	2,594	2,800	3,150	3,350	3,520
Newburyport	7,622	7,800	7,910	7,970	8,000
North Andover	10,516	11,100	12,050	12,550	13,120
Rowley	2,155	2,230	2,440	2,640	2,900
Salisbury	3,441	3,700	3,980	4,180	4,370
West Newbury	1,508	1,610	1,810	1,930	2,040
Total	123,577	130,700	135,100	139,400	143,300

Source: U.S. Census for 2010; MassDOT projections in consultation with MVPC

As mentioned previously, the Merrimack Valley region has experienced its worst economy since the end of World War II. Although the Commonwealth performed better economically than many other states, the national recession has created the worst unemployment rates in more than thirty years. Nevertheless, the state projects that 21,300 jobs (16.5% increase) will be added to the Merrimack Valley region between 2010 and 2035, as shown in **Table 3.7-3** below.

Table 3.7-3. Current and Projected Employment in the Merrimack Valley Region					
Community	2010	2020	2025	2030	2035
Amesbury	4,612	4,846	4,853	4,862	4,872
Andover	32,011	37,002	38,688	40,354	42,008
Boxford	1,018	1,057	1,052	1,048	1,044
Georgetown	2,212	2,727	2,926	3,123	3,317
Groveland	1,114	1,452	1,590	1,726	1,861
Haverhill	18,008	19,282	19,485	19,691	19,901
Lawrence	23,039	22,753	22,082	21,431	20,800
Merrimac	766	876	912	950	983
Methuen	14,684	16,054	16,380	16,706	17,033
Newbury	1,459	1,824	1,967	2,109	2,249
Newburyport	10,445	11,906	12,374	12,839	13,300
North Andover	13,149	14,091	14,244	14,400	14,559
Rowley	2,649	2,962	3,052	3,142	3,232
Salisbury	2,795	3,382	3,603	3,821	4,037
West Newbury	739	786	792	798	804
Total	128,700	141,000	144,000	147,000	150,000

Source: U.S. Census for 2010; MassDOT projections in consultation with MVPC

This regional employment growth of 16.5% is expected to be fueled by robust job growth in the Town of Andover (9,997 jobs) in particular, and by moderate job growth in the cities of Newburyport (2,855 jobs), Methuen (2,349 jobs), and Haverhill (1,893 jobs). Not surprisingly, job growth in the region's smaller suburban and semi-rural communities is expected to be modest. Among all of the communities, only the City of Lawrence is projected to experience an actual loss of jobs (-2,239 jobs) between 2010 and 2035.

3.8 Assessed Valuations By Community

The Massachusetts Department of Revenue (DOR) requires all communities to value all property each year and every third year a complete recertification is required. Both a recertification and an interim year adjustment (the two years in between the triennial re-certification) include a detailed analysis of the appropriate sales data as a basis for adjusting the property values. The goal is to keep the values as close as possible to 100% of market value and avoid an excessive swing in the assessments in one year. **Table 3.8-1** below contains the FY 2013 Assessed Values for all property classes in each Merrimack Valley region community.

Table 3.8-1. Assessed Values By Class in the Merrimack Valley Region						
Community	Residential	Open Space	Commercial	Industrial	Personal Property	TOTAL
Amesbury	1,478,695,853	0	138,642,632	95,180,185	62,402,765	1,774,921,435
Andover	5,441,912,945	8,391,900	544,010,554	574,064,300	234,340,227	6,802,719,926
Boxford	1,522,724,200	0	12,695,900	1,065,500	42,133,021	1,578,618,621
Georgetown	1,028,191,487	0	42,490,013	42,117,500	20,493,513	1,133,292,513
Groveland	722,665,025	0	23,054,873	21,860,300	28,200,260	795,780,458
Haverhill	4,056,936,646	0	418,963,765	224,100,765	213,699,180	4,913,700,356
Lawrence	2,151,293,326	0	313,582,474	199,752,400	154,725,420	2,819,353,620
Merrimac	627,689,583	0	19,674,490	7,426,740	8,483,960	663,274,773
Methuen	3,564,106,933	0	398,673,755	144,843,710	153,031,900	4,260,656,298
Newbury	1,140,835,871	0	36,569,062	2,831,700	17,779,037	1,198,015,670
Newburyport	2,783,697,944	211,500	260,663,356	154,911,100	55,355,972	3,254,839,872
North Andover	3,713,065,744	0	278,124,243	161,446,600	116,997,715	4,269,634,302
Rowley	702,892,480	119,000	77,195,200	33,272,620	17,603,877	831,083,177
Salisbury	1,152,841,469	0	214,081,550	28,067,998	30,676,930	1,425,667,947
West Newbury	706,313,123	0	6,150,587	1,587,600	18,050,430	732,101,740

Source: Massachusetts Department of Revenue, Division of Local Services

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. 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, in order to provide communities with information needed to prioritize mitigation strategies.

Natural hazards that are likely to occur in the Merrimack Valley region can generally be grouped – in order of frequency – in the following seven categories:

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

44 CFR Requirement

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

This grouping is based on data compiled for the Massachusetts State Hazard Mitigation Plan, as well as additional information gathered by The Dewberry Companies.

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.

In an urbanized area such as the Merrimack Valley region, natural hazards can result in disaster. Hazard mitigation planning is a process directed at reducing the impact that natural disasters may have on the built environment and the lives of area residents. As the region grows and the population increases, the risk of disaster caused by natural hazards becomes ever greater. While it is impossible to predict exactly when and where such a disaster might occur, through careful planning we can help to minimize the losses that may ensue.

The following discussion describes the natural hazards that affect the Merrimack Valley region, including their historical presence and probability of recurrence.

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.

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. In addition, there are scattered low-lying wetland areas that have the potential to flood. According to the National Climatic Data Center, fifty-four (54) flood events were reported in Essex County from January 1, 1950 to April 30, 2013. 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, including Newburyport, receiving as much as 17 inches. According to the Boston Globe, around 1,500 people evacuated their homes to escape the flood.



The most significant flood in the recorded history of the Merrimack River was in March 1936, when rain, melting snow and ice swelled the Merrimack in Lowell to 68.4 feet (20.8 m), 10 feet (3 m) higher than the 2006 flood. Downstream in Methuen, Lawrence, 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 a number of local rivers and streams to reach or exceed flood stage.

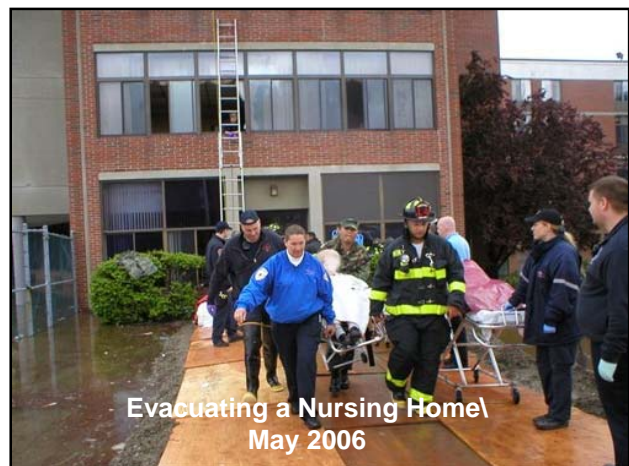
Riverine floods are most likely to occur in Spring. They result from the “overbanking” of swollen rivers and streams, and are typically caused by a large-scale weather event that generates an unusual amount of precipitation or by rapid snowmelt. *Coastal floods* commonly occur during the winter months, and are the result of storm surges spawned by northeast coastal storms (northeasters). Packing sustained wind speeds of up to 40 miles per hour and wind gusts of up to 70 mph, these storms cause repeated wave and erosion-induced damage to structures and natural resources, such as beaches and dunes. In the Merrimack Valley region, the barrier beaches of Salisbury Beach and Plum Island are especially vulnerable to coastal storms, and sustain frequent wind, wave, and flood damage. *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 of time. 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.

Flood-related hazards were identified in each of the **fourteen** participating communities in the region. The methodology for assessing the hazard presented by flooding involved mapping the 100-year floodplain elevations on an overlay map for each of the **14** communities. Next, 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.



Floodplains and Repetitive Loss Structures

As the data in **Table 4-1** below indicate, 11 of the region's 14 participating communities –Andover, Georgetown, Haverhill, Lawrence, Methuen, Newbury, Newburyport, North Andover, Salisbury, and West Newbury – have repetitive loss structures located within their mapped flood hazard areas. Combined, there are 496 such loss structures on 180 properties. Over the years, flood damage to these structures has resulted in the payment of almost \$21 million in insurance claims under the National Flood Insurance Program (NFIP).

Figure 4-1. Repetitive Flood Losses in Merrimack Valley Region		
Municipality	Total # of Losses	Total \$ Paid Out
Andover	81	5,393,864
Boxford	0	-
Georgetown	12	198,850
Groveland	0	-
Haverhill	33	1,257,832
Lawrence	78	7,574,215
Merrimac	0	-
Methuen	49	376,239
Newbury	45	1,553,327
Newburyport	51	624,986
North Andover	17	502,244
Rowley	0	-
Salisbury	114	2,900,621
West Newbury	2	84,232
TOTAL	482	\$20,996,410

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 prior to 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 are 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 the purpose of flood related hazards, the designation of structurally deficient is the most critical. Bridges in the region which are classified as structurally deficient and located over water are listed by community in Table 4-1.

Table 4-1. Structurally Deficient Bridges Over Water

Town	Roadway	Water Body	Owner	Year Built/ Rebuilt	Status	AASHTO Rating
Amesbury/ Newburyport	Interstate 95	Merrimack River	State Highway Agency	1954	Under Construction	36.3
Andover	Route 28	Shawsheen River	State Highway Agency	1879 1927	Preliminary Design	48.7
Groveland	Route 97/113	Merrimack River	State Highway Agency	1951	New Bridge under Construction (Completion in 2014)	
Haverhill	Route 125 (Bridge St.)	Merrimack River	State Highway Agency	1925	Preliminary Design	18.8
Haverhill/ West Newbury	East Main Street	Merrimack River	State Highway Agency	1883 1914	Under Construction (Completion in 2014)	
Lawrence	Amesbury Street	South Canal	City/Municipal Highway	1918 1982	MassDOT to address scour issues around footings	47.3
Lawrence	Union Street	Merrimack River	State Highway Agency	1888 1980	Construction Completed 2014	
Methuen	Hampshire Road	Spicket River	State Highway Agency	1959	Design Yet to be Initiated	50.5
Methuen	Route 213 WB	Spicket River	State Highway Agency	1959	Design Yet to be Initiated	76.1
Newburyport	Route 1 (Gillis Bridge)	Merrimack River	State Highway Agency	1976	Design Yet to be Initiated	60.3

Dams

A *dam* is an artificial barrier that has the ability to 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; or
- 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, 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 December 2012 there were four (4) High Hazard dams located in the Merrimack Valley region's 14 participating communities, as shown in **Table 4-2** below.

Table 4-2. High Hazard Dams			
Municipality	Dam Name	Impoundment Name	Date of Most Recent Inspection
Haverhill	Millvale Reservoir Dam	Millvale Reservoir	6/2/2011
Lawrence	Stevens Pond Outlet Dam	Stevens Pond	9/7/2006
North Andover	Lake Cochichewick Outlet Dam	Lake Cochichewick	5/17/2011

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 Special Flood Hazard Areas, 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 indicate a net increase of approximately 3,864.77 acres now determined to be located in the floodplain since the 2008 Natural Hazard Plan. The most significant expansions in 100-year floodplain acreage from most recent FIRM map updates have been in Newbury, Haverhill, Rowley, Newburyport, Salisbury, Andover, and Merrimac, as shown in **Table 4-3** below.

Table 4-3. 100-Yr Floodplain Area by Community						
Community	Acres of floodplain as shown on 1979 FIRM maps	Acres of floodplain as shown on 2014 FIRM maps	Difference in Floodplain acreage (1979-2014 FIRM maps)	% Change 1979-2014	Total Land Area in Acres	% Land Area in Floodplain (according to the 2014 FIRM maps)
Amesbury	1,732.62	1,761.00	28.38	1.64%	8,783.87	20.05%
Andover	1,569.33	1,791.29	221.96	14.14%	20,577.53	8.71%
Boxford	1,683.53	1,722.54	39.01	2.32%	15,618.75	11.03%
Georgetown	1,296.90	1,359.52	62.62	4.83%	8,414.97	16.16%
Groveland	1,088.71	1,043.54	-45.17	-4.15%	6,014.06	17.35%
Haverhill	3,531.02	4,593.42	1,062.40	30.09%	22,851.82	20.10%
Lawrence	814.20	762.35	-51.85	-6.37%	4,753.37	16.04%
Merrimac	417.31	513.56	96.25	23.06%	5,691.92	9.02%
Methuen	1,969.50	1,937.72	-31.78	-1.61%	14,716.99	13.17%
Newbury	6,583.97	7824.88	1,240.91	18.85%	16,528.52	47.34%
Newburyport	962.03	1,529.66	567.63	59.00%	6,965.78	21.96%
N. Andover	3,079.17	3,090.35	11.18	0.36%	17,738.86	17.42%
Rowley	3,966.25	4,802.42	836.17	21.08%	12,783.45	37.57%
Salisbury	4,450.86	4,778.73	327.87	7.37%	11,006.55	43.42%
W. Newbury	1,095.83	1,157.20	61.37	5.60%	9,424.01	12.28%
Region Total	34,241.23	38,668.18	4,426.95	12.93%	181,871.17	21.26%

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 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. The City of Haverhill is the only CRS community in the Merrimack Valley region.

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.

Effects from high winds can include downed trees and/or power lines and damage to roofs, windows, etc. High winds can cause scattered power outages, and are also a hazard for the boating, shipping, and aviation industry sectors. 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 has incorporated 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 (northeasters). While less frequent than coastal storms, hurricanes and tornadoes have the greatest potential to cause massive, widespread damage and loss of life in the Valley. 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.

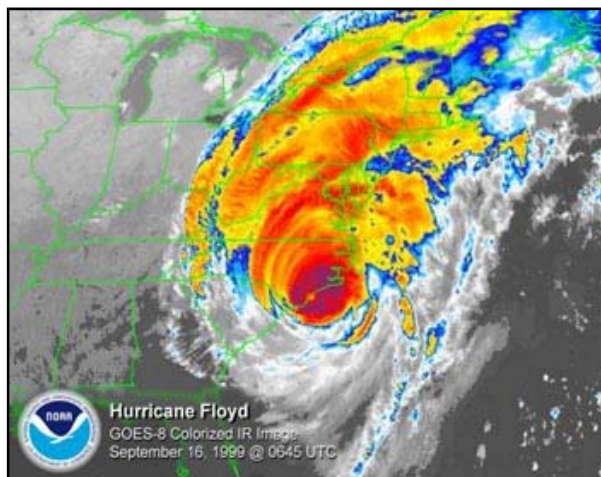
Hurricanes

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 39 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 a number of 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 4-3** below.

Table 4-3. 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.
<small>* Removable protective shutters or coverings temporarily placed over windows and doors during hurricanes to prevent damage by wind and flying debris</small>	

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 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 4-4** on the following page provides a summary of hurricanes that have affected New England since 1938.

In the Merrimack Valley region's coastal area, rapidly rising **storm surge** is the hurricane's primary threat to public safety, especially if timely notification and evacuations are not undertaken. Storm surge is a dome of water that moves ashore



Storm Surge Strikes the New England Coast, 1954
(Historic NWS Collection, Courtesy of NOAA/US Dept. of Commerce)

to the right of the hurricane eyewall. It packs a tremendous force, and places people and property in its path at grave risk. For this reason, it is imperative that residents and visitors alike be alerted to remain well above surge elevations until all threats have passed. In the case of Salisbury Beach and Plum Island, storm surge can scour and erode large swaths of beach and dunes, significantly altering the configuration of the shoreline. The extent of surge damage depends on the

hurricane's intensity, size, and direction of movement. Storm surges cause flooding that can quickly render evacuation routes impassable, cripple communications, cause sewers and stormwater systems to back up, and contaminate local drinking water supplies. Storm surge flooding can wash out roads and parking areas, leaving behind mounds of sand and debris and rendering streets impassable long after surge waters have receded.

Table 4-4. New England Hurricanes and Tropical Storms (1938-Present)

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

Table 4-4. New England Hurricanes and Tropical Storms (1938-Present)					
Date	Storm Event	Description	Deaths	Injuries	Property Damage
9/25/1985	Tropical Storm Henri	Minor effects	0	0	NA
9/27/1985	Hurricane Gloria	Category 2. Forward motion of 72 mph. Gusts to 80 mph.	NA	3	\$1 billion
8/7/1988	Tropical Storm Alberto	Winds of 50 mph.	31	NA	\$500 million
8/19/1991	Hurricane Bob	Category 2. Forward motion of 51 mph. Wind speeds of up to 60 mph. Set new 24- hour precipitation record. Major flooding and power outages	18	NA	\$1.5 billion
10/30-11/01/1991	Unnamed "Halloween" storm	Huge storm surge caused extensive damage along the coast	12	NA	\$210 million
7/13/1996	Hurricane Bertha	Forward motion of 48 mph. Very heavy rainfall and strong gusty winds. Spawned one tornado in Massachusetts	12	NA	\$275 million
9/02/1996	Hurricane Edouard	Left 40,000 residents without power, 3 inches of rain fell	0	0	\$3.5 million
7/25/1997	Tropical Storm Danny	Dropped 3-5 inches of rain	0	0	
9/16-17/1999	Tropical Storm Floyd	Forward motion of 56 mph. No significant damage in Massachusetts.	0	0	\$4.5 billion
9-3-2010	Hurricane Earl	Tropical Storm passed 98 miles east of New England with winds of 40+ mph producing high surf, heavy rain, and coastal flooding	1	0	NA
8/21/11	Hurricane Irene	Hurricane Irene became a tropical storm as it moved inland over NY, CT, MA, NH, and ME	42	NA	7-10 billion (est.)
10/29/2012	Hurricane Sandy	Sandy is the largest Atlantic hurricane on record with tropical storm force winds extended over an area of 1,000 miles diameter.	147	NA	In excess of \$50 billion with 24 states impacted

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**. These include six unnamed storms for the years 1858, 1869, 1874, 1893, 1916, and 1944, as well as Hurricane Donna (1960) and Hurricane Bob (1991). The figure that follows shows the tracks of these storms.

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 4-3** on the following page shows all Category 1-5 hurricanes whose centers have passed within 10 nautical miles of the Massachusetts state boundary from 1851 to 2010.

Figure 4-2. Historical Tropical Cyclone Tracks over Massachusetts

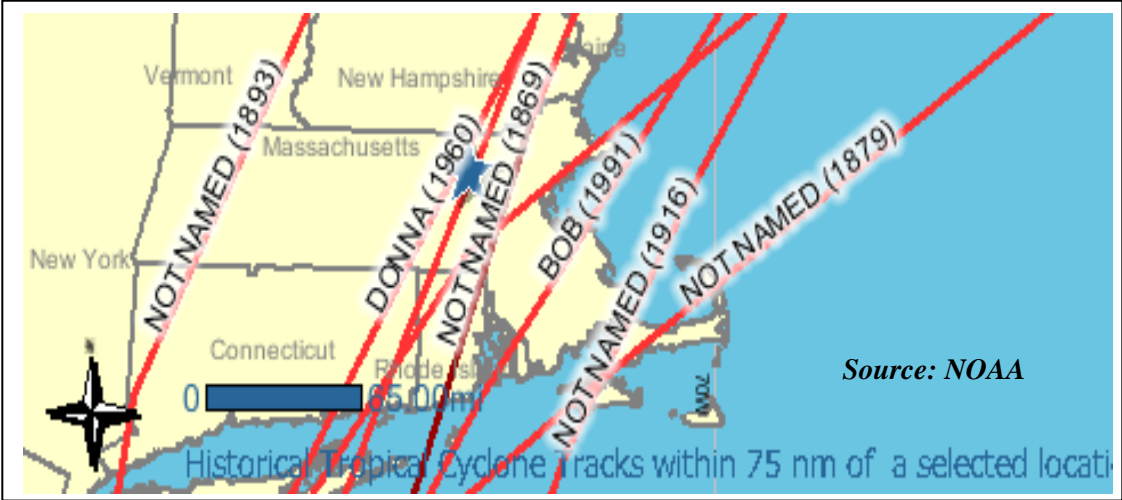
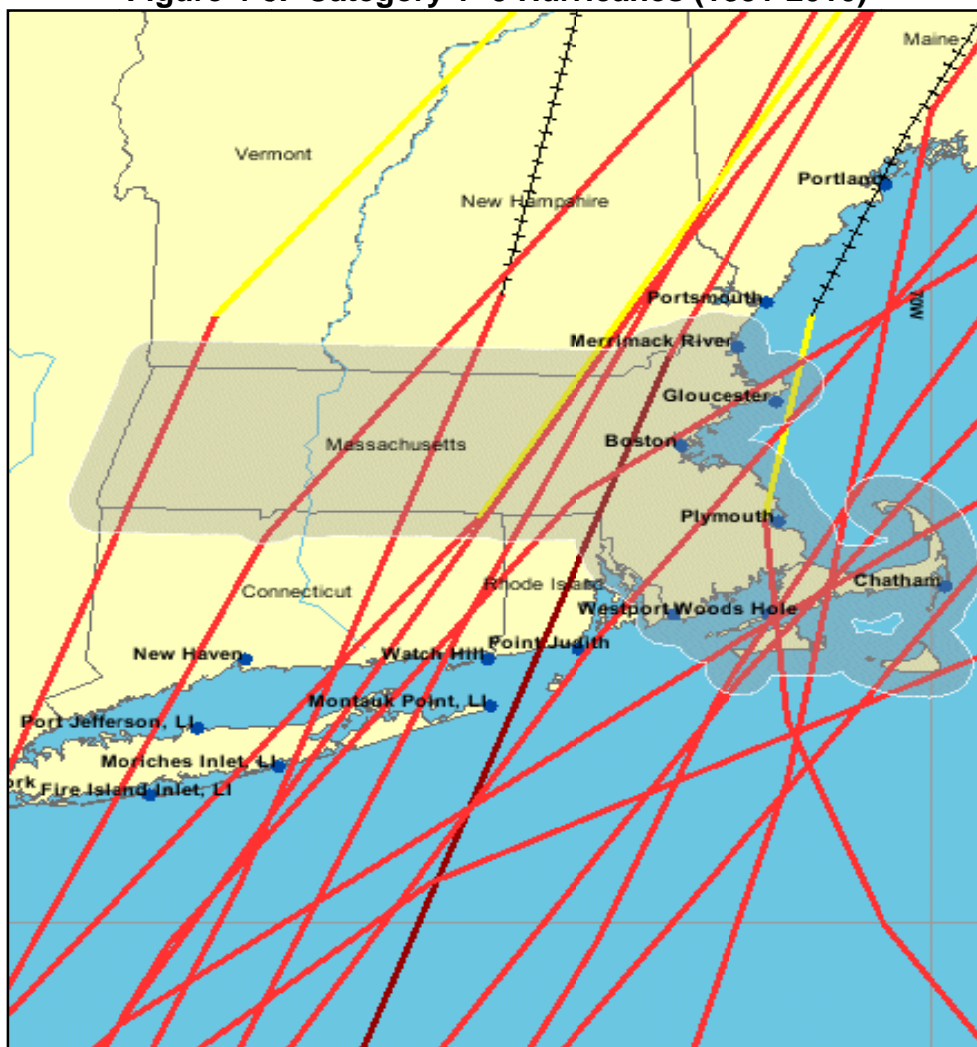











Figure 4-3. Category 1- 5 Hurricanes (1851-2010)



Legend:

-  Category 3-5 storm track
-  Category 1-2 storm track
-  Tropical storm track
-  Tropical depression track
-  Subtropical storm track
-  Extratropical storm track
-  Tropical low track
-  Tropical wave track
-  Tropical disturbance track

According to 2012 population estimates compiled by the Merrimack Valley Planning Commission, an estimated 339,189 people may be affected by a possible hurricane. Potentially, a number of these people, especially the elderly and disabled, may lack access to transportation. The maximum resident population potentially affected by a hurricane in the region is outlined by community in **Table 4-5** below.

Table 4-5. Estimated Population Impacted by a Possible Hurricane in the Merrimack Valley Region	
Municipality	Maximum Population Affected
Amesbury	16,535
Andover	34,142
Boxford	8,087
Georgetown	8,377
Groveland	6,794
Haverhill	61,797
Lawrence	77,326
Merrimac	6,517
Methuen	48,009
Newbury	6,771
Newburyport	17,654
North Andover	28,422
Rowley	5,966
Salisbury	8,425
West Newbury	4,367
Total	339,189

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 super cell, 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 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 that killed ninety-six people and injured over twelve hundred. Between 1950 and 2014, according to the Tornado History Project, there have been 162 recorded tornadoes in Massachusetts. Fifty of those were considered strong-violent tornadoes of which seven resulted in fatalities. Since 1950, tornado strikes have killed 109 people and injured 1,561 in Massachusetts. In addition to the 1953 Great Worcester Tornado, other devastating tornados in the

- August 28th, 1973: A tornado touching down in West Stockbridge leveled a Route 102 truck stop. Four people were killed and 40 injured.
- May 29th, 1995: Twenty four were hurt and three killed in Great Barrington, Massachusetts, by a tornado that moved through Columbia County, NY into Berkshire County.
- June 1, 2011: An outbreak of seven tornadoes in New England on this date, including the most destructive tornado since the 1953 Worcester strike. The Western. Mass. tornado produced 160 mph winds and caused \$227 million in

property damage in the Springfield, MA area including the communities of Monson and West Springfield. Three people were killed, 200 injured and hundreds left homeless according to news reports.

- In 2014, there were three recorded tornadoes in Massachusetts, including the July 28th, 2014 tornado that made landfall in Revere, the first twister to hit Suffolk County in more than 64 years. The Revere tornado with wind gusts of 120 mph injured two people and damaged about 100 buildings.
- 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.

Within the Merrimack Valley region, there have been six tornadoes since 1951, as shown in **Table 4-6** below.

Table 4-6. 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
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 2013 Hazard Mitigation Plan, the Reported Tornado Occurrence map shows tornado risk based on the historic past occurrence of tornadoes. The tornado density per 20 square miles indicated the probable number of tornado touchdowns for each square mile cell within the contoured zone that can be expected over a similar timeframe (fifty years). The analysis shows that the area of the state at greatest risk runs from central to northeastern Massachusetts but does not include the Merrimack Valley region.

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 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 tornadoes 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 4-7** and **4-8** illustrate the EF-scale and the damage indicators. Its uses three-second gusts estimated at the point of damage as judged by eight levels of damage to the 28 indicators listed in Table 4-8. These estimates vary with height and exposure.

Table 4-7. 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

¹Important: The 3 second gust is not the same as in standard surface wind observations. Standard measurements are taken by weather stations in open exposures, using a directly measured, "one minute mile" speed

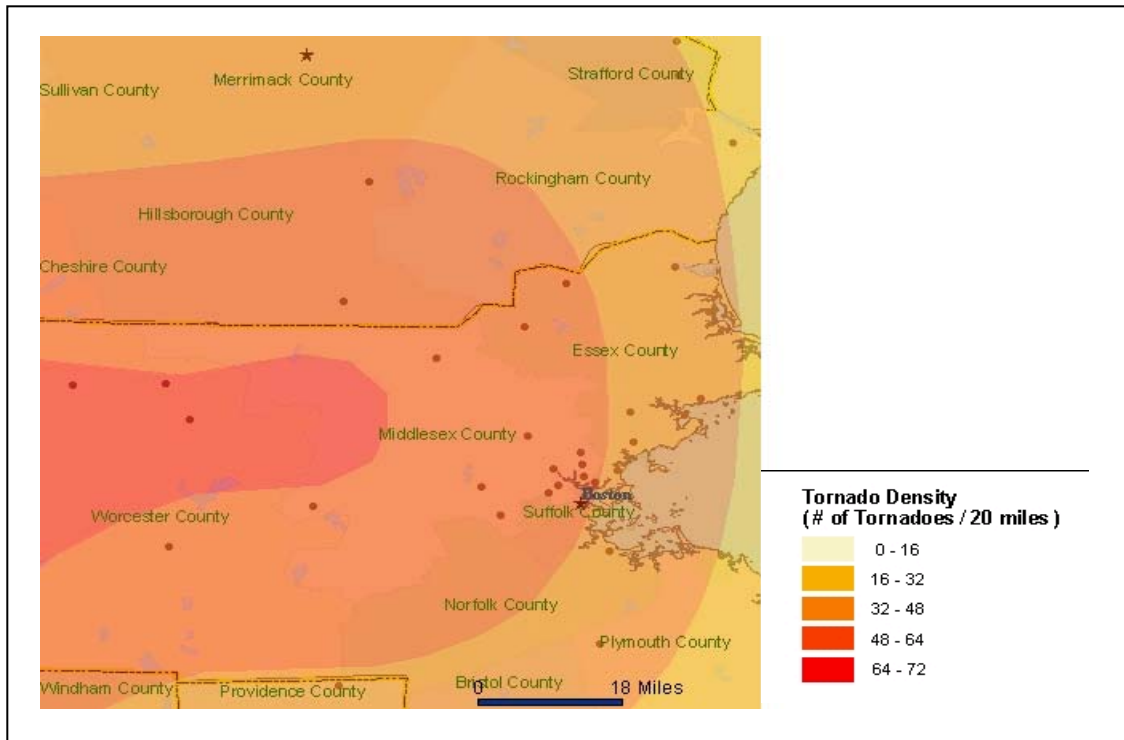
Table 4-8. Enhanced F-Scale Damage Indicators

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. **Figure 4-4** on the following page shows tornado density for eastern Massachusetts and Essex County.

Figure 4-4. Tornado Density



Source: NOAA

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, 14 tornadoes were recorded during the period of 1950-2014 (source: NOAA National Climatic Data Center). Of these, the great majority (11) fell within the lower F0 to F2 windspeed and damage categories. Only one tornado, occurring on September 29, 1974, reached the F3 ("severe damage") level, however, this occurred outside of the MVPC Planning Region. Since 1991, no tornadoes have been recorded for Essex County. On July 27th-28th, 2014, however, four tornado strikes occurred in New England, the closest taking place in the North Shore community of Revere, MA just south of the Merrimack Valley region. The EF2 force tornado of 120 mph winds accompanied by torrential rain lasted about four minutes and cut a swath of destruction two miles long and 3/8 mile wide through the coastal community of Revere. According to the City Fire Department, 65 buildings were substantially damaged including 13 homes left uninhabitable.

Tornado of July 5, 1643

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

Severe Thunderstorms

The National Weather Service considers a thunderstorm to be severe if it produces hail at least $\frac{3}{4}$ 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 over the course of the spring and summer. The greatest hazard caused by this type of storm is flash flooding. In addition, 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 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.

4.2 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 a twelve-hour period, or six or more inches over a twenty four-hour period. The leading cause of death during winter storms is from an automobile or other transportation accident. Exhaustion or heart attacks caused by overexertion are the second most likely cause of winter storm related deaths.



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

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

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

The most significant snowfalls in the region, as recorded in Newburyport, occurred in 1956 (120.5”), 2005 (110”), and 1969 (102.3”). Most recently, the October 2011 snowstorm left 640,000 Massachusetts homes and residents without power, according to MEMA.

Table 4-9 below details the annual snowfall totals for the City of Newburyport in the Merrimack Valley over six decades (1956 – 2013). These data were compiled by the staff of the Newburyport Water Treatment Plant (Weather Station #NEW602) from the monthly precipitation reports prepared for the Department of Conservation and Recreation’s Office of Water Resources.

Table 4-9. Merrimack Valley Snowfall (1956-2013) (City of Newburyport Weather Station)			
Year	Snowfall (inches)	Year	Snowfall (inches)
2013	78.55		
2012	22.5	1983	57.0
2011	74.5	1982	44.5
2010	33.0	1981	39.0
2009	63.5	1980	26.3
2008	61.0	1979	32.0
2007	66.3	1978	84.8
2006	33.3	1977	71.5
2005	110.0	1976	52.0
2004	33.0	1975	50.8
2003	83.5	1974	38.3
2002	45.0	1973	20.0
2001	70.8	1972	84.3
2000	28.8	1971	70.3
1999	35.0	1970	79.0
1998	17.5	1969	102.3
1997	50.0	1968	48.5
1996	82.5	1967	96.3
1995	43.3	1966	73.3
1994	60.5	1965	32.3
1993	89.8	1964	69.5
1992	24.3	1963	52.0
1991	27.0	1962	46.3
1990	42.0	1961	81.0
1989	26.5	1960	60.0
1988	46.8	1959	57.3
1987	63.0	1958	51.7
1986	29.3	1957	31.3
1985	32.5	1956	120.5
1984	59.0		
58-Year Annual Average – 55.2 Inches			

Since 2005, there have been five major disaster declarations related to winter weather, as well as two “snow emergency” declarations. A summary of the declarations involving Essex County is provided in **Table 4-10** on the following page.

Table 4-10. Winter Weather-Related Federal Disaster and Emergency Declarations for Essex County (2005-2014)		
Disaster Name (Date of Event)	Disaster Number (Type of Assistance)	Declared Areas
Severe Winter Storm, Snowstorm, and Flooding (February 8-9, 2013)	FEMA-DR-4110 (Public assistance)	All 14 Counties
Severe Storm (January 11-12, 2011)	FEMA-DR-1959 (Public)	Counties of Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, Worcester
Severe Winter Storm and Flooding (December 11-18, 2008)	FEMA-DR-1813 (Public and Individual)	Counties of Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, Worcester
Severe Winter Storm (December 11-18, 2009)	FEMA-EM-3296 (Public Assistance)	Counties of Berkshire, Bristol, Essex, Franklin, Hampshire, Middlesex, Suffolk, Worcester
January Snowstorm (January 22-23, 2005)	FEMA-EM-3201 (Public Assistance)	All 14 Counties

Source: www.fema.gov

Northeasters

Northeasters occur in New England more frequently than hurricanes and typically have a longer duration than hurricanes. A Northeaster is a large New England storm formed from a weather system traveling from South to North, passing along or near the seacoast. The Northeaster derives its name from the northeasterly direction of its counterclockwise cyclonic winds. It is not unusual for the sustained winds of a Northeaster to meet or exceed hurricane force. The duration of a Northeaster may outlast a hurricane event by many hours or even days. High winds associated with a Northeaster can last from 12 hours to 3 days, while the duration of a hurricane rarely exceeds 12 hours.



Northeasters pose a threat to infrastructure, including critical facilities. During the height of a storm, blizzard conditions present a hazard to driving or any other outdoor activity. A blizzard is defined as a storm with winds in excess of 35 mph, with falling and blowing snow reducing visibility to less than ¼ mile for at least three hours.

Heavy snow disrupts transportation and may impede the passage of emergency vehicles. Heavy snow may also bring down power lines and trees, and lead to roof collapses. The Blizzard of 1978 dumped 24-48 inches of snow on eastern Massachusetts and paralyzed the region for a number of days.

The Merrimack Valley region experienced a significant Northeaster on March 5-7, 2001, that resulted in a Presidential Disaster Declaration on April 10, 2001. Two feet of snow fell over a three-day period (March 5-7). Wind gusts up to 64 miles per hour were reported in some areas. The combination of heavy wet snow and high winds resulted in broken tree limbs that blocked roadways and downed power lines. More than 16,000 people in the Merrimack Valley were left without power on March 6, 2001. This late season snow also set the stage for flooding. Two subsequent



rainstorms, on March 20-22 and 29-30, 2001, resulted in the flooding of more than 10,000 residences and businesses in northeastern Massachusetts. Most of the damage due to flooding occurred along smaller rivers and tributary streams rather than the larger mainstems such as the Merrimack River.

In April 2007, a major Northeaster in combination with astronomical high tides lashed the Merrimack Valley coastline,

resulting in extensive flooding and beach erosion along Salisbury Beach and Plum Island. U.S. Route 1 (Bridge Road) in Salisbury was especially hard hit when a railroad berm across the salt marsh was breached, inundating area businesses and homes with up to 3-4 feet of seawater. This busy interstate was rendered entirely impassable for several days, seriously disrupting traffic flow as well as commerce in the area.

In October 29-30, 2011, the region experienced a significant Northeaster, known as the Halloween Northeaster. This storm produced a snow fall in excess of 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.

More recently, in early March of 2013, the latest in a series of powerful coastal storms combined with damaging high tides blasted a path of destruction along Plum Island in Newbury and along Salisbury Beach in Salisbury. On Plum Island, according to a *Daily News* account, "a ferocious morning tide proved to be the knockout blow for two Annapolis Way homes after high seas washed away the sand dune from beneath them, compromising their



foundations and rendering them a danger to the public. Three other houses suffered significant structural damage in the storm and at least a dozen more were left teetering perilously close to the edge.” In Salisbury, although no structures were lost to the storm tides, the remnants of a formerly extensive system of sacrificial dunes were largely washed away, after having been severely eroded by the earlier February blizzard. Seawater streamed between homes and onto North End Boulevard, and Army National Guardsmen were called in to help Town crews clear sand and other debris (broken snow fencing, pieces of boardwalk) deposited by the waves.

Recovery during the aftermath of a major snowstorm poses its own 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 gives an indication of 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 4-11** on the following page illustrates how NESIS values are 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 4-11. 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 4-12 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 period.

Table 4-12. 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)

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 clearing and disposal of downed trees and tree limbs. Given the magnitude of damage, the storm resulted in a Presidential Disaster Declaration. More recently, the Halloween Northeaster in 2011, caused billions of dollars in damage along the Eastern Seaboard. In Massachusetts, the ice storm accompanied by wind gusts up to 69 mph was responsible for six deaths and 420,000 power outages. (*Associated Press report 11/1/2011*)

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

Ice Jams

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

4.4 Fire Related Hazards

Fire poses a danger to densely developed, urbanizing, and rural areas of the region, as well as to forested and grassed areas. A wildland fire can be defined as any non-structure fire that occurs in wildland. 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, discussion is limited to drought and wildfire/brush fire hazards.

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 of time, 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 of time, 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 deficits in precipitation reached 8-12 inches below normal over a one-year period. Stream flows routinely fell below the 25th percentile of historical flows for the month. Ground water 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 ground water 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 use of emergency supplies is necessary.

During the summer of 2002, one-third of the nation, including New England, experienced drought conditions. Massachusetts has experienced multi-year drought episodes in 1879-1873, 1908-1912, 1929-1932, 1939-1944, 1961-1969, and 1980-1983. The most recent drought advisory for the state was issued in April 2012 when a number of days had “red flag” wildfire warnings due to warm and dry weather, high winds, and low fuel moisture. DCR placed heightened emphasis on wildfire detection and suppression during this time.

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 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 2009 to 2013, there were 47,920 fires classified as “other fires” (i.e., non-structure and non-vehicle fires), the vast majority of which were local brush fires. As part of the current Plan update, MVPC staff contacted the region’s local fire departments for more detailed information on the incidents of local brush fires that have occurred annually since the 2008 Plan, including the number and locations of fires as well as the estimated acres burned (when known). This information is presented in each community’s individual risk and vulnerability assessment in Section 5 of the Plan.

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, as large-lot development continues to encroach into forest land. (Forest currently constitutes 72,000 acres, or about 43% of the region’s 260 square miles.) 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.



Interface fire can move rapidly through agricultural landscapes as well. Drought conditions, high winds, and the accumulation of fine fuels, such as grass or stubble, set the stage for interface fires far away from any forests. In addition to building and equipment loss, crops, feed, soil, livestock, and farm infrastructure are also at risk.

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.

Wildland fires produce firebrands that are lofted into the air and can travel great distances, often igniting spot fires ahead of the main fire. Firebrands that land on a combustible roof can start a fire that will consume a building if not suppressed in time. The reality of firebrand-caused ignitions is that buildings located in relatively urban settings, even some distance inside the community interface boundary, are still vulnerable to wildland fires. Additionally, direct flame contact or radiant heat can ignite vulnerable buildings. Ignitions can result from both vegetation-to-structure spread and structure-to-structure spread.

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

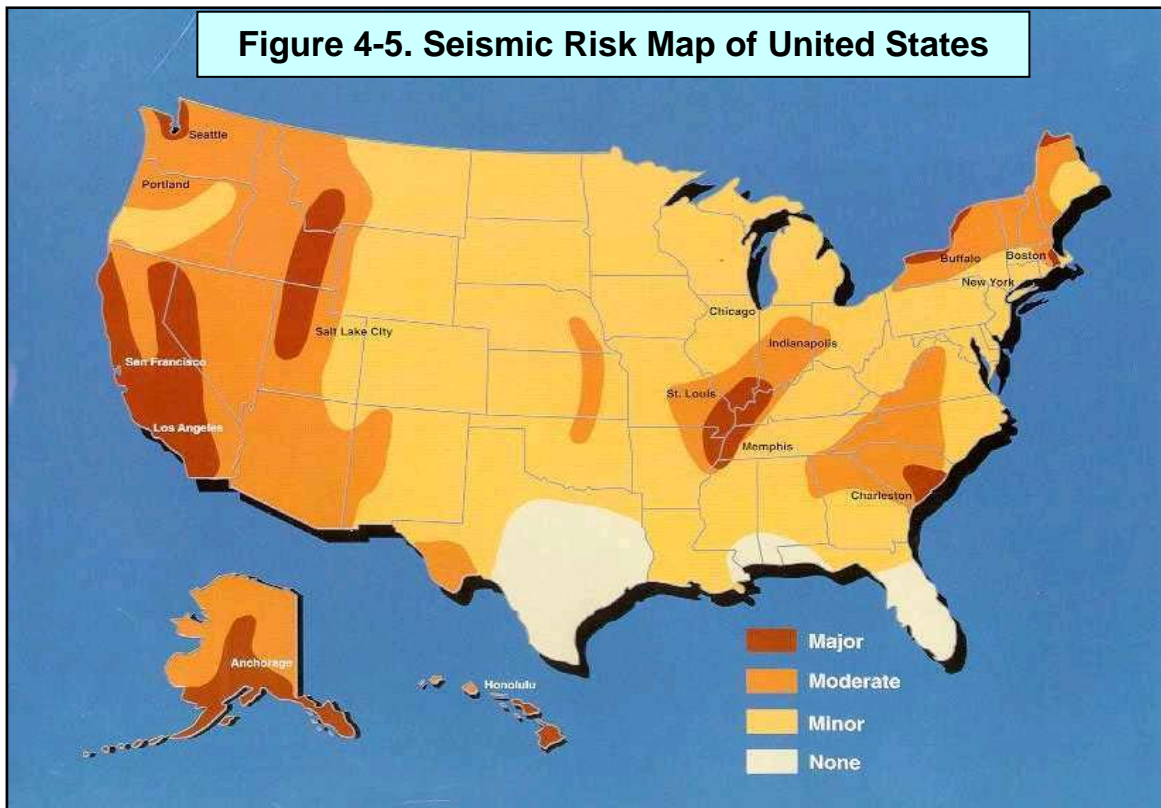
mapped at the earth's surface in the northeast are the same faults along which earthquakes are occurring.

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 of time. 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 of time between strong earthquakes. Between 1627 and 1989 there were 316 earthquakes recorded in Massachusetts. From 1924-1989 there were eight earthquakes with 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 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.

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 result in total destruction of 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 landfill, 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 past 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 4-6. NEW ENGLAND EARTHQUAKE PROBABILITY

Source: Weston Observatory, Boston College

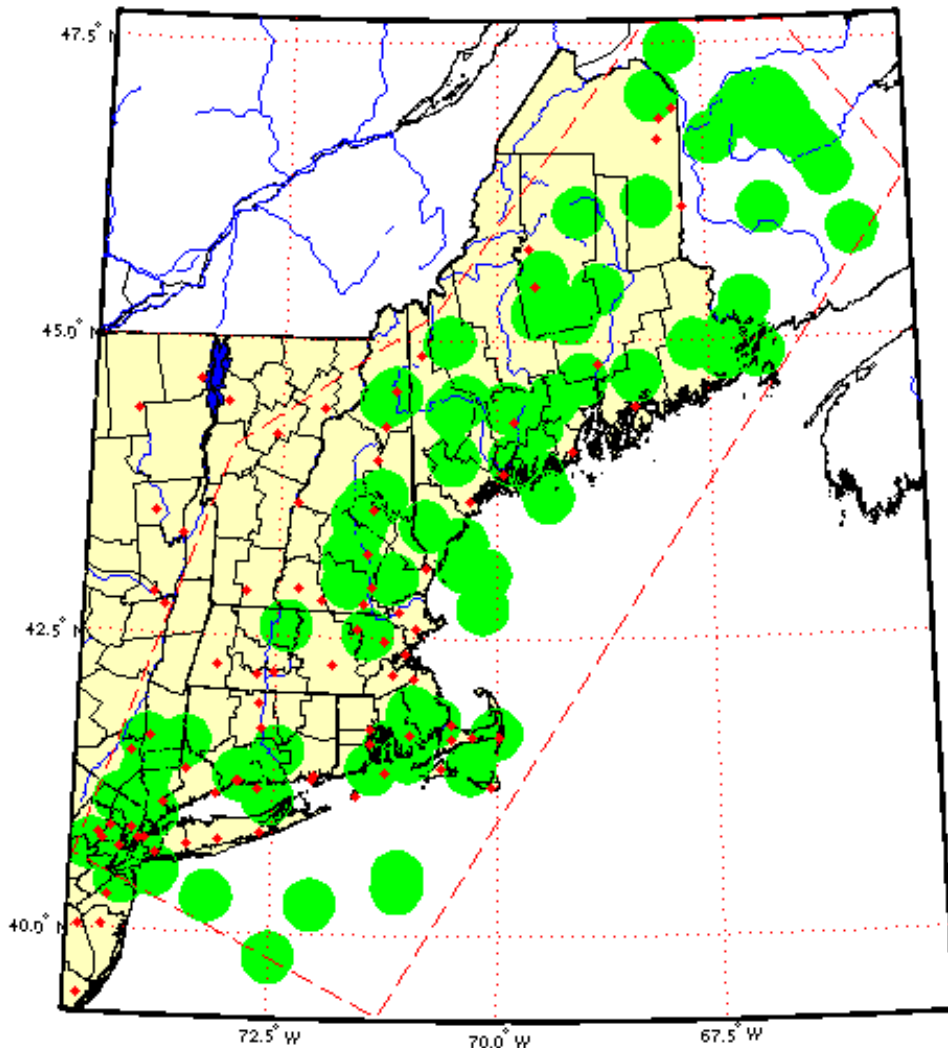
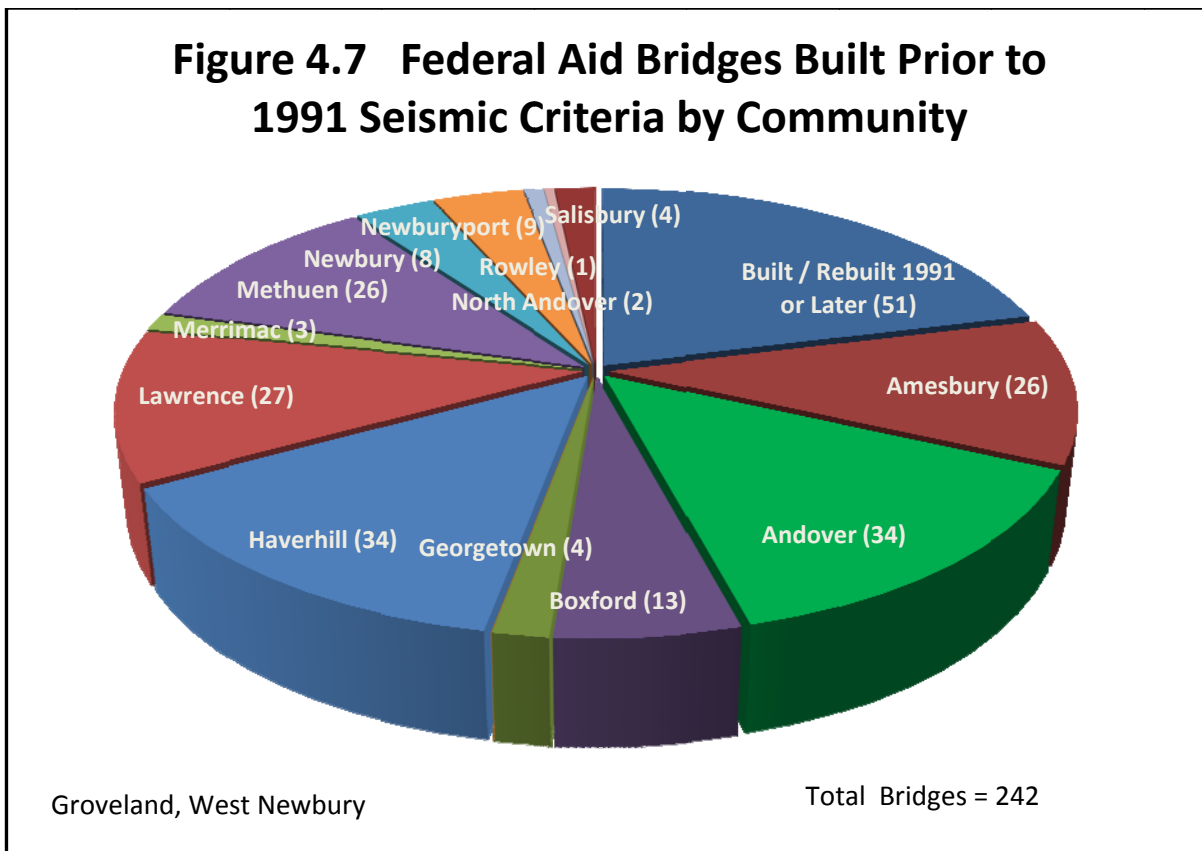


Figure 4-6 above shows the results of an earthquake probability analysis conducted by the Weston Observatory at Boston College. The study examined earthquake activity of magnitude greater than 2.7 between 1975 and 1998. According to the analysis, there is a 66% chance that the next earthquake of magnitude greater than 2.7 will occur in the green areas shown on the map above.

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. For example, only since 1991 has the Commonwealth of Massachusetts required new or rehabilitated bridges to meet minimum seismic criteria. Therefore, many bridges in

the region have an elevated risk of failure during a significant earthquake. As **Figure 4-7** below indicates, 191 of the 242 federal aid bridges (78.9%) in the Merrimack Valley region have not been subject to any specific seismic evaluation because they were built or rebuilt prior to state seismic requirements.



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.

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. The Merrimack Valley region is considered to be at **very low risk** for this type of natural hazard.

4.6 Heat Waves/Extreme Heat

A heat wave is a period of 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 heat stroke. If left untreated, heat exhaustion can progress to heat stroke 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.

Recent statistics in the United States 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 black outs 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 the Merrimack Valley region.

4.7 Climate Change/Sea Level Rise

Scientific assessments indicate that climate change is expected to alter the frequency or severity of weather-related natural hazards, increasing the vulnerability to such hazards. These assessments suggest that the potential effects of climate change on weather-related events could be significant. For example, increasing temperatures may impact communities by altering the frequency or severity of hurricanes, tornadoes, and severe thunderstorms. There is growing evidence that the warming surface temperatures in the sea have increased the destructive potential of Atlantic tropical storms since 1970.

Massachusetts' climate is already changing – 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 snow melt and spring peak flows.² 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. Days with temperatures above 90°F are predicted to increase from 5 to 20 days annually presently, to 30 to 60 days annually. Sea temperatures are expected to increase by 8°F. 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.³

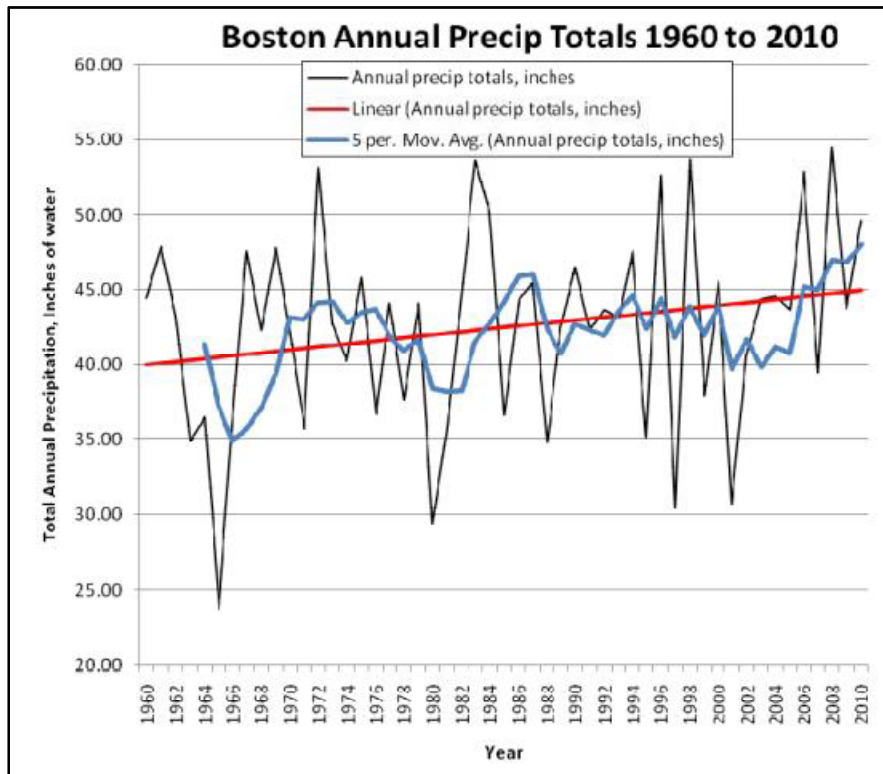
New England is expected to experience changes in the amount, frequency, and timing of precipitation. Since 1900, precipitation recorded at the U.S. Historical Climatology Network weather stations located across the northeast has increased by 5 to 10 percent. In the past few decades, more of the precipitation has fallen during the winter as rain. By the end of the century, annual precipitation is expected to increase 14% with a slight decrease in the summer.⁴ 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. In addition, 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.

² 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.

³ Massachusetts Climate Adaptation Report, Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, September 2011.

⁴ Ibid.

Figure 4-8



Source: National Weather Service

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. Floods caused by high intensity precipitation will also impact the region and the state. Should these events occur with greater frequency as many climate expert 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.

Climate change is also expected to impact the state and local economy. Among the sectors most likely to be affected are agriculture, forestry, fisheries, manufacturing and service industries, tourism, recreation and health care. Establishing redundant supply routes and sources, developing renewable energy sources, and protecting facilities and sites which are vulnerable to flooding, will help minimize the potential economic impact to businesses.

With higher temperatures, electricity demand in Massachusetts could increase by 40% in 2030. Most of the increase would occur during the summer months, requiring significant investment in peak load capacity and energy efficiency measures.⁵

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 the future of our communities and impact their ability to be resilient. Second, given significant time is required to develop adaptive strategies and implementation capacity, acting now will allow the time needed for communities 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.

By creating an engaged community and taking a proactive approach to reducing the region's vulnerability, the region will be better positioned to deal with the increased threats posed by climate change. Some solutions that address climate change can also be viewed as hazard mitigation strategies in that they achieve reductions in greenhouse gas emissions that contribute to global warming and exacerbate the severity and impacts of natural hazards.

Developing effective and efficient initiatives to address climate change will require communication, coordination, and collaboration among government bodies, the private sector, non-profit organizations, academic institutions and other stakeholders. Neither adaptation nor mitigation alone can address the impacts of climate change, but taken together the two programs can reduce the risks of climate change and result in more resilient communities.

The Region's Vulnerability to Climate Change

The most significant vulnerability to structures in the region is that they were designed and constructed based on historic weather conditions. This puts infrastructure at an increased risk of future damage from increased precipitation and flooding. It is expected that increased frequency of extreme weather events will raise the risk of damage to transportation systems, energy-related facilities, communications systems, and water supply and wastewater management systems. Improving siting and design of new structures to include consideration of the impacts of climate change will minimize the region's vulnerability and allow communities to be more resilient. The Insurance Institute for Business & Home Safety (IBHS) released a 2012 report which provides an analysis of residential building codes in the 18 hurricane-prone coastal states along the Gulf of Mexico and the Atlantic Coast. Massachusetts rated fourth with a score of 87 out of 100.⁶

⁵ Ibid.

⁶ "Rating the States: An Assessment of Residential Building Codes and Enforcement Systems for Life Safety and Property Protection in Hurricane Prone Regions", IBHS, 2012.

Municipalities and the State should adjust traditional maintenance and inspection schedules for roadways, bridges and drainage structures to take into account the impacts of climate change. Short-term measures for publicly-owned water and wastewater treatment facilities could include flood-proofing by increasing the elevation of structures, installing water-tight doors and windows, replacing wet/dry well pumps with submersible pumps, increasing emergency back-up provisions to keep key equipment operational, and relocating vulnerable equipment.

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. In addition, 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.

In the Merrimack Valley region's coastal and estuarine communities, increases in sea level rise poses severe consequences for both natural and man-made systems. Sea level rise would increase the height and negative impact of storm surges and associated coastal flooding frequencies, permanently inundate low-lying coastal areas (including commercially valuable shellfish beds), amplify shoreline erosion, and threaten barrier beach and dune systems.

Higher summer temperatures, less summer precipitation, and an increase in drought frequency will impact water quality and quantity. Intermittent streams will cease flowing earlier in the season and some coldwater habitat will be replaced with warm water habitat. The predicted changes in precipitation patterns will also increase stormwater discharge. Hydrologic changes from increased flooding will lead to increased erosion, stream scouring and sedimentation. Overbank floods that once spilled across the floodplain can become confined within the channel and disconnect the waterway from the floodplain. Adaptation strategies should integrate the protection of rivers, streams, lakes, coastal and floodplain, and wetlands with land use, watershed, and floodplain management.

In order to help protect existing structures and minimize or prevent exposure, sound land use decisions should be promoted through technical support to local communities on effective land use standards, model bylaws, and permitting processes. Hazard mitigation, evacuation, and emergency response plans should be evaluated and updated to reflect changing climate conditions and new development patterns.

Climate Change Planning and Adaptation at the State Level

Massachusetts is actively working to reduce greenhouse gas emissions and address climate change adaptation. The Global Warming Solutions Act, passed by the Massachusetts Legislature and signed by Governor Patrick in 2008, directed the Secretary of Energy and Environmental Affairs to convene an advisory committee charged with developing a report that analyzed strategies for adapting to the predicted impacts of climate change. The *Massachusetts Climate Change Adaptation Report* was published in September 2011. The report provides an overview of the observed and predicted changes to Massachusetts' climate and the anticipated impacts, outlines key findings, sets guiding principles, and identifies key adaptation strategies that could help increase resilience and preparedness.

B. Non-Natural Hazards

The Massachusetts Emergency Management Agency (MEMA) is the state agency responsible for coordinating federal, state, local, voluntary, and private resources during emergencies and disasters in the Commonwealth of Massachusetts. MEMA provides leadership in developing plans for 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 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 Regional Hazard Mitigation Plan provides an overview of several hazards that are non-natural and pose a threat to the state, the region, and individual municipalities.

This section of the Regional Hazard Mitigation Plan is intended to 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 communities 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.

According to the *National Preparedness Report* published by the Department of Homeland Security (DHS) in March 2012, the Nation's preparedness capabilities have improved considerably since 9/11. Areas of overall strength include:

- **Planning:** All hazards planning considers routine emergencies and catastrophic events, integrating local perspectives;
- **Operational Coordination:** The National Incident Management System (NIMS) provides a common doctrine for incident management;

- Intelligence and information sharing: A national network of fusion centers and Joint Terrorism Task Forces (JTTFs) brings together federal, state and local law enforcement, intelligence community, and other public safety officials and private sector partners;
- Environmental Response/Health and Safety: A diverse set of federal, state and local assets have the capabilities to address a wide range of routine and large-scale hazardous material and chemical, biological, radiological, nuclear, and explosive incidents;
- Mass Search and Rescue Operations: Federal, state and local resources comprise a comprehensive rescue network;
- Operational communication: Government partners have established communication capabilities tested through exercises and real events; and
- Public Health and Medical Services: A wide range of partners provide a responsive public health and medical network.

4.8 Public Health Emergencies and Hazards

A community or region may face serious illness due to a communicable disease which threatens to overwhelm the public health system. Infectious disease emergencies are extremely rare - while the Massachusetts Department of Public Health (MDPH) receives 10,000 case reports of infectious disease annually, only a small fraction are considered public health infectious disease emergencies. Health care providers, local boards of health, and the MDPH handle most infectious diseases routinely. However, when an infectious disease spreads undetected or undeterred through a community, especially an easily communicable disease with high morbidity and mortality, it is considered an emergency. The longer this type of disease goes unrecognized and untreated, the more severe the impact will be on human health and mortality.

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). The H1N1 flu (also referred to as the swine flu) caused by a new virus first recognized in April of 2009, and was the most recent public health emergency. The H1N1 flu quickly spread to many parts of the world and was identified as a pandemic, or global outbreak impacting Massachusetts.

Bioterrorism is 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 Transportation Accidents

Transportation accidents can occur in any community. Automobile accidents occur with great frequency across the region, while rail accidents occur less frequently and are isolated to areas where active lines exist. Aircraft accidents occur with the least frequency but have the potential to affect the region, given current flight paths and patterns for local and regional airports.

MVPC has an ongoing safety program aimed at identifying, reducing and mitigating motor vehicle crashes within the region. Using crash data collected by MassDOT and the Registry of Motor Vehicles, the top 100 most hazardous intersections within the region were identified. Over a three-year period extending from 2008-2010, a total of 20,056 crashes were reported within the Merrimack Valley region. Twenty-four percent (24%) of the crashes resulted in non-fatal injuries, while 43 crashes involving fatalities were reported. **Table 4-13** provides a summary of the total crashes reported in each of the Merrimack Valley communities.

Table 4-13. Total Crashes by Community in MVPC Region (2008 – 2010)				
Community	Total Crashes	Roadway Miles	Crashes per Roadway Lane Mile per Year	Percent of Crashes for Region
Amesbury	883	161.66	1.82	4.4%
Andover	2,311	498.65	1.54	11.5%
Boxford	300	224.36	0.45	1.5%
Georgetown	314	149.08	0.70	1.6%
Groveland	54	77.36	0.23	0.3%
Haverhill	4,784	539.91	2.95	23.9%
Lawrence	3,790	285.20	4.43	18.9%
Merrimac	222	100.36	0.74	1.1%
Methuen	3,774	444.74	2.83	18.8%
Newbury	219	144.03	0.51	1.1%
Newburyport	744	167.44	1.48	3.7%
North Andover	1,406	281.44	1.67	7.0%
Rowley	247	97.03	0.85	1.2%
Salisbury	852	123.51	2.30	4.2%
West Newbury	156	96.37	0.54	0.8%
MVPC Region	20,056	3,391.14	1.97	100.0%

Source: MassDOT 2011 Road Inventory File

4.10 Nuclear Event

As described in the joint Nuclear Regulatory Commission and Federal Emergency Management Agency publication “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants” (NUREG-0654 REMA-REP-1 Rev.1), a radioactive plume released from a nuclear power plant consists of gaseous and/or particulate material. Three dominant modes of exposure have been identified from atmospheric releases: external whole body irradiation, inhalation, and ingestion. External whole body irradiation is direct exposure from gamma radiation in or from the plume. Internal exposure occurs primarily through the inhalation of airborne radioactive material in the plume or from breathing re-suspended material deposited from a passing plume. Ingestion is exposure to radiation following the consumption of contaminated food or water by mouth.

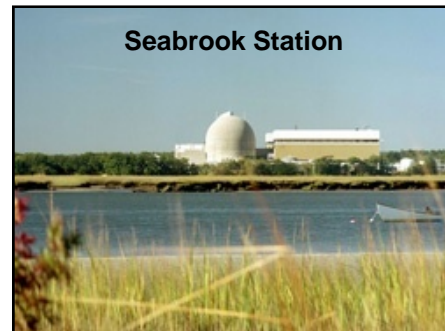
Exposure to radiation is measured on a dose equivalent basis. Dose equivalent (or effective dose) combines the amount of radiation absorbed and the medical effects of that type of radiation. For beta and gamma radiation, the dose equivalent is the same as the absorbed dose. By contrast, the dose equivalent is larger than the absorbed dose for alpha and neutron radiation, because these types of radiation are more damaging to the human body. Units for dose equivalent are the roentgen equivalent man (rem) and sievert (Sv), and biological dose equivalents are commonly measured in 1/1000th of a rem (known as a millirem or mrem).⁷ Linear no-threshold (LNT) dose-response relationship is used to describe the relationship between radiation dose and the occurrence of cancer. This dose-response model suggests that any increase in dose, no matter how small, results in an incremental increase in risk. The U.S. Nuclear Regulatory Commission (NRC) accepts the LNT hypothesis as a conservative model for estimating radiation risk. The greater the dose received the greater the potential for biological effect. However, it is impossible to predict precisely how an individual will respond to a particular dose, as effects will vary from one person to another.

The average annual whole body dose equivalent from all natural sources of radiation in the U.S. is estimated to be approximately 360 millirems. This dose results from exposure to cosmic and terrestrial radiation sources and radiation from internally deposited radio nuclides. Additionally, the use of x-rays and radioactive materials in medicine and dentistry add to overall population doses.

Radiation effects can be classified in two categories, early or delayed, but these categories are not mutually exclusive. Early acute effects of radiation exposure generally occur within 90 days from exposure, and may include fatalities, symptoms of acute radiation syndrome, or clinically detectable changes in blood and chromosomes. However, emergency protective actions can be taken to prevent or minimize these effects. Delayed effects of radiation exposure (i.e., biological effects that can only be observed on a statistical basis) could occur in some members of a

⁷ <http://www.nrc.gov/about-nrc/radiation/health-effects/measuring-radiation.html>

population that has been exposed to radioactive materials. The effects may include fatalities or disabilities of anatomical or genetic origin.



The Nuclear Regulatory Commission (NRC) and the Environment Protection Agency (EPA) utilize the emergency planning zone (EPZ) concept. EPZs are designated areas for which plans are prepared to ensure that prompt and effective actions can be taken to protect the public in the event of an incident at a nuclear power plant. There are three EPZs that impact Massachusetts. The Pilgrim Nuclear Power Station located in Plymouth and operated by Entergy Nuclear Northeast is the only nuclear power generation facility located within the borders of Massachusetts. Two other licensed facilities are located just over the border from Massachusetts. These include the Vermont Yankee Nuclear Power Station (Vermont Yankee) located in Vernon, Vermont, and operated by Entergy Nuclear Northeast; and Seabrook Nuclear Power Station, located in Seabrook, New Hampshire, and operated by NextEra Energy.

The Seabrook Nuclear Power Station is located on 900 acres north of the Merrimack Valley region in the seacoast region of southern New Hampshire. The plant is sited in one of the lowest hazard zones for earthquakes, according to the U.S. Geological Survey, and is designed to withstand an earthquake significantly higher than any recorded in New England history. The plant lies two miles inland and is elevated 20 feet above sea level to protect against coastal flooding and extreme storm surges. With its 1244 megawatts of electrical output, Seabrook station is the largest individual electrical generating unit on the England power grid.

West of the Merrimack Valley region, the University of Massachusetts Lowell (UML) operates a small nuclear reactor that is utilized for educational purposes. The UML Nuclear Reactor is water cooled and operates at a maximum power level of one megawatt. It is used primarily for training and research in the fields of nuclear science, radiochemistry and engineering. The reactor is housed in a containment building which is part of the UML Radiation Laboratory.

4.11 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.

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. Communities should consider mitigation measures such as installing emergency generators, burying cable, installing back-up systems, and undertaking regular vegetation management (tree and brush pruning) to help reduce risks.

The New York Blackout of 2003, the December 2008 Ice Storm, and the October 2011 Snowstorm resulted in widespread power outages of up to five days. These outages significantly impacted the delivery of services, the Merrimack Valley regional economy, and the quality of life for the Valley's residents.

4.12 Commodity Shortages

Commodities are goods that are in demand in an emergency, such as food, fuel, and medicine. For example, petroleum shortages in Massachusetts may be caused by natural disasters in the Commonwealth itself or in those parts of the world which supply petroleum. The shortage may be created by geopolitical events such as revolutions, embargoes, or war, or by economic factors that drive up prices or reduce available supply.

Petroleum Shortages

Massachusetts is particularly vulnerable to petroleum shortages during the winter months due to a combination of high demand for home heating oil and severe weather that may impact regional distribution mechanisms. This vulnerability is in spite of increasing shift over the past decade from oil to natural gas as power source. Today half of Massachusetts households are heated by natural gas and 31.6% by oil. (Mass. DOER, 2014). Massachusetts and New England in general are logistically isolated from major U.S. refineries and oil pipelines, and depend on imports, from domestic and foreign sources.

Historically, there have been several events that have impacted the price and availability of petroleum. The Arab Oil Embargo in 1973 led to increased fuel prices and rationing throughout the United States. In 1979, the Iranian Revolution caused a steep decline in that country's oil exports, which in turn caused a spike in fuel prices in the United States. Severe weather in January and February of 2000 not only increased demand in Massachusetts, but limited supply as weather conditions slowed the docking and unloading of barges and tankers. In 2005, Hurricane Katrina shut down refineries and oil rigs in the Gulf of Mexico, leading to price spikes in Massachusetts due to limited supplies. In the summer of 2008, oil prices skyrocketed to almost \$150 per barrel, creating concern that residents would have difficulty

affording the oil needed to heat their homes in winter. The volatility of oil market pricing is such that by Winter 2014-2015, because of technology advances that have enabled increased domestic natural gas supply, oil prices had fallen to their lowest level in a decade to \$50 per barrel (Jan. 2015).

The *Merrimack Valley Clean Energy Action Plan* (MVPC, 2012) and the *Merrimack Valley 2012 Regional Transportation Plan* (MVPC, 2011) outline policies that will result in reducing fossil fuel use in buildings, power generation, and transportation. The use of renewable energy sources would help to reduce greenhouse gas emissions, manage energy costs, and reduce reliance on fossil fuels, thereby creating a more sustainable energy future for the Merrimack Valley region. Increased reliance on local solar, wind, and geothermal energy sources would provide a buffer against the fluctuations in supply and prices of traditional fossil fuel markets.

Natural Gas Shortages

Natural gas shortages may be caused by a natural disaster, disruptions to pipelines and other facilities which transport natural gas, geopolitical events such as revolutions, embargoes or war, or by economic factors that drive up prices or reduce available supply. New domestic supplies from the Marcellus Shale in Pennsylvania and New York and increased demand for natural gas have spurred recent initiatives for new pipelines to New England from the Mid-West and mid-Atlantic. Liquefied natural gas (LNG) is also imported through the Distrigas facility in Everett. Massachusetts has been part of the Independent System Operator-New England regional energy market since 1999. The ISO-NE electric grid has an operating capacity of 31,000 Mega-Watts generating capacity and in Massachusetts in September 2014, according to the Massachusetts Division of Energy Resources, 71% of the electricity generated by power plants in the Commonwealth are from natural gas, 18% from nuclear, 2.3% from coal & petroleum, and 8% from hydro or renewable energy sources. Concern for natural gas supply reliability and, most recently, for overdependence on natural gas as a power source has been raised more frequently as a regional issue. During the three winter months, interstate pipelines feeding Massachusetts operate at over 90% of capacity. Half of all homes in Massachusetts are heated with natural gas.

Severe winter weather can cause increased demand for natural gas for heating and electric power generation, along with delays of over-the road transportation of LNG to satellite facilities. Hurricanes in the Gulf of Mexico may shut down or damage natural gas infrastructure in that area. Intensely cold weather in January 1981, combined with disruptions in the supply of liquefied natural gas created by storm off the coast of Algeria which disrupted tanker shipments, caused the Governor to declare an energy emergency in Massachusetts. Schools heated by natural gas were closed, non-residential buildings were ordered to lower thermostats to 55 degrees, and residential customers were urged to lower their thermostats by ten degrees.

Electricity Shortage

Electricity shortage may be caused by a sudden increase in demand due to weather conditions, a shortfall in generating capacity, or by power issues in neighboring regions that decrease available electricity reserves. An electricity shortage is distinguished from a power failure in that the electric transmission infrastructure has suffered little or no damage.

All areas are vulnerable to electricity shortages. Shorter-duration heat waves (2-3 days) may cause demand surges, generator stresses/outages, and transmission problems. A prolonged heat wave may lead to electricity supply problems, rolling blackouts, and health and safety risks if priority users cannot be supplied with power. Electricity problems in neighboring power pools may deplete available electricity reserves, leading to supply problems if conditions in New England deteriorate.

Disruptions in the supply of natural gas or petroleum may impact generating capacity in the region. Disruptions to generation plants or key transmission lines due to natural disasters, mechanical failure, or deliberate action may reduce the supply of electricity. National Grid is the delivery company for the region. Many of the region's smaller communities—Rowley, Georgetown and, Groveland—are served by municipal lighting departments.

4.13 Food Contamination/Food-borne Illnesses

Food-borne illnesses are caused by more than two hundred different pathogens, including viruses, bacteria, parasites, toxins, chemical contaminants, and metals. Symptoms of food-borne illness range from mild stomach upset to life-threatening neurological conditions, liver and kidney syndromes, or even death. All communities are vulnerable to food-borne illness. According to the Centers for Disease Control (CDC), there are approximately 76 million cases per year of illness from food-borne agents, including about 325,000 hospitalizations and 5,000 deaths. Most cases of food-borne illness are natural or accidental in nature, but deliberate contamination of food for financial gain or as an act of terrorism is possible.

In addition to illnesses and deaths, food contamination can cause significant economic impact to the food industry through the effects of recalls and decreased consumer confidence. Changes in demographics and consumption patterns have increased susceptibility to food-borne pathogens and contamination. Approximately 25% of the population is in a high-risk category from food-borne illness (e.g. young, elderly, pregnant, immune compromised). Furthermore, people are increasingly consuming ready-to-eat and prepared foods, and these “convenience foods” are at higher risk of cross-contamination from other foods and/or from food workers. Consumers are also eating a greater variety of foods year-round, particularly those consumed raw or with minimal processing, which are often associated with food-borne illness. In addition, a greater proportion of foods are imported now than in the past, some of which come from countries with less well-developed food safety systems.

In September 2011, Colorado's state health department reported to CDC an outbreak of listeriosis. From August to October, the outbreak reached 28 states, and 146 cases of invasive listeriosis were confirmed and reported to public health officials. Ultimately, thirty patients died. The outbreak made national headlines as the deadliest outbreak of food-borne illness since 1924.

4.14 Water Contamination/Water-borne Illnesses

Water supplies in the Merrimack Valley region may be contaminated by pathogens, such as *E. coli* or *Giardia*, or by chemicals from stormwater runoff or point sources such as industrial sources or storm sewers. Infants, young children, the elderly, pregnant women, and the immune-compromised are particularly vulnerable to water contamination and water-borne illness. There is also an economic impact if public water supplies are unusable for extended periods, as businesses which rely on these supplies must remain closed and bottled water is substantially more expensive per gallon than tap water.

When water supply contamination is suspected, boil water orders are issued by MassDEP to local public water suppliers, who in turn issue advisories to their consumers recommending that they boil their tap water for drinking and other human-consumption uses like cooking, hand washing, and brushing teeth. Boil water orders are preventative measures issued to protect public health from water-borne infectious agents that are known to be or could be present in drinking water. When a boil order is issued by MassDEP to the local public water supplier (PWS), the PWS must take appropriate corrective action, notify/advise its customers, continue to monitor its water supply, and notify customers when it has remedied the problem and the boil water order has been lifted.

4.15 Chemical/Hazardous Materials Spills and Releases

Chemical agents are poisonous vapors, aerosols, liquids, and solids that have a toxic effect on people, animals, or plants. Such agents can be released by accident, by bombs, or sprayed from aircraft, boats, and vehicles. They can have an immediate effect (a few seconds to a few minutes) or a delayed effect (2 to 48 hours). While potentially lethal, chemical agents are generally difficult to deliver in lethal concentrations. Outdoors, the agents tend to dissipate rapidly. Chemical agents also are difficult to produce. A chemical attack could come without warning. Symptoms of a chemical release include difficulty breathing, eye irritation, loss of coordination, nausea, or a burning sensation in the nose, throat, and lungs. The presence of many dead insects or birds may also indicate a chemical agent release.

Chemicals are found throughout our communities. They are used to purify drinking water, increase crop production, and simplify household chores. But chemicals can be hazardous to humans or the environment if used or released improperly. Hazards can occur during production, storage, transportation, use, or disposal processes.

Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or because of chemical accidents at industrial plants. A hazardous material spill or release can pose a risk to life, health or property. An incident can result in the evacuation of a few people, a section of a facility or an entire neighborhood.

There are a number of Federal laws that regulate hazardous materials, including: the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Resource Conservation and Recovery Act of 1976 (RCRA), the Hazardous Materials Transportation Act (HMTA), the Occupational Safety and Health Act (OSHA), the Toxic Substances Control Act (TSCA) and the Clean Air Act. Title III of SARA regulates the packaging, labeling, handling, storage and transportation of hazardous materials. The law requires facilities to furnish information about the quantities and health effects of materials used at the facility, and to promptly notify local and State officials whenever a significant release of hazardous materials occurs.

Communities with a large industrial base may be more likely to experience a hazardous materials release due to the number of facilities that use such materials in their manufacturing processes. Communities with major highways or rail corridors may also be at a greater risk due to the number of trucks or trains transporting hazardous materials.

4.16 Terrorism

Terrorism is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom. Terrorists bypass established institutions (such as courts), using violence against citizens to force changes in society or to force governments to change policies in support of their cause. Terrorists might use weapons of mass destruction, such as toxic or poisonous chemicals, disease causing organisms, dangerous radiation, explosive, incendiary or poison gas bombs, grenades, rockets or missiles, mines or similar devices. Terrorists may also use traditional weapons such as automatic guns or grenades in armed attacks on targets.

The terrorist attacks of September 11, 2001 had a profound impact on the nation, the state and the region. A series of four suicide attacks were carried out by nineteen terrorists from the Islamist militant group al-Qaeda. The attacks involved the hijacking of four passenger jets. Two of the planes were flown into the towers of the World Trade Center in New York City, a third plane hit the Pentagon just outside Washington, D.C., and the fourth plane crashed in a field in Pennsylvania. The two passenger jets that struck the World Trade Center, American Airlines Flight 11 and United Airlines Flight 175, originated from Logan Airport in Boston. Following this attack, a presidential disaster declaration was made that provided \$1.5 million in FEMA Individual Household Program funds for Massachusetts residents who requested crisis counseling.

Depending on the severity and type of a terrorist attack, many things can impact a community or the region overall:

- There could be casualties;
- Significant damage to buildings and the community's infrastructure;
- Health and mental health resources in the affected communities could be strained to the limit or overwhelmed;
- There could be heavy involvement of law enforcement at local, state and federal levels, due to the event's criminal nature;
- Evacuations may be necessary;
- Workplaces and schools may be closed;
- There may be restrictions on domestic and international travel;
- Cleanup could take months; and
- Public fear could continue for a prolonged period.

High-risk targets for acts of terrorism include military and civilian government facilities, as well as high-profile landmarks. Terrorists might also target large public gatherings, water and food supplies, utilities, public transportation facilities, and corporate centers.

Since 1995, MEMA has conducted multiple anti-terrorism programs, training thousands of local, state, and federal public safety officials, hospital emergency room personnel, and emergency management personnel, through classes in Anti-Terrorism, Incident Command, and Hazmat Awareness, including chemical-biological threats. To ensure adequate preparedness, MEMA has conducted hundreds of exercises in conjunction with local communities and other state and federal agencies.

The MEMA Planning Department works closely with communities to ensure that the all hazards Comprehensive Emergency Management Plans (CEMP) are current. These local plans include a Terrorism Annex, which helps local officials focus on specific potential terrorist threats to their particular community. The Massachusetts Statewide Anti-Terrorism Unified Response Network (SATURN) is an information sharing and first responder network created to enhance the existing public security delivery system. SATURN brings together fire, emergency management, and police personnel from each municipality, and provides a process for receiving and exchanging information during a terrorist threat.

The Commonwealth maintains a fusion center which is defined by the Global Justice Information Sharing Initiative as: "a collaborative effort of two or more agencies that provide resources, expertise, and/or information to the center with the goal of maximizing the ability to detect, prevent, apprehend and respond to criminal and terrorist activity." The Commonwealth Fusion Center operates around the clock and provides terrorist-related intelligence and public safety and security information to state, local and federal public safety interests. The CFC also serves as a clearinghouse for information and information requests between the state's public and private safety and security entities, as well as DHS.

SECTION 5. COMMUNITY PROFILES, CRITICAL FACILITIES, AND RISK AND VULNERABILITY ASSESSMENTS

A. Natural Hazard Risks for the Merrimack Valley Region

This section of the Hazard Mitigation Plan identifies and assesses the natural hazard risks in each of the 14 participating communities. The section is organized in individual community subsections that provide information, as applicable, on each community's flood prone areas, repetitive loss structures, structurally deficient bridges over waterways, and the hazard potential of local dams.

In preparing the risk assessments, a database was developed of each 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 the Emergency Managers, and the Fire, Police, and Public Works personnel within each municipality. During individual community meetings, the list of critical facilities was reviewed and updated to reflect the most current information. For example, several new schools have been built in the region since completion of the 2008 Pre-Disaster Mitigation Plan, so these were added. Some of these new facilities have emergency backup generators, and therefore, are a logical choice for emergency shelter locations. The list of critical facilities and infrastructure inventoried for each community included the following:

44 CFR Requirement

Part 201.6c(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 hazard events.*

Critical Facilities and Infrastructure

1. Emergency Operations Center
2. E911 Dispatch Center
3. City/Town Offices
4. Police Stations
5. Fire Stations
6. Emergency Shelters
7. Public Works Garages
8. Water Treatment Plants
9. Water Pumping Stations and Storage Tanks
10. Sewage Treatment Plants
11. Sewage Pumping/Lift Stations
12. Solid Waste Transfer/Disposal Facilities
13. Transportation Hubs (Bus, Train, Air)
14. Electric Power Plants and Substations

15. Telephone/Cell/Communications Facilities
16. Hospitals and Clinics
17. Elderly Housing/Senior Centers
18. Nursing Homes
19. Day Care Facilities
20. Schools and Colleges
21. Libraries
22. Courts
23. Bridges
24. Dams
25. Evacuation Routes
26. Historical/Cultural Assets
27. Problem “Hotspots”, based on local knowledge

The 2008 Plan list was expanded to include the two additional categories of “Evacuation Routes” and “Historical/Cultural Assets”, based on the recommendation of various local hazard mitigation team members, and with information from emergency managers, city/town planners, and historical commission representatives.

The above facilities are part of an electronic database and are graphically displayed on individual maps for each community. The maps are included as Attachments 1 through 14 of this document. In addition to providing information relative to critical facilities, each community was also invited to identify other sites that are of key local concern or are known problems areas (such as chronic stormwater choke-points or localized flooding hotspots), although these areas may not show up on state, regional, or even town-wide inventories. This information was also mapped using GIS and linked to a corresponding electronic database.

Finally, a relative risk assessment was conducted for each community, based on information contained in the community’s CEMP and the judgment of emergency management personnel, taking into consideration the historic occurrence of natural hazards, and utilizing data available through the municipalities, MEMA, and other sources. The risks identified by each community were then averaged to quantify the overall risk to the region. For the most part, the risks have not changed appreciably since the completion of the 2008 Plan.

Figure 5-1 on the following page represents a weighted aggregation of the communities’ risk assessments, and serves as a tool for focusing attention on key regional issues. In each CEMP, the community assesses natural hazards on a scale of low, low-moderate, moderate, moderate-high, and high. In order to assess the relative risks of these hazard events on a **regional** level (i.e., across all 14 participating communities), a point scale was established as follows: *low* risk = 1 point, *low-moderate* risk = 2 points, *moderate* risk = 3 points, *moderate-high* risk = 4 points, and *high* risk = 5 points. Therefore, the lowest possible regional score a single risk event could tally would be “14” (i.e., 1 point per community times the 14 communities). Similarly, the highest possible score a single event could achieve regionally would be “70” (from 5 points per community x 14 communities = 70points).

**FIGURE 5-1. Region-Wide Natural Hazards Risk Assessment
(14 Communities)**

Natural Hazard	Composite Score	Regional Risk
Floods	70	HIGH
Winter Storms (blizzard/snow/ice)	70	HIGH
Northeasters	70	HIGH
Power Outages	52	Moderate
Hurricanes	44	Moderate
Wildfire/Brush Fires	38	Moderate
Dam Failure	38	Moderate
Drought	36	Moderate
Earthquakes	22	Low
Landslides	16	Low
Tornado	14	Low

B. Natural Hazard Risks By Community

5.1 TOWN OF ANDOVER Natural Hazard Risk Assessment

Community Profile

The Town of Andover is located in Essex County in the northeastern part of Massachusetts, approximately 23 miles north of Boston. Its land area lies within three watersheds: the Merrimack River watershed; the Shawsheen River watershed; and the Ipswich River watershed.



Andover is bordered on the north by the cities of Lawrence and Methuen, on the east by the town of North Andover, on the south by the towns of North Reading and Wilmington, and on the west by the towns of Tewksbury and Dracut. Andover has approximately 31 square miles of land area and 223 miles of roadways.

Andover, with 223 miles of roadway, is bisected by two major highway systems, Routes 93 and 495, and a number of secondary roadways including Routes 28, 133, 114, and 125. Public transportation is available via two commuter rail service stations (Ballardvale, Andover) from Andover to the metropolitan Boston area provided by the Massachusetts Bay Transportation Authority. Commuter bus service to Boston is operated by the Merrimack Valley Regional Transit Authority, the regional transit service provider in the region. The MVRTA also operates local bus service that connects Andover with downtown Lawrence.

Andover has a population of 33,201 people and 11,851 households (2010 U.S. Census). The Town experienced very rapid growth in the early post WWII years and doubled its population between 1945 and 1970. As the Town approaches build-out under its zoning blueprint, growth is moderating, but is still strong. From 2000 to 2010, the Town's population increased by 6.3%, more than the 3.1% Massachusetts growth rate and greater than the 4.8% population increase for the Merrimack Valley region.

During the 2013-14 school year, 6,110 pupils enrolled in the public school system. Additional students attend private schools at Phillips Andover Academy, Pike School, St. Augustine's Grammar School, Andover Montessori School, and others. Merrimack College, located in North Andover, houses students in dormitories located in Andover.

Andover has land area of 31 square miles with a 2010 population density of 1,076 people per square mile. The predominant land uses are forest land (43%) and residential development (27%). Commercial & industrial development represent 5% of the Town's land use; and wetlands and water area make up 14.5% of the Town. Farming, once an important part of the Andover landscape and economy, today constitutes only 252 acres, 1% of the community land area.

Public drinking water, serving 99% of residential households, is supplied locally and drawn from three sources, the primary being Haggetts Pond, a 220-acre glaciated natural pond. The Haggetts Pond reservoir is supplemented with water pumped from Fish Brook and the Merrimack River.

Wastewater disposal is conducted by both a municipal sewer system that is treated at the Greater Lawrence Sanitary District and on site septic systems. There are approximately 4,200 acres of preserved open space in Town managed by the Commonwealth of Massachusetts, the Andover Conservation Commission, or the Andover Village Improvement Society (AVIS)

Land Use Development Activity/Changes Since the 2008 Plan

Andover has continued to build on its economic assets of real estate value, convenient transportation access and quality government services. It has a thriving downtown and desirable industrial parks. The Town, as of 2010, is home to 32,011 jobs making Andover the largest employment address among Merrimack Valley communities. Major employers include Raytheon, Phillips Healthcare, Pfizer Biopharmaceuticals, Putman Investments, Schneider Electric, Vicor Computer Equipment, Verizon Communications, Hewlett Packard, Enterasys and Smith & Nephew Medical Devices.

Recent land use initiatives included adoption of Industrial 2 Zoning District along sections of River Road and Dascomb Road as a smart growth zoned area to accommodate service-focused development and pedestrian access between homes, employment and service conveniences and, in Spring 2015, adoption of the Andover Historic Mill District, an area of 100 acres stretching from Dundee Park to Whole Foods and from Main Street to the Shawsheen River. Because of these tools and the Town's management of new development, Andover according to its planning and conservation officials, is less vulnerable to high hazard events than it was when this Multi-Hazard Mitigation Plan was first prepared in 2008.

The Town over the past five years is also one of the few Commonwealth communities to surpass the 10% threshold goal under Chapter 40B of subsidized housing inventory.

MVPC projections of housing and employment for Andover forecast a 22% increase in the Town's population by 2030 to 36,500 people and a 26% increase in employment to 40,354 jobs.

Below is a listing of major development projects in Andover, that as of early 2015, are recently completed or various phases of planning, permitting or construction.

Andover Development Projects					
Project Name	Project Type	Status	Completion Year	Total Housing Units	Approx. Sq. Ft. Non-Res
Rolling Green	Residential-Apts	Construction	2015	224	
Franciscan Site	Residential	Projected	2018	44 single family or senior community with 200+ individual units	
Downtown Potential 40R	Mixed Use	Projected	2018	24 acres around MBTA station	
Medical Center	Commercial	Completed	2014		30,000
Medical Center	Commercial	Planning	2016		30,000
Merrimack College Dormitories	Residential	Planning	2015	117	

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.1-1**, on the following page was derived from the Town's current Comprehensive Emergency Management Plan (CEMP) and the Emergency Management Planning Committee. The locations of these and other critical facilities and infrastructure were entered into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The critical facilities are depicted in the Andover map series that is presented in **Appendix F** of this Plan.

Table 5.1-1. Andover Emergency Operations, Health Care Facilities, and Shelters

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Patient Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center(s)	State Police HQ Andover Police Public Safety Center	Andover By-Pass 32 N. Main Street					Yes
	Andover Fire	Andover By-Pass Central 32 N. Main St; Ballardvale 163 Andover St West 200 Greenwood Road					Yes Yes Yes
	Water Treatment Plant/Backup Operations Center	397 Lowell Street					Yes
Health and Nursing Facilities	Health Center at Greater Lawrence Voc-Tech School	57 River Road	Med clinic	N/A		Yes	Yes
	Wingate at Andover	80 Andover St.	Nursing Home	135 beds	135	Yes	
	Academy Manor (Genesis Health Care)	89 Morton St.	Nursing Home	174 beds	174	Yes	Yes
	Isham Health Center (upgrades underway 2015, to be complete Jan. 2016)	Phillips Academy	Clinic	18 beds	18 + 6 day beds	N/A	Yes
Shelters	Andover Youth Center (to open end of year 2015)	Bartlett Road (rear Town Hall & Doherty School)		NA	200+	Yes	Yes
	Memorial Hall Library (used as warming station/reception area)			NA	400 seats	No	No

Flood Prone Areas

The Town of Andover spans parts of three major watersheds, as defined by the state: Shawsheen River watershed (50% of town), Merrimack River watershed (33%), and Ipswich River watershed (17%).

MVPC conducted a GIS analysis using July 2014 FIRM flood hazard maps and determined that 1,791 acres, 8.7% of the land area in town, is located within the 100-year floodplain and thus vulnerable to flooding. An additional 605.7 acres lies within the 500-year floodplain.

Together, these two flood zones constitute 11.65% of the total area of the community. The majority of the flood prone areas in Andover are along the Shawsheen River, although there is also localized flooding along smaller tributaries in the community. Fish Brook as it crosses under Greenwood Road and High Plain Road historically is a problem, and Rogers Brook is partially culverted as it passes through the center of town, where the culvert can be easily overwhelmed. The following is a list of areas prone to flooding:

Table 5.1-2. Critical Facilities in Flood Hazard Areas – Andover		
Facilities in 100-Year Floodplain		
Facility Name	Parcel ID / Street Location	2014 Buildings Valuation
Atria Marland Place/Assisted Living	15 Stevens Street/Parcel ID 4011	\$7,821,200 (129 units)

Andover Flood Prone Areas

1. Shawsheen Village where the Shawsheen River runs between North Main Street and Interstate 495, including the areas of Riverina Road, Haverhill Street, Balmoral Street, Shawsheen White section, and Washington Park.
2. Powdermill Square, where the Shawsheen River runs between Stevens Street and North Main Street.
3. Shawsheen River at Andover Street.
4. Shawsheen River at River Street.
5. Shawsheen River at Central Street
6. Fish Brook at Greenwood Road
7. Fish Brook at High Plain Road
8. Skug River at Salem Street
9. River Street at Laconia (outlet from Fosters Pond)
10. Unnamed stream at Woburn Street (outlet from Fosters Pond).



The 1996, 1998, and subsequent floods in 2006 and 2010 showed the FIRM flood hazard areas to be generally accurate in predicting areas that would be impacted by flooding. The Mothers Day Flood of 2006 resulted in severe damage to buildings on Balmoral Street, Haverhill Street, North Main Street, Washington Park, and other nearby properties. In all, approximately 350 dwelling units were damaged by the flooding Shawsheen River along North Main Street between Stevens Street and the Kenilworth Street Bridge.



Shawsheen River Flooding in Andover – May 2006

Based on the frequency, areal extent, and severity of historical floods in selected areas of Andover, Town officials consider the community to be at **high risk** from flooding.

Special Flooding Concerns

The flooding impacts can be broken into four sections of the Shawsheen River, as follows:

1. Shawsheen River at Main Street

The Shawsheen River narrows as it enters the area known as Powdermill Square at Stevens Street. The former mill has been redeveloped into housing units and an assisted living facility that have been threatened by flooding. During the 2006 flood, the bottom level of the assisted living facility was damaged by the flood, resulting in the temporary evacuation of the structure. The housing units were not damaged but were threatened as the flood storage behind them was filled.

The narrow riverbed forces the river to run swiftly beneath and over the North Main Street Bridge where the row houses along that stretch flood during each event. Beyond the bridge, the river sweeps around a bend as it bisects a low-lying shopping plaza and residential condominium. The shopping plaza was saved from flooding only after Market Basket brought in sand bags and pumps to prevent the store from being totally inundated; as it was, part of the dry storage area did flood.

2. Washington Park Condominiums

The Washington Park Condominiums are built on a peninsula into the river, and most of the buildings were damaged in the flood. The three buildings along North Main Street all sustained damage to their basement units as well as the buildings' mechanical systems. Most of the other buildings suffered some sort of damage to their mechanical systems. The entire property of 167 units was evacuated at the height of the rains. Washington Park is currently seeking ways to prevent the building damage in the future through the creation of hard mitigation structures.

3. The Balmoral

Continuing downstream, the flooding impacted dwellings and businesses along North Main Street to the Balmoral Building. The Balmoral is a former school that has been converted into 86 dwelling units, including four in the basement. The flooding completely inundated all four basement units, which have not been rebuilt and most likely will not be. The basement also contained all utilities, which were completely damaged and required replacement. This resulted in the evacuation of the building as electricity was shut off. The Balmoral is seeking ways to prevent future damage through mitigation efforts in the area.

In this same area, municipal athletic fields served as flood storage areas, but dwellings abutting them had their basements flooded; oil storage tanks in the basement were known to have rolled over and released product to the environment.

4. Riverina Road

Riverina Road runs parallel to the Shawsheen River with homes on one side and the river on the other. Most dwellings on that section were damaged with basement flooding. Electricity was cut to the area, and several homes were damaged when oil storage tanks in their basements were toppled and spilled their contents.

All of the above four areas would benefit from mitigation efforts downstream that would create additional flood storage. The May 2006 flood was the result of the surge of the Merrimack River causing a backup of the Shawsheen River, which in turn caused the backup to proceed upstream. The lack of flood plain storage through this area forces water to overtop the riverbanks, and thus damage property. ***A comprehensive study of the entire stretch of the Shawsheen River from its confluence with the Merrimack River (Lawrence-North Andover) upstream through Andover is needed.***

Repetitive Flood Loss Structures

According to file data provided by the MA Department of Conservation and Recreation, there are 29 repetitive loss sites in Andover. Nine of the properties are classified as single-family residential. The remaining sites are a mix of multi-family and non-residential properties. Together, these 29 properties have resulted in the payout of 81 National Flood Insurance Program (NFIP) claims totaling \$5.4 million since 1982. (Twenty three repetitive loss claims followed March 2010 flooding along the Shawsheen banks.)

According to FEMA, there are 396 flood hazard insurance policies in force for Andover properties. Insurance value of these properties is \$96.9 million. (Source: *FIRM Policy Statistics, 6/30/2014*)

Structurally Deficient Bridges Over Waterways

According to file data compiled by MassDOT and recently reviewed by MVPC, there is one bridge over water in Andover that is currently classified as “Structurally Deficient” and that is the Route 28 (North Main Street) bridge over the Shawsheen River. This structure is located approximately $\frac{3}{4}$ miles north of the town center and is adjacent to Shawsheen Plaza. Route 28 connects to Interstate 495 approximately one mile north of the bridge, and is perhaps the major gateway into the town. An August 2012 traffic count taken on Route 28 north of the bridge and south of Route 133 (Haverhill Street) showed a volume of roughly 19,700 vehicles per weekday. Over the years, this bridge has frequently been closed due to flooding of the Shawsheen River (see **Andover Flood Prone Areas**).

Hazard Potential of Dams

The DCR Office of Dam Safety lists 23 Andover dams on its statewide dam classification list. Of these, eight dams are classified as “significant” hazard dams. These dams are identified and described in **Table 5.1-2**. As part of a Shawsheen River ecological restoration project, the Town has been working since 2009 with state and federal agencies, environmental organizations and neighborhood groups in planning removal of Shawsheen dams and reestablishing a free-flowing river. The Shawsheen was dammed in the 19th century to provide power for mills operating along the river. Today, there are three Shawsheen dams in Andover. Two of the dams—the Marland Place Dam (north of Stevens Street) and the ornamental Balmoral Dam (built in the 1920’s) are slated for removal in 2016.

Based on the large number of dams in the community, as well as the potential safety risk of the dams cited below, Town emergency management officials have assigned a **medium risk** rating to the hazard of dam failure.

Table 5.1-2. Significant Hazard Dams – Andover

Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Ballardvale Dam	Shawsheen River (360 acre-feet)	1838	Significant	7/31/2012	5 years
Brackett Pond Dam	Brackett Pond (142 acre-feet)	1930	Significant	5/26/2011	5 years
Collins Pond Dam	Collins Pond (32.5 acre-feet)	1930	Significant	5/26/2011	5 years
Field Pond Dam	Field Pond (380 acre-feet)	1930	Significant	5/26/2011	5 years
Field Pond Dike	Field Pond (378 acre-feet)	1930	Significant	6/5/2011	5 years
Fosters Pond Dam	Fosters Pond (550 acre-feet)	1913	Significant	11/28/2011	5 years
Haggetts Pond Dam	Haggetts Pond (1750 acre-feet)	1940	Significant	9/19/2011	5 years
Shawsheen River Dam	Shawsheen River (112 acre-feet)	1929	Significant	5/8/2012	5 years

Brush Fire/Wildfire Hazard

Andover Fire over the past five years has responded to an average of 26 brush fires annually. The Fire Department currently has two (2) heavy duty pick-up trucks that are equipped specifically for brush fire response. Each truck has a 250 gallon tank of water on it with specific brush tools.

The chart below indicates brush fire incidents by month from 2009 through 2014, according to Andover Fire records.

	Jan.	Feb.	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
2009			5	3		2					1	1	12
2010		1	2		5	1	9	9	3		2	1	33
2011		1		2	5	3	4	6	1	1	2		25
2012	2	3	2	11	4	3	3			2	2	1	33
2013			1	6	4		3	2	1	1	2		20
2014				13	7	4	1	1	2	1	2		31
Total	2	5	10	35	25	13	20	18	7	5	11	3	154

Natural Hazards Disaster Response Capacity

The Town of Andover has a central command response team with full-time Police and Fire departments based out of the Public Safety Building on Main Street.

The Andover Police Department is led by Chief Keefe and is staffed by 51 additional officers including a Commander, five Lieutenants, eight Sergeants and 39 Patrol Officers. In addition, 19 civilian members provide support in network administration (1) animal control (1), parking supervisors (1.5), dispatch supervisor (1), dispatchers (12) and clerical (5).

The Andover Fire Department is led by Chief Mansfield. Staff includes four Deputy Chiefs, 13 Lieutenants and 52 firefighters.

The Department operates out of three stations.

- Central Fire Headquarters, 32 North Main Street, which primarily services the central area of town;
- West Fire Substation which is located at 200 Greenwood Road and services the west side of town; and
- Ballardvale Fire Substation which is located at 1 Clark Road and services the south side of town.

The Fire Prevention Office, where all permits are issued, is located at the Andover Town Offices, 36 Bartlett Street.

Police Chief Patrick Keefe heads the **Town's Emergency Management Planning Group** aided by Deputy Director Police Commander Charles Heseltine. Participants on the Planning Group which meets monthly, in addition to Police and Fire, are representatives of the following Town departments: Health Dept., School Dept., Municipal Services- Public Works, Planning Dept. and Memorial Hall Library.

The Chief Executive Officer of Andover is the **Town Manager** appointed by the elected 5-member Board of Selectmen. The Town Manager is responsible for financial management and administration of the Town.

Andover is also lead agency for the Greater River Valley Medical Reserve Corps (MRC) which currently has 250 citizen available to assist in public health or community emergencies. The MRC is a partnership of seven communities—Andover, North Andover, Methuen, Lawrence, North Reading, Lynnfield and Wilmington. MRC Director is Joanne Martel of Andover Health Department and Coordinator is David Nichols. MRC member volunteers are pre-credentialed and trained in Emergency Dispensing sites, sheltering, Incident Command System, and numerous emergency response topics. They serve as essential responders in the event of pandemic or natural disaster. The MRC coordinates trainings and drills in collaboration with the Emergency Preparedness Coalition and the local participating community Health Departments.

Natural Hazards Risk Analysis Summary

The Town of Andover’s risk analysis of natural hazards was undertaken with input from planning, public works and emergency management personnel. Potential impacts and losses, vulnerabilities, and likelihood of hazard occurrence factored into the assessment. Based on the local planning team review analysis, Andover has **high risk** from floods and winter storms (blizzards/snow/ice storms); **medium risk** from hurricanes, drought, wildfire, dam failures, and power outages; and **low risk** from earthquakes, tornadoes, and landslides.

Table 5.1-3. Andover Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Hurricanes	Moderate
Drought	Moderate
Wildfire/Brush Fires	Moderate
Dam Failure	Moderate
Power Outages	Moderate
Tornadoes	Low
Earthquakes	Low
Landslides	Low

5.2 TOWN OF BOXFORD Natural Hazard Risk Assessment

Community Profile

The Town of Boxford is located in north-central Essex County and covers approximately 24 square miles. The landscape is characterized by gently rolling hills and stream valleys interspersed with wetlands and ponds.

The Town's population, according to the 2010 U.S. Census is 7,965 and the population density is 338 people per square mile. The total number of housing units is 2,757, and the average household size is 2.96 people. Until the construction of Interstate 95 in the 1950s, Boxford was primarily a farming community. However, with the growing Metro Boston job centers situated within commuting distance, the Town experienced decades of rapid population growth (more than 100% each decade in the 1950's and 1960's). After 26% growth in the 1990's, Boxford's population stabilized in the last decade as development slowed and housing costs escalated. From 2000 to 2010, Boxford's population grew less .5%, an increase of fewer than 50 people.



Boxford's predominant land uses are forest (61% of land area) and low-density residential development. (12.3%) Agricultural uses constitute about 3.6% of the



town; freshwater wetlands and ponds make up 8.3% of the Town. Commercial/industrial activity is limited to 30 acres concentrated in the Town's two village centers – Boxford Center and West Boxford Center – and a small commercial development in the north-central section of town near the Georgetown line. In the western and northwestern sections of town, there still exists significant agricultural activity which, combined with extensive conservation open space, gives the area its rural character. In central and east Boxford, the open lands are mostly conservation properties.

The Town is not served by either a municipal water supply system or a centralized sewage treatment plant, but instead relies on individual on-site wells and septic systems.

Boxford Development Since the 2008 Regional Hazard Plan

Boxford has experienced relatively modest development of new single family housing since 2008. The financial crisis in the late 2000s as well as the dearth of buildable land contributed to the slow growth of the past decade. The largest new developments in recent years have been single family subdivisions Eagle's Nest (6 homes), Weathered Walls (8 homes @ Sagamore Lane) and Pine Ridge (8 homes @ Deer Run Road).

MVPC population projections for Boxford forecast 2030 Town population of 9,900 people, an increase of 24% from 2010.

The Town's Hazard Mitigation team considers the community has marginally reduced its vulnerability to high-risk hazards of flooding and winter storms/power outages since 2008 with no significant development in high hazard areas. The team attributes the reduction in vulnerability to DPW development and implementation of a capital infrastructure investment strategy in culvert replacements and completion of projects including the earthen dam upgrade at the Stiles Pond outlet completed in 2014. In addition, the DPW and National Grid in recent years have systematically worked on tree clearing to remove power line hazards, a program that has appeared to reduce frequency of power outages.

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.2-1**, was prepared by the local planning team for this Natural Hazard Mitigation Planning Project. The locations of these and other critical facilities and infrastructure were entered by MVPC into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The critical facilities are depicted in the Boxford map series that is presented in **Appendix F** of this Plan. None of the facilities identified lie within floodplain areas.

Table 5.2-1. BOXFORD Emergency Operations Centers, Health Care/Nursing Facilities, and Shelters

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations	Boxford Emergency Operations Center	285 Ipswich Road (Housed in Police Dept.)	N/A	N/A	N/A	N/A	Yes
Health Care and Nursing Facilities	NONE						
Emergency Shelters	Spofford School	31 Spofford Road	N/A	N/A	300	Yes	Yes
	Lincoln Hall	565 Main Street	N/A	100	100	Yes	Yes
	Masconomet Regional HS	20 Endicott Road	N/A	N/A	2,000	Yes	Yes
	East Fire Station (warming center)	6 Middletown Road	N/A	N/A	50	Yes	Yes
	West Fire Station (warming center)	585 Main Street	N/A	N/A	50	Yes	Yes
	Police Station (warming center)	285 Ipswich Road	N/A	N/A	30	Yes	Yes

Surface Waters and Flood Prone Areas

Boxford lies within three major drainage basins: the Merrimack, Parker, and Ipswich River watersheds. The Merrimack basin occupies a small part of northwest Boxford and consists of Hovey's, Johnson's, and Chadwick Ponds and their associated wetlands and intermittent streams. Much of this area is a protected public water supply watershed.

The Parker River originates in West Boxford in wetlands west of Sperry's Pond, and flows northeast into Groveland, Georgetown and on through Newbury to Plum Island Sound. The Boxford portion of the basin contains Baldpate Pond and some small tributaries of the Mill River in central Boxford. Although subject to periodic and even damaging flooding, the Parker River basin has been determined to be hydrologically stressed during low flow periods, "...exhibiting low flow conditions over the past 10+ years that are lower than historic averages." (*Parker River Watershed Action Plan 2006-2010*, MA Executive Office of Energy and Environmental affairs).

In Boxford Village, Fish Brook and Pye Brook are the principal sub-drainage systems, eventually flowing into the Ipswich River mainstem in Topsfield. These two brooks and their associated wetlands and tributaries drain many of the larger ponds in Boxford, including Four Mile, Spofford, Stiles, Lowe, and Kimball Ponds. All of these water bodies contribute water flow to the Ipswich River, which, like the Parker River, is subject to periodic flooding but is hydrologically stressed during low flow periods.

Areas in the community that experience occasional flooding include lands bordering the Parker River, Pye Brook, and Fish Brook, as well as lands on the perimeter of numerous ponds and wetlands. Of particular concern to local emergency management personnel are selected areas in the vicinity of Four Mile Pond and Lowe Pond.

Four Mile Pond off Georgetown and Herrick Road flows into Lowe Pond, where there is an earthen dam that has required sand-bagging on multiple occasions over the last decade, most notably during the damaging May 2006 Mothers Day Flood. Lawrence Road, downstream from the outlet of Stiles Pond, floods with regularity and has been closed to traffic on numerous occasions.



Flooding Vulnerability Assessment

A GIS analysis of the town's FIRM flood hazard areas by MVPC has determined that 1,684 acres (2.6 sq. mi.) of land area in Boxford is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 76 acres (0.12 sq. mi.) lies with the 500-Year floodplain. Together, these two flood zones constitute almost twelve (11.5%) of the total area of the community.

Based on an additional analysis by MVPC, approximately six (6) acres in these flood zones have been determined to be still open and “potentially developable” under the Town’s current zoning scheme. Although a relatively small area, it would nonetheless be prudent to preserve this acreage as permanently protected open space, so as not to increase the impervious surface cover and stormwater runoff in the flood zones, and thereby exacerbate the existing flooding problems.

As part of the mapping analysis, MVPC also investigated the presence of any “critical” facilities at potential risk of future flood damage or loss. No such facilities were identified in the mapped FIRM flood zones, nor, according to town officials, are there plans to site any future critical facilities in these zones.

MVPC also examined *non-critical* facilities in flood hazard areas. According to GIS analysis, 72 parcels with 80 structures lie within the 100-year floodplain. Total value of these residential & institutional properties is \$17.7 million.

Based on the frequency, areal extent, and severity of historical floods in dispersed locations in Boxford, Town emergency management officials consider the community to be at **high risk** from flooding.

Repetitive Flood Loss Structures

According to file data provided by the MA Department of Conservation and Recreation, there are currently no repetitive flood loss sites in Boxford. Town-wide, there are 27 flood insurance policies in place for properties located in flood hazard areas. The combined insurance value for these properties is \$7,539,000 (source: *NFIP Policy Statistics for Massachusetts – 6/30/2014.*)

Structurally Deficient Bridges Over Waterways

According to file data compiled and maintained by MassDOT, there are currently no bridges over waterways in Boxford that are classified as “Structurally Deficient.”

Hazard Potential of Dams

The DCR Office of Dam Safety includes 13 Boxford dams on its dam classification list. Of these, five dams have been identified by Town officials as dams of “concern”: Stiles Pond Dam, Lowe Pond Dam, Four Mile Pond Dam, Howe Pond Dam, and Lockwood Dam. Two of these dams – Stiles Pond Dam and Howe Pond Dam– are classified by the state as “significant” hazard dams. These dams are listed in **Table 5.2-2** on the following page.

Table 5.2-2. State Classified “Significant” Hazard Dams – Boxford

Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Stiles Pond Dam	Stiles Pond (260 acre-feet)	1920 (original dam replaced in 1996; major repair completed Fall 2014)	Significant	8/23/2011	8/23/2016
Howe Pond Dam	Howe Pond (40 acre-feet)	1800	Significant	11/28/2011	11/28/2016

Five Dams of Local Concern. A description of the five dams of special interest and concern to local emergency management and conservation officials follows:

Stiles Pond Dam. The Stiles Pond Dam, owned by the Town, is a 170-foot long earthen embankment with a reinforced concrete wall forming the center 100 feet. The spillway of the dam is a reinforced concrete block culvert. Inside this culvert there are stoplogs which establish normal operating levels in the pond. Stiles Pond forms the headwaters of Fish Brook. The dam’s flashboards cause adverse flow conditions downstream. The dam was inspected most recently in 2011 as a requirement of the dam management plan for operation and significant improvements including stabilizing the structure with clay, regarding and riprap installation were made to the earthen dam by the Town DPW in Fall 2014.



Fall 2014 Construction of Earthen Dam & Outlet at Stiles Pond

Four Mile Pond Dam. Four Mile Pond Dam is a privately owned dam located at the pond outlet at Georgetown Road. The dam outlet is a concrete structure with two spillways that are approximately five feet wide, separated by a center concrete post. This dam has no operation and maintenance plan.

Lowe Pond Dam. Lowe Pond Dam is a privately owned dam that was constructed in the late 1950s and was rebuilt in the 1970s. The Town regards this dam condition as of highest concern. Emergency officials note recent history of the Town installing sandbags at the dam area prior to major flood events in May 2006 and March 2010. The dam is comprised of two structures, an earthen dam and a concrete weir. The earthen dam is 137 feet long and is in stable condition. The concrete weir is 53 feet long and is in good condition. Maintenance of this dam is simple and consists mostly of erosion control and vegetation management. Currently there is no management plan for this dam and floodwaters are stored upstream at Four Mile Pond, which causes flooding of properties bordering Four Mile Pond. In spite of the lack of a dam management plan and watershed management plan for Pye Brook, the Town with the owner has taken significant planning steps in recent years. A phase 1 evaluation study of the dam was prepared in 2010, and the Town completed a flow analysis study in 2012.

Howe Pond Dam. Howe Pond Dam, off Mill Road, is a privately owned structure that was originally built in the 1700s. It has been repaired many times over the years. The dam consists of three channels, the main dam (in the center) approximately 100 feet across. To the left and right of this main structure there are two spillways. The dam and surrounding areas are well maintained by the homeowner.

Lockwood Dam. Lockwood Dam is located on lower Fish Brook and is the first impoundment of Fish Brook upstream from the Ipswich River. Part of the dam is owned by the town, while the remainder is privately owned. The dam is constructed of iron plates that are driven across the brook. It is approximately 60 feet long and holds back approximately 2.5 feet of water. The dam was most recently repaired in the fall of 2007 and again in 2010.

Based on the relatively large number of dams in the community (13), as well as the potential safety risks of the two “significant hazard” dams listed in Table 5.2-2 above and the significant local concern and flooding history at Lowe Pond Dam, Town emergency management officials have assigned a **moderate** risk rating to the hazard of dam failure.

Wildfires/Brush Fires

The Town has extensive protected forested areas of more than 1,145 acres including Boxford State Forest, Baldpate Pond State Forest Cleveland State Forest, Phillips Wildlife Sanctuary and Rowley-Georgetown State Forest. Forest lands make up 61% of Boxford’s land area, according to GIS analysis by MVPC. Emergency Response officials report they respond to brush fire incidents each year in peak months though these are infrequent (24 small brush fire call incidents in 2013). Based on this record and given the low density settlement in proximity to Boxford forest lands, officials assigned a **low** risk rating to the hazard of wildfire/brush fire.

Power Outages

Emergency management officials report more frequent outages in Boxford in recent years and report high priority efforts in petitioning utility provider National Grid to upgrade the Town's electricity infrastructure. Memorable power outage in 2010 resulted in many Boxford homes being without power for five days. Power loss is a particular hardship in the Town where there is no public water supply and residents are dependent on private wells requiring electricity to operate.

Natural Hazards Management and Response

Boxford has an Emergency Management Planning Committee that provides a unified command structure. The Committee, currently led by Lt. Robert Hazelwood, is made up of the Town Administrator, Director of Public Health, Police Department, Fire Department, Department of Public Works, Council on Aging and Planning/Environmental Protection Department.

The TOWN ADMINISTRATOR is the Chief administrative official with office in Town Hall and reports to the elected 5-member Board of Selectmen.

BOXFORD FIRE DEPARTMENT operates out of two stations, East Station and West Station. The Department is led by a full-time Chief, Deputy Chief, two Captains and five Lieutenants. The department employs two full-time employees that work a 40 hour week staffing the department Monday thru Friday. The balance of the department is volunteer staffed on a call-paid basis.

BOXFORD POLICE DEPARTMENT is led by the Chief and two Lieutenants with 10 full-time officers. The department also has another 10 reserve officers available for service.

Department staff provide 24-hour 911 communications and dispatch service for Public Safety Police & Fire departments. Police Department employs programmable sign board and has pumps available for use in emergencies.

BOXFORD DEPARTMENT OF PUBLIC WORKS is led by the Superintendent and has seven full-time personnel. In addition to providing roadwork, culvert and public facility maintenance, the DPW provides vehicle and equipment used in emergencies including barriers, generators and pumps.

Natural Hazards Risk Analysis

The Town of Boxford’s risk analysis reviews potential events that, according to Town officials, pose a high, medium, or low risk to the community. On the basis of this analysis, which incorporated the judgment of local emergency management and project planning team personnel, Boxford considers itself to be at **high risk** from floods and winter storms (blizzards/snow/ice storms) and power outages; **medium risk** from hurricanes, drought, and dam failure; and **low risk** from earthquakes, wildfire/brushfire, tornadoes, and landslides.

Table 5.2-3. Boxford Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Power Outages associate w Storms	HIGH
Hurricanes	Moderate
Drought	Moderate
Dam Failure	Moderate
Tornadoes	Low
Wildfires/Brush fires	Low
Earthquakes	Low
Landslides	Low

5.3 TOWN OF GEORGETOWN Natural Hazard Risk Assessment

Community Profile

The Town of Georgetown is centrally located in Essex County, about 28 miles north of Boston. It has a total land area of 12.9 square miles and a resident population of 8,183 (2010). The population density is 636 people per square mile. The total housing units in 2010 (U.S. Census) was 3,044, a 16% increase over the previous decade. The average household size is 2.7 people.



Georgetown's open landscape is characterized by low and gently rolling topography that consists of deciduous and pine woods, wetlands, streams, and ponds, including two recreationally-important Great Ponds; 57-acre Rock Pond and 85-acre Pentucket Pond. The predominant land uses in the community are forest (55%) and residential land (26%), followed by wetlands (5.5%) and agricultural land (2.7%). Commercial and industrial uses combined constitute less than 2%

of the total land area. Georgetown's woodlands are second or third growth post-agricultural forests. Sinuous stone walls, rock piles, and wild apple and pear trees scattered throughout the town are a testament to the community's rich agricultural heritage.

Located handy to nearby seaports in Newburyport and southern New Hampshire and Maine, as well as to the Metro Boston employment centers, Georgetown offers high quality schools in addition to rural appeal, making it attractive to residential development. Most of the town is served by a municipal water system, supplied from several shallow wells



located in the Parker River Aquifer in the western end of town. There is currently no centralized sewerage system in the community, so households and businesses rely on on-site septic systems for wastewater treatment and disposal.

Recent Development Activity in Georgetown

The Georgetown Planning Office reports a few notable development projects in the community since the adoption of the 2008 plan. These projects are as follows:

Subdivisions

1. Pond View Estates: A single family development located on Pond Street near Pentucket Pond. This seven lot subdivision consists of an existing single family lot with the creation of six new single family lots on a parcel of land

nearly six acres in size. Two parcels of land have easements to accommodate infiltration chambers as part of the design to manage stormwater run-off from the 700' long cul-de-sac. Extensive wetland and floodplain delineations are also considered in the project's layout. Due to this, a parcel of land was given to the Town as conservation land and is accessed from the cul-de-sac by an easement across one of the residential lots.

2. Turning Leaf Open Space Residential Development: Currently in the early phases of municipal review, this development proposes modifications to three existing single family residential lots and the creation of 24 new single family residential lots. The development is proposed on a 25 acre parcel of land with several acres of wetland area within the Conservation Commission's jurisdiction. The development's construction is limited to the continuous upland area of the property. Stormwater runoff is to be managed by a series of proposed infiltration basins and country drainage systems.

Site Plan and Special Permit

1. #35 East Main Street - Athletic Fields: This is a municipal development proposed by the Parks and Recreation Department. This is a 4.5acre, two phase development with the first phase including an approximately 500 foot long gravel driveway leading to a 100 parking gravel driveway. Included in Phase One is a concrete skate park and associated stormwater management systems. Phase Two considers a 200 foot extension of the gravel driveway to a smaller parking area, dog park, natural grass baseball field and additional stormwater management systems.
2. #11 Martel Way – Industrial Building for light manufacturing operations: This development used a previously cleared but undeveloped site. A 7,200 square foot building was constructed for the purpose of light manufacturing. Associated site improvements were accomplished with best management practices such as pervious pavement and limiting site development to existing disturbed areas.
3. #6 Norino Way – Expansion of existing fleet maintenance facility: An existing industrial use required expansion of the fleet maintenance building's footprint. Part of the site plan approval process considered relocating equipment and associated materials from outdoor storage areas into the enclosed environment of the proposed building addition. Site clean-up and installation of new stormwater inceptors was also approved in the site plan review.
4. #124 Tenney Street – Proposed multi-use development for contractor: The special permit application considered a 3,000 office building and a 4,800 warehouse structure. Both structures were proposed for a previously cleared but undeveloped site. Best management practices were part of the design in terms of pervious and stone gravel pavement as well as development only on the previously cleared areas of the site.

Given the moderate level of growth and siting of new development outside high hazard areas, Georgetown planning team members consider the relative level of hazard risk vulnerability to be unchanged since the 2008 Multi-Hazard Plan process.

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.3-1**, was derived from the Town’s current Comprehensive Emergency Management Plan (CEMP). The locations of these and other critical facilities and infrastructure were entered by MVPC into an Excel database and subsequently incorporated into MVPC’s ArcView GIS for use in digital mapping. The critical facilities are depicted in the Georgetown map series that is presented in Appendix G of this Plan.

Table 5.3-1. GEORGETOWN Emergency Operations, Health Care Facilities, and Shelters							
Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center	Public Safety Building	47 Central St.	Police and Fire Complex	10	40	No	Yes
Health and Medical Aid Facilities	Baldpate Hospital	83 Baldpate Road	Hospital	60		Yes	Yes
	Erie Fire Station	474 North Street	Fire Station	20		Yes	Yes
	Georgetown Fire Dept.	47 Central Street	Fire Station	7	30	No	Yes
	Georgetown Intermediate Care Facility	111 Jewett Street	Nursing	16		Yes	Yes
	Group Home	294 Andover Street	Group Home	4		Yes	Yes
	Limited Group Residence	8 Ordway Street	Group Home	4		Yes	Yes
	Over The Rainbow	29 Summer Street	Daycare	10	10	Yes	Yes
	Pentucket Workshop	161 West Main Street	Daycare	16	35	No	No
	Smith Family Tree House	42 E. Main St.	Daycare	64	64	No	No
	Trestle Way Elderly Housing	Trestle Way	Elderly Housing	134	140	Yes	Yes
Emergency Shelters	Georgetown Middle / High School	11 Winter Street	Shelter	1,000	1250	Yes	Yes
	Penn Brook School	68 Elm Street	Shelter	600	600	Yes	No
	Perley Elementary School	51 North Street	Shelter	200	200	Yes	Yes

Natural Hazards Mitigation and Response

Georgetown is a rural residential community with a Town government almost entirely dependent on residential property tax revenue for financing of local government operations and initiatives. It is a challenge to the municipality to plan for and respond to flood events and other natural disasters. The following describes the Town of Georgetown's facilities and personnel that are key to local emergency planning and event management.

Georgetown Town Hall: The Town of Georgetown's Town Hall is located at 1 Library Street with associated town departments located across three floors. The former elementary school is a wood structure dating to the mid-1800's and is on the national registry of historic places. Town Hall contains ten separate office spaces housing a number of departments including the Selectman and Town Administrator's Office, Council on Ageing, Planning Office, Zoning Board, Building Inspector, Treasurer Office, Town Clerk and Assessor. The Town's Department of Public Works, Municipal Light Department and Water Department are located in separate buildings across the municipality.

Town Hall also contains a central meeting room with associated cable broadcast facilities that can hold up to 50 residents. This meeting room is used regularly by Board and Commissions of the Town with other Committees gathering in the two smaller meeting rooms in Town Hall.

Public Safety: Public Safety Services in the Town of Georgetown include Police, Fire, Emergency Medical Services and Emergency Management Services.

Police Department: The Georgetown Police Department maintains a roster of 11 full-time officers and 15 part-time police officers. The department also supervises the Georgetown Communications Center which is responsible for all 911 and emergency calls as well as communication services for all town departments when they are not available.

The department utilizes a Code Red emergency notification system with telephone and e-mail access to rapidly notify residents of emergency situations and hazardous conditions.

The Police Department recently joined the NEMLEC (Northeast Massachusetts Law Enforcement Council) organization which provides comprehensive emergency responses to the community when needed. This affiliation affords access to dozens of personnel and equipment for searches and rescues as well as scene security during all hazardous events.

The Police Chief is the Emergency Management Director and the Fire Chief serves as the Assistant Emergency Management Director. A police Sergeant also serves in an assistant capacity as well.

The police station is located in the Public Safety Building with approximately 5,600 square feet of space. The Fire Department is also located in the building and the entire building serves as the communities Emergency Operations Center. A full building generator is available as well as a secondary unit with connections for a back-up system if it is ever needed. Systems are tested weekly to ensure operational readiness.

The police department has a part-time appointed Harbormaster to supervise and enforce regulations on the two (2) great ponds in the community. Animal Control Services are handled by a full-time police officer as well as three (3) assistants to provide services and security relating to animal calls for service in the community.

Fire Department: The Town of Georgetown Fire Department coexists with the Georgetown Police Department in the Public Safety Building located at 47 Central Street. The Fire Department has occupied this location since the late-1980. Additionally there's a fire station located at 474 North Street that is owned and operated by the Erie Four Fire Association. The Erie 4 Association is a totally private organization which owns the fire apparatus. The Georgetown Fire Department has a long-term lease with Erie 4 for the leasing of a pumper and four-wheel drive brush vehicle.

Currently the fire department has one fulltime employee, the Fire Chief, and thirty-four paid-on-call firefighters. 71% of the staff is rated as Emergency Medical Technicians (EMT), or higher, and 36% are certified as Firefighter Level 1 and 2. The fire department began per diem staffing in 2008, and now has staffing seven days a week from 6:00 am until 9:00 pm. Between the hours of 6:00 am and 4:00 pm we have the Chief and three firefighters on duty in the station. From 4:00 pm until 9:00 pm two firefighters are on-duty to primarily staff the ambulance but will staff the engine as needed. After hours there are two assigned firefighters to respond for medical aid calls as well as the balance of the staff. As is the trend with most fire departments in the United States the greater number of responses is for medical calls and requests for public service. On average, the Georgetown Fire Department responds to 1,400 calls for assistance annually.

Apparatus comprising the Georgetown Fire Department (including Erie 4), consists of (3) engines, (1) 107' aerial ladder truck, (1) medium-duty rescue truck, (1) multi-purpose 4-wheel drive brush rigs, and (1) Chief's vehicle. In 2012 the fire department began operations as a licensed Basic Life Support ambulance service responding with two Type 1 ambulances that were a gift from the Central Fire Company. The ambulances respond to all 911 emergency calls and motor vehicle crashes in the Town.

The Fire Department belongs to the Essex County Fire Chiefs Association and is a member of the Essex County Mutual-Aid network providing and receiving mutual-aid from other Essex County fire departments. In addition, the fire department is a member of the Fire Chiefs Association of Massachusetts (FCAM) which is a

professional organization providing support and guidance to fire chiefs throughout the state.

The fire department conducts training on Tuesday nights, and subjects will range from medical-based scenarios to fire-related as well as special rescue classes. In addition to this, many personnel have attended the 330 hour fire recruit training program administered by the Massachusetts Firefighting Academy (MFA). This program meets two nights and a Saturday for a five month period covering a wide range of fire service subjects and hazmat. Individuals successfully completing this program comes out as fully certified Firefighter Level 1 and 2 (FFI/II). The commitment for this program is very big but what the town receives is a very well trained firefighter able to safely handle many of the dangers we are faced with daily.

Department of Public Works: The Highway Department consists of a Highway Surveyor, a part-time administrative assistant and a four man crew housed at 203 East Main Street. The department is responsible for sixty-five miles of roadway, sidewalks and more than 1,200 drainage structures. The department is also responsible for mowing of town fields and around town buildings except for school structures.

The Highway Department has the following equipment; loader, skidsteer, mini excavator, brush machine and four 7-8 yard dump trucks with sanders. The department also has two one-ton trucks with a sander as a pick-up truck. This equipment is used when the Department is out for any weather event whether snow or flood related. With heavy snow events the Department sub-contracts for snow clearing operations as needed.

Building Department: Georgetown's Building Commissioner oversees the building department and serves as the Towns Zoning Enforcement and Building Inspector. The Building Department issues building, electrical and plumbing permits. Its inspectors interpret and enforce the Massachusetts State Building, Electrical and Plumbing codes as well as review and inspect work associated with permits. The Building Commissioner is also responsible for interpreting and enforcing the town's Zoning Bylaw.

Water Department: The Georgetown Water Department has a staff that consists of 6 full-time employees and 1 part-time employee. The Water Department is overseen by a General Manager who reports to the Board of Water Commissioners. Staff includes 3 licensed operators (treatment and distribution systems), 1 laborer, 1 office manager, and a part-time administrative assistant.

The Water Department office is located at 1 Moulton Street at the corner of West Main Street. The water treatment plant (WTP) is located at 75 West Street. The Marshall Well and the Duffy's Landing Well are located to the rear of the property. The Commissioner's Well is located off lower Bailey Lane. Three water storage tanks are located on Baldpate Road; one is adjacent to the Black Swan Country Club, and

two are behind Baldpate Hospital. The water office, WTP, and wells have backup power systems available. The water tanks operate by gravity.

The Water Department also utilizes the Code Red emergency notification system through coordination with the Police Department. Additional communication is performed using in-vehicle radios, coordinated with the Fire Department, and cell phones.

The Water Department participates in the Massachusetts Water/Wastewater Agency Response Network (MAWARN). MAWARN is a formal mutual aid program designed to provide a mechanism whereby water and wastewater utilities that face threatened or specific damages from a natural or human-caused event could quickly obtain emergency assistance in the form of personnel, equipment, materials, and other associated services, as necessary, from other water/wastewater utilities.

Water Department staff is equipped to handle most routine water emergencies, including water main breaks, minor power outages, and small equipment failures. Major emergencies would require outside assistance through specialty vendors, MAWARN, and/or State agencies.

Municipal Light Department: The Georgetown Municipal Light Department is a municipal electric utility that has been serving the ratepayers of the Town of Georgetown since December of 1912. GMLD owns and maintains a 50 mile overhead and underground power distribution system that services approximately 3500 customers. The department employs 8 full time employees consisting of a General Manager, two Business / Customer Service Coordinators, and five Electrical Lineworkers. GMLD own three buildings and two substations. One of the department's buildings is collocated with the Moulton Street Sub Station and is currently occupied by the Georgetown Water Department. The other two buildings are collocated with the Searle Street Sub Station and are the home of the department's main office and garage that houses the department's six truck fleet.

The Georgetown Municipal Light Department is a 24 hour operation which employs a rotating 'on call' system of Electrical Lineworkers. They are contacted for emergencies by the Public Safety Communications Center.

If staffing issues occur, the department utilizes a mutual aid system to receive and provide man power and equipment to and from the surrounding towns. The department can also receive mutual aid through its affiliation with the Northeast Public Power Association more commonly known as NEPPA. Through NEPPA, Georgetown Municipal Light Department can be supplied with aid from all of New England and New York if necessary.

Surface Waters and Flood Prone Areas

Georgetown lies within the watershed of the Parker River, which flows easterly through the community and contains the Rock Pond and Pentucket Pond impoundments. Major tributaries to the Parker include:

- **Penn Brook**, which originates at Baldpate Pond in neighboring Boxford and flows northward through the center of town, joining the Parker River between Pond street and North Street;
- **Wheeler Brook**, which rises from wooded wetlands southwest of the intersection of Jewett Street and Route I-95;
- **Jackman Brook**, which is fed by wooded wetlands bounded by Jewett Street, Tenney Street, and I-95, and joins Wheeler Brook north of Jackman Street before entering the Parker River in Newbury;
- **Lufkin's Brook**, which flows northward to the Parker River in the western part of town;
- **Plough Brook**, a smaller stream which flows from wetlands just east of Georgetown center (between North Street and East Main Street) northward to the Parker River, joining the Parker at near the abandoned gravel pits south of Thurlow Street;
- **Muddy Brook**, which originates in wetlands near the southbound entry ramp to Interstate 95 at Route 133 and flows to the Mill River, a tributary to the Parker River in Rowley.



The abundance of streams, ponds, and wetlands throughout Georgetown gives rise to localized flooding problems in dispersed locations during periods of prolonged rainfall and heavy snowmelt. Significant flood prone areas include:

- Parker River at West Main Street (between Rock Pond outlet and Pentucket Pond inlet)
- Parker River at Bailey Lane, upstream from Rock Pond inlet
- Penn Brook at Library Street (from Rt. 97 to Rt. 133, plus several hundred feet further east where Penn Brook flows under Rt. 133 and Central Street)
- Bulford Brook, including Skunk Point sub-drainage area

All of the above flood hazard areas experienced severe flooding during the May 2006 Mothers' Day storm when Georgetown received over 15 inches of rain in two days.

SPECIAL FLOODING CONCERNS

According to Georgetown Public Works Department and emergency management officials, there are two recurring flooding problems that are of particular concern and warrant immediate attention in order to protect public safety, private property and town infrastructure. These problem areas are summarized below.

- **Parker River @ West Main Street (Route 97)**

Two hundred feet (200') of this key road was flooded and closed for a prolonged period during the 2006 Mothers' Day Flood event. Main Street is the major connector route between Greater Haverhill and Route I-95, and carries more than 5,000 vehicles each day. Soil washout caused by the flooding at West Main Street exposed an 8-inch gas main, posing a potential safety risk to town personnel, area residents, and passersby.

- **Parker River @ Bailey Lane**

Culvert has been replaced. River needs to be dredged from Bailey Lane to Rock Pond.

Flooding Vulnerability Assessment

A GIS analysis of the town's current delineated FIRM flood hazard areas by MVPC has determined that 1,359.5 acres (2.12 sq. mi.) of land area in Georgetown is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 206.8 acres (0.32 sq. mi.) lies with the 500-Year floodplain. Together, these two flood zones constitute almost nineteen percent (19%) of the total area of the community. Based on an additional analysis by MVPC, 219 acres in these zones are still open and "potentially developable" under the Town's current zoning scheme. Development of this open space would increase the impervious surface cover and stormwater runoff, thereby exacerbating the existing flooding problems.

As part of the mapping analysis, MVPC also investigated the presence of any "critical" facilities at potential risk of future flood damage or loss. No such facilities were identified in the mapped flood zones, nor, according to town officials, are there plans to site any future critical facilities in these zones.

MVPC also examined *non*-critical facilities in flood hazard areas. This analysis revealed the presence of 221 residential, commercial, industrial and institutional structures (collectively valued in 2014 at \$69,383,580) in the 100-yr floodplain.

Based on the frequency, areal extent, and severity of historical floods in Georgetown, Town emergency management officials consider the community to be at **high risk** from flooding.

Repetitive Flood Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there are four repetitive flood loss sites in Georgetown. All are single-family residences located, respectively, on Heather Road, Rock Pond Avenue, Spofford Avenue and West Main Street. Flooding incidents at these properties have resulted in the payout of twelve National Flood Insurance Program (NFIP) claims totaling \$198,850 since 1996. Currently, FEMA reports 59 flood insurance policies for properties located in Georgetown flood hazard areas. The combined insurance value for these properties is \$15,627,900 (source: *NFIP Policy Statistics for Massachusetts – 6/30/2014.*)

Floodplain Management and Compliance with NFIP

The Town of Georgetown supports numerous floodplain management activities in an effort to meet compliance of National Floodplain Insurance Program (NFIP) requirements. These efforts include:

- Participate in training courses and seminars offered by MEMA, DCR and other agencies that address flood hazard planning and best management practices (BMPs).
- Address NFIP monitoring and compliance activities.
- Maintain Town's erosion control and stormwater management bylaws to ensure current BMPs are in place to improve stormwater management and reduce flood events in the community.
- Adoption of a revised Floodplain District bylaw at Annual Town Meeting in May of 2012 to accept the new Flood Insurance rate Maps (FIRMs) that were issued by FEMA and went into effect in July of 2012.
- Participate in the ISO's Building Code Effectiveness Grading Schedule (BCEGS).
- Provide information on as-needed basis to property owners regarding FEMA FIRMs delineation and local floodplain delineations that may consider their property.
- Provide information on as-needed basis to property owners regarding building codes pertaining to construction within delineated floodplains

Structurally Deficient Bridges Over Waterways

According to file data compiled and maintained by the Massachusetts Highway Department, there are currently no structurally deficient bridges over waterways in Georgetown.

Hazard Potential of Dams

The DCR Office of Dam Safety lists one Georgetown dam – the Pentucket Pond Outlet Dam – on the statewide dam classification list. This dam is classified as a “significant” hazard dam and is described in **Table 5.3-2** on the following page.

Table 5.3-2. Significant Hazard Dams – Georgetown

Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Pentucket Pond Outlet Dam	Pentucket Pond (620 acre-feet)	1850	Significant	5/25/2010	5/25/2015

Town emergency management officials have assigned a **medium risk** rating to the hazard of dam failure in the community.

Wildfire/Brush Fires

The Fire Department has approximately 1,100 acres which is comprised primarily of the Georgetown/Rowley State Forest located in the Central Street (State Route 97) area. Georgetown also borders the towns of Boxford, Rowley, Newbury and Groveland that includes some their woodland areas as well. Other large areas of woodlands include Lufkin Brook Conservation Area off Andover Street (State Route 133) near the Boxford town line, Baldpate Pond State Park off Nelson Street near Camp Denison, and the Crane Pond Wildlife Management Area off Thurlow Street near the Newbury town line.

During the period 2008 through 2012 Georgetown firefighters responded to approximately 22 brush-woods-grass fires consuming approximately 40 acres of land. In several instances Georgetown firefighters were assisted by the State Forestry personnel as well as surrounding towns to quell these fires. In many of these instances access to the fire areas was extremely challenging because of limited access roads. In several cases manpower and equipment had to hike in considerable distances to get to the fire.

During this same period the fire department was able to take advantage of grants through the Department of Conservation and Recreation (DCR) known as the “Volunteer Firefighter Assistance” program. This has been a 50/50 matching program with a \$4,000 total cap allowing the fire department to purchase wild-land firefighting gear, hose, nozzles and an assortment of tools for fighting wild-land fires.

Firefighter training for fighting wild-land type fires is on-going and takes place yearly at the start of the spring season. We have also received teaching and training assistance from members of the local DCR fire team. This educational series has helped in reminding fire personnel of the dangers in fighting these fires. Specialized programs aimed at training firefighters on cutting down trees as well as the use and application of special firefighting foam has helped in reducing time spent on the fire ground while making firefighters more safety conscious.

Lastly, in 2010, the Fire Department instituted an on-line program for the annual Open Burning season that starts January 15th and runs through May 1st each year.

Residents are able to purchase their Open Burning Permit through the fire department website utilizing a credit card. Daily permit activation is also accessed through this same site and controlled by the Fire Chief, who also is appointed as Forest Fire Warden for the Town. Daily open permits are registered between 10:00 am and noon. On days when conditions warrant no burning, the Fire Chief is able to block access to permit activation. At any given time fire personnel can access this site to check on legal registrations as well as permit activation for a given day. Residents register their email and cell phone numbers and this data is used throughout the season to update/remind residents on the Open Burning Regulations. Annually, the Department processes approximately 500 registrations with a high percentage being done through the online service.

Based on the number, frequency, and extent of brush fires in the community, Town emergency management personnel have assigned a **moderate risk** to the hazard of brush fires in Georgetown.

Natural Hazards Risk Analysis

The Town of Georgetown’s Comprehensive Emergency Management Plan (CEMP) contains a risk analysis for the majority of the natural hazards that are addressed by this Plan. This risk analysis covers events that, according to Town officials, pose a high, medium, or low risk to the community. On the basis of this analysis, Georgetown considers itself to be at **high risk** from floods and winter storms (blizzards/snow/ice storms); **medium risk** from hurricanes, drought, wildfire, dam failure, and power outages; and **low risk** from earthquakes, tornadoes, and landslides.

Table 5.3-3. Georgetown Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Hurricanes	Moderate
Drought	Moderate
Wildfire/Brush Fires	Moderate
Dam Failure	Moderate
Power Outages	Moderate
Tornadoes	Low
Earthquakes	Low
Landslides	Low

5.4 TOWN OF GROVELAND Natural Hazard Risk Assessment

Community Profile

The Town of Groveland is located 31 miles north of Boston along the south bank of the Merrimack River. State Routes 97 and 113 traverse the Town and Interstate Highways I-95 and I-495 are located nearby. The Town covers 8.9 square miles and has a resident population of 6,459 (U.S. Census Bureau 2010). The population density is 727 people per square mile; the average household size is 2.75 people. The median age of town residents is 43.5 years, and one in five residents are age 60 or older. The Merrimack Valley Planning Commission (MVPC) projected potential population of 9,489 at full build-out.



The topography of Groveland ranges from low-lying vales marked by streams, ponds, and wetlands to gently rolling hills composed of glacial deposits. The northern, more heavily developed section of the town is made up of undulating terrain with scattered hills that rise to a height of approximately 250 feet above mean sea level. The terrain for the rest of the town tends to be flatter, and includes sizable areas of freshwater wetlands.

The predominant land uses are forest (45%), residential development (21.5%), and wetlands/water (21%). Agriculture uses make up 3% of the Town;. Commercial and industrial activity is limited to 99 acres, less than 2% of the town area.

The Town provides public drinking water from three municipal wells that draw water from various locations throughout town. Sewer service is provided to the more densely-developed parts of town, and the sewage is piped to the 18 MGD regional wastewater treatment plant in neighboring Haverhill, where the wastewater is treated prior to its discharge to the Merrimack River. Selected outlying areas continue to rely on individual on-site septic systems for their wastewater disposal.

Development Activity in Groveland

Groveland Village Center, designated a local priority growth area in the Merrimack Valley regional land use plan (2015) is approximately 101 acres and is zoned business, limited business, and residence district C. A mix of uses is allowed in this area including medium density residential, offices, service establishments, business in single-family units, and retail establishments. The town's master plan calls for the creation of a vibrant mixed-use town center with a balance of small and medium size businesses and adjacent residences that provide a sense of place. The master plan also called for the development of an urban design plan for the town center and establishment of Groveland Square theme with unified lighting, signage, and

streetscape improvements. Much of this work has been completed. The town also wants to expand waterfront access to the town center.

The Town had 7% population growth in the 2000-2010 decade. MVPC forecast 2030 Groveland population of 7,900 people and a potential employment base of approximately 1,700 jobs (a 50% increase over 2010 levels).

Given the moderate level of growth and siting of new development taking place, Groveland planning team members consider the relative level of hazard risk vulnerability to be unchanged since the 2008 Multi-Hazard Plan process.

Critical Facilities

A list of selected critical facilities (emergency operations centers, health care/nursing facilities, public shelters) is shown in **Table 5.4-1** and was derived from the Town's Comprehensive Emergency Management Plan (CEMP) and from conversations with local emergency management personnel. The locations of these and other critical facilities and infrastructure in Groveland were entered by MVPC into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The critical facilities are depicted in the Groveland map series that is presented in Appendix F of this Plan.

Table 5.4-1. GROVELAND Emergency Operations Centers, Health Care/Nursing Facilities, and Shelters							
Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Centers	Groveland Public Safety Building (Police & Fire)	181 Main Street	N/A	N/A	N/A	N/A	Yes
	Mobile Trailer (secondary EOC)	181 Main Street	N/A	N/A	N/A	N/A	Yes
Health Care and Nursing Facilities	NONE						
Emergency Shelters	Dr. Elmer S. Bagnall Elementary School (Addition completed 2013)—primary shelter	253 School Street	N/A	N/A	250-300	Yes	Yes
	Pentucket Regional Middle School (Gymnasium) Secondary shelter-warming station	20 Main Street, West Newbury	N/A	N/A	150	Yes	Yes
	Groveland Housing Authority Community Center-warming station	10 River Pines Drive	N/A	N/A	50	Yes	Yes
	Town Hall Center Meeting Room-warming station	183 Main Street	N/A	N/A	100	Yes	Yes
	Fire State Meeting Room—warming station	181 Main Street	N/A	N/A	50	Yes	Yes

Brush Fire/Wildfire Hazard

Although, nearly half of the town's land area is forest, incidence of brush fires annually has been low. Groveland officials note potential for major damage to property and have assessed hazard potential as moderate risk.

Surface Waters and Flood Prone Areas

The Town of Groveland is divided into two major drainage basins: the Merrimack River basin and the Parker River basin. Approximately 62.5% of the town area lies within the Merrimack basin, with the remainder (37.5%) in the Parker basin. The Merrimack River collects most of the drainage from the northern and southeast sections of the Town, while the Parker River drains most of the south-southeastern sections. Within the two basins, there are a number of smaller sub-drainage areas that contain an abundance of tributary streams, ponds, and wetlands.

The following surface waters are the most prominent waterways in Groveland, and are subject to periodic flooding during prolonged rainfall events and heavy snowmelt.

Rivers and Streams

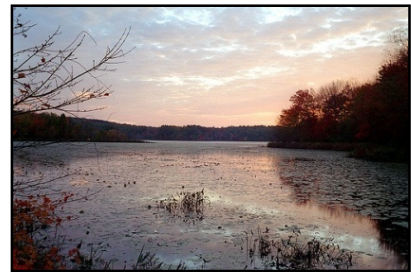
- **Merrimack River:** The Merrimack River is the major waterway in the area and connects this part of the State with the Atlantic Ocean near Plum Island. It is tidally influenced and navigable above Groveland and forms the Town's 2.2-mile northern border with the City of Haverhill. Approximately 62.5% of the town area lies within the Merrimack River drainage basin, including most of the northern and southeast sections of town. The Merrimack and its tributaries have experienced flooding on numerous occasions throughout the years. The flood of record occurred in 1936 with a water surface elevation in Groveland of about 25.0 feet above mean sea level (msl). Since 1936, the construction of a series of upstream flood control structures (in NH) by the Army Corps of Engineers has alleviated some of this flooding along the Merrimack mainstem. However, flooding continues to occur along parts of the south bank of the river, most notably along Main Street from the downtown area by the Bates Bridge west (upstream) to Washington Street.
- **Parker River:** The Parker River enters and leaves Groveland in two locations, and a significant portion of the Town (3.4 sq. miles) lies within its drainage area. About 900 feet of the river crosses the Town at the very southern tip near the Boxford-Georgetown line. The river again enters in the eastern part of Groveland from Georgetown, flows into Crane's Pond, and then emerges from the pond



continuing in an easterly direction. A total of 1.25 miles of the Parker River flows within Groveland. Most of the Parker River watershed area in Groveland lies within the Crane's Pond Wildlife Management Area, owned by the Massachusetts Division of Fisheries and Wildlife. Flooding occurs along the Parker River mainstem and the perimeter of Crane's Pond, but the extent and impact are significantly mitigated by the expansive bordering wetlands that offer substantial flood storage.

- **Johnson's Creek:** Johnson's Creek originates at the outlet of Johnson's Pond and connects a series of ponds in the western part of town along Washington Street. Approximately 1.4 miles in length, it collects drainage from both the Brindle Brook and the Argilla Brook sub-basins before discharging into the Merrimack River near the Haverhill-Groveland town line.
- **Brindle Brook:** Brindle Brook is slightly over 1.1 miles long and originates in the southern section of the Town near the Georgetown town line. Its confluence with Johnson's Creek is just south of Center Street about midway between Zackery Path and Washington Street. Throughout its entire course, it flows through or adjoins industrially-zoned land.
- **Argilla Brook:** Argilla Brook originates just north of Center Street and west of King Street. It flows approximately 0.8 miles in a southwesterly direction to Center Street, and then turns northwesterly and crosses Center Street, flowing near the old railroad bed to its confluence with Johnson's Creek. The total length of Argilla Brook is approximately 1.8 miles, of which approximately 0.45 miles are located within the Zone II of Town Well #1.
- **Intermittent Streams:** Numerous smaller drainage channels exist throughout the Town and contribute flow to the larger rivers and streams cited above. Notable examples include **Cemetery Brook**, which drains land in the populated area of Seven Star Road just north of Governors Road and King Street, and **Singing Brook**, which flows from Spofford Pond into Johnson's Pond.

Ponds. In addition to the above rivers and streams, there are four major ponds in Groveland: Johnson's Pond, Meadow Pond, New Mill Pond, and Crane's Pond. These are described below.



- **Johnson's Pond:** Johnson's Pond, the largest of the four ponds, is a Great Pond. It has a water surface area of about 225 acres, 78 acres of which lie within the neighboring Town of Boxford. Its watershed area is approximately 3 square miles, and the pond serves as a back-up water supply source for the City of Haverhill.
- **Meadow Pond:** Meadow Pond lies at the outlet of Johnson's Pond and is a man-made pond controlled by an outlet structure with stop-planks at Salem Street. This pond is normally quite shallow (about 8 feet deep at the outlet), with

protruding tree stumps and aquatic growth at its upper end. A management plan has been proposed for this pond, which would likely be part of a management plan for the larger Meadow Pond Conservation Area.

- **New Mill Pond:** New Mill Pond is situated just north of Center Street off Washington Street, and was formed by a dam located behind the old Highway Department Garage. The pond lies downstream from Johnson's Pond, Meadow Pond, and Old Mill Pond, all of which are connected by Johnson's Creek.
- **Crane's Pond:** Crane's Pond is a relatively shallow, 21-acre impoundment of the Parker River, and is located in the eastern corner of town. The Parker River meanders between Byfield Road and Crane's Pond, entering the pond near its southwest corner. The river emerges from the northwest corner of the pond and follows a meandering course until it reaches the Town of Newbury.

Flooding Vulnerability Assessment

A GIS analysis of the town's FIRM flood hazard areas by MVPC has determined that a total of 1,044 acres (1.6 sq. mi.) of land area in Groveland is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 198 acres (0.31 sq. mi.) lies with the 500-Year floodplain. Together, these two flood zones constitute over twenty percent (20%) of the total area of the community. Based on an additional analysis by MVPC, 135 acres in these zones have been determined to be open and "potentially developable" under the Town's current zoning scheme. Development of this open space would increase the impervious surface cover and stormwater runoff volumes in the flood zones, thereby exacerbating the existing flooding problems.

As part of the mapping analysis, MVPC also investigated the presence of any "critical" facilities at potential risk of future flood damage or loss. No such facilities were identified in the mapped FIRM flood zones, nor, according to town officials, are there plans to site any future critical facilities in these zones.

MVPC also examined *non-critical* facilities in flood hazard areas. This analysis revealed the presence of 92 residential, commercial, and industrial structures on 69 parcels (collectively valued in 2014 at \$88,051,600) in the 100-yr floodplain.

Based on the frequency, areal extent, and severity of historical floods in dispersed locations in Groveland, Town emergency management officials consider the community to be at **high risk** from flooding.

Repetitive Flood Loss Structures

According to data compiled by the MA Department of Conservation and Recreation, there currently are no repetitive flood loss sites in the Town of Groveland. Town-wide, there are 23 flood insurance policies for properties located in FIRM flood hazard areas. The combined insurance value for these properties is \$5,622,400 (source: *NFIP Policy Statistics for Massachusetts – 6/30/2014.*)

Structurally Deficient Bridges Over Waterways

The Town of Groveland at present has no “Structurally Deficient” bridges over waterways. The Bates Bridge on Routes 97/113 over the Merrimack River had previously been listed as structurally deficient by MassDOT Highway, and in fact, the AASHTO Bridge Rating for the structure in May 2007 was only 2.0 (out of 100), at the time the *lowest rating* of any bridge in the Merrimack Valley region. For many years MassDOT had to periodically close the bridge, also known locally as the Groveland Bridge, to traffic to perform short-term repairs that were the result of the structure's continued deterioration. This deterioration eventually resulted in MassDOT posting the bridge with a weight limit.



Work was completed in October 2013 on construction of a new Bates Bridge, located 50-60 feet downstream from the 1950 span.

Like the prior bridge, the new structure includes a functioning draw mechanism that allows larger watercraft to proceed upstream as far west as downtown Haverhill.

Hazard Potential of Dams

The DCR Office of Dam Safety includes seven (7) Groveland dams on its statewide dam classification list. These include: Dyes Pond Dam, Johnson’s Creek Dam, Johnson’s Pond Dam, Mill Pond Dam, Pleasure Pond Dam, Small Pond Dam, and White Pond Dam. Of these, two dams – Johnson’s Creek Dam and Johnson’s Pond Dam – are classified as “significant hazard” dams. The Town has concept plans for design improvements at Johnson Creek Dam, determined by Town officials to be the dam structure most in need of repair. The Town has procured engineering consultants to advance project design & permitting. The two significant hazard dams are described in **Table 5.4-2** below.

Table 5.4-2. Significant Hazard Dams – Groveland					
Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Johnson’s Creek Dam	Johnson’s Creek (220 acre-feet)	1913	Significant	12/28/2006	12/27/2011
Johnson’s Pond Dam	Johnson’s Pond (1,080 acre-feet)	1930	Significant	5/01/1998	4/30/2003*

*Inspection overdue, according to DCR/Office of Dam Safety spreadsheet record

In light of the presence of seven dams in the community, two of which are classified as “significant hazard” dams, Town emergency management personnel have assigned a **medium risk** rating to the hazard of dam failure.

MANAGEMENT RESPONSE CAPACITY

Groveland Fire Department, led by Chief Robert Lay, operates out of Central Station and South Station with a staff of 40 firefighters who serve on an on-call paid basis.

Chief Robert Kirmelewicz heads the Groveland Police Department with a team of five Superior Officers, 3 full-time patrol officers and 11 reserve officers. Deputy Chief Jeffrey Gillen serves as the Town’s Emergency Management Director.

The Town’s Municipal Electric Department and Highway Department provide emergency management support with equipment, communications, and personnel.

Natural Hazards Risk Analysis

The Town of Groveland’s Comprehensive Emergency Management Plan (CEMP) contains a risk analysis for the majority of the natural hazards that are addressed by this Plan. This risk analysis covers events that, according to Town officials, pose a high, medium, or low risk to the community. On the basis of this analysis, plus the judgment of local emergency management personnel, Groveland considers itself to be at **high risk** from floods and winter storms (blizzards/snow/ice storms); **medium risk** from hurricanes, drought, wildfire, dam failure, and power outages; and **low risk** from earthquakes, tornadoes, and landslides.

Table 5.4-3. Groveland Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Hurricanes	Moderate
Drought	Moderate
Wildfire/Brush Fires	Moderate
Dam Failure	Moderate
Power Outages	Moderate
Tornadoes	Low
Earthquakes	Low
Landslides	Low

5.5 CITY OF HAVERHILL Natural Hazard Risk Assessment

Community Profile

The City of Haverhill covers an area of 33.0 square miles and has a resident population of 60,879, according to the 2010 U.S. Census. The population density is 1,846 people per square mile. There are 24,150 housing units in the City, and the average household size is 2.5 people. 12.2% of the City's population is 65 years of age or older. There are 9,396 students enrolled in the school system, which consists of seven elementary schools, eight middle schools, and two high schools. Over 90% of the City is on the public drinking water supply. Water is pumped from Millvale Reservoir and Crystal Lake into Kenoza Lake where the water treatment plant is located. On average, the plant supplies 6.3 million gallons per day. The predominant land uses in Haverhill are forest (39.7%) and residential development (32%), followed by agriculture (10.5%) and wetlands/water (6%). Commercial and industrial uses together constitute less than 3% of the City area.



There are 170 full-time public safety personnel, including 86 uniformed police officers and 84 firefighters.

Development Activity in Haverhill

The City of Haverhill's population grew by 3.2% in the decade of the 2000s. MVPC forecasts that between 2010 and 2030 the City's population will grow 12.6% to 68,550 people and its employment base will increase 9.3% from 18,008 jobs in 2010 to 19,691 in 2030.

City planning team members consider the City's vulnerability for hazard risks to be unchanged since organization of the 2008 Merrimack Valley Region Multi-Hazard Plan. Smart growth overlay districts facilitating downtown urban revitalization are in place. While the City is systematically working to upgrade aging infrastructure, the improvement needs in stormwater systems, roadways and bridges, exceed available resources.

Major development recently in construction, permitting or planning include the following:

Haverhill Development Projects					
Project Name	Project Type	Status	Completion Year	Total Housing Units	Approx. Sq. Ft. Non-Res
Harbor Place	Mixed Use	Construction	phased-demo began Jan. 2015	80	81,000
Tenney Place	Residential	Permitted	2017	144	
Chen Building	Mixed Use	Planning	2016	62	
Ornsteen Property	Residential	Planning	2018	Tbd-80 (est.)	
Stevens Street Mills	Residential	Planning	2018	60 (est.)	
Music Center Bldg. /Washington St.	Mixed Use	Permitted	2015	16	15000

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.5-1** on the following page, was derived from the City’s current CEMP. The locations of these and other critical facilities and infrastructure were entered into an Excel database and subsequently incorporated into MVPC’s Arcview GIS for use in digital mapping. The critical facilities are depicted in the Haverhill map series that is presented in Appendix F of this Plan.

Table 5.5-1. HAVERHILL Emergency Operations, Health Care Facilities, and Shelters

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Patient Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center(s)	Haverhill Police Headquarters	40 Bailey Blvd.	N/A	N/A	N/A	N/A	Yes
Health and Nursing Facilities	Merrimack Valley Hospital	140 Lincoln Ave.	Hospital		108	Yes	Yes
	Baker-Katz	194 Boardman St.	Nursing	54	77	Yes	Yes
	Merrimack Valley Hospice	360 North Ave.	Hospice		21	Yes	Yes
	Hannah Dustin	126 Monument St.	Nursing	110	116	Yes	Yes
	Haverhill Crossings	350 Amesbury Rd.	Nursing	99	116	Yes	Yes
	Kenoza Manor	290 North Ave.	Nursing	140	146	Yes	Yes
	Lakeview House	87 Shattuck St.	Nursing			Yes	No
	Oxford Manor	689 Main St.	Nursing	110	120	Yes	Yes
	Penacook Place	150 Water St.	Nursing	150	160	Yes	No
	Stevens-Bennett	337 Main St.	Nursing			Yes	No
	Whittier Rehab Hospital	145 Ward Hill Ave.	Rehab	45	60	Yes	No
Shelters	Citizen's Center (primary shelter)	10 Welcome St.	N/A	N/A	100	No	No
	Bradford Elem. School	16 Montvale Ave.	N/A	N/A	250	Yes	Yes
	Golden Hill School	140 Boardman St.	N/A	N/A	250	Yes	Yes
	Silver Hill School	675 Washington St.	N/A	N/A	250	Yes	Yes
	Pentucket Lake Elem. School	252 Concord St.	N/A	N/A	250	Yes	Yes
	Haverhill High School	137 Monument St.	N/A	N/A	250	Yes	Yes
	Whittier Voc-Tech High Sch.	115 Amesbury Line Rd.	N/A	N/A	1000	Yes	Yes
	Consentino School	685 Washington St.	N/A	N/A	250	No	No
	Nettle School	150 Boardman St.	N/A	N/A	200	No	No
	Whittier School	256 Concord St.	N/A	N/A	200	No	No
	Hunking School	98 Winchester St.	N/A	N/A	200	No	No

Flood Prone Areas

The City is bisected by the mainstem of the Merrimack River and is subject to flooding at select locations under particularly high river flow conditions. The floodplains of several of the Merrimack's tributary streams, including the Little River, East Meadow River, and Snow's Brook, are also subject to occasional flooding. In addition, there are numerous dispersed surface water and wetland areas, as well as poorly-draining low spots, where runoff water collects during high intensity/long duration rain events and periodically floods adjoining roads and properties.

Haverhill emergency management officials have identified in the City's CEMP the following eight flood-prone areas:

Haverhill Flood-Prone Areas

1. Lower River Street – Route 110
Western Avenue
2. Cove Road (Bradford)
Riverdale Avenue (Bradford)
3. Margin Street
Upper River Street
Washington St. Area behind
Tap Restaurant
4. Water Street
5. South River Street (Bradford)
6. Lincoln Avenue
Lower Jefferson Street
Lower Adams Street
Lower Monroe Street
Polk Street
7. Riverside Avenue
Coffin Avenue
Old Ferry Road
Ordway Street
Groveland Street
8. East Broadway



The City was especially hard hit during the Mothers Day Flood of May 2006, when the Merrimack River overtopped its banks at the Water Street (Rt. 97)/Groveland Street intersection, forcing the closure of this heavily traveled east-west route through the community. During the same storm event, numerous other City roads were flooded and ordered closed when ponds and tributary streams overflowed their banks. These areas included, among others: Crystal Lake (Lake Street, Crystal Street, Liberty Street all closed); East Meadow River (6 roads closed); Little River (Rosemont Street closed); and Snow's Brook (North Avenue at the Haverhill Country Club closed).

Flooding Vulnerability Assessment

A GIS analysis of the City's FIRM flood hazard areas by MVPC has determined that 4,593 (5.63 sq. mi.) of land area in Haverhill is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 847 acres (1.32 sq. mi.) lies within the 500-Year floodplain. Together, these two flood zones constitute almost twenty four percent (24%) of the total area of the community. Based on an additional analysis by MVPC, 289 acres in these zones are still open and "potentially developable" under the City's current zoning scheme. Development of this open space would increase the impervious surface cover and stormwater runoff, thereby exacerbating the existing flooding problems.



Special Flooding Concerns Addressed Since 2008 Plan

According to Haverhill public safety officials, two recurring flooding problems have been of particular concern, and warranted immediate attention in order to protect public safety, private property, municipal infrastructure, and environmental quality. These problem areas are summarized below.

- **Merrimack River Bank Stabilization @ Riverside and Coffin Avenues**

The Merrimack Riverbank adjacent to Riverside and Coffin Avenues is owned and maintained by the City of Haverhill. During the May 2006 flood event, rapidly-moving, debris-laden floodwaters rose to the top of the riverbank, causing severe erosion to a 10-foot section of Riverside Avenue. A 54-inch sewer interceptor located in the center of Riverside Avenue is now vulnerable to rupturing if further flooding and associated erosion occur. The 2006 floodwaters also caused significant erosion adjacent to a sewer lift station at Coffin Avenue. If the sewer interceptor and/or lift station were to be exposed and undermined, large quantities of untreated sewage would be discharged downstream, impacting the Merrimack River and possibly neighboring homes and businesses. Of particular concern are Riverside Plaza, which contains a large grocery store and a number of other businesses, and a cluster of 35 residences closest to the sewer interceptor. These properties could be seriously damaged by exposure to untreated sewage. The City acted to address this problem through a riverbank stabilization project, in which the eroded areas adjacent to the Riverside Avenue interceptor and the Coffin Avenue sewer lift station were outfitted with protective bio-vegetation mats and riprap. The Riverbank Stabilization Project was completed in June 2011 at a cost of \$489,000. The City received a grant from the Massachusetts Emergency Management Agency to cover 75% of the project cost.

- **Marginal Pump Station Redundancy**

The City's Marginal Pump Station was constructed in the late 1930s as part of the flood protection program following the devastating floods of 1936 and 1938. The pump station contains three pumps (and associated electrical components) with a total maximum capacity of 34 million gallons per day. The pumps are critical during seasonal high water periods and flood emergencies to prevent or limit flooding of downtown Haverhill. If the pump station with its antiquated parts were to fail, 20 commercial businesses located in the immediate area would sustain property damage. In addition, the Assisted Living Center for the elderly (adjacent to the pump station) would need to be evacuated, as was done in the May 2006 flood, impacting 100 elderly residents. After reviewing options, the City is addressing this problem by providing spare motor and electrical pump control components that can be installed in the event of a system failure. The equipment purchase was completed as part of the City's Flood Protection Certification in 2014.

As part of the mapping analysis, MVPC also identified the critical facilities that are located within the City's 100-year and 500-year floodplains and thus are at risk of future flood damage or loss. These facilities, together with their assessed values as derived from the current (2013) Assessor's records, are listed in **Table 5.5-2** below.

Table 5.5-2. Critical Facilities in Flood Hazard Areas – Haverhill		
Facilities in 100-Year Floodplain		
Facility Name	Parcel ID / Street Location	2013 Buildings Valuation
Haverhill Water Street Fire Station	207-2-2 / 135 Water Street	\$409,300
Merrimack Valley Reg'l Transit	712-684-8 / 123 Railroad Avenue	\$1,250,200
Haverhill Park & Ride Lot	408-2-5 / 219 Lincoln Avenue	\$1,435,300 (land value)
Mass. Electric Company Substation	207-2-4 / 165 Water Street	\$770,300
Facilities in 500-Year Floodplain		
Facility Name	Parcel ID / Street Location	2013 Buildings Valuation
Haverhill Moody School	505-246-2 / 59 Margin Street	\$1,238,500
Pennacook Place Nursing Home	207-1-2 / 150 Water Street	\$2,908,700
Boisvert Day Care Facility	536-17-5 / 1035 Western Avenue	\$173,600
Phoenix Row Elderly Housing	308-1-8 / 12 Phoenix Way	\$666,800
Washington Square Elderly Housing	300-52-2 / 13-29 Washington Sq.	\$2,183,400
MVRTA Washington Sq. Bus Station	308-1-10 / 12 Washington Sq.	\$512,500
Marginal Sewage Pumping Station	308-1-10 / 12 Washington Sq.	\$174,700

According to City officials, there are no current plans to site other critical facilities in the 100-year and 500-year flood zones with the exception of possible water supply facilities along the Merrimack River on East Broadway.

Based on the frequency, areal extent, and severity of historical floods in Haverhill, City officials consider the community to be at **high risk** from flooding.

Repetitive Flood Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there are fifteen (15) repetitive loss locations in Haverhill. Eight of these sites are along River Street on the north side of the Merrimack River; four sites are in the Bradford section of Haverhill on the south side of the Merrimack River. All of the sites except for one are residential properties. Together, these 15 sites have resulted in the payout of 33 National Flood Insurance Program claims totaling \$1,257,831 since April 1987. According to the City's former emergency management director, these repetitive losses stem both from periodic larger-scale *riverine* flooding of the Merrimack River and its tributaries and from recurring localized drainage problems.

Structurally Deficient Bridges Over Waterways

Haverhill currently has one waterway bridge classified as structurally deficient. The Route 125 (“Basiliere”) Bridge was built in 1925 and has an AASHTO rating of 18.8 (out of 100). This state highway bridge spans the Merrimack River in downtown Haverhill, and is the major access route connecting the City central business district to Bradford and to points south. Because Route 125 carries an average traffic load of 30,000 vehicles per day, any closure of the bridge due to flood damage or other natural disaster would have enormous negative consequences on the City’s public safety services, economy, and quality of life. The bridge is slated for replacement in 2017.



Since the last Regional Hazard Mitigation Plan in 2008, two structurally deficient highway bridges connecting Haverhill to neighboring communities have been replaced. The East Main Street (“Rocks Village”) Bridge previously listed as structurally deficient & closed to heavy vehicles was reconstructed by MassDOT and opened in August 2013. The Rocks Village Bridge was originally built in 1883 and last reconstructed in 1914. This bridge spans the Merrimack River near the City’s border with the Towns of Merrimac and West Newbury.

And in October 2013, the new Bates Bridge was opened. It spans the Merrimack River at Routes 97/113 and connects Haverhill to the Town of Groveland. The new span replaces a structure originally constructed in 1950.

Major rehabilitation also began in Spring 2014 of the MBTA rail bridge over the Merrimack River between Bradford and downtown Haverhill. The bridge, used by Pan Am freight and Amtrak Downeaster service to Maine in addition to MBTA commuter rail operations, has been subject to 15 mph speed restrictions because of its deteriorated condition. Construction work, scheduled in phases and to be fully complete April 2017, involves substructure and bearings replacement along with track upgrades.

Hazard Potential of Dams

The DCR Office of Dam Safety includes 12 Haverhill dams on its dam hazard classification list. Of these, six dams are classified as either high hazard or significant hazard dams. These six dams are identified and described in **Table 5.5-3** below.

Table 5.5-3. High Hazard and Significant Hazard Dams – Haverhill			
Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class
Millvale Reservoir Dam	Millvale Reservoir (558 acre-feet)	1898	High <i>Inspected May 2013</i>
Crystal Lake Dam	Crystal Lake (1,000 acre-feet)	1930	Significant <i>Inspected July 2009</i>
Frye Pond Dam	Frye Pond (90 acre-feet)	Not Available	Significant <i>Inspected July 2009</i>
Kenoza Lake Outlet Dam	Kenoza Lake (960 acre-feet)	1980	Significant <i>Inspected Dec. 2009</i>
Lake Pentucket Dam	Lake Pentucket (412 acre-feet)	1920	Significant <i>Inspected Sept. 2012</i>
Little River Dam	Little River (25 acre-feet)	1870	Significant <i>Inspected Feb. 2008</i>

Natural Hazards Risk Analysis

The City of Haverhill's Comprehensive Emergency Management Plan contains a risk analysis for a majority of the natural hazards that are addressed by this Plan. This risk analysis covers events that, according to City officials, pose a high, medium, or low risk to the community. On the basis of this analysis, Haverhill considers itself to be at **high risk** from floods and winter storms (blizzards/snow/ice storms); **moderate risk** from hurricanes, droughts, wildfire, dam failures, and power outages; and **low risk** from earthquakes, tornadoes, and landslides.

Table 5.5-3. Haverhill Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Hurricanes	Moderate
Drought	Moderate
Wildfire/Brush Fires	Moderate
Dam Failure	Moderate
Power Outages	Moderate
Tornadoes	Low
Earthquakes	Low
Landslides	Low

5.6 CITY OF LAWRENCE Natural Hazard Risk Assessment

Community Profile

The City of Lawrence was established in 1856 at the confluence of three rivers, the Merrimack, Shawsheen and Spicket Rivers. One of the nation's first planned communities, Lawrence covers a land area of 6.9 square miles and has a resident population of 76,377 (U.S. Census 2010). The City has the highest population density (11,069 persons per sq. mi.) in the Merrimack Valley region, and among the highest in the Commonwealth. There are 27,137 housing units, with an average household size of 2.87 persons. Lawrence has been developed with large residential districts (comprising 61% of the land area) and large industrial districts (21%) of the area. The commercial/business district is relatively small in comparison (9%).



The Lawrence Public School system has a pupil enrollment of more than 13,000. The district includes four early childhood centers, ten elementary schools, six middle schools and eight high schools, opened in 2007, on a 42-acre campus on North Parish Road. The City also has a number of private parochial and charter schools.

The City landscape is noted for large industrial mill buildings, most constructed between 1850 and 1900 when Lawrence was a leading world textile manufacturer. The City provides public drinking water from the Merrimack River via an 8 million gallons per day (mgd) water treatment plant. (The current average water use is 7 mgd.) The City also provides extensive sewer service and wastewater treatment via the 52-mgd Greater Lawrence Sanitary District (GLSD). Public safety personnel in the community, as of 2014, including 113 uniformed police officers and 117 firefighters.

Development Activity Since 2008

Lawrence’s population during the 2000’s increased 6%. MVPC forecasts that between 2010 and 2030 the City’s population will experience low moderate growth to 77,900 people with an employment base of about 21,000 jobs.

In the assessment of team members preparing this plan, the City’s vulnerability to hazards is unchanged based on the level and type of new development since the 2008 Plan. Lawrence is a mature industrial city which has been experiencing revitalization with large, visible mill property redevelopment into housing and mixed use.

Lawrence Development Projects					
Project Name	Project Type	Status	Completion Year	Total Housing Units	Approx. Sq. Ft. Non-Res
Union Crossing	Mixed Use 400,000 sq. Ft.	Completed	2013	131	90,000
Washington Mills	Residential	Completed	2012	155	
Malden Mills	Residential	Completed	2012	75	
Monarch Lofts	Residential	Completed	2012	204	
Riverwalk Properties	Commercial	Planning	2017		600,000

Major developments recently completed or in planning, permitting or construction include:

Critical Facilities

A list of selected critical facilities (emergency operations, health care facilities, public shelters), as shown in **Table 5.6-1** on the following page, was prepared by City emergency management planning team. The locations of these and other critical facilities and infrastructure were entered into an Excel database and subsequently incorporated into MVPC’s Arcview GIS for use in digital mapping. The full array of critical facilities, as identified by City emergency management and public works personnel, are depicted in the Lawrence map series that is presented in **Appendix F** of this Plan.

Table 5.6-1. LAWRENCE Emergency Operations, Health Care Facilities, and Shelters

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Patient Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center(s)	Lawrence Fire Alarm Hdqtrs	66 Bodwell Street	N/A	N/A	N/A	N/A	Yes
	Lawrence Police Headquarters	90 Lowell Street	N/A	N/A	N/A	N/A	Yes (needs replacement)
	Lawrence Fire Stations	*Engine 9—71 South Broadway *Engine 5—65 Lowell St. *Engine 6—48 Howard St. *Engine 7—290 Park St.	N/A	N/A	N/A	N/A	Generators are at 71 S. Bway and 65 Lowell; No generators at Howard St. & Park St. stations.
	Lawrence City Hall	200 Common Street	N/A	N/A	N/A	N/A	No
Health and Nursing Facilities	Lawrence General Hospital	1 General St.	Hospital	350-500	1000		Yes
	Greater Lawrence Family Health Center	34 Haverhill St.	H/C Clinical	200		None	Yes
	Greater Lawrence Family Health Center	700 Essex St.	H/C Clinical	100		None	No
	Greater Lawrence Family Health Center	150 Park St.	H/C Clinical	100		None	No
	Greater Lawrence Family Health Center	Winthrop St.	H/C Clinical	100			No
	Mary Immaculate	172 Lawrence St.	Nursing Home	250			Yes
	Sunrise Home	800 Essex Street	Nursing Home	94			
	German Home	374 Howard Street	Nursing Home	30			
	Colonial Heights Health Care	555 S Union Street	Nursing Home	90			
	Berkeley Nursing Center	150 Berkeley Street	Nursing Home	37			Yes
Emergency Shelters	Lawrence High School	70-71 North Parish Road	Shelter			Yes	Yes
	Arlington School	150 Arlington Street	Shelter			Yes	Yes
	South Lawrence East School	165 Crawford Street	Shelter			Yes	Yes

Table 5.6-1. LAWRENCE Emergency Operations, Health Care Facilities, and Shelters

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Patient Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Housing Shelters	Lawrence Citizens Center	250 Canal St.	Shelter				
	Lazarus House	Holley Street	Shelter	22	41	50	Yes
	Casa Nueva Vida	57 Jackson Street	Shelter	20	20	20	
	Windsor House	248 Broadway	Shelter	51	65	None	Yes

Flood Prone Areas

Parts of the City of Lawrence lie within the floodplains of the Merrimack River and two of its major tributaries, the Shawsheen River to the south and the Spicket River to the north. All three rivers are subject to recurring (and sometimes *highly damaging*) flooding from heavy watershed snowmelt and prolonged rainfall from intense tropical storms. The lower Spicket River also floods due to backwater effects from several major constriction points on the river, including those at the Daisy Street Bridge in Lawrence and at the railroad bridge upstream in Methuen.



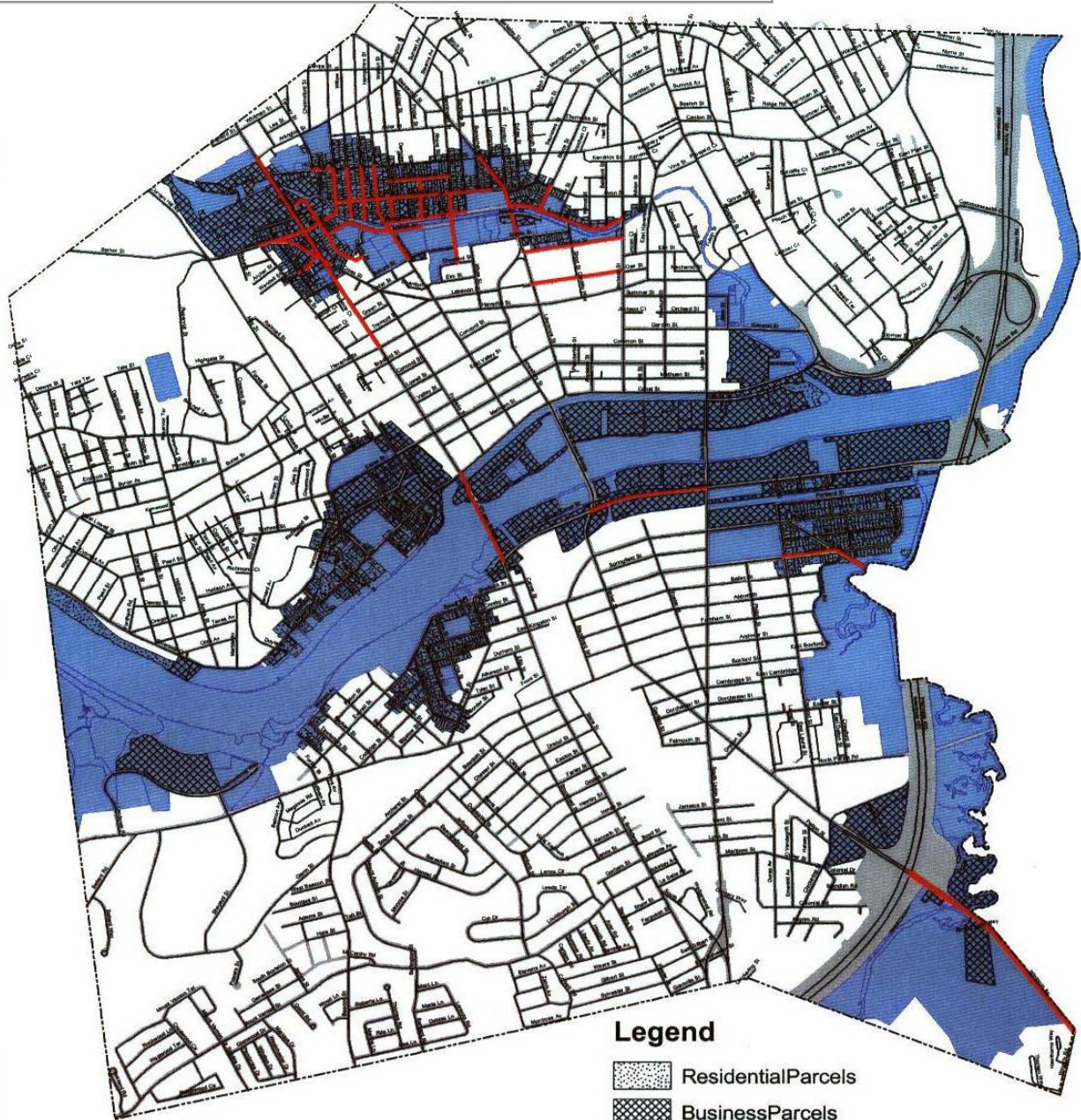
When the Merrimack River mainstem floods, it inundates and impacts a predominantly commercial and industrial district in the City. The Shawsheen River floods a predominately undeveloped recreational area, as well as some residences and parts of the Highway Access District (most notably busy Route 114 that connects the City to Route I-495 and neighboring North Andover.) The Spicket River floods a predominantly residential district, with some commercial flooding as well. All told, 17% of the City area lies within the combined 100-year floodplains of these three rivers. Also situated within the floodplains is much of the Greater Lawrence Sanitary District's (GLSD) sewer

interceptors and collector pipes. The GLSD is the region's largest (52-mgd) wastewater treatment facility, serving the four Merrimack Valley municipalities of Lawrence, Methuen, Andover, and North Andover, as well as nearby Salem, NH.

The notorious "Mothers Day Flood" of May 2006, depicted geographically on the following page, had especially disastrous consequences for the City. Impacts were widespread and included the week-long inundation and closure of numerous key commuter streets and parking facilities, widespread water damage to residences, businesses, and institutions, and the forced evacuation of nursing home residents and other sensitive populations. City emergency services were taxed to the extreme, and property damage estimates – residential, commercial, municipal – exceeded \$34 million.

CITY OF LAWRENCE

ESTIMATED SCOPE OF FLOOD DAMAGE – MAY 2006



Damage Estimates

Residential Losses:	\$18 million
Business Losses:	\$ 6 million
City Losses:	\$10 million



Special Flooding Concerns

City public safety officials cite five recurring flooding problems that are of particular concern and warrant ongoing attention in order to protect public safety, private property, and municipal infrastructure. These problem areas are summarized below.

Shawsheen River @ Merrimack Street Culvert

The Shawsheen River flows below ground for approximately 1/8 mile passing beneath Merrimack Street, a public way, as well as a rail line and commercial parking lot, before exiting to the Merrimack River. During the 100-year flood, the Shawsheen backs up into the local neighborhood impacting several homes and streets.

Shawsheen River @ Route 114 Bridge

The Shawsheen River, during the 100-year flood, is backed up by the existing bridge structure causing the river to overtop its banks and flood Route 114, effectively closing the busy public thoroughfare.

Spicket River @ Daisy Street Bridge

The Spicket River routinely backs up at this bridge and causes flooding at Holly, Daisy, Spruce and Myrtle streets. The City, with FEMA assistance in the last decade, purchased nine homes adjacent to the Daisy Street bridge and, combined with land provided by Central Catholic High School, built a recreational park/trail network designed with expanded flood storage.

Spicket River @ Hampshire Street Bridge.

The Spicket routinely backs up at this bridge, flooding Hampshire Street and Marion Avenue. The bridge, located near Central Catholic High School, in 2012-13 replaced with a new structure.

Bloody Brook @ Intersection of Swan/Knox Streets and Jackson Street

The Bloody Brook routinely backs up at this location at the Methuen City Line due to inadequately sized culverts and increased development upstream in Methuen. Several buildings in the flood area have been demolished and properties are now owned by City of Lawrence. Also, since the 2008 Plan, the City of Methuen has constructed drainage improvements in the Jackson Street area to increase storm drain capacity but infrastructure capacity bottleneck persists downstream as construction work did not extend beyond City line into Lawrence.

Flooding Vulnerability Assessment

A GIS analysis of the City's FIRM flood hazard area maps by MVPC has determined that 762 acres (1.2 sq. mi.) of land area in Lawrence is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 431 acres (.67 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute twenty-five percent (25%) of the City total area. As part of the mapping analysis, MVPC also identified the critical facilities that are located within the City's 100-year and 500-year floodplains and thus are at risk of future flood damage or loss. These facilities, together with their assessed values as derived from the current (2014) Assessor's records, are listed in **Table 5.6-2**.

Table 5.6-2. Critical Facilities in Flood Hazard Areas – Lawrence		
Facilities in 100-Year Floodplain		
Facility Name	Parcel ID / Street Location	2015 Buildings Valuation
Lawrence Dept. of Public Works Garage	148-0-5-0/ 31 Auburn Street	\$2,163,500
Mary Immaculate Nursing Home & Marguerite's House Asst. Living	129-0-3-0/ 172 Lawrence Street	na
Central Catholic High School	300 Hampshire St.	\$6,140,000
Leonard Middle School	60 Allen St.	Na
Engine 7 Fire Station	171-0-149-0/290 Park Street	\$ 434,700 *(Fire Dept. 2015 estimate of replacement value is \$3-4 million minimum)
Lawrence Citizens Center-shelter	105-0-8-0/ 250 Canal Street	\$1,347,100
Gr. Lawrence Family Health Center	165-0-1-0/ 700 Essex Street	\$2,807,800
Lawrence Water Treatment Plant & Sewage Pumping Station	204-0-44-0/396 Water Street	\$2,466,900
Day Care Facility-Kids Start Ctr	124-0-5-0/ 444 Canal Street	\$ 986,600
Day Care Facility-Gr. Law. Head Start	136 Water St.	Na
Day Care Facility-Merr. River Community Child Care Center	66-1-3-0/ 50 Island Street	\$ 765,200
Facilities in 500-Year Floodplain		
Facility Name	Parcel ID / Street Location	2014 Buildings Valuation
Buckley Transportation Center	126-0-18-0/295 Common Street	\$3,444,200
Merrimack Valley Hospice	46-0-14-0/ 360 Merrimack Street	\$6,143,200
Power Substation--MassElectric	103-0-7-0/ South Canal St.	na
Power Substation--MassElectric	141-0-9-0 /Rowe Street	\$ 2,700
E911 Dispatch Center/Fire Hdqtrs	146-0-23-0/ 90 Lowell St.	\$ 234,200
Leahy Elementary School	100 Erving Avenue	Na
Arlington Elem/ Middle School	150 Arlington Street	\$9,629,200

According to City officials, there are no current plans to site other critical facilities in the 100-year or 500-year flood zones. MVPC has also reviewed non-critical structures within Lawrence floodplain areas and through GIS analysis has identified 673 structures on 647 parcels within the floodplain. Value of these structures/properties is \$279,446,600 million, according to City Assessor records.

FEMA reports that as of 6/30/2014, there are 380 properties with flood insurance policies in place. Insurance value of these flood zone properties is \$87,716,000.

Based on the frequency, areal extent, and severity of historical floods in Lawrence, City officials consider the community to be at **high risk** from flooding.

Repetitive Flood Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there are twenty seven (27) properties in Lawrence that since 1978 have sustained repetitive flood losses. Three of the sites are classified as single-family residential. Nine repetitive loss properties are commercial/non-residential, fourteen are listed as 2-4 family residential and one property is other residential (multi-family). In total, these 27 properties have resulted in the payout of 78 National Flood Insurance Program claims totaling \$7,574,214.86 since 1978.

Structurally Deficient Bridges Over Waterways

When the prior 2008 Natural Hazard Mitigation Plan prepared, the City of Lawrence had six bridges over waterways classified by the MassDOT as “Structurally Deficient”. Because of investments by the Merrimack Valley MPO, the City and MassDOT Highway, as of the end of 2014 only one federal-aid eligible waterway bridge remains listed as “Structurally Deficient”.

Amesbury Street at South Canal over the Merrimack River

2014 AASHTO Rating of 47.3.

This is one of three central bridges in Lawrence over the Merrimack and the only one not reconstructed within the past five years. Originally constructed in 1918, the bridge has repair needs that include work to superstructure and abutments. The project is not currently included on the regional Transportation Investment Program by the Merrimack Valley MPO.

Four waterway bridges in Lawrence are classified as Functionally Obsolete. Of these, the Daisy St. Bridge, owned and maintained by the City of Lawrence, has been of highest concern. The bridge built in 1939 spanning the Spicket River has a 2014 AASHTO Rating of 31.1. Local DPW and emergency management personnel have identified the structure as a concern not only for its condition but also for its limited clearance over the Spicket River. During flood events, the bridge acts as a dam and exacerbates local flooding in the Daisy Street neighborhood.

Hazard Potential of Dams

The DCR Office of Dam Safety includes three operating and regulated Lawrence dams on its dam classification list: the Great Stone Dam (also called “Essex Dam”, Lower Locks Dam (“North Canal Outlet Dam” and the Stevens Pond Outlet Dam. Two other formerly active dams—the Lawrence Reservoir Dam and the Spicket River Dam—are no longer operational. (The Lawrence Reservoir was converted to a municipal drinking water storage tank and the Spicket River Dam, built of granite block, has been dismantled providing free flow of the Spicket in Lawrence. Of the Lawrence dams in operation, one, the Stevens Pond Outlet Dam, is listed as a High or Significant Hazard.

The massive Great Stone Dam, spanning the Merrimack River mainstem, is a hydropower generation facility, and as such is not regulated by the state DCR but rather by the Federal Energy Regulatory Commission (FERC). According to FERC officials, the dam is inspected every three years and is classified as a low hazard dam.

Table 5.6-3. Significant Hazard Dams – Lawrence					
Dam Name	Impoundment Name <small>(maximum capacity in acre-feet)</small>	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Stevens Pond Outlet Dam	Stevens Pond <small>(112 acre-feet)</small>	1877	High	9/7/2006	Inspection* overdue
*Based on DCR/Office of Dam Safety 2012 spreadsheet record					

Based on the risk condition of the Stevens Pond Outlet Dam and in spite of the low number of dams in the community, City officials have assigned a moderate risk rating to the dam failure hazard in Lawrence.

Wildfires

Lawrence Fire Department responds to approximately 60 brush fires on average each year. From 2008 through 2012, there were 298 brush fire incidents, most contained within small areas. Some of the more serious brush fires have occurred in wooded sections of Lawrence specifically Den Rock Park; behind the Frost School, the area between Shawsheen Road and Route 495, and Riverfront Park along the south bank of the Merrimack River. Given the frequency but limited extent of this hazard in the community, brush-fire hazard is considered a moderate community risk.

Natural Hazards Risk Analysis

The City of Lawrence's risk analysis covers events that, according to City officials, pose a high, moderate-high, moderate, low-moderate, or low risk to the community. On the basis of this analysis, Lawrence considers itself to be at **high risk** from flooding, winter storms (blizzards/snow/ice storms), and power outages; **moderate-high risk** from dam failure; **moderate risk** from hurricanes, earthquakes, and brush fires; **low-risk** from tornadoes, drought and landslides.

Table 5.6-4. Lawrence Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Power Outages	HIGH
Noreasters	HIGH
Dam Failure	Moderate-HIGH
Hurricanes	Moderate
Earthquakes	Moderate
Wildfire/Brush Fires	Moderate
Tornadoes	Low
Drought	Low
Landslides	Low

5.7 TOWN OF MERRIMAC Natural Hazard Risk Assessment

Community Profile

The Town of Merrimac is located 37 miles north of Boston in the heart of the lower Merrimack River Valley. Bounded on the south by the Merrimack River, it is a charming rural-residential community covering 8.5 square miles and accessible via interstate Route I-495 and regional Route 110.



The Town has a resident population of 6,338 and 2,417 households (U.S. Census 2010). The population density is 746 people per square mile, and the average household size is 2.61 people. The town's growth was a moderate 3.3% this past decade after relatively rapid growth of 18.8% during the 1990's and 16% in the 1980's.

Merrimac has a strikingly diverse topography, with a landscape and soil composition formed by glacial scouring and deposition. The mixed terrain ranges from 8 pronounced drumlin hills to broad floodplain lowlands and kettle hole ponds. The dominant landscape feature is the Merrimack River. The Merrimack is one of the Town's (and the region's) most distinctive and vital natural resources – environmentally, recreationally, and aesthetically.

The predominant land uses are forest (54%) and residential development (18%), followed in turn by wetlands/water (13.5%) and agriculture (8%). Commercial and industrial uses combined total about 82 acres and constitute 1.4% of the town area.

The Merrimac Water Department supplies drinking water to about 90% of the Town. Most of its customers are residents. The water supply comes from two tubular wellfields: Bear Hill and East Main Street, which also has a gravel packed well. Each wellfield produces 175,000-275,000 gallons per day. The town also provides municipal sewer service through a 450,000 gpd wastewater treatment plant, 15 miles of connector mains, and 9 lift stations.

Development Activity Since 2008

Merrimac Square is the 18-acre Village Center of Merrimac and is one of the Town's two Priority Development Areas, as defined in the regional land use plan (2015). It is located in the center of town, bisected by Route 110. Broad Street connects the square to I-495 at Exit 53. The Village Center zoning district is set forth "to preserve and enhance the historic built form of Merrimac Square, develop and sustain a vital local economy, provide goods and services used predominantly by residents of the Town, and provide a village that encourages people to live and work in the community."

Situated just east of Merrimac Square between Route 110 and I-495, **Merrimac's Route 100 Corridor** is also 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. In 2010, the Town's employment base was 766 jobs, according to the U.S. Census. MVPC forecasts that the Town's population will grow by an estimated 12% to 7,100 people in 2030.

Given the moderate level of growth and siting of new development outside high hazard areas, Merrimac planning team members consider the relative level of hazard risk vulnerability to be unchanged since the 2008 Multi-Hazard Plan process.

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.7-1**, was derived from municipal officials including local emergency management personnel. The locations of these and other critical facilities and infrastructure were entered into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The critical facilities are depicted in the Merrimac map series that is presented in Appendix F of this Plan.

Table 5.7-1. MERRIMAC Emergency Operations Centers Health / Medical Aid Facilities, and Shelters							
Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center(s)	Merrimac Fire Station (Primary EOC)	16 Main Street	N/A	N/A	N/A	N/A	Yes
	(Note: Town Hall deleted as secondary EOC because of lack of generator)						
Health and Medical Aid Facilities	NONE						
Shelters/ Warming stations	Dr. Sweetsir School	104 Church St.	N/A	N/A	1500	Yes	No
	Council on Aging	100 East Main St.	N/A	N/A	150	Yes	No

Surface Waters and 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.



- **East Meadow River** drains into neighboring Haverhill and feeds the Millvale Reservoir, one of Haverhill's public drinking water sources.
- **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. The brook corridor also features the Town's popular McLaren Trail.
- **Back River** originates in southern New Hampshire and flows by the town's eastern border into Lake Attitash, a 360-acre kettle hole lake shared by Merrimac and Amesbury in the Powow River sub-drainage area.

Merrimac also has abundant wetlands that comprise nearly 10% of Merrimac's total land area. Wetland complexes parallel each of the above-named rivers and streams, as well as areas south of Lake Attitash near the Town wellfield and to the west of Bear Hill Road. The large wetland between Red Oak Hill and Long Hill is the source of a tributary to Cobbler Brook and Silver Stream.

A notable amount of land in Merrimac is 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.

Flooding Vulnerability Assessment

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.

As part of the mapping analysis, MVPC also investigated the presence of any “critical” facilities at potential risk of future flood damage or loss. No such facilities were identified in the mapped FIRM flood zones, nor, according to town officials, are there plans to site any future critical facilities in these zones.

MVPC also examined *non*-critical facilities in flood hazard areas. This analysis revealed the presence of 72 residential structures on 66 parcels (collectively valued in 2014 at \$8,040,200) in the 100-yr floodplain.

Based on the frequency, areal extent, and severity of historical floods in dispersed locations in Merrimac, Town emergency management officials consider the community to be at **high risk** from flooding.

Special Flooding Concerns

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

- **Bear Hill Road.** Improving drain structures in this area along the Back River near the state line is currently the highest priority of local officials. The existing corrugated steel culvert is undersized and deteriorating. This is a new priority area since the 2008 Plan.
- **East Main Street.** The Cobblers Brook stream crossing at Route 110 is subject of localized flooding exacerbated by an undersized culvert. Area is of critical concern because of its location adjacent to the DPW/Fire/Police facility. During the May Day 2006 Flood, road closure here hampered emergency vehicle and DPW operations. This is an area of higher priority attention to the Town since the 2008 Plan.
- **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.** During periods of flooding, this bridge is often not passable.
- **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.** River Road was a connector road to neighboring Haverhill and Amesbury, but was discontinued by the Commonwealth and Town in 2013 following repetitive flood damage including closures from the May 2006 and April 2007 floods.
- **Mythical Street.** The 2006 and 2007 major storm events combined to wash out the existing culvert. The DPW replaced the culvert in 2009. Mythical Street is the *only access road* into Valley and Chestnut Streets.
- **Birch Meadow Road Loop.** This residential road experiences chronic water ponding during heavy rain events. A drainage improvement study is needed to identify corrective options.

Repetitive Flood Loss Structures

According to data compiled by the MA Department of Conservation and Recreation, there currently are no repetitive flood loss sites in the Town of Merrimac. Town-wide, there are 21 flood insurance policies in place for properties located in FIRM flood hazard areas. The combined insurance value of these properties is \$4,901,300. (source: *NFIP Policy Statistics for Massachusetts – 6/30/2014.*)

Structurally Deficient Bridges Over Waterways

According to MassDOT, the Town of Merrimac does not have any bridges within its borders that are classified as “Structurally Deficient”. However, two other "Structurally Deficient" bridges – the Rocks Village Bridge between Haverhill and West Newbury and the Bates Bridge connecting Haverhill to Groveland – are located in neighboring communities and impact Merrimac’s transportation system. These two bridges are described below.

Rocks Village Bridge

The historic Rocks Village Bridge spans the Merrimack River between the Rocks Village area of Haverhill and West Newbury. The bridge is historic because it is one of the last hand-operated turning mechanism bridges in New England.

This bridge provides a connection between Route 110 in Haverhill and Merrimac and Route 113 in West Newbury and Groveland. It is a major school bus route that connects the town of Merrimac to the other Pentucket Regional School system communities of Groveland and West Newbury. The Pentucket Middle School and the regional high school are located on



Route 113 at the Groveland/West Newbury town line on the south side of the Merrimack River. This route also provides access to Whittier Vocational High School, which is located on Amesbury Line Road in Haverhill approximately 1.25 miles north of the bridge. In addition to carrying the school-related traffic, the bridge is increasingly being used by commuters from southern New Hampshire/eastern Haverhill/western Merrimac to access I-95 in Newburyport.

In April 2013, the Rocks Village Bridge had an AASHTO rating of 0.0 (out of 100). Due to its deteriorating condition, the bridge had been posted with weight restrictions. Work on a project to rehabilitate this bridge began during the summer of 2012. A new bridge deck was installed along with stronger guardrails and new lighting. The bridge's piers and ice fenders were repaired as were components of the superstructure. All work was completed in August 2013 and the span fully reopened to traffic which had been disrupted during the year-long construction period.

Bates Bridge

The William H. Bates Bridge carries Routes 97/113 over the Merrimack River between Haverhill and Groveland. This bridge was built in 1950 and replaced the former structure at this location.

The AASHTO Bridge Rating for the structure in April 2013 was 34.0 (out of 100). Over the years it had not been uncommon for the structure to be periodically closed to traffic while MassDOT performed short-term repairs. MassHighway has also posted the bridge with a weight limit. This bridge does have a functioning draw mechanism, which allows larger vessels to proceed upstream as far as downtown Haverhill.

The Bates Bridge carries approximately 20,600 vehicles/day (August 2007). Many of these are commuters who are traveling to I-95 through Georgetown to work from their homes in Haverhill and even southern New Hampshire. Others are Groveland residents who shop at Rivers Edge Plaza or emergency vehicles from Groveland, West Newbury and Georgetown that access Merrimack Valley Hospital. Much of this traffic would have to be rerouted to downtown Haverhill through Bradford via Salem Street and then over the Basiliere Bridge (Route 125). Other drivers would seek to use the Rocks Village Bridge between Haverhill and West Newbury as an alternate route. Both of these bridges were also classified by the state as being “Structurally Deficient”, although the Rocks Village Bridge was also closed for repairs until August 2013 as noted above.



Given the high importance of the Bates Bridge to the region's transportation network and economic vitality, MassDOT undertook replacement bridge construction 50-60 feet downstream from the 1950 structure. The new bridge was completed and opened to traffic in October 2013. The older span has been removed.

Hazard Potential of Dams

According to dam inventory records maintained by the state Office of Dam Safety, Merrimac has only three (3) dams. 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**.

Brushfire/Wildfire Hazard

Merrimac Fire Department reports that it responds to an average of 10 to 20 brushfires in the community annually. More than half the Town's land area is forest and, therefore, risk is considered to be a moderate hazard by Town officials.

Natural Hazard Response Capacity

Merrimac's emergency response team includes the Town Police Department staffed by 17 uniformed officers and the Fire Department that includes 46 on-call firefighters, eight of whom are dedicated to emergency management planning and response.

Other emergency response personnel include Health Department (2 staff), Inspectional Services, and Department of Public Works (6 personnel)

DPW reports completion of the following infrastructure projects in recent years:

- February 2009: Repaired culvert outlet to prevent washing out of banking on Mythical St.
- March 2012 : Replaced failing steel arch with new concrete arch and wing walls on River Rd. (Cobblers Brook)
- July 2012: Replaced outlet pipe to correct banking washing out on Champion St.
- June 2012: Installed 300ft of drain pipe and structures to help out the flooding issues during heavy rains and help keep sediment out of Lake Attitash.

Natural Hazards Risk Analysis

The Town of Merrimac's Comprehensive Emergency Management Plan (CEMP) contains a risk analysis for the majority of the natural hazards that are addressed by this Plan. This risk analysis covers events that, according to Town officials, pose a high, medium, or low risk to the community. On the basis of this analysis, plus the judgment of local emergency management personnel, Merrimac considers itself to be at **high risk** from floods and winter storms (blizzards/snow/ice storms); **medium risk** from hurricanes, drought, wildfire, and associated power outages; and **low risk** from earthquakes, tornadoes, dam failure, and landslides.

Table 5.7-3. Merrimac-Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Hurricanes	Moderate
Drought	Moderate
Wildfire/Brush Fires	Moderate
Power Outages	Moderate
Tornadoes	Low
Dam Failure	Low
Earthquakes	Low
Landslides	Low

5.8 CITY OF METHUEN Natural Hazard Risk Assessment

Community Profile

The City of Methuen covers an area of 22.2 square miles and, according to the 2010 U.S. Census, has a resident population of 47,255. The City is predominantly a single-family residential community with a density of 2,129 persons per square mile. The public school system includes four large K-8 schools and one senior high school (grades 9 – 12), and has a current (2013-14) total student enrollment of 6,937. The predominant land use is residential development, which is sited on 43.9% of the City's land area. Commercial and industrial uses combined account for 5.5% of the total land area. Open space of forest and wetlands comprise one-third of the City. 5.3% of Methuen is vacant land, and Agriculture, once an important part of the Methuen landscape and economy, today constitutes only 3% of City land area. About three-quarters of residential development in the community is on lots of ½ acre or less. The City provides public drinking water from the Merrimack River. The water treatment plant has a design capacity of 15 million gallons per day (mgd), although current demand ranges from 5 – 9 mgd. There are 183 public safety personnel in the City, including 88 uniformed police officers and 72 fire fighters.



Development Activity Since 2008

Methuen's population during the 2000's increased 7.9%. MVPC forecasts that between 2010 and 2030 the City's population will grow 6.9% to 50,500 people and its employment base will increase 13.8% from 14,684 jobs in 2010 to an estimated 16,706 in 2030.

Based on the level and type of development taking place in Methuen, local planning/conservation officials consider the City vulnerability to hazard risks to be unchanged since preparation of the 2008 Multi-Hazard Mitigation Plan.

Major developments recently completed or in planning, permitting or construction include:

METHUEN Development Activity					
Project Name	Project Type	Status	Completion Year	Total Housing Units	Approx. Sq. Ft. Non-Res
Sorrento Farms	Residential	Complete	2012	31	
Malden Mills	Commercial	Projected	2017		100,000
Emerald Pines Golf Course	Residential	Planning	2015	70	
Merrimack Street	Commercial	Complete	2014		100,000
Merrimack St. / Village at Russell Farms	Residential	Complete	2013	90	
Merrimack Street	Commercial	Complete	2012		90,000
Maple Park Reserve Open Space Residential Development	Residential	Permitted/In Construction	2017	12	
Wheeler Street/Regency	Residential	Complete	2014	240	
Century Box Expansion	Commercial	Complete	2012		57,050
Merrimack Greens Phase 4	Residential	Construction	2015	11	

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.8-1**, was derived from the City's current CEMP. The locations of these and other critical facilities and infrastructure were entered into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The critical facilities are depicted in the Methuen map series that is presented in Appendix F of this Plan.

Table 5.8-1. METHUEN Emergency Operations, Health Care Facilities, and Shelters

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Patient Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center(s)	Quinn Building/Police Station	90 Hampshire St.	Clinic (limited)	5-10	N/A	No	Yes
	National Guard Armory (backup local operations center)	619 Lowell St.	N/A			Yes	Yes
Health and Nursing Facilities	Holy Family Hospital & Medical Center	70 East Street	Hospital	180	243	Yes	Yes
	Nevins Home	10 Ingalls Court	Nursing	151		Yes	Yes
	Methuen Health & Rehab. Center	480 Jackson street	Nursing	107			Yes
	Nevins Manor	110 Broadway	Nursing	46			Yes
	Presentation of Mary Nursing	209 Lawrence Street	Nursing	56			Yes
	Halcyon House	175 Berkeley St.	Nursing	20			Yes
	Grace Morgan House	489 Prospect Street	Nursing	21			No
	Park Gardens	10-12 Burnham Road	Senior housing	150			Yes
	Edgewood Ave.	Edgewood Avenue	Senior housing	64 units (8 bldgs)		Yes	
	Mystic Street	22-24 Mystic Street	Senior housing	174 units (18 bldgs)		Yes	
	Cedar Homes	222 Pelham Street	Senior housing	31 units			
	101 Broadway	101 Broadway	Senior housing	41 units		Yes	
	Merrimack Valley Apartments	20 Calumet Road	Senior housing	60 units		Yes	
	Methuen Village	4 Gleason Street	Assisted Living	91		Yes	
Shelters	Timony Middle School (designated regional shelter)	45 Pleasant View St.			350	Yes	Yes

Flood Prone Areas

Parts of the City of Methuen lie within the floodplains of the Merrimack River and the Spicket River (a tributary of the Merrimack), and are subject to recurring (and sometimes *highly damaging*) flooding during prolonged rainfall events. In addition, the City has numerous other surface water bodies – lakes, ponds, streams, and wetlands – that give rise to occasional localized flooding problems. These latter water bodies include: Forest Lake, Mystic Pond, Mill Pond, Searles Pond, and Hills Pond, as well as Bloody Brook, Hawkes Brook, Bare Meadow Brook, Harris Brook, Bartlett Brook, Sawyer Brook, Griffin Brook, and Bradley Brook.

According to the City officials, the Merrimack River flooding vulnerability is high along Armory and Lowell Streets, particularly in the area by Bartlett Brook. During severe flooding events, including May 2006, floodwaters near the Bartlett Brook outlet to the Merrimack River (by current site of Jules restaurant) forced closure of Route 110 and restricted access to the National Guard Armory emergency center from central Methuen.

The Spicket River flooding in Methuen can be particularly severe causing disruptions in Hampshire Road/Cross Street area, the center of the city along Pine Street, Horne Street, Bentley Circle, as well as in the area of Broadway/Park St./Morrison Court. Between 2006 and 2010, Spicket flooding at this location forced temporary residential relocations, street and business closures for several days on three occasions. The street closures on Broadway hampered Police and emergency access to the densely populated Arlington neighborhood in central Methuen abutting Lawrence.

Other neighborhood areas notably subject to flooding are:

- Joy Terrace/Newport Street area (waterway maintenance needed to mitigate localized flooding)
- Tobey Avenue/Grandview Avenue area in east Methuen off Route 110 (inadequate drainage capacity)
- Frye Road (Baremeadow Brook tributary) in east Methuen (waterway maintenance needed to mitigate localized flooding)



Special Flooding Concerns

City public safety officials cite two recurring flooding problems that are of particular concern and warrant immediate attention in order to protect public safety, private property, and municipal infrastructure. These problem areas are summarized below.

Spicket River @ Guilford Railroad Bridge

The former Guilford Railroad Bridge, now part of the Methuen Rail Trail and spanning the Spicket River at the end of Pine Street, has long been a troublesome “choke” point on the river. During high water events, of which there have been many over the last 10-15 years alone, the former RR bridge, converted in 2012 to the multi-use Rail Trail, causes a major backup of the Spicket River upstream from the bridge. Large areas of Hampshire Road, Cross Street, and Pelham Street, as well as many of their side streets, are severely impacted and frequently closed to the public. Additionally, at this same location, the floodwaters jump the RR tracks, which are no longer in use, follow the tracks under the City’s “5-corner” intersection, and spill out between the VFW building and Aurora Club on River Street. Back in the 1980’s, an occurrence of this nature inundated and washed out part of the regional sewer system of the Greater Lawrence Sanitary District (GLSD). At this same location today, a 48-inch sewer interceptor operated by the GLSD remains at risk. During each major high water event, Methuen DPW crews have been required to construct and maintain a sizeable containment berm next to the Spicket River at the Guilford RR Bridge. Without this berm, the GLSD sewer line would be in danger of being compromised by the erosive power of the surging Spicket River. This recurring task places an added strain on the City’s emergency response workforce at a time when their services are needed at other vulnerable locations in the community.

Bloody Brook @ Intersection of Swan and Jackson Streets

The City experiences significant recurring flooding along Bloody Brook in the vicinity of Swan Street (Route 110) and Jackson Street. The Swan Street/Jackson Street area is a commercial neighborhood and major commuter route for residents of both Methuen and neighboring Lawrence. The area is drained by the Bloody Brook culvert that begins between Curtis and Swan Streets (parallel to Jackson Street) as a 48-inch reinforced concrete pipe for approximately 100 feet, and changes to a 48-inch corrugated metal pipe. At the intersection of Swan Street, the culvert becomes a 4-ft X 4-ft mortared stone box culvert with a concrete roof. The culvert gradually increases in size as it flows into and through Lawrence, where it eventually empties into the Spicket River. The initial 750 linear feet of the culvert in Methuen is severely undersized, causing major flooding at the inlet and allowing substantial downstream capacity in the system to go under-used.

The City may seek state/federal funds (HMGP grant) to help finance structural solutions to the above problems.

The May 2006 flood event inundated much of the Swan Street and Jackson Street area described above for up to seven days, shutting down commercial establishments and forcing the evacuation of numerous residences, including six multi-family homes. The roadways in the area were also closed for this period, seriously impacting commuter traffic. A minimum of five police officers were required to post detours around the impacted areas. Other city personnel and private utility company crews were also required to respond. The 2006 flood was the most memorable in terms of severity. Other significant flooding events occurred in March 2010, April 2007, March/April 2004, spring 1998, and October 1996.

In response to these problems, City officials and their engineering consultant have proposed a major culvert and street drain improvement project, and are seeking a state HMGP grant to help finance the project.

Flooding Vulnerability Assessment

A GIS analysis of the City's current (July 1st, 2013) FIRM flood hazard area maps by MVPC has determined that 1,938 acres (3sq. mi.) of land area in Methuen is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 726.4 acres (1.1 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute eighteen percent (18%) of the total area of the community. Based on an additional analysis by MVPC, 420 acres in these zones are still open and "potentially developable" under the City's current zoning scheme. Development of this open space would increase the area's impervious surface cover and stormwater runoff, thereby exacerbating the existing flooding problems.

As part of the mapping analysis, MVPC also identified the critical facilities that are located within the City's 100-year and 500-year floodplains and thus are at risk of future flood damage or loss. These facilities, together with their assessed values as derived from the current (2014) Assessor's records, are listed in **Table 5.8-2** on the following page.

Table 5.8-2. Critical Facilities in Flood Hazard Areas – Methuen

Facilities in 100-Year Floodplain		
Facility Name	Parcel ID / Street Location	2014 Buildings Valuation
Methuen Water Supply Intake Structure	518-162-28 / 960 Riverside Dr.	\$ 446,200
Methuen Water Pumping Station	320-166-25 / 106 Lowell Blvd	Not assessed
New England Co Power Substation	512-124-39 / 141 Pelham Street	\$ 7,200
Methuen Sewage Pumping Station	218-130-18AA / 56 Hidden Road	Not assessed
Methuen Sewage Pumping Station	/Hampshire Road	Not assessed
Methuen Sewage Pumping Station	/Howe Street	Not assessed
Methuen Sewage Pumping Station	610-59-20D / 5 Kimball Circle	Not assessed
Methuen Sewage Pumping Station	/Rivers Edge Place	Not assessed
Methuen Sewage Pumping Station	1212-110C-12 / Merriline Avenue	Not assessed
Methuen Village-Asst. Living	612-120-13 /4 Gleason St.	\$7,238,700
Methuen DPW Garage	512-146-20 / 33 Lindberg Avenue	\$ 339,600
Methuen Water Maintenance Facility	410-126A-1/124 Cross Street	\$ 82,200
Facilities in 500-Year Floodplain		
Facility Name	Parcel ID / Street Location	2014 Buildings Valuation
Mariner Health Care Nursing Home	814-41-23F / 480 Jackson Street	\$1,057,800
Methuen Sewage Pumping Station	Lowell Street	Not assessed
Methuen Sewage Pumping Station	418-153B-70C / 1111 Riverside Dr	Not assessed
Little Genius Preschool	816-97-57 / 103 Jackson Street	\$ 113,000

According to City officials, there are no current plans to site other critical facilities in the 100-year or 500-year flood zones.

MVPC has also reviewed non-critical structures within Methuen floodplain areas and through GIS analysis has identified 215 structures on 178 parcels within the floodplain. Value of these structures/properties is \$76.3 million, according to City Assessor records; seventy-four percent (74%) of the properties identified are residential use and twenty-six percent (26%) are commercial/ industrial use.

FEMA reports that as of 6/30/2014, there are 166 properties with flood insurance policies in place. Insurance value of these flood zone properties is \$46,534,800.

Based on the frequency, areal extent, and severity of historical floods in Methuen, City officials consider the community to be at **high risk** from flooding.

Repetitive Flood Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there are sixteen properties in Methuen that since 1978 have sustained repetitive flood losses. Twelve of the sites are classified as single-family residential. Three repetitive loss properties are commercial/non-residential and one site is listed as 2-4 family residential. In total, these 16 properties have resulted in the payout of 49 National Flood Insurance Program claims totaling \$876,239.34 since 1979.

Structurally Deficient Bridges Over Waterways

Methuen has **three** bridges over waterways that are presently classified by the MassDOT as “Structurally Deficient”.

Hampshire Road Bridge over Spicket River

The Hampshire Road Bridge spans the Spicket River near the Methuen – Salem, NH town line. It was built in 1959 and is owned and operated by MassDOT. It serves as a connector route between Methuen and southern New Hampshire for commuter traffic and for commerce. According to the most recent (2002) traffic volume figures, Hampshire Road carries an average of 1,740 vehicles per day. The bridge has a current AASHTO rating of 50.7 (out of 100) due to a structural deficiency in its footings.

Route 213 Westbound Bridge over Spicket River

This bridge is classified as being "Structurally Deficient" despite having an AASHTO Rating of 76.1. Route 213 is a four lane divided highway that serves as a connector road between Interstates 93 and 495. A November 2010 traffic count taken by MassDOT on Route 213 between Howe Street and Route 28 showed a volume of just under 48,000 vehicles/weekday making this one of the most heavily traveled non-interstate roadways in the Merrimack Valley region. Closure of this bridge would have a noticeable adverse impact on travel in Greater Lawrence. Traffic would be diverted to Routes 110 and 113 in Methuen and likely create greater congestion in and around Methuen Square. In addition, interregional traffic that now uses Route 213 would likely be forced to use the already congested Interstate 93/Interstate 495 interchange in Andover.

Osgood Street bridge over Spicket River: The bridge is on Osgood Street in Methuen’s central business district and spans the Spicket just south of the Falls by Riverwalk Park. Osgood Street is a 2-lane roadway connecting Broadway to Lowell Street/Five Corners and classified by MassDOT as a minor arterial. The bridge, originally constructed in 1869, has an AASHTO rating of 40.5

Hazard Potential of Dams

The DCR Office of Dam Safety includes 11 Methuen dams on its dam classification list. Of these, two dams are classified as significant hazard dams. These three dams are identified and described in **Table 5.8-3** below. According to the City's CEMP, "*the safety of the Spicket River Dam at Lowell Street is of some concern to local officials*". This concern, coupled with the presence of two other significant hazard dams, has led to the City's assigning a **moderate-high** risk rating to the hazard of dam failure.

Table 5.8-3. Significant Hazard Dams – Methuen					
Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Forest Lake Dam	Forest Lake (224 acre-feet)	Not Recorded	Significant	12/1/2008	Every five years
Searles Pond Dam	Searles Pond (63 acre-feet)	1960	Significant	May 2014	Every five years

The Spicket River Dam at Lowell Street in the Regional 2008 Multi-Hazard Plan had been classified as Significant Hazard. Maintenance restoration work at the dam with Riverwalk pedestrian bridge has resulted in upgrade of the dam, originally constructed in 1860, to Low Hazard classification by the Commonwealth Office of Dam Safety. During the May 2006 Mothers Day Flood, surging Spicket River floodwaters began to overtop the dam and threatened the abutment, requiring City public safety crews to deploy sandbags in an effort to contain the water and prevent further scouring and erosion. According to the U.S. Geological Survey (USGS), the Spicket River peaked at 2,080 cubic feet per second (cfs), the highest flow recorded since streamflow monitoring began in the river in 2000.

"Flows during the flood peak for the Spicket River ... were at or exceeded those peaks that would be expected an average of once in a 100-year period"

- Kenneth Toppin
USGS Hydrologist



Wildfires

Methuen Fire Department responds to approximately 25-30 brush fires each year. From 2009 to Fall 2014, there were 161 brush fire incidents, most minor in scope of damage and/or disruption, according to Fire Department records. Given the frequency but limited extent of this hazard in the community, brush-fire hazard is considered a moderate community risk.

Response Management Capacity

Methuen has a full-time professional Police Department and Fire Department.

The Methuen Fire Department operates with 96 fire personnel. When fully staffed, fire personnel are as follows: 72 firefighters, 16 Lieutenants, 2 Captains, 4 Deputy Chiefs, 1 Assistant Chief, and 1 Chief. The Department runs 4 Engines, 1 Ladder, 1 Rescue and 2 Ambulances out of 4 Stations. All personnel are trained at the Massachusetts Fire Academy's fourteen-week recruit training program. Firefighters work a 24-hour shift, which consists of 1 tour on, 1 tour off, 1 tour on, and 5 tours off.

Methuen Police Department has staff of 88 uniformed officers led by the Chief of Police. The Police Department is the primary answering point for the Enhanced 911 System. The department is divided into three Bureaus: Field Operations, Support Services and the Criminal Investigations Bureau.

Methuen has a professionally staffed Health Department staffed by a Director, a Public Health Nurse, two health inspectors and a code enforcement officer.

The City's Chief Executive Officer is the Mayor elected every two years.

The City has a professional planning capacity within its Community Development Department and Conservation division. Maintenance of City infrastructure falls within the Department of Public Works organized in nine department divisions: Management, Engineering, Building Maintenance, Environmental Management, Equipment Maintenance, Highway, Water Distribution, Water Maintenance and Sewer Maintenance

Natural Hazards Risk Analysis

The City of Methuen's Comprehensive Emergency Management Plan contains a risk analysis for the natural hazards that are addressed by this Plan. This risk analysis covers events that, according to City officials, pose a high, moderate-high, moderate, low-moderate, or low risk to the community. On the basis of this analysis, Methuen considers itself to be at **high risk** from flooding, winter storms (blizzards/snow/ice storms), and power outages; **moderate-high risk** from dam failure; **moderate risk** from hurricanes, earthquakes, and brush fires; **low-risk** from tornadoes, drought and landslides.

Table 5.8-4. Methuen Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Power Outages	HIGH
Dam Failure	Moderate-High
Hurricanes	Moderate
Earthquakes	Moderate
Wildfire/Brush Fires	Moderate
Tornadoes	Low
Drought	Low
Landslides	Low

5.9 TOWN OF NEWBURY Natural Hazard Risk Assessment

Community Profile

The Town of Newbury is a small rural-residential community located 28 miles north of Boston in the historic North Shore region. It is bordered by Newburyport to the north; West Newbury, Groveland, and Georgetown to the west; Rowley to the south; and the Atlantic Ocean to the east. The town covers approximately 24 square miles and features an intricate tapestry of scenic vistas, woods and wetlands, working farms, salt marsh, and ecological communities that define the town's present landscape and serve as a vital link to its proud agrarian and coastal past. Included are large tracts of undeveloped land and salt marsh containing some of the most significant and fragile natural resources found anywhere on the North Shore or in the Commonwealth. These include the Parker River National Wildlife Refuge, the Great Marsh, state Wildlife Management Areas, and the "Common Pasture" to name a few.



The Town contains three major and distinct villages, each with its own unique identity:

- **Old Town:** Located along Route 1A/High Road, Old Town is anchored by two Greens – the Lower Green near the southern end, close to the Parker River and the landing place of the first settlers, who founded Newbury in 1635, and the Upper Green at the northern end, close to the municipal boundary with Newburyport. The Upper Green, which is in a National Register Historic District, is a classic village green, surrounded by historic homes, former farmhouses, municipal buildings, including Newbury's Town Hall, and a few businesses. Historic houses and a few working farms are located along the length of Route 1A/High Road, indicating the original development pattern of Old Town. However, since the 1950s, new residential development has slowly radiated out from the Greens along High Road, Parker, Hanover, and Hay Streets, and Newman Road, and a number of residential subdivisions that are more "suburban" in character have been built.
- **Byfield:** Created as a parish of Newbury in 1706, Byfield is located in the western part of town, west of Route 1. Byfield Village, located around the intersection of Central and Main Streets, is the "commercial" center of Byfield and, like the area around the Upper Green, is comprised of a relatively dense cluster of houses, small service-oriented businesses, and municipal facilities, including Newbury's Library. Byfield contains the Middle School and High School for the Triton Regional School District, as well as The Governor's Academy, founded in 1763. The remainder of Byfield is primarily residential, with some remaining farms and agricultural land. As in Old Town, residential development

since World War II has moved out from the Village center along main roads and within new suburban subdivisions.

- **Plum Island:** This densely populated area is located on a barrier island fronting the Atlantic Ocean at the eastern end of Newbury. The developed portion of the island includes land in both Newbury and Newburyport and reflects the character of a one-time vacation retreat with small (“postage stamp”) lots created by the Plum Island Beach Company in the 1920s and many modest “summer camp” style homes. In recent years a number of the original homes have been converted or demolished and rebuilt as year-round residences. Plum Island Center, located along Plum Island Boulevard between Northern Boulevard and Old Point Road, is a mixed use area containing both residences and small businesses, and is the primary access to the beach. It is also the only access to homes on the eastern part of the Island north of the Boulevard. The beach historically has been subject to varying degrees of erosion. Over the past several years, the primary frontal dunes along developed beachfront neighborhoods south of Plum Island Boulevard, particularly Fordham Way and Annapolis Way, have experienced significant erosion, resulting in the loss of six structures in the winter storms of early 2013. The southern half of the Island is occupied by the Parker River National Wildlife Refuge and Sandy Point Reservation and is now undeveloped.



- Newbury has low-lying and gently rolling terrain ranging from sea level to 168 feet above mean sea level (Old Town Hill). The predominant land uses in town are forest (34%) and salt marsh (30%), followed in turn by residential development (14%), agriculture (10%), and fresh water wetlands (3%). Commercial and industrial uses combined constitute less than 1% of the town area.

Over the past 40 years, Newbury has maintained a relatively consistent rate of growth, consuming approximately 30 acres of land every year on average. The current (2010) population is 6,666, a minor decrease of 51 residents (0.76%) from the 2000 population. According to MVPC projections, the town population is expected to rise to 7,300 by 2020 and to 8,250 by 2030. In 2010, there were 2,594 households, and the average household size was 2.57 people. MVPC projects an additional 756 households – to 3,335 households – by the year 2030. A build-out analysis conducted by MVPC estimated that there are approximately 2,900 acres of residentially-zoned land left in Newbury, which could yield approximately 2,480 new units of housing at the point of full build-out.



Transportation access to and from Newbury is convenient owing to the presence of Interstate 95, which bisects the town from north to south near the western edge of the town. The town also benefits from proximity to I-495, which is not only a major circumferential highway around the Boston metropolitan area, but also serves as a primary connector to the seacoast region of southern New Hampshire and also Maine. Other state routes passing through town are Routes 1 and 1A.

Public drinking water is provided to portions of Byfield by the Byfield Water District and to portions of Old Town and to all of the developed portion of Plum Island by the City of Newburyport Water Department; the remainder of residences and business are served by private wells. With the exception of Plum Island and a portion of Old Town, there is no central sewerage service in the community and residents rely on individual on-site septic systems for wastewater disposal.

Recent Development Activity in Newbury

According to the Newbury Planning Board and the Town Planner, there have been six noteworthy development projects in the community since the adoption of the 2008 Hazard Mitigation Plan. These projects are summarized below.

Residential

1. **Marsh Meadow Open Space Residential Development (OSRD):** This 6-lot Open Space Residential Development (OSRD) subdivision is located off of Orchard Street in the Byfield section of Newbury on 137.4 acres, with 85.9 acres retained as open space (of which 64.7 acres are upland). The subdivision consists of four new house lots, plus one lot with an existing historic farmhouse and barn, and one lot with an existing horse barn. Development includes a 1,600 foot long paved cul-de-sac, plus a common driveway serving three of the four new house lots. Stormwater runoff is managed by “country drainage,” including swales and cross culverts where required. No part of the project is located in a floodplain and there are no floodplain impacts.
2. **Hawk Haven Way:** This 2-lot conventional subdivision is located off of Old Rowley Road in the Old Town section of Newbury on 12.3 acres total, with an existing dwelling on one of the lots. Development includes a 20-foot wide gravel road 450 long, ending in a hammerhead-type emergency turnaround. Stormwater runoff is managed through country drainage and roof infiltrators. There are extensive wetlands in the development, and portions of both lots are in the floodplain (Zone AE) and the Great Marsh ACEC, but construction is limited to upland areas.
3. **Wilshire Road OSRD:** This 8-lot OSRD subdivision is located off of Rolfes Lane in the Old Town section of Newbury on 7.2 acres, with 3.7 acres retained as open

space (all of which is upland). The project is a redevelopment of two parcels formerly owned by the Harbor School; the layout locates the new homes within the area formerly occupied by the two structures existing on the lot. The new development includes a paved private 600-foot long U-shaped one-way lane entering from and exiting onto Rolfes Lane. Stormwater runoff is managed by underground infiltration units and roof infiltrators. No part of the project is located in a floodplain and there are no floodplain impacts.

Commercial

1. **90 Hanover Street Redevelopment:** This commercial project, approved in 2010, involved the conversion of the site of a former gravel trucking business into a dispatch center and parking for school buses owned by North Reading Transportation. The project scope included regrading of land and alteration of the parking area on a portion of the 3.8-acre property and creation of a constructed wetland for stormwater management. The parking area is primarily gravel, except for an area of recycled asphalt directly around the existing building and up to the edge of Hanover Street for dust control. The property is adjacent to wetlands and within the Great Marsh Area of Critical Environmental Concern (ACEC), but outside the floodplain. There are no floodplain impacts.
2. **101 Newburyport Turnpike:** This commercial project, approved in 2012, involves the development of 7.0 acres on the east side of Route 1 at the intersection with Sled Road; at the time of application, the land was vacant except for a cell tower located in the northeast corner of the parcel. The property is to be used as the headquarters of a site/civil contracting firm specializing in municipal site work. The project includes construction of an 8,000+/- g.s.f. building to house offices and vehicle bays, paved parking for 16 passenger vehicles and three trucks, and on-site storage for site construction related materials in bins. Portions of the lot are in wetlands and the Great Marsh ACEC, but outside the floodplain. There are no floodplain impacts.
3. **67-69 Newburyport Turnpike:** This project, approved in 2013, involves the redevelopment of a 0.93 acre mixed used parcel with two existing structures – a single family residence and a commercial building with a residential apartment on the second floor – for a new business. The commercial building has been renovated and expanded to house the new owner's family enrichment center (Harmony Natural Learning Center) and the second floor residential apartment; the single family residence serves as the owner's home. Site work included a new driveway to serve the residential uses, reconfigured and additional parking for both the residential and commercial uses, a stormwater management system, a new subsurface sewage disposal system, a new well, and landscaping and other site improvements. The site is in a water-supply protection district and portions of it are in wetlands. It is just outside the Great Marsh ACEC and the floodplain. There are no floodplain impacts.

Construction of the above development projects is in accordance with the requirements of the MA State Building Code, State Wetlands Act and Regulations, and MassDEP Stormwater Management Standards.

Two proposed development projects are “in the pipeline” for Route 1 at this time. The first project will involve construction of a building on a vacant lot and related sitework for a new yoga studio. The site is in a water supply protection district and a portion of it is in wetlands, but it is outside the floodplain. There are no floodplain impacts. The second is a self-storage facility which will involve construction of eight buildings in two phases on two parcels totaling bounded by Route 1, Boston Road, and Sled Road. A significant portion of the site is in wetlands. A small area at the northern edge of the site, abutting Sled Road, is in Zone X.

In reviewing development and local conditions since adoption of the 2008 Multi-Hazard Mitigation Plan, the local planning team notes concerns that the Town has become marginally more vulnerable to hazard events in the intervening years. The Town’s vulnerability has been most pronounced on Plum Island, a densely developed beach community of approximately 1,200 homes in Newbury & Newburyport. In 2013, six beachfront homes in Newbury collapsed into the surf because of coastal erosion from successive winter storms. Severe winter storms of early 2015 disrupted access and caused failure of the shared community sewer system serving the Newburyport and Newbury sections of Plum Island. Climate change and sea level rise pose long-term threats to existing development on the barrier beach. Vulnerability of the Town to flood hazards is confirmed by adjustments to the Flood Insurance Rate Maps for Newbury in 2012 and 2014 which as noted below in this annex section expanded the Town’s designated floodplain area by more than 1,200 acres.

Critical Facilities

Selected critical facilities in Newbury (emergency operations center, health and medical aid facilities, emergency public shelters) are listed in **Table 5.9-1** below. These were derived from the Town’s current Comprehensive Emergency Management Plan (CEMP) and conversations with local planning and emergency management personnel. The locations of these and other critical facilities and infrastructure in the community were entered by MVPC into an Excel database and subsequently incorporated into MVPC’s Arcview GIS for use in digital mapping. The full array of critical facilities, as identified by Town emergency management, public works, and conservation personnel, are depicted in the Newbury map series that is presented as **Appendix F** of this Plan.

Table 5.9-1. NEWBURY Emergency Operations Center, Health Care/Nursing Facilities, and Shelters

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center	Newbury Police Dept. (Newburyport EOC as backup)	25 High Road (backup EOC at 59 Low Street, Newburyport)	N/A	N/A	N/A	N/A	Yes
Health Care and Nursing Facilities	NONE						
Emergency Shelters	Triton Regional HS	112 Elm Street	N/A used for mass inoculation	N/A	1,500	Yes	Yes
	Newbury Elementary School	Hanover Street	N/A	N/A	500	Yes	Yes
	Governor's Academy	1 Elm Street	N/A	N/A	1,000	Yes	Yes
	Newbury Town Hall (warming station)	25 High Road	N/A	N/A	49	Yes	Yes
	Plum Island Taxpayers Hall	8 Plum Island Turnpike	N/A	N/A	50	Yes	Yes

Surface Waters and Flood Prone Areas

Newbury is blessed with an abundance of surface waters, ranging from the Parker River, which bisects the lower third of the community, to the Atlantic Ocean, which forms the town's eastern border, to the innumerable small tidal creeks that interlace the vast Great Marsh lying behind Plum Island. Fresh water wetlands abound as well.

The **Parker River** mainstem flows eastward from its headwaters in the Town of Boxford through Groveland and Georgetown and finally into Newbury. The river is fresh water upgradient from the Central Street dam, then becomes brackish on its course to Plum Island Sound. The tidal portion of the Parker River runs roughly nine miles. The dominant land uses in this area are forest and salt marsh. However, the Parker River floodplain also includes several residential areas.

The **Little River**, a major tributary to the Parker River, is roughly 7 miles long and flows south through neighboring Newburyport into Newbury. About 4 miles of the Little River is tidal. The Little River subwatershed contains the Newburyport Industrial Park; commercial retail properties; an inactive, unlined landfill in Newburyport; a

lined and capped landfill as well as an active transfer station in Newbury; agricultural land; and protected open space. Flooding from this river is a serious threat.

The **Mill River**, another major Parker River tributary, begins in the Georgetown-Rowley State Forest and runs north-northeasterly through Rowley until it joins the Parker River at Oyster Point about a mile east of The Governor's Academy. The lower section of the Mill River forms the boundary between Newbury and Rowley. The Mill River drainage area is the largest Parker River subwatershed (at least 8,200 acres in size). Mill River tributaries in neighboring Rowley include Muddy Brook, Great Swamp Brook, Bachelder Brook, and Ox Pasture Brook. The Mill River, also once known as Mill Creek, derives its name from the several mills it once powered.

Because Newbury is both a water-rich and a low-lying coastal community, significant portions of it are located in flood hazard zones and thus are susceptible to flooding. This is especially the case when high river flows from heavy rains coincide with high ocean tides. When high winds from the northeast and east are added to this mix, the effects can be truly devastating. Nowhere has this been more evident than on Plum Island, where storm surges have eroded large swaths of beach frontage and seriously damaged or destroyed a number of ocean-side structures.



The Ocean's Wrath on Plum Island

Town Conservation and Highway Department personnel have documented eighteen (18) inland and estuarine locations in Newbury that either flood on a regular basis or represent a significant potential flood hazard. These locations are listed in the chart below.

SPECIAL FLOOD HAZARD CONCERNS

1. Plum Island & Beach – erosion and overtopping
2. Plum Island Turnpike – roadway flooding, ice cakes, high winds, zero visibility
3. Plum Island Center – overtopping, flooding
4. Middle Road – flooding @ Tolman’s Auto, @ Stubbs, and south of the bridge over the Parker River
5. Scotland Road – flooding @ Wolf Brook and @ Highfield Road intersection and @ the Pikul field
6. River Street – dam failure and flooding
7. Newman Road – flooding @ marsh
8. Hanover Street – flooding @ Little River
9. Pine Island Road – flooding, ice cakes, high winds, zero visibility
10. Larkin Road – flooding @ bridge
11. Orchard Street – flooding of Cart Creek and north of Great Meadow
12. Central Street – dam failure and flooding
13. Hay Street – flooding and overtopping of road at Quill Pond and south of Newman Road
14. Moody Street – flooding 1/8 mile before Ash Street
15. Cottage Road – flooding at Parker River
16. Highfield Road – flooding from Middle Road to Merrimack Valley Beagle Club
17. Newburyport Turnpike – flooding north of Ould Newbury Golf Course during astronomical high tide and hurricane storm surge
18. Harvard Way – flooding

Flooding Vulnerability Assessment

A GIS analysis of the town’s most recent (2014) FIRM flood hazard areas by MVPC has determined that a total of 7,825 acres (12.3 sq. mi.) of land area and salt marsh



in Newbury is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 182.6 acres (0.3 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute forty-eight percent (48%) of the total area of the community. Among the 15 communities in the Merrimack Valley region, Newbury has the most total flood zone acreage and highest percentage of land area within the floodplain.

As part of the mapping analysis, MVPC also investigated the presence of any “critical” facilities at potential risk of future flood damage or loss. Two such facilities have been identified in the 100-year floodplain: PITA (Plum Island Taxpayers Association) Hall on Plum Island Boulevard and the sewage pumping station for Plum

Island off of Olga Way. According to Town officials, there are no plans to site any future critical facilities in the Town's flood hazard areas.

MVPC also examined *non-critical* facilities in the 100-year floodplain areas. This analysis revealed the presence of 799 residential, commercial, industrial, and institutional structures in the 100-year floodplain. Based on current (2014) Assessor records, these structures collectively are valued at \$124.9 million. *Residential* structures account for \$114.8 million (92%) of the total valuation, followed in turn by commercial at \$3.9 million (3.1%), institutional at \$5.8 million (4.6%), and industrial at \$322,800 (0.3%).



The current figure of 799 structures on 664 Newbury properties within the floodplain represents a greater than five-fold increase in structures within Newbury's flood zone since preparation of the last National Hazard Mitigation Plan. In 2008, 124 buildings in Newbury were located within the 100-year floodplain. It is important to point out that this increase is not the result of new building construction in the floodplain since 2008, but rather is due to the Town's adoption in 2012 and 2014 of the updated FIRM maps prepared by FEMA that went into effect on July 16th, 2014. The new maps expanded the previous (1979) flood hazard area in Newbury by 223 acres in 2012 and by another 1,023.9 acres in 2014.

Based on the frequency, areal extent, and severity of historical floods and storm surges in Newbury, especially on and around Plum Island, Town emergency management officials consider the community to be at **high risk** from flooding.

Repetitive Flood Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there are, as of 2014, 17 repetitive flood loss sites in Newbury. The majority of these sites are single-family residences (14), followed by multi-family/condominium residences (2), and non-residential properties (1). Flooding incidents at these sites have resulted in the payout of 45 National Flood Insurance Program claims totaling more than \$1.5 million since 1978.

Town-wide, there are 443 flood insurance policies in place for properties located in FIRM flood hazard areas. The combined insurance value in-force for these properties is \$118,382,800. (source: *NFIP Policy Statistics for Massachusetts* – 6/30/2014).

Floodplain Management and Compliance with NFIP

Newbury carries out a broad array of floodplain management activities in compliance with the requirements of the NFIP. These include:

- Participates in NFIP training courses and seminars offered by MEMA/DCR and/or FEMA that address flood hazard planning and management;
- Addresses NFIP monitoring and compliance activities;
- Is in the process of updating the Town's subdivision rules and regulations and the regulations accompanying its Stormwater Management, Illicit Discharge Detection and Elimination, and Erosion Control By-Laws, in order to improve stormwater management and control flooding in the community;
- Adopted a revised Flood Hazard By-Law in May 2012 to accompany the new Flood Insurance Rate Maps (FIRMs) that went into effect on July 3, 2012, and a subsequent revision of the By-Law to accompany the updated FIRM that went into effect on July 16, 2014;
- Participates in the ISO's Building Code Effectiveness Grading Schedule (BCEGS);
- Distributes and makes available explanatory pamphlets and booklets on the NFIP; provides information to property owners regarding building codes pertaining to construction in the floodplain;
- Identifies and becomes knowledgeable of non-compliant structures in the community;
- Inspects building foundations at the time of completion and before framing to determine if the lowest floor level is at or above Base Flood Elevation;
- Requires use of elevation certificates;
- Enhances local officials', builders', developers', local citizens', and other stakeholders' knowledge of how to read and interpret the FIRM;
- Works with elected officials, the state, and FEMA to correct existing compliance issues and prevent any future compliance issues through continuous communication, training, and education.

In the Town's commitment to enhancing the effectiveness of Newbury's local NFIP administration, the Newbury Building Commissioner recently stated, *"Over the next five years, Newbury will continue to enforce the provisions of 70 CMR The State Building Code and all associated flood regulations as well as actively encourage residents in flood hazard and/or flood prone areas to consider elevating their structure through hazard mitigation grants or other means."*

Structurally Deficient Bridges Over Waterways

Until the middle of the last decade, the Massachusetts Department of Transportation (MassDOT – then the Massachusetts Highway Department) listed two bridges in Newbury as being "Structurally Deficient": the Route 1A bridge over the Parker River and the Hay Street bridge over the Little River. In 2008, both of these outmoded bridges were replaced with modern structures that now meet the latest AASHTO

structural standards. There are currently no bridges in Newbury identified by the MassDOT as Structurally Deficient .

Hazard Potential of Dams

The DCR Office of Dam Safety lists eight (8) Newbury dams on its statewide dam classification inventory. These are: Blackwell Dam, impounding Blackwell Pond; Highfield Road Dam, impounding Highfield Road Pond; Central Street Dam, impounding the Parker River; Snuff Mill Dam, impounding the Parker River; Main Street Dam, impounding the Parker River; Parker River Dam North at River Street, impounding the Parker River; Parker River Dam South at River Street, impounding the Parker River; and Triton Dam, impounding a tributary of the Parker River.



A ninth dam, the Larkin Road Dam, was downgraded by DCR to “non-jurisdictional” status as it no longer impounds enough water to pose a risk of catastrophic failure. The dam, however does obstruct sediment transport and removal of this barrier obstruction would provide environmental and flood mitigation benefit in Great Marsh restoration.

None of Newbury’s dams is classified by DCR as either a “high hazard” or a “significant hazard” dam. Nevertheless, in view of the relatively large number of dams in the community, Town emergency management personnel have assigned a **moderate risk** rating to the hazard of dam failure.

Wildfire/Brush Fires

From approval of the Regional Hazard Mitigation Plan in 2008 to June 2013, Newbury firefighters have responded to 71 brush fires throughout the community. These fires are listed by date, location, and acres burned (where recorded) in **Table 5.9-2** on the following page.

Table 5.9-2. Newbury Brush Fires 2008 – 2013

Date	Location	Acres Burned
2008		
3/9	6 Fraser Lane	< 1 acre
4/19	45 Central Street	< 1 acre
4/28	36 Wayside Avenue	1 acre
5/3	Moody Street	<1 acre
5/5	69 Pearson Drive	<1 acre
2009		
3/26	44 Riverview Drive	
4/28	46 Elm Street	< 1 acre
4/28	50 Green Street	
6/9	26 Central Street	< 1 acre
9/2	26 Annapolis Way	
11/22	18 Orchard Street	< 1 acre
12/29	5 Moulton Street	< 1 acre
2010		
1/31	4 Girard Way	
2/28	17 Pine Island Road	
3/10	138 High Road	
3/20	91 High Road	
4/3	2 Moody Street	< 1 acre
4/3	20 Boston Road	
4/5	20 Old Farm Way	
4/6	110 High Road	
4/9	12 Newbury Neck Road	
4/9	3 Long View Lane	
4/10	33 Greentree Lane	< 1 acre
4/11	30 Plum Island TPKE	
4/12	Rte. 1 & Elm Street	< 1 acre
4/17	169 Elm Street	<1 acre
4/20	Orchard St. & Central St.	<1 acre
4/25	16 Boston Road	<1 acre
7/4	77 Old Point Road	
7/11	12 Hutchins way	
7/28	168 Hay Street	
11/1	41 Central Street	<1 acre
11/25	30 Main Street	<1 acre
2011		
3/6	6 Grove Street	<1 acre
3/10	136 Main Street	1 acre
3/18	Orchard St. & Central St.	<1 acre
4/9	4 Orchard Street	<1 acre
4/10	126 Elm Street	1 acre
4/30	2 Fruit Street	<1 acre
2012		
2/8	136 Main Street	<1 acre
2/13	118 Orchard Street	<1 acre
4/15	160 High Road	
4/15	183 Middle Road	
4/16	160 Hay Street	
4/17	191 Middle Road	
4/19	Forest Street	2 acres
4/21	Route 95	<1 acre

Table 5.9-2. Newbury Brush Fires 2008 – 2013		
Date	Location	Acres Burned
4/26	156 Elm Street	<1 acre
4/26	108 High Road	
4/30	60 Newburyport TPKE	
4/30	2 Silverledge Road	
5/5	12 Greentree Lane	<1 acre
7/25	75 Boston Road	
8/4	208 Newburyport TPKE	
9/17	Newman Road & Hay Street	
9/19	27 Central Street	
11/24	75 Boston Road	
11/25	75 Boston Road	
2013		
1/20	Middle Road	< 1 acre
1/26	Seaview Ln & Old Pine Is. Rd	
3/20	10 Longbrook Road	< 1 acre
3/31	Sled Road & Newburyport TPKE	
4/16	Plum Bush Downs & P.I. TPKE	
4/27	High Road & Old Rowley Road	
4/28	Route 95	< 1 acre
4/29	30 Wayside Avenue	< 1 acre
4/29	28 Plum Island TPKE	
4/30	14 Grove Street	< 1 acre
5/3	4 Morgan Avenue	
6/22	58 Northern Blvd	

Based on the number, frequency, and areal extent of brush fires in the community, Town emergency management personnel have assigned a **moderate risk** to the hazard of brush fires in Newbury.

Natural Hazards Risk Analysis

The Town of Newbury's Comprehensive Emergency Management Plan (CEMP) identifies and describes the range of natural hazards that are addressed by this Plan. The CEMP information, together with material compiled by MVPC and input from local planning, public works, and emergency management personnel, provides the basis for a general assessment of vulnerability to those natural hazard events that pose a high, moderate, or low risk to the community. Based on this assessment, Newbury considers itself currently to be at **high risk** from flooding, coastal storm surges, and winter storms (blizzards, snow storms, ice storms); at **moderate risk** from hurricanes, brush fires/wildfires, drought, dam failure, and power outages; and at **low risk** from tornadoes, earthquakes, and landslides. However, it should be noted that while recent earthquake activity has been minimal, Newbury sits at the northeast end of an active fault line – the Clinton-Newbury fault – and in the first two centuries after its settlement experienced a number of intense earthquakes, most notably the earthquake of 1727, which was described in records of the day as “tremendous” and “violent” and which toppled chimneys, rattled houses, and created

“liquefaction” plumes that sent geysers of sand into the air. The shock from this earthquake was felt from the Kennebec River to the Delaware River and several strong aftershocks were reported through February of 1728.

Table 5.9-3. Newbury Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Hurricanes	Moderate
Drought	Moderate
Wildfire/Brush Fires	Moderate
Dam Failure	Moderate
Power Outages	Moderate
Tornadoes	Low
Earthquakes	Low
Landslides	Low

Natural Hazards Management and Response

Newbury is a small rural-residential community with limited Town government that is almost entirely dependent on residential property taxes for financing local government operations. Planning for and responding to recurring incidents of flooding, coastal storm surges and erosion, and other natural hazards are an ongoing challenge for community officials. The following describes some of Newbury’s key facilities and personnel involved in local emergency management.

- Newbury Town Hall.** Newbury’s Town offices are located in approximately 2,600 square feet of space on the main floor of Town Hall at 25 High Road. This floor contains eight separate offices which house a total of ten and one half employees from a number of departments, including the Selectman’s Office, Town Administrator, Finance Department, Town Clerk, Planning Department, and Assessor. Newbury’s Health Agent and Health Inspector, both of whom work half-time for the Town, are housed in an office in a separate trailer which is adjacent to Town Hall and which is shared with the Police Department Administrative Offices. The Inspectional Services office, which includes the Conservation Agent, the Building Commissioner, and their Administrative Assistant, is housed in a separate trailer located in the parking lot adjacent to Town Hall.

In addition to offices, Town Hall contains a central meeting room, which can seat up to 49 people for public meetings. This meeting room is used regularly for

Board and Committee meetings. On occasion, due to high public attendance, meetings must be moved to the large function room in the Fire Station next to Town Hall.

The Town Hall facility is inadequate for its current use, due to the limited size of the building. While all Town Hall employees can be accommodated between the main building and the trailers, certain departments share very limited space, resulting in overcrowded offices and lack of privacy. There is a need for permanent secure storage space for town records, which until recently were stored off-site in the Woodbridge School, a retired School building a block away from Town Hall, and are now stored in trailers on the site of the Town's former landfill, approximately two miles away. Productivity is lost when department personnel must retrieve records from the off-site storage location. Finally, private conference rooms and meeting rooms are needed in Town Hall to supplement the main meeting room.

- **Public Safety.** Public Safety encompasses police, fire, and emergency medical response, as well as the Harbormaster and the Animal Control Officer. While the Police Department is part of the Town of Newbury, fire and emergency medical response services are provided by two private fire companies. The Newbury Police Department maintains a roster of 9 full-time officers and 7 part-time officers. In 2012, the Police Department responded to 23,745 incidents, up from 17,605 incidents in 2011. Calls vary widely, but a majority of calls were building checks (12,320) and motor vehicle complaints and citations (2,334). The Police Department maintains an active outreach and education program, including the School Resource Officer program in conjunction with the Triton Regional School District and the House Check Program, where residents alert the Department when they are going away on vacation. The Police Department also is the Emergency Management response agency for the Town.

The police station, located in the basement of Town Hall at 25 High Road, contains approximately 2,600 square feet of space. Limited additional space is provided by a temporary trailer, located behind the police station, which houses the Police Department Administrative Offices.

The police station is too small for current operations and cannot accommodate any future growth. The current space is crowded, as the responsibilities of the Department have continued to grow over the past 20 years. The space is functionally obsolete, as the space lacks separate holding cells for women, men, and juveniles, and suitable storage space. The police station is not in compliance with various provisions of the State Building Code and is subject to repeated flooding, septic system back-ups, insect and rodent infestations, and air quality and mold issues. All of these issues create potential financial liabilities for the Town.

There is a great need for a new public safety facility. Since 2012 several committees have been charged with investigating sites and developing a program to deal with the deficiencies in the Town Hall and public safety facilities. Most recently a Municipal Building Committee was formed to finalize the programmatic needs for the Police Station and municipal offices and develop a recommendation for a project and location that will best serve the Town's needs.

The Town is served by two private fire companies, Protection Fire Company #1, which covers the Byfield section of Newbury, and Protection Fire Company #2, which covers Old Town and Plum Island. The Town provides limited financial support for the two Fire Companies. The Town employs four (4) fulltime firefighters and has approximately 50 call fire-fighters. In 2012, the total call volumes were 358 fire calls, 490 EMS calls, and 380 service calls, for a combined total of 1228 calls. Since 2009, the average time to respond to building fires is 6.5 minutes. In 2010, a used ladder truck was purchased for the Byfield Station and Town Meeting in May 2014 approved the lease of a pumper truck and purchase turn out gear for the Fire Department.

- **Public Works.** The Newbury Department of Public Works maintains all of the Town's buildings and facilities, as well as public roads and parks. Utilizing a staff of eight employees, including the DPW Director, one Foreman, one Mechanic, and five workers, the DPW maintains approximately 140 lane miles of road and 50 acres of parks and greenspace, services all town vehicles, maintains 457 public catch basins, and cleans the streets as needed with a Town-owned street sweeper. The DPW is the department primarily responsible for implementing the Town's NPDES Phase II Stormwater Management Regulations.

For snow plowing operations, the DPW has eight plow trucks (one of which currently serves as a spare in case one breaks down during a bad storm, since there are not enough employees to operate all eight), one backhoe, and two front-end loaders. They depend on 15-20 hired contractors to assist with plowing.

Due to lack of staffing, the DPW no longer regularly cleans Newbury's two miles of beach on Plum Island. However, Plum Island residents may haul debris off the beach to a central area from which the DPW will then pick it up. The DPW also no longer has the manpower to mow and maintain the Town's recreational fields on Central Street, which are now maintained by the Recreation Committee.

The DPW operates out of a single story garage located on 1.5 acres at 197 High Road. The original building contains minimal office space and staff facilities plus five bays for storage and maintenance of vehicles. This building recently underwent renovations to bring it into code compliance and improve the working conditions. A new addition, which is unheated and uninsulated, contains three additional vehicle bays. Due to its small size, the DPW site is not adequate to accommodate all of the department's vehicles and equipment. Equipment not in use, such as plows, sanders, trailers, pipe, jersey barriers, blocks, road plates,

and similar items, are stored off-site. There is a concern that salt storage located adjacent to the building is compromising the environmental quality of the surrounding area.

Despite its staffing and equipment limitations, the DPW plays a major role in hazard mitigation and hazard response in the community. For example, after the destruction of a private residence on Plum Island by storm surge in November 2008, the DPW helped to establish a command post for the community in order to conduct operations for a prolonged period of time and in cooperation with multiple agencies.

In 2010, when Middle Road experienced significant flooding, DPW crews worked around the clock for 96 hours to dewater flooded areas before drainage improvements could be installed (in the vicinity of Tolman Auto). All told, DPW crews worked 11 straight days on the flood control project in order to minimize damage to area properties and to resume and sustain traffic flow.

The DPW recently purchased a new Dump Truck Snow Fighter in order to enhance the town's snow removal capabilities.

- **Building Commissioner.** Newbury's Building Commissioner serves as the Town's Zoning Enforcement Officer, Americans with Disabilities Act (ADA) Administrator, National Flood Insurance Program (NFIP) Coordinator, and facilities manager. His responsibilities are wide-ranging and include: 1) interpreting and enforcing the Massachusetts State Building Code and all applicable codes as they relate to it; 2) interpreting and enforcing the Town's zoning by-laws; 3) issuing building permits and assisting contractors and property owners in the permit application process; and 4) performing site inspections to ensure compliance with the State Building Code and permitted plans. He also serves as Assistant Conservation Agent and is on the Town's Emergency Management Team.
- **Harbormaster Office.** Newbury's Harbormaster Office operates completely under the jurisdiction of the Newbury Police Department and the Police Chief serves as the Harbormaster. The Harbormaster and Assistant Harbormasters are responsible for managing the Town's harbor and navigable waters, enforcing waterways by-laws and Massachusetts General Laws, and responding to emergencies on the waterways. In addition to carrying out administrative duties, they participate in marine rescues, manage recovery and securing of boats lost or adrift, patrol the Town's shorelines and waterways enforcing local, state, and federal laws and regulations, and issue citations and warnings for violations of the law. They oversee maintenance of all Town piers, launching ramps, and docks, as well as the installation and maintenance of channel markers and all other aids to navigation. They also manage responses to oil spills and calls for marine mammals in distress.

Recent Hazard Mitigation and Response Initiatives

In the seven years since the 2008 Hazard Mitigation Plan was approved, Newbury emergency management personnel have implemented several noteworthy projects aimed at enhancing the community's disaster mitigation and response capabilities. These projects include:

1. **Command Post Trailer (CP1).** The Town has established a Command Post Trailer (CP1) that is fully equipped with heat and air conditioning, radios for Police, Fire, and MEMA personnel, as well as internet access and complete dispatch capabilities, scene lighting, a 10,000-watt generator, a command table for seven, and a radio operator station. This command post is used for deployment at events requiring a unified command.
2. **Forward Command Post (CP2).** The Town also has a 4-wheel drive ambulance, donated by the Fire Company, which has been retrofitted by Newbury Emergency Management personnel into a mobile or Forward Command Post (CP2). This command post allows emergency personnel to deploy in active areas while the unified command can stage at the Command Post Trailer at the outer perimeter of an event. The Forward Command is vital for storm related events on Plum Island where access to the Island may be lost for extended periods of time. This unit will accommodate four personnel at the command table plus the operator station.
3. **Code Red Emergency Notification System.** This Emergency Notification System utilizes telephone and e-mail to rapidly notify residents of hazard emergencies and other important events.
4. **New ARGO Purchased for Off-road Emergency Response/Rescue.** This track vehicle is capable of transporting emergency personnel into hazardous areas and hard-to-reach locations for rescues and fire response. It is capable of navigating water, deep snow, and steep dunes, and is equipped with a stretcher attachment that allows Emergency Medical personnel to treat injured parties during extractions.
5. **Police Department Joined NEMLEC.** The Police Department has joined NEMLEC (Northeast Massachusetts Law Enforcement Council), which provides comprehensive emergency response. This affiliation affords the Town of Newbury access to dozens of personnel and equipment for searches and rescues as well as scene security during hazard events.
6. **Drainage and Paving Projects.** The Public Works Department completed two major drainage improvement projects on Longbrook Road and Parker Street. The DPW also paved the side roads on Plum Island when the water/sewer mains were completed. This was essential to the protection of the sewer structures in the roadways. Planning is underway for a major drainage system improvement project in Byfield Village along Main Street, to be done in conjunction with a planned roadway improvement project.

5.10 CITY OF NEWBURYPORT Natural Hazard Risk Assessment

Community Profile

The City of Newburyport is a small urban community with a vibrant, historic downtown and a strong tourist industry centered on the city's historic waterfront. Located 35 miles northeast of Boston, the coastal Clipper City is bordered to the north across the Merrimack River by Salisbury and Amesbury, to the south by the Town of Newbury and to the west by the Town of West Newbury.



Newburyport's coastal zone includes Plum Island, a barrier beach island fronting the Atlantic Ocean at the Merrimack River outlet. The developed northerly portion of the island includes land in both Newbury and Newburyport. It is densely populated and reflects the character of a vacation retreat with small lots created by the Plum Island Beach Company in the 1920s and many modest "summer camp" style homes. In

recent years a number of the original homes have been converted or demolished and rebuilt as year-round residences. Overdevelopment of the barrier beach and coastal erosion, caused by more intense storms in recent years and rising sea level of climate change are major concerns. Five beachfront homes **in the Newbury section of Plum Island** collapsed into the ocean in 2010 because of storm generated erosion.

Since the 1960's, Newburyport has maintained a relatively consistent rate of moderate growth. The current (2010) population is 17,416 people, a 1.3% increase from the 2000 population. According to MVPC projections, the town population is expected to grow at a continued low/moderate rate to 17,950 by 2030. In 2010, there were 7,622 households; MVPC projects 7,970 households in the City by the year 2030.

Transportation access to and from Newburyport is convenient owing to the presence of Interstate 95, Route 1, Route 1A and Route 113. The city also benefits from proximity to I-495, which is not only a major circumferential highway around the Boston metropolitan area, but also serves as a primary connector to the seacoast region of southern New Hampshire and also Maine.

With extension of the Salem-Beverly rail line in 1998, Newburyport became terminus for MBTA Commuter Rail service offering convenient transit commuter connection between the City and downtown Boston.

The City has expanded public water supply and wastewater collection systems to accommodate new development. The Wastewater Treatment facility on the waterfront near downtown recently underwent a \$32 million upgrade and the City also completed \$18 million in improvements at the Water Treatment Plan at Spring Lane.

Development Activity in Newburyport

The historic seaport of Downtown Newburyport, which had gone through significant decline in the mid-20th century, was transformed through public-private revitalization efforts initiated in the 1970's and 1980's. The downtown, designated a regional priority growth area, according to the MVPC Regional Growth Strategy (updated 2015) is comprised of approximately 150 acres of densely developed mixed uses. It includes retail, service, and office uses. The scale is intended to reinforce downtown's role as the focus of activity in Newburyport. Multi-use development combining residential and business use is encouraged. Activity is oriented to pedestrian traffic and centralized parking is in place. Businesses that consume large amounts of land and interrupt pedestrian circulation and shopping patterns, and single and two-family dwellings are prohibited.

The Newburyport **Business & Industry Park**, also designated a regional priority development area, is an area of approximately 443 total acres of which approximately 80 acres is developed and has almost 3.5 million square feet of building space. This area is zoned Industrial-1 (west of Henry Graf Jr. Road) and Industrial 1B (east of Henry Graf Jr. Road), which allows a broad range of manufacturing and industrial uses as of right, along with accessory retail uses. Most non-industrial uses are prohibited, as are all residential and marine uses. Parcels in this zoning district must be at least 50,000 square feet in area, maximum lot coverage ranges from 30 to 40 percent, depending on use, and buildings cannot exceed 40 feet in height.

According to Newburyport's Strategic Land Use Plan, this area is likely to see incremental, infill development on the remaining buildable lots, and possible expansion of existing developed lots where feasible given zoning, environmental considerations, and existing covenants on the land.

In addition, the City **in 2015 is establishing** a planned 40R smart growth district near the MBTA Commuter Rail Station and the Route 1 traffic circle. All new development would be multi-story, mixed-use buildings with much greater total floor area. Recommended uses in this area include retail, office, and residential with integrated parking and shared lots. Following density and design now in the downtown, this area could be a dramatic new gateway to Newburyport.

Newburyport prepared an individual community Hazard Mitigation Plan in 2007-2008 and did not directly participate in the regional plan development. Given the moderate level and type of development in recent years, the City through its planning team indicates that the extent of its risk vulnerabilities is unchanged since the prior planning process.

Below is a listing of major development in planning/permitting phases in Newburyport.

Project Name	Project Type	Status	Completion Year	Total Housing Units	Approx. Sq. Ft. Non-Res
Merrimac Street Downtown	Mixed Use - Hotel, Condos, Parking Garage, Retail, Office	Projected	2017-18	40	80,000
MBTA Station TOD	Mixed Use	Projected	2016	80 (540 @ buildout)	3,500 (50,000 @ buildout)
Towle Building Redevelopment	Merrimack St. residential	Projected	2016	15	

Critical Facilities

Selected critical facilities in Newburyport (emergency operations center, health and medical aid facilities, emergency public shelters) are listed in **Table 5.10-1** on the following page. These were identified by the local emergency management planning committee and updated from the City's 2007 Hazard Mitigation Plan. The locations of these and other critical facilities and infrastructure in the community were entered by MVPC into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The full array of critical facilities, as identified by City emergency management, public works, and conservation personnel, are depicted in the Newburyport map series that is presented as Appendix F of this Plan.

**Table 5.10-1. NEWBURYPORT Emergency Operations Center,
Health Care/Nursing Facilities, and Shelters**

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations	Emergency Management/ Operations Center	59 Low St.	N/A	N/A	N/A	N/A	Yes
	National Guard Armory	49 Low St	N/A	N/A	N/A	N/A	Yes
	Atlantic/Cataldo Ambulance Station	3 Boston Way	N/A	N/A	N/A	N/A	Yes
	Central Fire Station	3 Greenleaf Street	N/A	N/A	N/A	N/A	Yes
	Police Station	4 Green Street	N/A	N/A	N/A	N/A	Yes
	U.S. Coast Guard Station-Merrimack River	64B Water Street	N/A	N/A	N/A	N/A	Yes
	West End Fire Station	153 Storey Avenue	N/A	N/A	N/A	N/A	Yes
Health Care and Nursing Facilities	Anna Jaques Hospital	25 Highland Avenue	Hospital; Level 3 trauma center	123 bed		Yes	Yes
	Brigham Manor Nursing Home/Rehab Center	77 High Street	Nursing home	64 bed	64	yes	yes
	Country Rehabilitation/Nursing Center	180 Low Street	Nursing Home	111 bed	111	Yes	Yes
	Avita Assisted Living Facility	4 Wallace Bashaw Jr. Road	Assisted Living	67 bed	67	Yes	
	Atria Merrimack Place	85 Storey Avenue	Assisted Living			Yes	
	Port Healthcare Center	Low & Hale Streets	Nursing Home	100 bed	100	Yes	Yes
Emergency Shelters	Newburyport High School	241 High Street		Approx. 100	Approx. 100	Yes	Yes
	Rupert A. Nock Middle School/Molin Upper Elementary School	70 Low Street		Approx. 200	Approx. 200	Yes	Yes
	Bresnahan Elementary School	333 High Street				Yes	Yes
	Salvation Army—warming station	Water Street		Approx. 100	Approx. 100	Yes	Yes (installed 2015)

Surface Waters and Flood Prone Areas

Newburyport is a city of three watersheds: the Merrimack, the Little River and the Artichoke.

The Merrimack River flows alongside Newburyport downtown before draining into the Atlantic. As the Merrimack approaches the western boundary of the City, it meets the Artichoke River, source of public drinking water supply for Newburyport and West Newbury. The headwaters of the Little River are by Route 95 north of Hale Street. The main branch meanders along the Old Route 95 road bed. The western tributaries include streams that originate behind the shopping centers on Storey Avenue. The Little River flows south through Newbury and enters the Parker River, which along with the Ipswich and Rowley rivers are freshwater sources entering into Plum Island Sound, part of the Great Marsh ecosystem designated an Area of Critical Environmental Concern (ACEC).

Because Newburyport is both a water-rich and a low-lying coastal community, significant portions of it are located in flood hazard zones and thus are susceptible to flooding. This is especially the case when high river flows from heavy rains coincide with high ocean tides. When high winds from the northeast and east are added to this mix, the effects can be truly devastating. Nowhere has this been more evident than on Plum Island, where storm surges have eroded large swaths of beach frontage and seriously damaged or destroyed a number of ocean-side structures.

The City in 2012 and again in 2014 adopted changes in the FEMA Flood Insurance Rate Maps. The 2012 update significantly expanded the 100-year floodplain zone area in the City.

Historically, Newburyport has been directly impacted by flooding and erosion during storm events, both along the waterfront and in the Business Park and low-lying neighborhoods. Flooding problems in downtown are exacerbated by outdated infrastructure including undersized drainage pipes and culverts built over 100 years ago. Sea level rise attributed to climate change is also contributing to the flooding and beach erosion problems.

Vulnerability Assessment:

A GIS analysis of the City's most recent (2014) FIRM flood hazard areas by MVPC has determined that a total of 1,529.6 acres (2.39 sq. mi.) of land area and salt marsh in Newburyport is located within the 100-year floodplain and thus is vulnerable to flooding.

Newburyport has a number of critical facilities identified as vulnerable to flooding. These include the **Wastewater Treatment Facility**, located on the waterfront off the downtown and recently upgraded with a \$32 million capital investment. The facility was reconstructed to address the aging infrastructure of the Plant and was built

slightly higher than the current 100-year flood elevation to the greatest extent practicable. Unfortunately, the reconstruction elevation may not be adequate to adapt to the projected 2' to 3' rise in sea level which could potentially render the treatment plant inoperable by 2050 **or earlier**. City officials express concern climate change impact may eventually require relocation of the facility away from the riverfront.

Risk of salt water intrusion is a significant concern at two of the City's four surface water supply reservoirs—the **Lower Artichoke Reservoir and the Bartlett Spring Pond**. Fortunately, the dam holding back the Lower Artichoke was not breached during the 2006 Mother Day Storm floodwaters. The river surcharge, however was just inches below the top of the dam, City engineering officials report. During the same 2006 event, the Artichoke River came close to overtopping the dike/roadway protecting Bartlett Spring Pond. With the potential of sea level rise increasing in coming decades, City officials foresee heightened risk that the tidal Merrimack River will back up into these reservoirs during storm events and render the water supply unsuitable for consumption because of salination.

The **Water Treatment Plant** is located at Spring Lane, just west of Interstate 95 and less than 500 feet from the Merrimack River. The City expended \$18 million on a recent facility upgrade. While the City does not anticipate rising seas will impact the main facility, ancillary structures and the piping network may be vulnerable and will need to be evaluated.

The **National Grid Power Substation** at 95 Water Street on the Merrimack River shoreline is in the FEMA flood zone and subject to waves and coastal flooding during severe storm events. The utility has plans and in 2015 is seeking local permits for a flood protection project to install barriers and timber wall systems to protect the facility from damage during 100-year flood events.

There are sixty businesses in the 550-acre **Business Park** area, built on low-lying former farm land within the Parker River watershed. Many of the industrial and manufacturing facilities there have hazardous materials on site and are vulnerable to flooding. During heavy rainstorms, the primary access road, Malcolm Hoyt Road, is flooded and impassable. During the May 2006 flood, all six entrances into the Business Park area were inaccessible, not only creating private business losses, but also shutting down critical routes of egress and emergency vehicle access.





Flash Flooding Market Square July 1st 2014
(photo courtesy Newburyport Daily News)

The **Central Waterfront** is the cultural, aesthetic and commercial center of Newburyport's downtown. The waterfront attracts hundreds of thousands of visitors and tourists each year for boating recreation, shopping, dining or participating in the many concerts, social events and festivals held in downtown.

Market Square, the commercial center, has old drainage lines and catch basins and the limited capacity of that drain infrastructure is evident during heavy rain events including most recent flashflood events on July 1st, 2014 and July 15-16, 2014 disrupting business activity and circulation downtown.

Surging tides and storm events are changing the region's coastline and nowhere is this more prevalent than at the densely developed **Plum Island**, a barrier island that includes a beachfront community of 1,200 homes. From the 1920s through the 1990s, beach erosion rates on Plum Island were minimal. Over the past decade, however, according to Newbury and Newburyport officials, erosion rates have increased to more than 13 feet per year. During Winter 2013, ocean surges destroyed two homes in the Newbury section of Plum Island; another four homes were condemned because of eroding beachfront and had to be demolished. Another six homes were rendered temporarily uninhabitable and several dozen more properties were damaged. Work to repair jetties at the entrance to Newburyport harbor and Merrimack River outlet is intended to mitigate continued erosion impacts that have contributed to obstructing channel navigation. South jetty repair in Newburyport was completed in 2014 and work to repair the North jetty on the Salisbury side of the channel was underway in Spring 2015.

Vulnerability of Plum Island property and infrastructure was demonstrated in Winter 2015 when winter storms in February battered the barrier island with nearly ten feet of snow. The island's public sewer system, designed as a vacuum system and installed in 2007, failed in the severe winter conditions. Six hundred three (603) homes on the north side of the island were impacted. Residents were evacuated and forced to relocate for several weeks to area hotels. It took a month to get the sewer system back in operation, and in responding to the emergency, the City incurred costs of approximately \$347,000.

The City's Stormwater Master Plan identifies flooding areas for priority action. They include:

SPECIAL FLOOD HAZARD CONCERNS

1. Plum Island & Beach – erosion
2. Plum Island Turnpike – roadway flooding, ice cakes, high winds, zero visibility
3. Plum Island Center – overtopping, flooding
4. Newburyport Turnpike – flooding north of Ould Newbury Golf Course during astronomical high tide and hurricane storm surge
5. Cashman Park, Downtown Waterfront, –high tide flooding and storm surge
6. Hale Street – Flooding/Inadequate infrastructure
7. Fox Run Road – Localized Flooding/inadequate infrastructure
8. Henry Graf Road – Flooding
9. Business Park at Malcolm Hoyt Road – Flooding and inadequate infrastructure
10. Merrimac Street – Localized Flooding
11. Ocean Avenue – High Tide Flooding and storm surge
12. Parker Street at Scotland Road – Flooding/inadequate infrastructure
13. Quail Run Hollow – Localized flooding
14. Downtown State Street/Market Square – Major flooding, aged infrastructure.

MVPC also examined *non-critical* facilities in the 100-year floodplain areas. This analysis revealed the presence of 802 residential, commercial, industrial, and institutional structures on 668 parcels in the 100-year floodplain. Based on current (2014) Assessor records, these structures collectively are valued at \$203.5 million. *Residential* structures account for \$151.5 million (74%) of the total valuation, followed in turn by commercial at \$22.2 million (10.9%), institutional at \$21.2 million (10.4%), and industrial at \$8.7 million (4.3%).

Flood Insurance Rate Maps (FIRM) prepared by FEMA were most recently updated for Newburyport this past year effective July 16, 2014.

Based on the frequency, areal extent, and severity of historical floods and storm surges in Newburyport, especially on coastal and riverfront areas, City emergency management officials consider the community to be at **high risk** from flooding.



Repetitive Flood Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there are, as of 2014, 21 repetitive flood loss sites in Newburyport. The majority of these sites are single-family residences (18), followed by multi-family/condominium residence (1), and non-residential property (1). Flooding incidents at these sites have resulted in the payout of 51 National Flood Insurance Program claims totaling \$625,000 since 1978.

City-wide, there are 581 flood insurance policies in place for properties located in FIRM flood hazard areas. The combined insurance value in-force for these properties is \$156,797,500. (source: *NFIP Policy Statistics for Massachusetts – 6/30/2014*).

Floodplain Management and Compliance with NFIP

Newburyport carries out a broad array of floodplain management activities in compliance with the requirements of the NFIP. These include:

- Participates in NFIP training courses and seminars offered by MEMA/DCR and/or FEMA that address flood hazard planning and management;
- Updated the City's subdivision rules and regulations and the regulations accompanying its Stormwater Management, Illicit Discharge Detection and Elimination, and Erosion Control By-Laws, in order to improve stormwater management and control flooding in the community;
- Adopted a revised Flood Hazard Ordinance accompany the new Flood Insurance Rate Maps (FIRMs) that went into effect on July 2014;
- Participates in the ISO's Building Code Effectiveness Grading Schedule (BCEGS);
- Distributes and makes available explanatory pamphlets and booklets on the NFIP; provides information to property owners regarding building codes pertaining to construction in the floodplain;
- Identifies and becomes knowledgeable of non-compliant structures in the community;
- Inspects building foundations at the time of completion and before framing to determine if the lowest floor level is at or above Base Flood Elevation;
- Requires use of elevation certificates;
- Enhances local officials', builders', developers', local citizens', and other stakeholders' knowledge of how to read and interpret the FIRM;
- Works with elected officials, the state, and FEMA to correct existing compliance issues and prevent any future compliance issues through continuous communication, training, and education.

Structurally Deficient Bridges Over Waterways

The Massachusetts Department of Transportation Highway Division currently lists one bridge in Newburyport as "Structurally Deficient": the Route 1 (Bridge Street) Gillis Drawbridge over the Merrimack River. A second bridge—the regionally significant Whittier Bridge of Interstate 95—had been listed as structurally deficient but is being replaced through a MassDOT Highway construction project begun in 2013.

Route 1 Bridge over Merrimack River (Gillis Drawbridge)

The Gillis Drawbridge, constructed in 1976, is the gateway connector between Salisbury and Newburyport. A 2006 count at this location showed a daily traffic volume of 15,600 vehicles. Higher volumes have been counted at this location

during the summer months. There are no current plans for programming funds in the region's Transportation Improvement Program (TIP) for bridge upgrades or including as a project in the long-range Regional Transportation Plan.

Whittier Bridge over Merrimack River

The Whittier Bridge currently carries six lanes of Interstate 95 traffic lanes (three northbound; three southbound) over the Merrimack River between Amesbury and Newburyport. This section of Interstate 95 provides a critical link between Greater Boston and Maine, eastern New Hampshire and the maritime provinces in Canada. A 2012 traffic volume count taken by MassDOT showed that 71,000 vehicles cross the bridge on an average weekday but this number rises to over 90,000 on busy summer weekends.



MassDOT has committed over \$285 million in Accelerated Bridge Program funding to replace this older structure with a new one that would carry four travel lanes and a breakdown lane in each direction. Sections of Interstate 95 north and south of the bridge would also be widened to create a consistent four lane profile in each direction. Notably, the new bridge will also include a bicycle and pedestrian lane that will run adjacent to the northbound travel lanes. This will be the first time that MassDOT has incorporated bicycle and pedestrian travel accommodations into a bridge that carries an interstate highway. It will be an important connection in the growing trail network that exists on both side of the river in the communities of Amesbury, Salisbury and Newburyport.

Because of the importance of I-95 to the nation's economy and transportation network, MassDOT has committed to keeping three lanes of traffic open in each direction while the new bridge is being built. Construction of the new bridge began in July 2013 and it is expected that the new structure will open to traffic by the end of 2016.

Hazard Potential of Dams

The DCR Office of Dam Safety lists four (4) Newburyport dams on its statewide dam classification inventory. These are: Upper Artichoke Reservoir Dam, Lower Artichoke Reservoir Dam, Fred Maudslay Dam (impounding Flowering Pond), and Artichoke River Dam.

While none of Newburyport's dams is classified by DCR as either a "high hazard" or a "significant hazard" dam, local officials in recent years have taken action to address conditions at the Upper Artichoke Reservoir Dam, built in 1915. During inspection in 2012 and 2013, it was discovered that the dam, inlet pipes and gatehouse were

deteriorating and required major repairs. Improvements completed in Fall 2014 by the City have restored the dam and provided the Newburyport Water Department with updated technology to control basic dam functions.

Given the conditions and relatively few number of dams in Newburyport, emergency management personnel have assigned a **low risk** rating to the hazard of dam failure.

Wildfire/Brush Fires

Newburyport firefighters respond to an average of 12 brush fires each year throughout the community, according to Newburyport Fire Department. Prevalent areas for brush fire calls in recent years have been in areas of March's Hill off High Street, Maudslay State Park and open lots in vicinity of Low Street, Crow Lane and Hale Street.

Based on the number, frequency, and areal extent of brush fires in the community, City emergency management personnel have assigned a **moderate risk** to the hazard of brush fires in Newburyport.

Natural Hazards Management and Response Capacity

Newburyport is a small coastal city with efficient government including an emergency management team led by the City's Chief Executive Officer, Mayor Donna Holaday.

Hazard Mitigation Plan Steering Committee members include:

- City Marshal
- Director of Newburyport Emergency Management Services
- Deputy Director of Emergency Management
- Fire Chief
- Director of Policy & Administration
- Director and Deputy Director of Department of Public Services (DPS)
- Chief Operator, DPS Sewer Department
- Superintendent of DPS Water Operations
- Building Inspector
- Director of Public Health
- Planning Director
- School Department Facility Engineer
- Harbormaster
- President of Newburyport Chamber of Commerce

Newburyport Emergency Management maintains an informational website and provides links to the Newburyport webpage for distributing preparedness information and instructions during weather events and other emergencies.

Newburyport Fire Department is led by the Fire Chief, the Deputy Chief and four Lieutenants. There are 28 full-time firefighters on staff and four dispatchers.

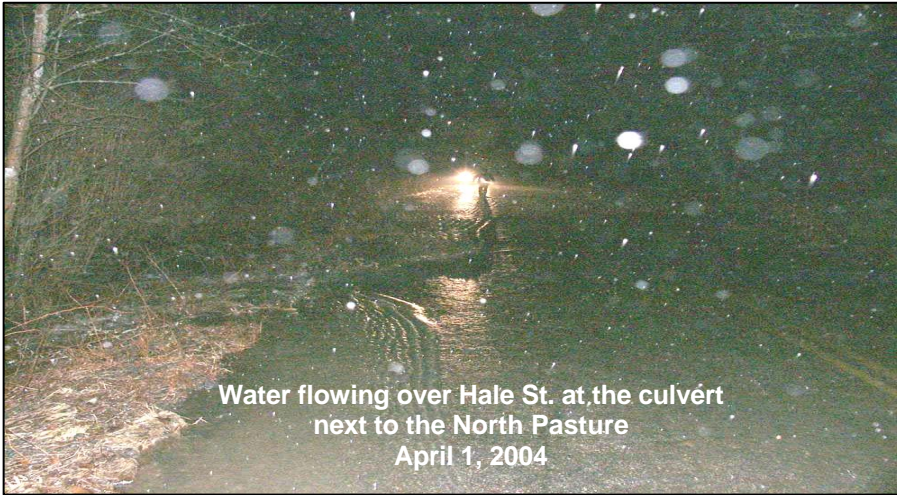
Newburyport Police Department is led by the City Marshal with an officer team of seven Superior Officers, 24 patrolmen and 4.5 dispatchers.

The City is also a partnership member of the **Merrimack River Beach Alliance (MRBA)** with the Town of Salisbury and the Town of Newbury. MRBA, meets on a regular basis throughout the year, with participation that includes elected state and federal representatives, state and federal agencies. It provides a critical forum for public outreach and community dialogue on issues and project prioritization. The community organization is focused on barrier beach erosion and aided in advocacy for state funding to advance restoration projects at the north (scheduled -- 2015) and south (Newburyport—completed 2014) Merrimack River jetties. As part of MRBA's efforts, the Army Corps of Engineers dredged the Merrimack River in 2010 with state financial assistance and used the dredged material for beach replenishment on both Salisbury Beach and Plum Island.

Natural Hazards Risk Analysis

The City of Newburyport's Comprehensive Emergency Management Planning Team analysis identifies and describes the range of natural hazards that are addressed by this Plan. With material compiled by MVPC and input from local planning, public works, and emergency management personnel, provides the basis for a general assessment of vulnerability to those natural hazard events that pose a high, moderate, or low risk to the community. Based on this assessment, Newburyport considers itself to be at **high risk** from flooding, coastal storm surges, hurricanes and winter storms (blizzards, snow storms, ice storms); at **moderate risk** from, brush fires/wildfires, drought, earthquakes, landslides, and power outages; and at **low risk** from tornadoes and dam failure.

Table 5.10-2. Newburyport Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Hurricanes	HIGH
Drought	Moderate
Landslides	Moderate
Wildfire/Brush Fires	Moderate
Power Outages	Moderate
Earthquakes	Moderate
Tornadoes	Low
Dam Failure	Low



Water flowing over Hale St. at the culvert
next to the North Pasture
April 1, 2004

2004 - Result of a 5.53"
24 hour (7.38" 48 hour)
rain event



Hale St. at the culvert next to the North Pasture
April 2, 2004



Zampell Detention Basin on the corner of Malcolm Hoyt and Stanley Tucker Drives April 2, 2004



2004 - Result of a 5.53" 24 hour
(7.38" 48 hour) rain event



The Little River flowing over Parker St.
April 2, 2004



The Little River flowing downstream from Parker St. April 2, 2004 (two merged photos)



The corner of Quail Run Hollow and Wildwood Dr.
June 14, 1998

1998 - Result of a 4.69" 24 hour
(5.53" 48 hour) rain event



Looking North up the Little River tributary from the culvert on Hale St.
June 14, 1998



Looking North West up the flooded Little River tributary from the corner of Doe Run
Dr. and Quail Run Hollow June 14, 1998 (two merged photos)



Newburyport Civil Defense vehicle
driving east on Hale St.
Oct. 20, 1996

1996 - Result of a 10.62" 24 hour (12.91" 48 hour) rain event
1998 - Result of a 4.69" 24 hour (5.53" 48 hour) rain event



Flooded back yard of 46 Hale St.
June 14, 1998

5.11 TOWN OF NORTH ANDOVER Natural Hazard Risk Assessment

Community Profile

The Town of North Andover covers 26.3 square miles and has a population of 28,352, according to the 2010 U.S. Census. The population density is 1,078 people per square mile. In the last decade, North Andover experienced a population growth rate of 4.2%.

There are 10,964 housing units in the Town, and the average household size is 2.6 people. 13.3% of the population is 65 years of age or older.

The predominant land uses are forest land (43.9%) and residential development (22.6%), followed by wetlands/water (18.6%) and agriculture (4.2%). Commercial and industrial uses combined account for 3.6% of the Town area.

Farming, once a major part of the North Andover landscape and economy, today constitutes 743 acres – down 1,017 acres, a loss of almost 60% in agriculture use land since 1971. Public drinking water is supplied from Lake Cochichewick, a 600-acre impoundment located in the northeast corner of town. The municipal water system serves 95% of the population, which consumes an average of 3.0 million gallons per day. There are 94 public safety positions in the community, including 39 uniformed police officers and 55 firefighters.



North Andover Town Hall

Recent Development Activity

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

North Andover Development Projects

Project Name	Project Type	Status	Completion Year	Total Housing Units	Approx. Sq. Ft. Non-Res
Brightview Senior Care	Residential	Complete	2013	133	
Merrimack Village-Rt. 114	Residential	under const.	2014-2015	50	
Rt. 114/Berry St.	Residential - 40B	Approved	2017 est.	200-240	
Osgood Landing	Residential - 40R	Planning	2017 est.	530	
Osgood Landing	Commercial/Indust.	existing property of 1.5 million sq.ft.	on-going lease-up		Approx 500,000 sq. ft. occupied

Based on the level and type of development taking place in Town, local planning/conservation officials consider the Town vulnerability to hazard risks to be unchanged since preparation of the 2008 Multi-Hazard Mitigation Plan.

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.11-1**, was derived from the Town's current CEMP. The locations of these and other critical facilities and infrastructure were entered into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The critical facilities are depicted in the North Andover map series that is presented in **Appendix F** of this Plan.

Table 5.11-1. NORTH ANDOVER Emergency Operations, Health Care Facilities, and Shelters

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Patient Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center(s)	North Andover Fire Station	Chickering Rd./Prescott St. (under construction 2014-2015 with opening scheduled Fall 2015); to replace facility at 124 Main St.					Yes
	North Andover Fire Station 2	9 Salem Street					Yes
	North Andover Police Station	1475 Osgood Street (opened 2011)					Yes
Health and Nursing Facilities	Meadows at Edgewood	575 Osgood Street	Nursing/dementia care	60 beds	60	Yes	Yes
	Edgewood Independent Living	575 Osgood Street	Assisted Living	438	438	Yes	No
	Ashland Farms	700 Chickering Road	Assisted Living	93	93	Yes	No
	Brightview Senior Living	1275 Turnpike Street	Assisted Living	547	547	Yes	Yes
	Sutton Hill Center	1801 Turnpike Street	Nursing		142	Yes	No
	Prescott House	140 Prescott Street	Nursing		126	Yes	No
Emergency Shelters	Senior Center	120 (Rear) Main Street			200	Yes	Yes
	Middle School	495 Main Street			500	Yes	No
	North Andover High School	430 Osgood Street			625	Yes	Yes (however no emergency power for heat)
	Osgood Landing	1600 Osgood Street			4000	4000	Yes

Flood Prone Areas

The Town of North Andover spans parts of four major watersheds, as defined by the state: Ipswich River (59.2% of town), Merrimack River (32.7%), Shawsheen River (7.2%), and Parker River (0.9%). In 2004, with grant funding from the MA Department of Environmental Management (now DCR) and technical assistance from an engineering consultant, the Town prepared the planning document, "Town of North Andover Flood Hazard Mitigation Plan".

This plan identifies, describes, and maps in detail North Andover's FIRM flood hazard areas, critical facilities, and key flooding issues and hot spots. Based on local knowledge, several geographic areas that were of particular concern were highlighted. These include: the Mosquito Brook drainage area, where numerous residences and public infrastructure facilities are at risk from flooding; the lower Sutton Street area near the confluence of the Shawsheen and Merrimack Rivers; and the Shawsheen Street and Salem Street area along the lower Shawsheen River.

According to Town officials, during extreme flood events, there are four neighborhoods that require evacuation of residents. These are:

- 1) the Elmwood, Glenwood, Jetwood, Inglewood Street neighborhood in the northwestern part of town;
- 2) the Massachusetts Avenue and Commonwealth Avenue neighborhood to the west of Mass. Avenue in the northwestern part of town;
- 3) the Riverview and North Main Street neighborhood on the south bank of the Merrimack River in the north section of town; and
- 4) the 90 Sutton Street area near the confluence of the Shawsheen and Merrimack Rivers.



The Town typically experiences flooded roads which require closure to traffic at the following locations: Great Pond Road, Brook Street, Elmwood Street, Glenwood Street, Jetwood Street, Inglewood Street, Mass. Avenue, Commonwealth Avenue, Bradford Street, Riverview Street, and North Main Street.

Special Flooding Concerns

According to North Andover public works and public safety officials, two recurring flooding problems are of particular concern, and warrant immediate attention in order to protect Lake Cochichewick – the Town’s primary drinking water source – and public health. These problems are the surcharging beyond pumping and wet well capacity of the Rea’s Pond and Winter Street sewer lift stations. The surcharging occurs when floodwaters infiltrate into the sewer manholes that flow to the two pumping stations.

Rea’s Pond lies immediately adjacent to Lake Cochichewick and is directly connected to the Lake through an approximately 50-foot long conduit under Great Pond Road (Rt. 133). The Winter Street lift station is located by the bank of a tributary stream to the Lake, less than 500 feet from the edge of the Lake. Any surface water discharges (including emergency sewage surcharges) that were to enter Rea’s Pond and the tributary stream would quickly flow into and contaminate Lake Cochichewick, which supplies 3.0 million gallons of potable water per day to 95% of North Andover residents.

During the past 15 years, North Andover has experienced periodic sewer surcharging events that together required pumping to prevent contaminated releases to Lake Cochichewick. These events occurred on March 2001, April 2004, April 2005, October 2005, May 2006, and March 2010.

The most costly and disruptive flooding event in memory occurred May 13-15, 2006 (“Mothers Day Flood”) was characterized as a 100-year flood event. This event caused severe surcharging of the Rea’s Pond and Winter Street lift stations, and cost the town \$7,799.00 in regular pay and \$1,447.83 in emergency response pay for the services of the responding Water Treatment personnel. It also cost the town \$17,515.00 in contractual services for a private vacuum truck to pump and haul sewage from the two surcharging lift stations. There were additional costs for pumping and treating the sewage at the Greater Lawrence Sanitary District wastewater facility, but these costs are not quantifiable.

The Town of North Andover is funding through its capital program structural upgrades to prevent the recurring surcharge problems at Rea’s Pond and Winter Street lift stations near the town’s Lake Cochichewick public water supply. Conditions here with pump station operations have posed high risk of a public health threat with sewage contamination during flood events. The Town DPW has completed design work and is scheduled to undertake replacement of the Rea’s Pond sewer lift station in Summer 2015. Initial phase work of replacing and floodproofing area manholes was completed in 2010 with Hazard Mitigation Program Grant funds.

During the Mothers Day flood of May 2006, significant flooding occurred along the lower reaches of the Shawsheen River, inundating and damaging numerous residences and business establishments, closing the roads cited above, and causing major traffic disruptions. Significant flooding also occurred at Lake Cochichewick, forcing the temporary closure of Great Pond Road (Rt. 133) where the Lake and Rea's Pond overtopped the road. In response to this latter problem, Town engineering and public works officials have proposed drainage improvements at the Rea's Pond and Winter Street sewer lift stations.



During periods of extreme wet weather and high groundwater, the Town DPW has used a portable diesel pump to increase pumping capacity and minimize sewerage overflow. The planned improvements will include permanent capacity upgrade of lift stations and relocation of the Rea's Pond station out of the 100-year floodplain.

Flooding Vulnerability Assessment

A GIS analysis of the Town's FIRM flood hazard area maps by MVPC has determined that 3,090 acres (4.8 sq. mi.) of land area in town is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 384 acres (0.6 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute almost twenty percent (20%) of the total area of the community. Based on an additional analysis by MVPC, 169 acres in these zones are still open and "potentially developable" under the Town's current zoning scheme. Development of this open space would increase the area's impervious surface cover and stormwater runoff, thereby exacerbating the existing flooding problems.

As part of the mapping analysis, MVPC also identified the critical facilities that are located within the 100-year and 500-year floodplain and thus are at risk of future flood damage and loss. These facilities, together with their assessed values as derived from the Assessor's records, are listed in **Table 5.11-2** on the following page.

According to Town officials, there are no current plans to site other critical facilities in the 100-year and 500-year flood zones.

Based on the frequency, areal extent, and severity of historical floods in North Andover, Town emergency management officials consider the community to be at **high risk** from flooding.

Table 5.11-2. Critical Facilities in Flood Hazard Areas – North Andover

Facilities in 100-Year Floodplain		
Facility Name	Parcel ID / Street Location	2013 Buildings Valuation
North Andover Water Pumping Station	35-0-21/Great Pond Road	\$119,900
Coachman's Lane Sewage Pumping Station	37.A-0-29/ 125 Coachman's Ln.	Not Available
Hawthornes Place Sewage Pumping Station	026-0016; 41 Hawthorne Place	\$267,300
Bonny Lane Sewage Pumping Station	062-0049; 133 Bonny Lane	\$595,700
Glenwood Sewer Lift Station	61 Glenwood Avenue	n/a
Rea's Pond Sewer Lift Station	1653 Great Pond Road	n/a
Facilities in 500-Year Floodplain		
Facility Name	Parcel ID / Street Location	2014 Buildings Valuation
Waste Water Treatment Plants	GLSD/072-0014	Not Available
DPW Garage	094-0002/ 384 Osgood Street	\$1,185,100

Repetitive Flood Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there are seven repetitive flood loss sites in North Andover, all single-family residences. Most were impacted by flooding of the Shawsheen River in 2006, 2007, and most recently March 2010. Flooding incidents at these seven properties have resulted in the payout of 17 National Flood Insurance Program claims totaling \$502,244 since 1987.

According to FEMA records, town-wide, 120 North Andover properties are covered today by flood hazard policies. The total insurance coverage value for these properties is \$43,664,100. (source: FIRM Policy Statistics dated 6/30/2014) That is more than a 150% increase in FIRM participating properties since 2005 when there were 47 North Andover properties, cumulatively valued at \$10 million, with flood insurance coverage.

Structurally Deficient Bridges Over Waterways

According to data compiled by MassDOT, there are no bridges over water in North Andover that are currently classified as “Structurally Deficient.”

Hazard Potential of Dams

The DCR Office of Dam Safety includes 11 North Andover dams on its dam classification list. Of these, two dams are classified as either “high” or “significant” hazard dams. These two dams are identified and described in **Table 5.11-3** on the following page. Based on the large number of dams in the community, as well as the potential safety risks of the two dams cited below, Town emergency management officials have assigned a *moderate* risk rating to the hazard of dam failure.

Table 5.11-3. High and Significant Hazard Dams – North Andover					
Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Lake Cochichewick Outlet Dam	Lake Cochichewick (8100 acre-feet)	1837 (repair in 2007)	High	5/17/2011	Every two years*
Cochichewick River Dam	Cochichewick River (32.4 acre-feet)	Not Recorded	Significant	6/1/2012	Every five years

*Inspection overdue, according to DCR/Office of Dam Safety spreadsheet record

Natural Hazards Risk Analysis

The Town of North Andover local planning team’s risk analysis reviewed potential hazard events and based on frequency, intensity and potential impact to the community categorized potential hazards as high, moderate-high, moderate, low-moderate, or low risk to the community. On the basis of this analysis, North Andover considers itself to be at **high risk** from flooding, winter storms (blizzards/snow/ice storms), and power outages; **moderate risk** from dam failure, hurricanes and, earthquakes; **low risk** from tornadoes, forest fires, drought, and landslides.

Table 5.11-4. North Andover Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Power Outages	HIGH
Hurricanes	Moderate
Dam Failure	Moderate
Earthquakes	Moderate
Tornadoes	Low
Forest Fires	Low
Drought	Low
Landslides	Low

5.12 TOWN OF ROWLEY Natural Hazard Risk Assessment

Community Profile

The Town of Rowley is located approximately 32 miles north of Boston on Massachusetts' historic "North Shore". The Town encompasses 18 square miles, and is characterized by gently rolling uplands and expansive salt marsh. It is bordered to the north by the Town of Newbury, to the west by Georgetown, to the southwest by Boxford, to the south by Ipswich, and to the east by Plum Island Sound and the Atlantic Ocean. According to the 2010 U.S. Census, the year-round resident population is 5,856, an increase of 6.5% from 2000. The pace of growth moderated last decade after a 25% population increase in the 1990s. There are 2,155 households and the town-wide population density is 321.6 people per square mile. Prior to the recent economic downturn, Rowley had experienced some of the highest population growth rates among Essex County communities, and the Merrimack Valley Planning Commission projects a maximum ("build-out") population for the Town of over 11,000 (based on current zoning).



According to the latest state (MassGIS Office) figures, the predominant land uses in Rowley are: *forest* – 5,401 acres (42.25%); *salt marsh/wetlands* – 2,515 acres (19.7%); *residential development* – 1,213 acres (9.5%); and *agriculture* – 700 acres (5.5%). Commercial and industrial uses combined comprise 214 acres, or less than 2% of the total area. Rowley's most conspicuous and visually stunning landscape feature is its vast salt marshes. Part of the 25,000-acre, multi-community Great Marsh ACEC (Area of Critical Environmental Concern), the Rowley salt marshes protect broad upland areas in town from the full brunt of high-energy coastal winds and waves. Interlaced with myriad tidal creeks, these ecologically-rich salt wetlands are home to diverse plant and animal species, including commercially-valuable soft-shell clams. They also provide outstanding recreational opportunities for bird watchers, kayakers, and other outdoor enthusiasts.



Rowley Water Department provides municipal water from three public wells and serves all but about 400 homes which have private wells. In 2010, high levels of E.coli were detected in two of the town's three wells prompting MassDEP to order Town construction of a water treatment plant. The Town has been under an administrative consent agreement with MassDEP for compliance with the Clean Water Act and in 2012 began construction of the Pinegree Farm Filtration plant off Haverhill Street. Filtration of Well #3 began in August 2014 and as of the end of

2014, construction of the long-anticipated \$12.3 million treatment plant was nearing full completion.

Recent Development Activity in Rowley

Rowley's Village Center is designated a historic preservation Priority Development Area in the Merrimack Valley Region Priority Growth Strategy (2015 update). The Town's Master Plan goals for the Village Center focus on maintenance of existing municipal and civic uses; protection of historic character and specific historic properties, and accommodation of new commercial growth along Route 1 and Route 133, away from the historic Village Center.

Rowley Development Projects					
Project Name	Project Type	Status	Completion Year	Total Housing Units	Approx. Sq. Ft. Non-Res
The Residences @ Rowley Country Club	OSRD duplex townhomes	Construction	2014	36	
Rowley Village Green (Heritage Way)	Townhomes	Construction	2015	25	
Fox Meadow Condominiums	OSRD Duplex Townhomes	Complete	2011	28	
Wild Pasture Estates	OSRD Single Family Subdivision	Construction	2015	28	
Meetinghouse Farms (Cindy Lane)	Single Family Subdivision	Construction	2015	18	
Sheehan Estates (Gurczak Lane)	Single Family Subdivision	Complete	2014	5	

The Rowley planning team has determined the Town has become marginally less vulnerable to hazard risks since the 2008 Multi-Hazard Plan process because of the following factors:

- Roadway and bridge infrastructure repairs including mitigation capacity projects at Dodge Road bridge over Mill River, Wethersfield Street bridge over Mill River, Wethersfield Street bridge over Bachelder Brook, Newbury Road and Route 133 (Haverhill St.) completed in the wake of the 2006 Mother's Day flood eliminated key drainage obstructions;
- The Town has put in place land use regulatory tools that have been effective in preventing development in floodplain areas; and
- Acquisition for conservation of the 222-acre Rough Meadows sanctuary in 2012 by Mass. Audubon Society with participation of Greenbelt Association. The property

encompasses coastal woodlands, tidal creeks, and salt marsh and is within the state-designated Great Marsh Area of Critical Environmental Concern (ACEC). Property preservation was accompanied by conservation restriction and demolition of private occupied structures adjacent to areas subject to flooding and coastal storm flowage.

Critical Facilities

A list of selected critical facilities (emergency operations, nursing/health care, shelters), as shown in **Table 5.12-1**, was derived from the Town's current CEMP. The locations of these and other critical facilities and infrastructure were entered into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The critical facilities are depicted in the Rowley map series that is presented in **Appendix F** of this plan.

Table 5.12-1. ROWLEY Emergency Operations, Health Care Facilities, and Shelters							
Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Patient Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center	Rowley Fire Dept.	7 Hammond Street	N/A	N/A	N/A	N/A	Yes
E911 Dispatch Center	Rowley Police Dept.	477 Haverhill Street	N/A	N/A	N/A	N/A	Yes
Health and Nursing Facilities	Seaview Manor	50 Mansion Drive	Nursing Home	86	86	Yes	Yes
Shelters	Pine Grove Elem. School	191 Main Street	N/A	N/A	300-400	Yes	No

Surface Waters and Flood Prone Areas

Rowley is blessed with a diverse array of interconnected rivers, streams, ponds, estuarine waters, and wetlands including:

- **Mill River**, which rises from a series of wetlands in the northwest corner of the Town and flows northeastward to the Parker River above the Town's northern border;
- **Upper and Lower Mill Ponds**, two elongated impoundments created by a broadening of the Mill River channel;
- **Great Swamp Brook**, a southeastward-flowing tributary of the Mill River;
- **Mud Creek**, which flows through the salt marsh into Plum Island Sound;

- **Bachelor** and **Ox Pasture Brooks**, which emerge from wetlands in the central part of Town and flow northward to the Mill River;
- **Rowley River**, a tidal waterway that forms the Town's southeast boundary and provides important shellfish habitat; and
- **Plum Island Sound**, a broad estuary on the Town's eastern edge fed by the Parker and Rowley Rivers.

Together, these surface waters offer many environmental and public benefits, including important ecological functions and a variety of opportunities for recreational enjoyment. However, they also give rise to occasional floodwaters that place selected homes, businesses, and town infrastructure at periodic risk.

According to Rowley Highway Department personnel, several areas in Town are subject to *chronic* flooding. These include: Wethersfield Street at Bachelor Brook, Hillside Street at Great Swamp Brook, Route 133 at Cedarwood Lane, and several areas on the west side of Town south of Route 133, including Boxford Road, Leslie Road, and Newbury Road. A number of these older roads were built across the floodplains of perennial streams. Since they were constructed at existing grade, the roads can become inundated and impede travel during high rainfall-runoff events.



The May 2006 “Mothers Day” Flood in particular caused widespread damage to key town roads and drainage infrastructure, and resulted in several long-term road closures and detours. The following excerpt from the Town’s *2006 Annual Highway Department Report* aptly sums up the flood’s devastating impacts:

“... The May floods caused many problems throughout the town. Three main culverts/bridges were heavily damaged, two beyond repair, and are closed until they can be replaced (Dodge Road Bridge and Taylor Bridge on Wethersfield Street). The Bachelor Bridge, also on Wethersfield Street, has been temporarily secured with two 10’ x 8’ x 1” steel road plates for the deck until replaced; the crossing has one lane and weight limit of 2-1/2 tons. Many roadway shoulders and curbing were washed out, ... causing catch basins and culvert pipes to collapse. Localized street flooding throughout the town caused many detours, making it difficult to travel within the town and from town to town until the water subsided and that section of roadway could be inspected and/or repaired for safe travel...”

Flooding Vulnerability Assessment

A GIS analysis of the town’s FIRM flood hazard areas by MVPC has determined that a total of 4,802 acres (7.5 sq. mi.) of land area and salt marsh in Rowley is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 402 acres (.63 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute over forty (40%) of the total area of the community. Based on an additional analysis by MVPC, 245 acres in these zones has been determined to be

open and “potentially developable” under the Town’s current zoning scheme. Development of this open space would increase the impervious surface cover and stormwater runoff volumes in the two flood zones, thereby exacerbating the existing flooding problems.

As part of the mapping analysis, MVPC also investigated the presence of any “critical” facilities at potential risk of future flood damage or loss.

Table 5.12-2. ROWLEY Critical Facilities in Flood Hazard Areas		
Facilities in 100-Year Floodplain		
Facility Name	Parcel ID / Street Location	2014 Bldgs/Structures Valuation
Rowley Town Well #3	5-76/ 129 Boxford Road	\$52,700
Communications Cell Tower	31-17/ 594 Main Street	\$44,000
Majestic Harbor Community School	16-12/ 303 Haverhill Street	\$1,654,100

MVPC also examined *non*-critical facilities in flood hazard areas. This analysis revealed the presence of 98 residential and commercial structures (collectively valued at \$11,532,800 in 2014) in the 100-yr floodplain.

Based on the frequency, areal extent, and severity of historical floods and storm surges in Rowley, Town emergency management officials consider the community to be at **high risk** from flooding.

Repetitive Flood Loss Structures

Despite its vulnerability to flooding, the Town of Rowley chose not to participate in the National Flood Insurance Program (NFIP) until 2009. As a result, town residents and businesses were not eligible to carry an NFIP insurance policy, and thus no NFIP claims were filed for property damage sustained from previous flooding in Rowley and there are no repetitive flood loss structures.

In the fall of 2009, the Rowley Board of Selectmen requested detailed information on the National Flood Insurance Program from the state flood hazard mitigation program (DCR/MEMA) and the Merrimack Valley Planning Commission. Equipped with this information, and in consultation with other town boards and personnel, the Rowley Selectmen carefully evaluated the potential benefits of the National Flood Insurance Program and subsequently voted to join the Program. The Town’s enrollment in the NFIP became effective on December 3, 2009.

As of June 2014, there are flood insurance policies in place for eight Rowley properties. Total insurance value of these properties is \$2,990,000. (Source: FEMA Policy Statistics, 6/30/2014).

Structurally Deficient Bridges Over Waterways

MassDOT's current bridge inventory (2014) for the Merrimack Valley region shows that there are no bridges over water in Rowley that are currently classified as "Structurally Deficient". The Route 1A Bridge spanning the Parker River in neighboring Newbury – a major north-south travel route for residents of Rowley and other North Shore communities – was classified as "Structurally Deficient" and a risk to public safety. However, in 2008, the (then) Massachusetts Highway Department replaced this outmoded bridge with a modern structure that now meets the latest AASHTO structural standards.

Hazard Potential of Dams

The DCR Office of Dam Safety lists seven (7) Rowley dams in its statewide dam classification inventory. These are (in alphabetical order): Central Street Dam, Country Club Pond Dam, Jewel Mill Dam, Lower Millpond Dam, Ox Pasture Brook Dam, Ox Pasture Brook #2 Dam, and Upper Millpond Dam. Of these, the Jewel Mill Dam, an impoundment of Mill River, and the Lower Mill Pond Dam are considered "significant hazard" dams.

Table 5.12-3. ROWLEY Significant Hazard Dams					
Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Jewel Mill Dam (Glen Mills Historic District)	Mill River (35 acre-feet)	Not Identified	Significant	9/9/2012	9/9/2017
Lower Mill Pond Dam	Lower Millpond (70 acre-feet)	1900	Significant	4/3/2012	4/3/2017

In view of the relatively large number of dams in the community, Town emergency management personnel have assigned a ***moderate risk*** rating to the overall hazard of dam failure.

Natural Hazards Management and Response

The ROWLEY BOARD OF SELECTMEN is the executive body of the Town. The Board of Selectmen is responsible for setting administrative policies and it appoints the Town Administrator. The Town Administrator provides professional assistance to the Board of Selectmen and implements town policies in day-to-day administration.

ROWLEY FIRE DEPARTMENT is a combination career and on-call department led by a full-time Chief who also heads the Town's Emergency Management Agency. Operations are out of the Fire Station at 7 Hammond Street.

ROWLEY POLICE DEPARTMENT is led by the Chief and staff that include 12 full-time officers and another six reserve officers. The Police Station is at 477 Haverhill Street.

ROWLEY DPW includes the MUNICIPAL LIGHTING PLANT (RMPL), HIGHWAY DEPARTMENT, TREE DEPARTMENT, AND WATER DEPARTMENT. The Rowley Municipal Lighting Plan is led by a general manager. The Highway Department is led by an elected Highway Surveyor. The Tree Department is led by an elected Tree Warden. The Water Department is led by the Superintendent. In addition to providing roadwork, culvert and public facility maintenance, the DPW provides vehicle and equipment used in emergencies including barriers, generators and pumps. The Fire Department also provides pumps. The RMLP is located at 47 Summer Street; the Highway Department and Tree Department are both at 40 Independent Street; and the Water Departments is at 401 Central Street.

Natural Hazards Risk Analysis

The Town of Rowley's Comprehensive Emergency Management Plan (CEMP) identifies and describes many of the natural hazards that are addressed by this Plan. The CEMP information, together with material compiled by MVPC and input from local emergency management personnel, provides the basis for a general assessment of vulnerability to those natural hazard events that pose a high, moderate, or low risk to the community. Based on this assessment, Rowley considers itself to be at **high risk** from flooding, coastal storm surges, and winter storms (blizzards, snow storms, ice storms), along with associated power outages; **moderate risk** from hurricanes, brush fires/wildfires, drought and dam failure; and **low risk** from tornadoes, earthquakes, and landslides.

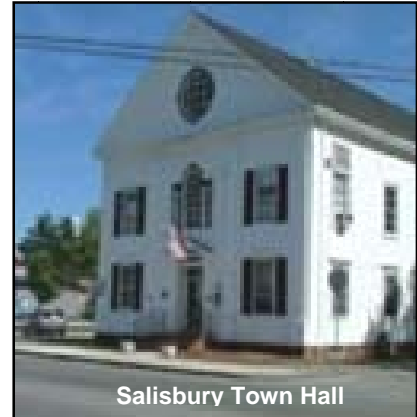


Table 5.12-4. ROWLEY Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Hurricanes	Moderate
Drought	Moderate
Wildfire/Brush Fires	Moderate
Dam Failure	Moderate
Power Outages	Moderate
Tornadoes	Low
Earthquakes	Low
Landslides	Low

5.13 TOWN OF SALISBURY Natural Hazard Risk Assessment

Community Profile

The Town of Salisbury is located about 40 miles north of Boston on Massachusetts' scenic and historic North shore. It covers a land area of 15.4 square miles and has an estimated 2012 year-round resident population of 8,283 (2010 Federal Census). The population density is approximately 538 people per square mile. MVPC projects a maximum residential population of 10,853 at full buildout.



Development is generally concentrated in four distinct areas:

- *Salisbury Beach*, a 3.8-mile long barrier beach and salt marsh complex with dense residential and commercial development;
- *Salisbury Plains*, featuring farms and suburban homes set in fields and rolling woodlands;
- *Salisbury Square*, a colonial village center with a town common fringed by municipal buildings and institutions, small stores, and village residences; and
- *Ring's Island*, a former colonial fishing village fronting on the Merrimack River and now supporting a neighborhood of restored antique homes and riverfront marine businesses.

The predominant land uses in Salisbury are forest (38%) and wetlands/water (28%), followed by residential development (17%), agriculture (6%), and commercial and industrial development (4%). A vast salt marsh (2,670 acres) covers 27% of the landscape and buffer broad upland areas from the full brunt of high-energy coastal winds and waves. Interlaced with myriad tidal creeks, the ecologically-rich salt marsh is home to diverse plant and animal species, including commercially-valuable soft-shell clams. They also provide outstanding recreational opportunities for bird watchers, kayakers, and other outdoor enthusiasts.

A municipal water supply system serves most of the community, although about 400 private wells are still in use. The public water system consists of three gravel-packed wells which together are permitted by the State to pump up to 1.1 million gallons per day (mgd) of drinking water. The system currently serves about 3,477 residential, commercial, and industrial accounts, including 160 users in the Ring's Island Water District. According to future use projections developed by the Salisbury Public Works Department, the town will need an additional 0.5 mgd of drinking water within the next 10-15 years. A new well, well #8, is currently in development, with a capacity of 0.33mgd.

A municipal sewer system serves approximately 65% of the homes in town. Sewage is treated at the Town's modern and innovative wastewater treatment plant, which currently processes about 700,000 gallons of wastewater per day. The design capacity of the plant is 1.3 million gallons per day, so sufficient excess capacity exists to tie in significantly more households, businesses, and industries over time.

Recent Development Activity in Salisbury

According to Salisbury Planning Board and Town Planner, there have been **twenty** noteworthy development projects in the community since the adoption of the 2008 Hazard Mitigation Plan. **The Town of Salisbury has taken a number of proactive steps that have had the effect of marginally reducing the vulnerability of the community's new development since the 2008 Multi-Hazard Mitigation Plan was established. Town officials continue to monitor closely local conditions. Salisbury Beach experiences coastal erosion during storm events along most of the shoreline, concentrated in the highly developed beach center and the surrounding area. In 2009 and 2012, FEMA made significant changes to the flood insurance rate maps and included nearly the entire beach into the floodplain, reflecting the increased risk and effects that erosion and sea level rise have on the coastal properties. The Town, through its various regulatory boards and commissions, has enforced flood and environmental compliance for proposed development, requiring structures to be raised or relocated in order to avoid risk. The Town actively seeks out grant programs that reduce risk such as entering into the FEMA Community Rating System, the successful HMGP funded Flood Mitigation project at Town Creek and the relocation of the Police Station to a property that has a much lower flood risk than the previous location.**

These projects are summarized in the table below:

Table 5.13-3 TOWN of SALISBURY Development Projects (Planning Board)					
Street Location	Project Development	Total Housing Units	Acres	FIRM	Stormwater/ Mitigation
15 Atlantic Avenue, East	Scuito	6 unit condo	5,000 s/f	VE	Yes
60 Lafayette Road, Northeast	Moonlight Limo	1,296 s/f garage	36,454 s/f		No
77 Main Street, Northwest	Herman Fortin	Mini-golf	7.55 acres		Yes
5 Shea Street, East	ABCAP Prop.	Parking	15,190 s/f	AE	Yes
12-14 Rabbit Road, West	True North	Solar farm	54.54 acres		Yes
167 Elm Street, West	Stor U Self	40X16 building	19.23 acres		Yes
191 Beach Road, East	Tidewater at Salisbury	Proposed 210 units	13.10 acres	AE	Yes
201 Elm Street, West	Arakelian	Cinema/new parking	9.71 acres		Yes
23-25 Fanaras Dr., Northwest	T.H. Glennon	Indust.bldg. 30,800 s/f	1.77 acres		Yes
12 Beach Road, East	Village at Salisbury Square	31 homes	5.94 acres		Yes
11&19 Fanaras Drive, Northwest	Andover Healthcare	Indus.bldg. 36,450 s/f	3.93 acres		Yes
211 Beach Road, East	Beach Realty Trust	6 unit building	10,000 s/f	AE	Yes
Mason Lane, Northeast	Northpointe	48 units	34 acres		Yes
54 Beach Road, East	SPL Development	32 units	11 acres		Yes
188-190 Beach Road, East	Atlantic Breeze	102 rentals/ 2 houses	10.74 acres	AE	Yes
218 Beach Road, East	DCR	Lifeguard station	Beach	VE	No
23-25 Fanaras Drive	TH Glennon	2 Buildings, A: 14,000s/f, B: 16,800s/f	1.77 acres		Yes
18 Fanaras Drive	Harnum Industries	14,000s/f building	5.5 acres		Yes
17 Elm Street	Town of Salisbury	17,000 s/f Library	87,120 s/f		Yes
82 Lafayette Road	Doherty	2 self-storage buildings. A: 15,885s/f, B: 3,000sf	4.48 acres		Yes

Critical Facilities

Selected critical facilities in Salisbury (emergency operations center(s), health and medical aid facilities, emergency shelters) are listed in **Table 5.13-1** on the following page and were derived from the Town's current Comprehensive Emergency Management Plan (CEMP). The locations of these and other critical facilities and infrastructure in the community were entered into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The full array of critical facilities, as identified by Town emergency management and public works personnel, are depicted in the Salisbury map series that is presented in **Appendix F** of this Plan.

Table 5.13.1. SALISBURY Emergency Operations, Health / Medical Aid Facilities, and Shelters							
Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center(s)	Primary EOC: Salisbury Fire Dept.	37 Lafayette Rd					Yes
	Alternate EOC: Salisbury Elementary School	100 Lafayette Rd					Yes
Health and Medical Aid Facilities	Salisbury Fire Dept.	37 Lafayette Rd	First Aid	35		No	Yes
	Salisbury Police Dept.	24 Railroad Ave	First aid		40	No	Yes
	Assisted Living Center, Inc.	19 Beach Road	Assisted Living		30	Yes	No
Emergency Shelters	Hilton Center	39 Lafayette Rd	N/A	N/A	100	Yes	Yes
	Salisbury Elementary School	100 Lafayette Rd	N/A	N/A	800	Yes	Yes
	Star of the Sea Church	19 Beach Road	N/A	N/A	210	Yes	No
	East Parish United Methodist Church	8 Lafayette Rd	N/A	N/A	70	Yes	No

Flood Prone Areas

The Town of Salisbury spans parts of two major watersheds, as defined by the Commonwealth of Massachusetts: the Merrimack River watershed (52.8% of town) and the North Coastal watershed (47.2%). Within these two watersheds, the Town is subject to both riverine and coastal flooding (including coastal storm surges) that chronically impact or place at risk a number of residential neighborhoods, businesses, and recreational and natural resource areas. Special flooding problem areas, such as along parts of Salisbury Beach, the Blackwater River, State Route 1A (Beach Road) and U.S. Route 1, are described in the highlighted blue boxes on the following four pages.

Special Flooding Problems/High Hazard Concerns

Salisbury Beach Erosion

Background: Salisbury Beach is a 3.8-mile long barrier beach. The beach is owned by the Massachusetts Department of Conservation and Recreation (DCR), but most of the beachfront is densely settled, except for the DCR's Salisbury Beach State Reservation. The beach has suffered significant erosion over many years and is subject to severe damage from coastal storms.

Several coastal storms in the past 5 years severely eroded the beach and caused significant damage to several beachfront homes while threatening many more. Long-term predictions of rising sea levels portend more erosion and property damage in the future. As a result of damaging coastal storms, the DCR has spent \$550,000 since 2011 for dune nourishment and an average of \$70,000 per year on snow fence.

Since 2008 the Town participates in the Merrimack River Beach Alliance (MRBA) with the City of Newburyport and the Town of Newbury. The MRBA includes elected state and federal representatives, state and federal agencies and community organizations and is focused on barrier beach erosion and maintenance of the Merrimack River jetties. As part of MRBA's efforts, the Army Corps of Engineers dredged the Merrimack River in 2010 with state financial assistance and used the dredged material for beach replenishment on both Salisbury Beach and Plum Island. In addition, during 2012 the Army Corps of Engineers restored most of the Merrimack River south jetty on Plum Island. In 2015, the Corps will rebuild the North Jetty and finish the remainder of the South Jetty.

During 2008 DCR and the Town cooperated on development of a Beach Management Plan for Salisbury Beach. As part of the plan DCR is installing and maintaining snow fence along the front of the coastal dunes to aid in dune-building. In addition, new standards have been implemented governing design and construction of stairways to the beach that help to prevent erosion and storm damage. Funding for work done under the Beach Management Plan is generated from a surcharge on parking and camping fees from visitors to the Salisbury Beach Reservation.

Needs Assessment: The DCR is currently updating this plan. The Corps conducted a study to redesign the jetties and found no useful alternatives.

One of MRBA's goals is conducting a Regional Sediment Management Study that would study erosion and sediment movement along the beaches north of Cape Ann. The study could provide the basis for a long-term Regional Sediment Management Plan that could aid in beach replenishment and harbor and channel maintenance. The Coastal Hazards Commission Report recommends implementing beach replenishment programs on a wider basis. State and Federal funding will be needed to study the feasibility of such a program along the North Shore and to implement it. The Corps is conducting a sediment study offshore, while the DCR is planning to

conduct a sediment study onshore. The hope is to marry the 2 studies. In 2010, the Army Corps of Engineers spent \$5.5 million dollars to dredge the navigation channel at the mouth of the Merrimack River and the spoils were used for dune nourishment on Salisbury and Plum Island beaches.

Storm Over-wash at Salisbury Beach Center

Background: The center of Salisbury Beach at Broadway is regularly flooded by overwash during ocean storms that are accompanied by higher than normal tides. Sacrificial dunes have been constructed across part of the area and have offered significant protection against flood damage. There is a long-term plan to construct a boardwalk and deck across the part of the Beach Center that is not now protected by sacrificial dunes. To protect against overwash during coastal storms the sacrificial dunes near the Beach Center are being monitored and maintained by DCR under the Salisbury Beach Management Plan. In addition, as part of its emergency response plan, the Town DPW builds temporary sand barriers across the part of the Beach Center that is not protected by the sacrificial dunes.

Needs Assessment: The boardwalk and deck at Salisbury Beach Center should be designed to include elements that will protect the Beach Center against overwash.

Blackwater River Flooding

Background: The Blackwater River is a tidal river that drains a large area of saltmarsh west of Salisbury Beach and north of Beach Road, flowing under a bridge on Route 286 into Seabrook, Hampton Harbor, and the ocean. A Route 286 bridge renovation project (1948) constricted the tidal flow into the river and low-lying areas along the marsh in Salisbury were developed with housing. After the Route 286 bridge was rebuilt in 1991, the tidal restriction was largely eliminated, allowing a much greater tidal flow into the Blackwater River salt marsh. This has resulted in regular flooding of low-lying residential areas bordering the Blackwater River salt marsh during high lunar tides and coastal storms.

Needs Assessment: The Army Corps of Engineers has studied the flooding problems and has designed a floodwall that could protect the area that is flooded most severely. Federal funds are available to contribute to building the floodwall and the Massachusetts Department of Conservation and Recreation has agreed to act as the non-federal sponsor of the project and to contribute state funds. At the May 2008 Town Meeting, the voters approved an appropriation of \$12,500 to pay the Town's share of the cost of a feasibility study required by the Army Corps of Engineers. . In addition, at the October 2009 annual fall Town Meeting, the voters approved an appropriation of \$15,000 to hire a consultant to assist in negotiating easement agreements with property owners affected by the project, and at the May 2010 Annual Town Meeting, the voters approved an appropriation of \$30,000 for the purpose of performing survey work relative to the project. The Town anticipates that its contribution to the non-federal match requirement for the floodwall project will consist of a combination of monies appropriated, as outlined above, the value of the

necessary easements to be obtained from private landowners, and the provision of in-kind services by the Town's Conservation Agent, Town Manager and Department of Public Works. The Town is completing acquisition of the necessary easements. Permits were obtained in 2014, including an historic variance of the MAWPA. Construction is underway 2015.

Flooding of U.S. Route 1 North at Town Creek

Background: Town Creek is a tidal creek that enters the Merrimack River just west of the U.S. Route 1 highway bridge. The creek drains a large salt marsh area north of the river as well as an adjacent area of uplands. The mainstem of Town Creek is crossed by an MBTA-owned rail bed and US Route 1 (Bridge Road). A tide gate and culvert were installed in the rail bed in the late 1800's to help protect upstream areas against flooding from the Merrimack River. Subsequently, the low-lying area along US Route 1 was developed commercially.

Needs Assessment: In May 2005 and April 2007, coastal storms, coupled above normal tides, washed out the rail bed at Town Creek and caused significant flood damage to commercial properties along US Route 1. The Town and the MBTA cooperated to reconstruct the rail bed after the 2005 breach for a total cost of approximately \$100,000. The 2007 breach damaged a much larger section of the rail bed and tidal flooding conditions were severe and prolonged. Sections of the highway were covered by floodwaters during high tides for 5 days after the 2007 breach and were closed to traffic, resulting in significant disruption and public safety concerns throughout the area. The Town immediately engaged a contractor and spent \$400,000 to make a temporary repair of the breach so the highway could be reopened. The Federal Emergency Management Agency (FEMA) reimbursed the Town for 75% of the cost of the repair.

The Town obtained a 99-year lease on the MBTA-owned rail bed and cooperated with the Massachusetts Department of Transportation (MassDOT) on the design and construction of a rail trail on the rail bed that is part of a regional trail network. The design of the rail trail raised the level of the rail bed across the Town Creek marsh above the 100-year flood level. The higher trail elevation and the paved trail are now providing protection against future breaches and flood damage.

In addition, a major rain event (18 inches in 2 days) in May 2006 caused flooding along Town Creek and in nearby businesses as the runoff was restricted by the highway and rail bed culverts. The Town and the MA Coastal Zone Management Wetlands Restoration Program conducted coordinated studies to: 1) design a permanent repair of the breach, and 2) determine the proper culvert size and tide gate arrangement that will facilitate runoff drainage while protecting low-lying properties from tidal flooding.

The Town applied for and was awarded a FEMA Flood Hazard Mitigation Grant and State Environmental Bond Bill funding to reconstruct the part of the rail bed that was temporarily repaired after the 2007 breach and to install new culverts and modern

tide gates that will protect against tidal flooding and facilitate runoff as well as improve tidal flows to aid in restoration of the marsh. The project was substantially completed during 2014.

The 2007 coastal storm not only breached the rail bed at Town Creek to flood U.S. Route 1 North, but also raised coastal water levels high enough to push flood waters over Ferry Road from the east which made the flooding along U.S. Route 1 North worse. The 2012 revision of the FEMA Flood Maps increased the 100-year flood level in the marshes east of U.S. Route 1 and Ferry Road **from 8 feet (NAVD 88) to 9 feet (NAVD 88)**. The Town plans to survey Ferry Road and determine the increase in elevation that is needed to protect the northern section of U.S. Route 1 from coastal storm flooding. The Town will also estimate the cost of increasing the elevation of the roadway and of installing gates in culverts under Ferry Road that would be needed to prevent tidal flooding.

Tidal Flooding of U.S. Route 1 South; March Road and First Street Flooding

Background: In the Patriots Day Storm of April 2007, a coastal storm surge and extreme astronomical tides combined to cause tide levels in the Merrimack River to reach the then 100-year flood stage (9 ft. NGVD). This raised the water level in the adjacent salt marshes above the level of Ferry Road and March Road at Ring's Island in Salisbury for several days during high tides, which resulted in flooding of a number of businesses along the southern end of Route 1 in Salisbury. Furthermore, the small size of the culverts under Ferry Road, March Road, and First Street limited drainage of the flooded area, thus prolonging the flooding conditions and causing additional flood damage. FEMA issued new Flood Maps during 2012 which increased the 100-year flood elevation in this area by an additional foot.

Needs Assessment: The Town should cooperate with property owners to permit raising their buildings above anticipated flood levels, or to build floodwalls to protect their property. During major storm events, this area continuously floods, causing at times the complete closure of March Road and First Street. The Town plans to use the results of the study of Town Creek to estimate the increase in the elevation of Ferry Road and March Road that would be needed to provide better flood protection to the southern section of U.S. Route 1. The Town will also estimate the cost of raising the elevation of the roadways. In addition, the Town will seek assistance from the MA Coastal Zone Management Wetlands Restoration Program to study the drainage in the culverts under the roads. The goal would be for CZM to make recommendations on appropriate culvert sizes and tidal control structures that would be appropriate to increase tidal flows (for marsh restoration) while providing increased protection from flooding during coastal storms or Merrimack River floods.

Tidal Flooding of State Route 1A (Beach Road)

Background: State Route 1A (Beach Road) provides the only evacuation route from Salisbury Beach to the rest of the Town. This route is flooded frequently by coastal

storms which not only prevents evacuation of the beach, but also restricts access to the beach by fire, police and emergency personnel.

Needs Assessment: The recent increase in the FEMA Flood Map's 100-year flood elevation in the area and expectations of continued increases in flood levels emphasize the importance of maintaining access to Salisbury Beach during coastal storm events. The Town plans to survey State Route 1A (Beach Road) to determine the increase in elevation of the roadway that would allow the route to be used for evacuation and emergency access during coastal storm events. The Town will consult with MassDOT on developing plans to increase the elevation of the highway.

Jak-Len Drive Flooding

Background: In the May 2006 storm a low-lying part of Jak-Len Drive flooded and cut off access to the street. Drainage of this area would be improved by replacing the existing antiquated and undersized culvert/drainage infrastructure on Jak-Len Drive.

Needs Assessment: The Town DPW plans on replacing the existing 12" corrugated metal pipe culvert with appropriate headwalls. The Town also plans on replacing the existing, undersized drain system with larger and appropriate pipe classes to improve the flooding/stormwater management of this area. The Town also plans to clean and dredge the drainage areas within the outfall. To accomplish this, the Town needs to investigate the locations and descriptions of the local drainage easements.

Smallpox Brook Flooding

Background: In the May 2006 Storm, Smallpox Brook flooded and washed out part of US Route 1 (Lafayette Road), which was subsequently repaired by MassHighway. That section of US Route 1 is expected to be reconstructed as resources become available.

Needs Assessment: When the project is designed, it may be appropriate to redesign the culvert at Smallpox Brook to prevent future highway flooding.

North End Boulevard Flooding (From Old Town Way to 18th Street)

Background: Central Avenue and Old Town Way are subject to flooding due to an antiquated, undersized, and inefficient drainage system. During major storm events, this area continuously floods, at times causing complete closure of Old Town Way and Central Avenue.

Needs Assessment: It is anticipated that there will be substantial redevelopment of Salisbury Beach Center in future years. Redevelopment plans for the area need to take into account the drainage problems on Central Avenue and Old Town Way and provide a solution. The Planning Board should seek mitigation payments from developers to contribute to the drainage improvements.

Flooding Vulnerability Assessment: A geographic information system (GIS) analysis of the Town's FIRM Flood Hazard Area maps by MVPC has determined that 4,779 acres (7.5 sq. mi.) is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 23 acres lies within the 500-year floodplain. Together, these two flood zones constitute 44 percent of the total area of the community. Based on an additional analysis by MVPC, Salisbury has 1,710 structures in the 100 year floodplain. The total assessed value of this property was \$353,110,622 in 2012. This value is further broken down as \$319,900,422 residential, \$31,359,900 commercial, \$170,400 industrial, and \$1,679,900 institutional. Nearly 30% of the building structures located within the floodplain in the Merrimack Valley region are in the Town of Salisbury. This underscores the need for vigorous enforcement of the Town's floodplain and stormwater management regulations, as well as the acquisition/preservation of flood-prone open space parcels as Town and state financial and personnel resources permit.

As part of the mapping analysis, MVPC also identified the critical facilities that are located within the Town's mapped flood hazard areas and SLOSH* zones. These facilities are considered to be at potential risk of future flood damage or loss. They are listed in **Table 5.13-2** on the following page, together with their locations and values as derived from the (2012) Assessor's records and the Town's (FY12) GASB 34 Report.

According to Town officials, there are no current plans to site other critical facilities in the mapped floodplains or SLOSH zones.

Based on the frequency, areal extent, and severity of historical floods in Salisbury, Town emergency management officials consider the community to be at **high risk** from flooding.

Table 5.13-2. TOWN OF SALISBURY Critical Facilities in Flood Hazard Areas

Facilities in 100-Year Floodplain		
Facility Name	Parcel ID / Street Location	2012 Buildings Valuation
Police Station/E911 Dispatch Center (note: Planned & approved 2015 for relocation to inland site)	32-62 / 24 Railroad Avenue	\$742,800
Water Storage/Pumping	33-38 / 91 North End Boulevard	\$247,539
Sewage Pumping Station	7-56/15 Second Street	\$150,000
Sewage Pumping Station	14-94 / 180 Bridge Road	\$241,800
Sewage Pumping Station	14-64 / 121 Ferry Road	No Building Valuation
Sewage Pumping Station	24-54 / 52 Dock Lane	No Building Valuation
Sewage Pumping Station	32-52 / 228 Beach Road	No Building Valuation
Sewage Pumping Station	33-61 / 139 North End Boulevard	\$44,800
Sewage Pumping Station	30-5 / 472 North End Boulevard	No Building Valuation
Town Creek Tide Gate		No Building Valuation
Facilities in 500-Year Floodplain		
Facility Name	Parcel ID / Street Location	2012 Buildings Valuation
*No Critical Facilities Identified in 500-Year Floodplain		
Facilities in SLOSH Zones		
Facility Name	Parcel ID / Street Location	2012 Buildings Valuation
Police Station/E911 Dispatch Center	32-62 / 24 Railroad Avenue	\$742,800
Water Storage/Pumping	33-38 / 91 North End Boulevard	\$247,539
Water Storage/Pumping	28-5 / 175 Beach Road	\$122,700
Water Storage/Pumping	33-38 / 91 North End Boulevard	\$247,539
Sewage Pumping Station	14-94 / 180 Bridge Road	\$250,000
Sewage Pumping Station	14-64 / 121 Ferry Road	\$150,000
Sewage Pumping Station	24-54 / 52 Dock Lane	\$250,000
Sewage Pumping Station	32-52 / 228 Beach Road	\$500,000
Sewage Pumping Station	33-61 / 139 North End Boulevard	\$250,000
Sewage Pumping Station	30-5 / 472 North End Boulevard	\$250,000
Sewage Pumping Station	3-55 / 7 Grover Street	\$150,000
Sewage Pumping Station	5-49 / 13 Lynne Avenue	\$150,000

Repetitive Loss Structures

According to file data provided by the MA Department of Conservation and Recreation, there are thirty seven (37) repetitive flood loss sites in Salisbury as of 2014. Not surprisingly, a majority of the documented repetitive loss sites are located in the Salisbury Beach section of the community. The loss sites in Salisbury include 15-multi-family residences, 10-single-family residences, 10-non-residential structures, and 2- other-residential structures. Altogether, flood incidents at these 37 loss sites have resulted in the payout of 114 National Flood Insurance Program (NFIP) claims totaling \$2,900,621 since 1978.

The total number of active NFIP policies in Salisbury is currently 1,102. The combined insurance value in-force for these properties is \$253,123,600. (source: NFIP Policy Statistics for Massachusetts 6/30/2014).

Floodplain Management and Compliance with NFIP

Since 2008 the Town of Salisbury has carried out a broad array of floodplain management activities in compliance with the requirements of the NFIP. These include:

- Participated in NFIP training courses or seminars offered by the State (MEMA/DCR) and/or FEMA that addresses flood hazard planning and management.
- Established mutual aid agreements with neighboring communities to address administering the NFIP following a major storm event.
- Addressed NFIP monitoring and compliance activities.
- Revise/adopt subdivision regulations.
- Prepared, distributed, and made available NFIP insurance and building codes explanatory pamphlets or booklets.
- Identify and become knowledgeable of non-compliant structures in the community.
- Inspects foundations at time of completion before framing to determine if lowest floor is at or above the Base Flood Elevation (BFE).
- Requires use of elevation certificates.
- Enhanced local officials', builders', developers', local citizens' and other stakeholders' knowledge of how to read and interpret the Flood Insurance Rate Map (FIRM)
- Work with elected officials, the state (MEMA/DCR), and FEMA to correct existing compliance issues and prevent any future NFIP compliance issues through continuous communications, training, and education.
- Worked to prepare CRS application.

The Town of Salisbury intends to take the following actions over the next 5 years:

- Participate in NFIP training courses or seminars offered by the State (MEMA/DCR) and/or FEMA that addresses flood hazard planning and management.
- Address NFIP monitoring and compliance activities
- Revise/adopt stormwater management regulations.
- Continue to update distribute, and make available NFIP insurance and building codes explanatory pamphlets or booklets.
- Identify and become knowledgeable of non-compliant structures in the community.
- Continue to inspect foundations at time of completion before framing to determine if lowest floor is at or above the Base Flood Elevation (BFE).
- Continue to require use of elevation certificates.
- Continue to enhance local officials', builders', developers', local citizens' and other stakeholders' knowledge of how to read and interpret the Flood Insurance Rate Map (FIRM)
- Work with elected officials, the state (MEMA/DCR), and FEMA to correct existing compliance issues and prevent any future NFIP compliance issues through continuous communications, training, and education.
- Participate in Community Rating System (CRS) or undertake activities to increase the grade level of the community's CRS current participation.
- Create a website for flood information

Structurally Deficient Bridges Over Waterways

Route 1 Bridge over Merrimack River

The Town of Salisbury has one bridge classified as "Structurally Deficient", that being the Route 1 (Gillis) Bridge over the Merrimack River that links the town with the City of Newburyport. A 2006 count at this location showed a daily traffic volume of 15,600 vehicles. Higher volumes have been counted at this location during the summer months.



In addition to the Route 1 Bridge over the Merrimack River, the Whittier Bridge, which carries Interstate 95 over the Merrimack River between Newburyport and Amesbury, greatly influences Salisbury's transportation system volumes and efficiency.

Whittier Bridge over Merrimack River

The Whittier Bridge currently carries six lanes of Interstate 95 traffic lanes (three northbound; three southbound) over the Merrimack River between Amesbury and Newburyport. This section of Interstate 95 provides a critical link between Greater Boston and Maine, eastern New Hampshire and the maritime provinces in Canada. A 2012 traffic volume count taken by MassDOT showed that 71,000 vehicles cross the bridge on an average weekday but this number rises to over 90,000 on busy summer weekends.

MassDOT is currently in construction and has committed over \$285 million in Accelerated Bridge Program funding to replace this older structure with two new bridges that will carry four travel lanes and a breakdown lane in each direction. Sections of Interstate 95 north and south of the bridge will also be widened to create a consistent four lane profile in each direction. Notably, the new bridge will also include a bicycle and pedestrian lane that will run adjacent to the northbound travel lanes. This will be the first time that MassDOT has incorporated bicycle and pedestrian travel accommodations into a bridge that carries an interstate highway. It will be an important connection in the growing trail network that exists on both side of the river in the communities of Amesbury, Salisbury and Newburyport.

Because of the importance of I-95 to the nation's economy and transportation network, MassDOT has committed to keeping three lanes of traffic open in each direction while the new bridge is being built. Construction of the new bridge began in July 2013 and it is expected that the new structure will open to traffic during 2017.

Wildfire/Brush Fires

From approval of the Regional Hazard Mitigation Plan in 2008 through 2014), Salisbury firefighters have responded to 55 brush fires as indicated in the table below:

Table 5.13-3 TOWN of SALISBURY Brush Fires 2008-2012		
Date	Location	Area Burned
2008		
2/7	109 Rabbit Road	300X400 ft
3/13	239 Lafayette Road (marsh)	400X400 ft
4/19	54 Mudnock Road	5x5 ft
4/24	168 Lafayette Road	100X100 ft
4/25	168 Lafayette Road	Hot spots
6/3	Rt 495 Southbound	10X10 ft

Table 5.13-3 TOWN of SALISBURY Brush Fires 2008-2012

Date	Location	Area Burned
8/20	298 Northend Blvd	10X10 ft
8/26	175 Elm Street	5X5 ft
11/2	9 Kelori Drive	50X30 ft
2009		
4/25	48 Toll Road	20X40 ft
4/26	221 Lafayette Road	5X5 ft
4/27	52 Locust Street	Piles
6/2	13 Toll Road	10X5 ft
8/1	215 Beach Road	15X15 ft
8/20	End of Ferry Lots Lane	Camp fire
12/19	98 Forest Road	40X60 ft
2010		
1/29	142 Lafayette Road	25X25 ft
1/21	19 Beach Road	100X100 ft
4/26	17 Mudnock Road	10X10 ft
5/2	58 Baker Road	40X40 ft
6/25	181 Lafayette Road	10X10 ft
7/6	2 Erica Way	100X50 ft
8/6	Carr Island	15X15 ft
9/3	Ferry Lots Lane	50X50 ft
2011		
7/22	74 Bridge Rd Rail Trail	150X15 ft
9/16	55 Dock Lane (marsh)	30X25 ft
2012		
1/8	53 Bridge Road	5X5 ft
4/18	31 True Road (rail trail)	100X100 ft
4/19	238 North End Blvd	10X10 ft
4/20	50 Elm Street	50X50 ft

Table 5.13-3 TOWN of SALISBURY Brush Fires 2008-2012

Date	Location	Area Burned
4/20	212 Beach Road (marsh)	100X100 ft
7/22	Route 95	20X30 ft
11/24	9 Locust Street	30X30 ft
2013	TOTAL: 11	
2014	TOTAL : 11	

Hazard Potential of Dams

The DCR Office of Dam Safety includes only one Salisbury dam on its statewide dam classification list. This is the “Little River Dam”, a small, privately-owned and maintained dam located north of True Road. The Little River is a small, easterly-flowing tributary of the Blackwater River which courses northward through the northeastern part of Salisbury into Hampton Harbor in neighboring Seabrook, NH. DCR dam inspectors have not classified the Little River Dam as either “high hazard” or “significant hazard”, so it is not considered to pose either a serious or a significant risk to downstream populations or properties in the community. Accordingly, the Town of Salisbury is considered to be at **low risk** from the natural hazard of dam failure.

Natural Hazards Risk Analysis

The Town of Salisbury's Comprehensive Emergency Management Plan (CEMP) identifies and describes the range of natural hazards that are addressed by this Plan. The CEMP information, together with material compiled by MVPC and input from local emergency management personnel, provides the basis for a general assessment of vulnerability to those natural hazard events that pose a high, moderate, or low risk to the community. Based on this assessment, Salisbury considers itself to be at **high risk** from flooding, coastal storm surges, and winter storms (blizzards, snow storms, ice storms), along with their occasional associated power outages; at **moderate risk** from hurricanes, brush fires/wildfires, and drought; and at **low risk** from tornadoes, earthquakes, landslides, and dam failure.

“In the storm’s wake...

...A continued onslaught of extreme high tides and a storm surge battered the coast yesterday, further eroding beaches and flooding areas near the beach and marsh, none more so than Bridge Road, where a number of businesses have been devastated by water damage...

...The severe flooding in the area is due to the breach of the old railroad bridge and culvert behind David’s Fish Market, which yesterday stood almost window-deep in water by 1 p.m...

...’The railroad bed collapsed – the dike broke – and the water flooded in’ ...”
 (Bob Cook, Salisbury Emergency Management Director)

The Daily News of Newburyport

Table 5.13-4. Salisbury Natural Hazards Risk Assessment	
Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Power Outages	HIGH
Hurricanes	Moderate
Drought	Moderate
Wildfire/Brush Fires	Moderate
Tornadoes	Low
Earthquakes	Low
Landslides	Low
Dam Failures	Low

Natural Hazards Management and Response

Salisbury is a small, coastal bedroom community located on the North Shore of Massachusetts. Planning for and responding to recurring incidents of flooding, coastal storm surges and erosion, and other natural hazards are an ongoing challenge for community officials. The following describes some of Salisbury’s key facilities and personnel involved in local emergency management.

Salisbury Town Hall: Salisbury’s main Town offices are located in approximately 9,704 square feet of space over two floors of Town Hall, at 5 Beach Road. Most of the Town departments are housed in the Town Hall, including the Selectman’s Office, Town Manager, Finance Department, Town Clerk, Planning and Development Department, Building Inspector, Health Department, Assessor, and Harbormaster as well as many various boards and commissions. During the summer months, the Harbormaster holds office hours in Town Hall as well as at the Town Pier.

In addition to offices, Town Hall contains a central meeting room, which can seat up to 70 people for public meetings, which is used regularly for Board and Committee meetings.

The Town Hall facility is adequate for its current use and Town employees can be accommodated. All Town records are stored on-site in either the basement or the 2nd floor.

Public Safety: Public Safety encompasses police, fire, emergency medical response, and emergency management. While the Police, Fire and Emergency Management Departments are part of the Town of Salisbury, emergency medical response services are provided by private companies.

Police: The Salisbury Police Department maintains a roster of 15 full-time officers and 15 reserve and special officers. In 2014, the Police Department responded to 15,762 incidents, an increase of 1,482 or 9.4% incidents over 2013. Calls vary widely, but a majority of calls were larceny type crimes. The average response time is 8.1 minutes, from call to arrival on scene-this is an average of total calls and does not take in to account available manpower, location of call, or weather conditions. The Police Department maintains an active outreach and education program, including Code RED Emergency Notification System, Citizens Police Academy, The TRIAD Program, Neighborhood Watch and the Annual Department Open House.

The police station, currently located at 24 Railroad Avenue, contains approximately 7,993 square feet of space. The police station has no central location for storage. Files are found throughout the building including in offices, hallways and dispatch. There are 3 storage containers in the parking lot outside that stores equipment and lost/stolen property. The police department is located in Salisbury's Beach District Neighborhood in a facility built in the 1929. There have been minimal upgrades to the two story brick building since then and it is currently entirely inadequate to serve the needs of the town. Due to its age and decades of deferred maintenance deficiencies can be cited in each operational area of the facility (Salisbury Master Plan-Volume 1: Existing Conditions and Trends, February 2008).

Because of the many hurdles associated with the existing police station and location, plans are in the works for the construction of a new police station in the very near future. The Police Station Building Committee is working with HKT Architects to finalize bid-ready plans and specifications for May 2015 Town Meeting for the construction of the new police station at 175 Beach Road. The location of the new station will be 0.7 of a mile west, on Beach Road, from the current site. This new location will address the flood issues associated with the current location.

Fire & Rescue: The Town operates Engines #1, #3, and #4, Ladder #1 and Marine #1, as well as an all-terrain-vehicle (ATV). All of the engines are designated "Class-5", meaning that they can do everything an ambulance can do, other than transport patients. The Town employs five (5) fulltime firefighters and has approximately 23 part-time and "call" fire-fighters. The Salisbury Fire Department responds to on-average, 2,000 calls a year, with the majority of them being medical calls. The average response time is 4 minutes.

Salisbury Fire & Rescue responds to all calls for medical assistance as a three tier system with Fire, Police, and Private Ambulance (Atlantic EMS). Engines are staffed by MA Certified EMT's, Intermediates or Paramedics, certified as Class V Ambulances and are stocked with Basic and Advanced Life Support Equipment. Vehicles are also equipped with Automated External Defibrillator's (AED's). Fire and

Rescue responds to all calls and start initial treatment of patients and patients are then transported by Private Ambulance.

Emergency Management: The Salisbury Emergency Management Agency is a department under the Town of Salisbury. They provide residents with vital information in the event of a serious storm or other emergency event. They work closely with other public safety agencies both within the Town as well as neighboring communities, State and Federal agencies. The agency provides planning for emergencies, guides residents on the proper actions to take should the need arise. In addition, the Salisbury Emergency Management Agency interfaces with both the Massachusetts Emergency Management Agency (MEMA) as well as the Federal Emergency Management Agency (FEMA). Through those agencies we can request additional resources if needed. (<http://www.salisburyemergencymanagement.com/>).

Town-wide sirens are available, mainly for emergencies and tests associated with the Seabrook Nuclear Power Plant. These sirens are operated out of the Police Department and can be used in a catastrophic emergency, not just for the power plant.

The Hilton Senior Center, located at 43 Lafayette Road and the Salisbury Elementary School, located at 100 Lafayette Road, both serve as shelters for residents during disasters. Both shelters are equipped with back-up generators. The Hilton Senior Center can accommodate approximately 100 people and the Salisbury Elementary School can accommodate approximately 800 people.

Public Works: The Salisbury Department of Public Works maintains all of the Town's buildings and facilities, as well as public roads and parks. Utilizing a staff of seven employees, including the DPW Director, one foreman, three heavy equipment operator/laborer/skilled maintenance laborers, a business manager and an administrative assistant, the DPW maintains over 50 miles of road and 30.25 acres of parks and green space, maintains approximately 730 public catch basins, which are cleaned annually, runs the wastewater treatment plant, and oversees the town wells. The majority of the Town is swept, concentrating on environmentally sensitive areas (like the beach). Most streets are swept at least once per year, and more than once at the beach and the town center. The DPW is the department primarily responsible for implementing the Town's NPDES Phase II Storm-water Management Regulations.

For snow plowing operations, the DPW has three plow trucks and the Waste Water Treatment Plant owns two. This past winter, the Town depended on four hired contractors to assist with plowing, as well as one additional contractor to clear the sidewalks of snow when the snowfall amounts were over 3".

The DPW operates out of a single story garage located at 39 Lafayette Road. The building contains office space and staff facilities plus six bays for storage and maintenance of vehicles-including 3 plow trucks/dump trucks, a loader, backhoe, trash truck, a roller, a street sweeper, 3 varying sizes of SUVs/pickups. The salt storage barn is located adjacent to the building.

Conservation Agent: Salisbury's Conservation Agent serves as the local representative for the Commonwealth's Coastal Storm Team. During and after coastal storms, the Agent surveys the affected areas and reports back to Coastal Zone Management (CZM) and/or Massachusetts Emergency Management Agency (MEMA). This information is used to determine losses and designation of disaster declarations. Also, documents used when claims sent to FEMA/MEMA for reimbursement.

Building Commissioner: Salisbury's Building Commissioner serves as the Town's Zoning Enforcement Officer, and National Flood Insurance Program (NFIP) Coordinator. His responsibilities are wide-ranging and include: 1) interpreting and enforcing the Massachusetts State Building Code and all applicable codes as they relate to it; 2) interpreting and enforcing the Town's zoning by-laws; 3) issuing building permits and assisting contractors and property owners in the permit application process; and 4) performing site inspections to ensure compliance with the State Building Code and permitted plans.

Chief Harbormaster: Salisbury's Chief Harbormaster is responsible for managing the Town's harbor and navigable waters, enforcing waterways by-laws and Massachusetts General Laws, and responding to emergencies on the waterways. In addition to carrying out administrative duties, he participates in marine rescues, manages recovery and securing of boats lost or adrift, patrols the Town's shorelines and waterways enforcing local, state, and federal laws and regulations, and issues citations and warnings for violations of the law. He oversees maintenance of all Town piers, launching ramps, and docks, as well as the installation and maintenance of channel markers and all other aids to navigation.

Recent Hazard Mitigation and Response Initiatives

In the six years since the 2008 Hazard Mitigation Plan was approved, several noteworthy projects aimed at enhancing the community's disaster mitigation and response capabilities have been implemented. These projects include:

1. Town Creek Project. Multiple flooding events in 2005, 2006 & 2007, resulted in floods washing out the entire embankment because of the failed stone culvert in Town Creek. The Town of Salisbury in Fall 2014 completed construction on the Town Creek restoration project which included installation of two 5x5 sluice flap tide gates. The project included funding through FEMA, the Mass. Emergency Management Agency, the Executive Office of Energy and Environmental Affairs, the Town of Salisbury and the U.S. Fish & Wildlife Service among other partners.

2. Great Marsh Restoration Project. Eight Towns and the Great Marsh is a committee of municipally appointed citizens dedicated to the protection of coastal waters and associated watersheds on the upper North Shore of Massachusetts Bay. The Committee works to foster stewardship of coastal resources by heightening public awareness of, and mitigating coastal water quality impacts, providing technical assistance, and developing and supporting local research and educational projects.

The committee members represent nine North Shore communities: Salisbury, Amesbury, Newburyport, Newbury, Rowley, Ipswich, Essex, Gloucester and Rockport.

The Committee is the upper North Shore regional representative of the Massachusetts Bays Program (MBP). The Committee is partially funded under the Clean Water Act through the U.S. Environmental Protection Agency and is administered by both MBP and the Merrimack Valley Planning Commission. MVPC has been providing staff and technical support to the Committee since 1993.

Eight Towns and the Great Marsh is one of five local governance committees within the Massachusetts Bays National Estuary region. Committee members meet monthly and are appointed by the chief elected officials in their communities. They work closely with local officials, citizens, nonprofit groups, and state and federal agencies to promote coastal protection. However, the Committee isn't limited to the nine communities it represents. Issues within the coastal watersheds of the Merrimack River, Parker River, Ipswich River and the North Coastal Basin are other impacted geographic areas.

Eight Town and the Great Marsh projects include:

- Designation of the Great Marsh Area of Critical Environmental Concern (ACEC)
- Development of a web-based kayakers guide
- Low impact development (LID) projects
- Circulation modeling in the Merrimack Estuary/Plum Island Sound
- Smart Growth (including OSRD, Affordable Housing, Green Neighborhoods, Open Space)
- Anadromous fish passage, boater no-discharge area designation and sea level rise
- Scenic coastal byway designation, and more (www.mvpc.org)

3. Merrimack River Beach Alliance (MRBA). The MRBA is a tri-municipal working group, made up of the Towns of Salisbury and Newbury and the City of Newburyport. Since 2008, local, state and federal officials, including representatives from the US Army Corps and the MA Department of Conservation and Recreation (DCR) have met monthly to discuss regional beach problems and solutions. The following projects are a result of this coordination.

- a. Merrimack River Dredging and Dune Nourishment Project (2010)
- b. Dune Nourishment Project (2014)
- c. Repair of North Jetty - Under construction 2015
- d. Repaired South Jetty-(2014), except for the seaward end-planned for 2015.

4. Rail Trail Improvement. The Old Eastern Marsh Rail Trail (parallel to Bridge Rd/Route 1) was improved in 2009. The improvement including raising the embankment and paving the trail. When subsequent flooding occurred, the raised embankment allowed flood waters to be held back.

5. Floodwall Project. The Town of Salisbury is working on obtaining the final easements to permit building a floodwall around the neighborhoods of 9th, 10th, 11th, 12th, Florence and Lewis Streets. The floodwall will abate flooding caused by the widening of the Route 286 bridge in New Hampshire. **The floodwall work is to be underway 2015-2016.**

6. Code Red Emergency Notification System. The CodeRED® system is used to send critical communications, from evacuation notices to missing child alerts. CodeRED® employs a one-of-a-kind Internet mapping capability for geographic targeting of calls, coupled with a high speed telephone calling system capable of delivering customized pre-recorded emergency messages directly to homes and businesses, live individuals and answering machines.

This service can be used in case of fires, chemical spills, evacuations, lock downs, downed power lines, lost individuals, natural disasters, abductions, water system problems, bomb threats, or other emergencies. Calls can be geographically targeted for localized messaging. If widespread, the entire community could be called within minutes. The system also reports who did not get a call so that they may be contacted by other means.

Salisbury residents are welcome and encouraged to enter their contact information for home, business, and mobile phones so they may be contacted by the system in the event of an emergency. It is important for Salisbury residents and businesses customers to register, especially if they use unlisted numbers, cell phones, or VOIP. Those who do not register their address and phone number may not be notified with CodeRED in the case of an emergency. Registration is confidential, free, and easy. (<http://www.salisburypolice.com/page/20139-Programs>). **This system has been in place since 2010.**

5.14 TOWN OF WEST NEWBURY Natural Hazard Risk Assessment

Community Profile

The Town of West Newbury is a semi-rural community that is located approximately 40 miles north of Boston. It covers a total area of 14.6 square miles and a land area of 13.5 square miles. The landscape is characterized by rolling hills with broad valleys and an unspoiled rural charm. The Merrimack River flows along the Town's northern border, providing scenic vistas and recreational boating and fishing.



The Town's current population is 4,235, according to the 2010 U.S. Census, and the population density is 313.3 people per square mile. There are 1,508 households, and 11.4% of the population is 65 years or older.



West Newbury's predominant land uses are forest land (45%) and low density residential development (14.5%). Agriculture (12.9%) and wetlands/water (23.5%) are also prominent land use features. Commercial and industrial uses account for less than 10 acres, about .1% of the Town area. The preservation of open space – for agriculture, woodlots, passive recreation, wildlife conservation, and scenic views – has been identified by the Town's Master Plan and Open Space & Recreation Plan as a priority community goal.

The Town is not served by a centralized municipal sewerage system, but instead relies on individual on-site septic systems for wastewater treatment and disposal.

Public water is supplied to approximately 63% of the town, or about 940 dwellings, from two sources. The major source (72%) is the West Newbury Wellfield #1, located on the south side of Main Street (Route 113) in the northeastern corner of the town. The second source (28%) is water purchased from the neighboring City of Newburyport, which draws its water from both the Artichoke Reservoir system and from city wells/ the inflow from Newburyport runs through the Wellfield #1 pump house. Currently, West Newbury's average daily water demand is 178,000 gallons per day (gpd). Its maximum daily demand during the height of the growing season (when lawn watering peaks) is 320,000 gpd. The Water Department recognizes the need for additional in-town water sources to meet present and future demands, and has drilled numerous test wells in a search for a new source. While well resource expansion is needed for meeting long-term local water demand, the Newbury Water Department has focused on enhancing the productivity of its existing well in the short term until development of the bedrock wells becomes financially viable.

Recent Development Activity in West Newbury

According to the U.S. Census, West Newbury's grew moderately in the 2000's with a 2.1% population increase from 2000 to 2010. Population projections completed by MVPC forecast a potential 2030 population for West Newbury of 5,150 people, a 22% increase from 2010.

From 2010 through 2013, the Building Department issued permits for between 9 and 19 single family homes each year.

The largest development underway in recent years has been the Over-55 Adult Community known as Ocean Meadow on 54 acres off Main Street. Built under the Town's Open Space Development zoning bylaw, 25 acres of the site are under conservation/open space restriction.

Given the moderate level and type of recent development activity, the Town's vulnerability risks are considered by local officials to be unchanged since 2008.

Critical Facilities

Selected critical facilities in West Newbury (emergency operations centers, health and medical aid facilities, emergency public shelters) are listed in **Table 5.14-1** on the following page. These were derived from the Town's current Comprehensive Emergency Management Plan (CEMP). The locations of these and other critical facilities and infrastructure in the community were entered into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. The full array of critical facilities, as identified by Town emergency management, public works, and health personnel, are depicted in the West Newbury map series that is presented as Appendix F of this Plan.

**Table 5.14-1. WEST NEWBURY Emergency Operations Centers,
Health / Medical Aid Facilities, and Shelters**

Facility Type	Common Name	Street Address	Health Facility Type	Average Daily Capacity	Maximum Capacity	Feeding Capability	Emergency Generator Available
Emergency Operations Center(s)	<i>Primary EOC:</i> West Newbury EMA /Public Safety Complex	401 Main Street					Yes
	<i>Alternate EOC:</i> MEMA Region 1	Region 1 365 East St. Tewksbury, MA					
Health and Medical Aid Facilities	Training Room Public Safety Complex	401 Main Street	First Aid	N/A	12-15	No	Yes
	Town Office Building Annex	381 Main Street	First Aid Board of Health EDS	N/A	50	No	Portable
Emergency Shelters	Town Office Building Annex	381 Main Street	N/A	N/A	50	Possible	Portable
	Public Safety Complex	401 Main Street	N/A	N/A	12-15	No	Yes
	Page School	694 Main Street	N/A	N/A	1500 CEM Plan	Yes	Yes
	Pentucket High School	22 Main Street	N/A	N/A	2000 CEM Plan	Yes	Yes

Flood Prone Areas

West Newbury spans two major watersheds as defined by the Commonwealth of Massachusetts: the Merrimack River watershed and the Parker River watershed. The majority of the Town (74%) lies within the Merrimack watershed and drains northward to the Merrimack River mainstem.

Flooding occurs periodically along the Merrimack River, as well as along tributaries to both the Merrimack and Parker. Additional flooding occurs in dispersed locations (generally low points) in the community where groundwater intersects the surface and where wetlands expand during prolonged rainfall events. In general, there are six major flood prone areas:



- Merrimack River along River Road
- Merrimack River east of Bridge Street (Worth's Lane) westerly to the Groveland town line
- Upper and Lower Artichoke Reservoirs and the Artichoke River
- Wetland area between Crane Neck Street and Georgetown Road, and between Georgetown Road and Middle Street
- Wetland area between Middle and Garden Street, east of Archelaus Hill
- Wetland area to the south and southeast of Upper Artichoke Reservoir between Indian Hill Street and the West Newbury-Newbury-Newburyport town line.



A GIS analysis of the Town's FIRM flood hazard area maps by MVPC has determined that 1,157 acres (1.81 sq. mi.) in West Newbury is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 603 acres (0.94 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute nearly one-fifth (18.7%) of the total area of the community. Based on an additional analysis by MVPC, 281 acres in these zones are still open and "potentially developable" under the Town's current zoning scheme. Development of this open space would increase the area's impervious surface cover and stormwater runoff, thereby exacerbating the existing flooding problems.

Flooding Vulnerability Assessment

As part of its mapping analysis, MVPC also investigated whether any of the community's existing critical facilities are located within either the 100-year or 500-year floodplain, thus placing them at risk of future flood damage or loss. Of the 28 critical facilities identified by the Town's emergency management team, none was determined by MVPC to be located in a mapped flood hazard zone. In addition, Town officials affirm that there are no current plans to site future critical facilities in the 100-year or 500-year flood zones.

MVPC also examined *non*-critical facilities in flood hazard areas. This analysis revealed the presence of 41 structures on 32 parcels (valued in 2014 at \$9,429,000) within the 100-yr floodplain.

Based on the frequency, areal extent, and severity of historical floods in West Newbury, Town officials consider the community to be at **high risk** from flooding.

Repetitive Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there is one repetitive flood loss site in West Newbury, a single-family residence at Church Street. Flooding occurred at this site in May 2006 ("Mothers Day Flood") and April 2007 ("Patriots Day Flood").

Town-wide, there are 18 flood zone properties covered by flood insurance policies. The combined insurance value for these properties is \$5,055,200 (source: *NFIP Policy Statistics for Massachusetts – 6/30/2014.*)

Structurally Deficient Bridges Over Waterways

The Town of West Newbury currently has no bridges classified as “Structurally Deficient”.

In the prior plan, the historic Rocks Village Bridge connecting West Newbury to Haverhill was listed as the only bridge within town borders classified as “Structurally Deficient”. Two other bridges impacting transportation to West Newbury were also previously classified as “Structurally Deficient” – the Bates Bridge in Groveland and the Whittier (Route 1-95) Bridge in Newburyport. All three bridges have been reconstructed and reopened in the past two years.

Rocks Village Bridge

The Rocks Village Bridge provides a connection between Route 110 in Haverhill and Merrimac and Route 113 in West Newbury and Groveland. It is a major school bus route that connects the town of Merrimac to the other Pentucket Regional School system communities of Groveland and West Newbury. The Pentucket Middle School and the regional high school are located on Route 113 at the Groveland/West



Newbury town line on the south side of the Merrimack River. This route also provides access to Whittier Vocational High School, which is located on Amesbury Line Road in Haverhill approximately 1.25 miles north of the bridge. In addition to carrying the school-related traffic, the bridge is increasingly being used by commuters from southern New Hampshire/eastern Haverhill/western Merrimac to access I-95 in Newburyport.

Constructed in 1883 with major reconstruction in 1914, the bridge spanning the Merrimack was closed for closed to heavy vehicles such as tractor-trailers as major bridge rehabilitation work took place from Summer 2012 through Fall 2013. A new bridge deck was installed along with stronger guardrails and new lighting. The bridge's piers and ice fenders were repaired as were components of the superstructure. The rehabilitated bridge opened to traffic in Fall 2013.

Hazard Potential of Dams

The DCR Office of Dam Safety includes three (3) West Newbury dams on its dam classification list. Of these, only one dam – Mill Pond Dam at the outlet of Mill Pond – is classified as a “significant” hazard dam. Key characteristics of this dam are given in **Table 5.14-2**. Based on the limited number of dams in the community, as well as the

“significant” safety risk of the Mill Pond Dam, Town emergency management officials have assigned a **moderate** risk rating to the hazard of dam failure.

Table 5.14-2. WEST NEWBURY Significant Hazard Dam					
Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Mill Pond Dam	Mill Pond (85 acre-feet)	1937*	Significant	10/20/2006	10/19/2011
*Dam rebuilt in 1995 as part of condition from MADEP to allow pond dredging for sediment, water quality, and nuisance aquatic weed (milfoil) control					

Wildfires/Brushfires Hazard Potential

Almost one-half of the Town’s land area is woodland. Incidence of brush fire, however, has been relatively low with the on-call Fire Department responding to approximately 5-10 brushfires each year since 2008. Given the extent of brush/forest coverage and proximity to development, the Town has determined brush fire to be a moderate risk.

Response Management Capacity

West Newbury has an active emergency management agency led by the Town’s Emergency Management Director. Emergency Management planning and response team includes participation by Police Department, Fire Department, Communications, Senior Center, DPW Transportation, and the Water Department.

Natural Hazards Risk Analysis

The Town of West Newbury emergency management planning team identifies and describes the range of natural hazards that are addressed by this Plan. The team’s information, together with material compiled by MVPC, provides the basis for a general assessment of vulnerability to those natural hazard events that pose a high, moderate, or low risk to the community. Based on this assessment, West Newbury considers itself to be at **high risk** from flooding and winter storms (blizzards, snow storms, ice storms), along with their occasional associated power outages; at **moderate risk** from hurricanes, brush fires/wildfires, dam failure, and drought; and at **low risk** from tornadoes, earthquakes, and landslides.

Table 5.14-3. West Newbury Natural Hazards Risk Assessment

Natural Hazard	Community Risk Rating
Floods	HIGH
Winter Storms (blizzard/snow/ice)	HIGH
Northeasters	HIGH
Hurricanes	Moderate
Drought	Moderate
Wildfire/Brush Fires	Moderate
Dam Failure	Moderate
Power Outages	Moderate
Tornadoes	Low
Earthquakes	Low
Landslides	Low

SECTION 6. EXISTING PROTECTIONS MATRIX

This section of the Plan presents an **Existing Protections Matrix** for each community. The matrix is an inventory of current measures, programs, projects, and activities already in place that are related to natural hazard mitigation. Compiling such an inventory allows gaps and deficiencies to be identified. This process is further described in Task 4 of the Massachusetts Community Planning Guide (*Natural Hazards Mitigation Planning: A Community Guide, January 2003*).



In preparing the region's 2008 Pre-Disaster Mitigation Plan, a detailed questionnaire was prepared and distributed among knowledgeable local personnel in each community. A copy of the questionnaire is provided in Appendix D. As part of the plan updating process, the 2008 information was reviewed and revised through a series of meetings, email communications, and conversations with local officials. In addition, local zoning ordinances/bylaws, subdivision rules and regulations, NPDES Phase II stormwater management plans, master plans, and open space & recreation plans 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 community matrices. The matrices have been prepared using the format suggested in FEMA guidelines.

Examples of Local Hazard Mitigation Measures



Local Wetlands Protection Regulation



Regular Street Sweeping



Tree-pruning to Protect Utility Lines

Table 6-1. TOWN OF ANDOVER Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness	Improvements Needed
Participation in National Flood Insurance Program (NFIP)	Federal program provides flood insurance for structures in flood-prone areas	FEMA flood zones town-wide	Very effective	None
Floodplain Overlay District Zoning	Zoning bylaw regulates development in flood hazard areas	Zones A and AE on FIRM Maps	Very effective	Zones need to be reviewed and updated by FEMA
Storm Water Management	Implementation of EPA Phase II storm water requirements	Large construction sites before Planning Board & Conservation Commission	Somewhat effective	Review for update with pending EPA MS4 permit anticipated to be final 2015
Local Wetlands Protection Bylaw & Regulations	Local bylaw more restrictive than MA Wetlands Protection Act regulation	Town-wide	Very effective	Additional staff and training needed
Groundwater Protection Overlay District	Zoning bylaw regulates development and other activities in recharge area for Tewksbury Hospital well.	Small area on western border with town of Tewksbury	Very effective	None
Watershed Protection Overlay District	Zoning bylaw regulates development and other activities in municipal surface water supply areas	Haggetts Pond & Fish Brook Watersheds	Very effective	None—updated 2013
Local Open Space Plan	Plan targets purchase of available floodplain and wetlands buffers for protection	Town-wide	Effective	Requires regular updating; future review should look at preserving undeveloped flood prone areas.
Regulation of Communication and Wireless Communication Towers	Zoning bylaw addresses height and construction issues	Town-wide	Very effective	None
Steep Slope Regulation	Zoning bylaw restricts residential development on steep slopes	Single Residence Districts where slopes exceed 25%	Very effective	Should be considered town-wide
Earth Movement Bylaw	Zoning bylaw regulates earth movement, both as an import and export product, as well as earth stabilization	Town-wide	Very effective	None
Mobile Homes Not Allowed	Because the Zoning Bylaw does not specifically allow them, they are prohibited	Town-wide	Very effective	None
Sewer Commissioner Policy on Gravity Sewers	Policy requires all municipal sewers being installed to be gravity-fed	Town-wide	Somewhat effective	Policy and regulations being updated still allow privately-owned sewer lift stations
Forest Debris Cleanup Program	Partial removal of combustible debris from forest floor	Harold Parker State Forest and selected AVIS (Andover Village Improvement Society) properties	Effective	Resources for debris removal from open space areas (both public and private) are limited
Wildfire Hazard Notification	Public notice of hazardous conditions that could lead to wildfire via Reverse 911 phone calls, posting on municipal website, and local cable access t.v.	Town-wide	Very effective	None

Table 6-1. TOWN OF ANDOVER Existing Protections Matrix (cont'd)

Type of Existing Protection	Description	Area Covered	Effectiveness	Improvements Needed
Educational Outreach on Natural Hazards Preparedness, Mitigation, and Response	Town provides outreach via information and links on website, and display of educational materials at Town Offices, Public Library, and Public Safety Center. Municipal staff also provides educational seminars upon request.	Town-wide	Very effective	Direct mailing of educational materials may assist in reaching all residences in the community
No Net Increase in Runoff	Subdivision and Site Plan Special Permits require no net increase in site runoff from pre-construction runoff conditions	Town-wide	Very effective	Subdivision Rules & Regulations currently being reviewed for updating
Cluster Subdivision Development	Where allowed and feasible, cluster development promoted to preserve open space and reduce storm water runoff	Residential zones (other than Single Residence A District) of 10 acres or more	Very effective	None
Capital Improvement Programs	Identification and budgeting of projects that mitigate natural hazards as appropriate	Town-wide	Effective	Seek increased funding via outside sources
Municipal Drainage System Maintenance	Town Municipal Services routinely inspects and cleans drainage systems to ensure proper operation	Town-wide	Effective	Increased funding to cover costs of proper cleaning; Equipment/resources needed for catch basin cleaning
Private Drainage System Maintenance	Private Storm water Management Plans (SWMPs) filed with Planning Board and Conservation Commission dictate required procedures to maintain private drainage systems	New development projects town-wide	Somewhat effective	Additional funding and staff required to ensure that private systems are being inspected and repaired as needed
Street Sweeping Program	Routine street sweeping to remove sand & debris before they enter the storm drain system	Town-wide	Very effective	Additional funding needed to expand the program and cover more area more often
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs in collaboration with power company and upon notification by property owners	Town-wide	Very effective	Needs to be routine; additional funding required
Emergency Management Planning Group	Coordinating group of town officials headed by Chief Keefe. Includes Health Dept., Municipal Services, Library, Fire Dept., Planning, & School Dept.	Town-wide	Effective	Group activated as of 2014. Regular monthly meetings at Public Safety Building.

Table 6-2. TOWN OF BOXFORD Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Town participation in the National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	None
Local Wetlands Protection Bylaw and Regulations	Regulates building on: - Wetland Resource Areas - 100-ft buffer zones - 200-ft riverfront protection area	Town-wide	Effective – actively enforced	None
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 Boxford as identified by U.S. Census.	Effective – actively enforced	None
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 – actively enforced	None
Town Zoning Bylaw	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. Includes mapped Conservation Overlay district for wetland and flood prone areas.	Town-wide	Effective – actively enforced Updated flood provision in zoning code in 2012.	None
Master Plan, Community Development Plan, Open Space & Recreation Plan	Provide guidance for community growth and preservation of open space and natural resources	Town-wide	Effective	As appropriate, integrate hazard mitigation in future plan updates
Reverse 911 phone notification capability	Town has ability to contact town residents en masse or individually	Town-wide	Highly Effective	None
Comprehensive Emergency Management Plan (E-CEMP)	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective – actively enforced and prepared electronically.	Maintain E-CEMP on regular basis to ensure its applicability
Beaver mitigation measures	Boxford's beaver population has a significant influence on flooding risks. The Town implements several measures, such as "Beaver Deceivers", to mitigate beaver-related flooding	Town-wide	Effective— observation is that beaver problem has been reduced over past five years.	None
Community Preservation Act	As opportunities arise, CPA funds are used to purchase and protect key open space parcels.	Town-wide	Effective	None

Table 6-3. TOWN OF GEORGETOWN Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Participation in National Flood Insurance Program (NFIP)	Federal program provides flood insurance for structures in flood-prone areas	FEMA flood zones town-wide	Very effective	None
Floodplain Overlay District Zoning	Zoning bylaw regulates development in flood hazard areas	Zones A, A1-30 and V on the Flood Insurance Rates Maps	Very effective	None
Storm Water Management	Implementation of EPA Phase II storm water requirements	Large construction sites before Planning Board & Conservation Commission	Somewhat effective	Local bylaw needs to be amended to improve development and performance standards
Local Wetlands Protection Bylaw & Regulations	Local bylaw more restrictive than MA Wetlands Protection Act regulation	Town-wide	Very effective	Additional commissioner training needed and public outreach needed to gain wider support for bylaw
Watershed Protection Overlay District	Zoning bylaw regulates development and other activities in municipal surface water supply areas		Very effective	Review and update to current DEP standards; expand district to cover watershed of new well sites
Local Open Space Plan	Plan targets purchase of available floodplain and wetlands buffers for protection	Town-wide	Effective	Need to update the local plan and prioritize conservation goals to floodplain or wetland areas
Regulation of Communication and Wireless Communication Towers	Zoning bylaw addresses height and construction issues	Town-wide	Very effective	None
Earth Filling and Earth Removal Bylaws	Zoning bylaws regulate earth movement, both as an import and export product, as well as earth stabilization	Town-wide	Very effective	Increased training in addressing expansion of existing facilities
Local Master Plan	Recent adoption of the Master Plan places an emphasis on the protection of sensitive natural resource areas	Town-wide	Very effective	Policy and regulations are in the process of being updated to strengthen the Town's land use regulations
Disaster and Emergency Notification Program	Adoption of program to provide notification to town in event of emergency or disaster	Town-wide	Very effective	None
Educational Outreach on Natural Hazards Emergency Management Plan	Town provides outreach via information and links on website, notices on community access TV channel, and display of educational materials at Town Hall and the Public Safety Building	Town-wide	Very effective	Plan needs to be fully integrated into the Town's GIS and Pictometry software to enhance implementation and effectiveness

Table 6-3. TOWN OF GEORGETOWN Existing Protections Matrix (cont'd)

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
No Net Increase in Runoff	Subdivision and Site Plan Special Permits require no net increase in site runoff from pre-construction runoff conditions	Town-wide	Very effective	Subdivision Rules & Regulations currently being reviewed for updating
Capital Improvement Programs	Identification and budgeting of projects that mitigate natural hazards as appropriate	Town-wide	Effective	Seek increased funding via outside sources
Municipal Drainage System Maintenance	Town DPW routinely inspects and cleans drainage systems to ensure proper operation	Town-wide	Very effective	Increased funding to cover costs of proper cleaning on a more regular basis
Private Drainage System Maintenance	Private Storm Water Management Plans (SWMPs) filed with Planning Board and Conservation Commission dictate required procedures to maintain private drainage systems	New development projects town-wide	Somewhat effective	Additional funding and staff required to ensure that private systems are being inspected and repaired as needed
Channel, Grates, Catch-Basins and Street Sweeping Program	Routine street sweeping to remove sand & debris before they enter the storm drain system	Town-wide	Somewhat effective	Additional funding needed to expand the program, add staff and increase coverage and frequency of application
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs in collaboration with power company and upon notification by property owners	Town-wide	Very effective	Needs to be routine; additional funding required for staff and capital costs for tree removal equipment
Emergency Management Equipment Program	The Board of Health loans the Fire Department portable trash pumps, generators and a digital camera in emergencies	Town-wide	Effective	Additional equipment is needed.
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Effective	Regulations are generally effective but do need to be updated to better accommodate enhanced stormwater management techniques
Town Zoning Bylaw	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	Efforts are underway to strengthen the OSRD provisions for cluster housing as well as evaluation of adopting a village center overlay district for downtown.

Table 6-4. TOWN OF GROVELAND Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Town participation in the National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas	FIRM Flood Zones, as mapped by FEMA	Effective	None
Floodplain zoning district bylaw and regulations in place	Floodplain bylaw requires all development, including structural and nonstructural activities, be in compliance with state building code requirements for construction in floodplains	FIRM Flood Zones, as mapped by FEMA	Generally effective for new construction, but older structures pre-date bylaw. Updated 4/30/2012	None
Stormwater management policy and program	Planning Board and Conservation Commission review projects for consistency with MA DEP stormwater standards. Peak runoff rates for new development must not exceed pre-development rates	Town-wide	Generally effective	Enhance local stormwater management program to include new NPDES Phase II requirements for small MS4s
Local wetlands protection blaw	Local bylaw stricter than State WPA and Regulations	Town-wide	Generally effective	Periodic Board training would aid project reviews and enforcement
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	5-year plan update completed and compliant to July 2019.
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	Generally effective	More public works personnel and funds would increase overall effectiveness of program
Street sweeping and catch basin cleaning program	Highway Dept. sweeps city streets and cleans catch basins on a regular basis	Town-wide	Generally effective	More public works resources would increase overall effectiveness of program
Comprehensive Emergency Management Plan (CEMP)	Details procedures to be followed in the event of an emergency of any type	Town-wide	Generally effective	Maintain CEMP on regular basis to ensure its applicability
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs in collaboration with power company and upon notification by property owners	Town-wide	Generally effective	Needs to be routine; additional funding required
Community Preservation Act	As opportunities arise, CPA funds are used to purchase and protect key open space parcels	Town-wide	Effective	None

Table 6-4. TOWN OF GROVELAND Existing Protections Matrix (cont'd)

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Generally effective	None
Town Zoning Bylaw	Promotes the health, safety, and welfare of Town residents. Selected sections detail the requirements relating to lot size, setbacks, contiguous buildable area, site plan review, and lot/slope requirements	Town-wide	Generally effective	None
Aquifer Protection Overlay District Bylaw	Regulates construction and use activities in groundwater supply recharge zones to protect drinking water	Aquifer recharge areas	Generally effective	None
Conservation Subdivision Design Bylaw	Promotes "cluster" style development for new subdivisions where appropriate, in order to preserve open space (50% of site) and natural hydrology, minimize impervious surface cover, and protect natural resources	Selected large lots where appropriate	Moderately effective	Better education of developers needed regarding cost-savings of this approach (less infrastructure, more opportunity for low impact development techniques, etc.)

Table 6-5. CITY OF HAVERHILL Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
City participation in the National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	None
Floodplain zoning district ordinance in place	Floodplain ordinance requires all development, including structural and nonstructural activities, be in compliance with state building code requirements for construction in floodplains	Covers FIRM zones A, AO, AH, A1-30, AE, A99, VO, V1-30, VE and V (100-year floodplain)	Generally effective for new construction, but many older structures pre-date ordinance	None
Stormwater management policy and regulations in place	Planning Board and Conservation Commission review projects for consistency with MA DEP stormwater standards. Peak runoff rates for new development must not exceed pre-development rates	City-wide	Generally effective	Additional trained staff needed to increase frequency and thoroughness of site inspections
Phase I CSO upgrade program	City recently completed a Phase I CSO upgrade program consisting of: 1) pump station upgrades to pump 60 mgd, modulating gate structure w/SCADA controls; 2) aerated grit chamber w/SCADA controls; 3) secondary bypass which includes SCADA controls; and Bradford CSO modifications			
Local wetlands protection ordinance in place	Local ordinance stricter than State WPA and Regulations	City-wide	Generally effective	Additional staff and ongoing training would improve enforcement
Local Open Space & Recreation Plan in place	Generally seeks to preserve and protect City's natural resources, but does not focus on flood hazard areas specifically	City-wide		5-year plan update in progress. Should give increased attention to preserving undeveloped flood-prone areas and associated uplands
Municipal drainage system maintenance and repair program	City strives to keep municipal drainage facilities (storm drains swales, culverts, stream channels, etc.) open and in good working order	City-wide	Generally effective	More public works personnel needed to increase overall effectiveness of program
Street sweeping and catch basin cleaning program	Highway Dept. sweeps city streets and cleans catch basins on a regular basis	City-wide	Effective	None

Table 6-5. CITY OF HAVERHILL Existing Protections Matrix (cont'd)

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Phase II Storm Water Management Plan (SWMP)	City departments work collaboratively to implement array of storm water BMPs, including drainage facilities inventorying, mapping, and maintenance; runoff and erosion control; illicit discharge detection and elimination; municipal "good housekeeping" practices; and public education/involvement.	City-wide	Limited effectiveness to date, as SWMP still under development	SWMP to be completed in 2008 and operational thereafter
Tree limb removal program	City crews work closely with National Grid to remove dead and diseased tree limbs that pose a public safety hazard and threaten utility lines	City-wide	Moderately effective	City involvement limited to summer months only. More staff needed to expand program
Surface water supply protection district zoning	City prohibits or strictly regulates land uses deemed potentially harmful to drinking water supply quantity and quality	Drinking water supply watersheds: Millvale Reservoir, Crystal Lake, Kenoza Lake	Effective	None
Fire safety alert program	City Fire Dept. notifies city residents (via newspapers, local cable t.v.) of elevated wildfire/brush fire risks during extended dry periods	City-wide	Effective	None

Table 6-6. CITY OF LAWRENCE Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
NFIP Participation	City Participation in the National Flood Insurance Program Provides Flood Insurance for structures located in flood-prone areas	FEMA Flood Zones	Effective	None
Local Wetlands Ordinance	Established Local Wetlands Ordinance Stricter than State WPA and Regulations	City-wide	Effective	Periodic training of Board members to improve understanding and enforcement of wetland ordinance
Local Open Space & Recreation Plan in Place	Strategy in place for protecting open space and recreation districts from development.	City-wide	Generally effective	New Plan Drafted each five year period cycle
Annual Spicket River Clean-up	The City in partnership with local non-profit annually cleans the Spicket River of debris.	The Spicket River and its' banks	Effective	Increase pollution awareness to avoid large scale dumping of debris in Spicket River
Street Sweeping and Catch basin cleaning program	DPW sweeps City streets and cleans catch basins on a regular basis	City-wide	Effective	None
Use of FEMA funds to purchase homes in flood area.	City purchased 9 homes which flooded on a regular basis and demolished them.	Spicket River along Marion Avenue	Effective	Continue policy of property acquisition for distressed properties in repetitive flood areas
Creation of Recreational area with flood storage from land purchase.	The City constructed a 3 acre park with flood retention area from land from FEMA purchase.	Spicket River along Marion Avenue	Effective	Continue policy of creation of open space

Table 6-6. CITY OF LAWRENCE Existing Protections Matrix (cont'd)

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Participation in State Urban River Visions Project	The City has acquired and redeveloped existing City properties to create an urban river park system along the Spicket River	Along the Spicket River	Effective	Continue participation in program
Master Plan, Community Development Plan, Open Space & Recreation Plan	Provide guidance for community growth and preservation of open space and natural resources	City Wide	Effective	As appropriate integrate hazard mitigation in future update plan
Comprehensive Emergency Management Plan	Details Procedures to be followed in an event of an emergency of any type	City wide	Effective	Maintain CEMP and upgrade as needed to ensure its applicability
Participation in Geographic Response Initiative with EPA	Detailed Plan to protect municipal water, sensitive ecological sites and other municipal interests during	Fire Department, Planning Department	Generally Effective	Prepare utilization of new plan and devise ways to effect and activate plan to
Draft of New City of Lawrence Sewer & Stormwater Ordinance	Guidelines establish review standard for stormwater management best practice.	Department of Public Works, Planning Department	Effective	Effectuate new storm water guidelines through site plan approval and permitting process.
Draft of New City of Lawrence Food, Oil and Grease Waste Ordinance	Protect stormwater infrastructure system by preventing dumping of grease oils and other products which will	Department of Public Works, Board of Health, Inspectional Services Department	Effective	Educational process to identify and instruct polluters in best practices.
Participation in Federal Brownfields Program- Storm Water mitigation conditions	The City has leveraged storm water management projects within the 100 year flood and adjacent to wetlands and rivers through the Brownfields Program	City of Lawrence, EPA	Generally Effective	Continue to enforce conditions for new development by including stormwater management best practices.

Table 6-7. TOWN OF MERRIMAC Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Town participation in the National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	None
Local Wetlands Protection Bylaw and Regulations	Regulates building on: - Wetland Resource Areas - 100-ft buffer zones - 200-ft riverfront protection area	Town-wide	Effective	None
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	None
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	None
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		Future iterations should give increased attention to preserving undeveloped flood-prone areas and bordering uplands
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
Street sweeping and catch basin cleaning program	Streets and catch basins cleaned on a schedule as resources permit	Town-wide	Generally effective	More public works resources would increase overall effectiveness of program
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
Phase II Stormwater Management Program	Policies, procedures, and best management practices, including public education, to reduce urban runoff generation and nonpoint source pollution	Town-wide	Moderately effective	More resources needed to increase reach and effectiveness of program

Table 6-7. TOWN OF MERRIMAC Existing Protections Matrix (cont'd)

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Water Supply Protection District Bylaw	Regulates development activity and uses in public water supply areas	Aquifer recharge areas for Town wells	Effective	None
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs in collaboration with power company and upon notification by property owners	Town-wide	Generally effective	Needs to be more routine; additional resources required
Earth Removal Bylaw	Limits and regulates removal of soil from Town	Town-wide	Somewhat effective	Small projects need better supervision
Septic Regulations	Regulations to protect the residents from on-site subsurface sanitary sewage disposal systems	Town-wide	Effective	Review and update regulations to coincide with revisions to the State Environmental Code, 310 CMR 15.00

Table 6-8. CITY OF METHUEN Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness	Improvements Needed
City participation in the National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas.	FEMA flood zones	Effective	None
Floodplain zoning district ordinance in place	Floodplain ordinance requires all development, including structural and nonstructural activities, be in compliance with state building code requirements for construction in floodplains	Covers FIRM zones A, AO, AH, A1-30, AE, A99, VO, V1-30, VE and V (100-year floodplain)	Generally effective for new construction, but many older structures pre-date ordinance	None
Stormwater management policy and regulations in place	Planning Board and Conservation Commission review projects for consistency with MA DEP stormwater standards. Peak runoff rates for new development must not exceed pre-development rates	City-wide	Generally effective	None
Local wetlands protection ordinance in place	Local ordinance stricter than State WPA and Regulations	City-wide	Generally effective	Periodic training of Board members would improve understanding and enforcement of wetlands ordinance
Local Open Space & Recreation Plan in place	Generally seeks to preserve and protect City's natural resources, but does not focus on flood hazard areas specifically	City-wide		OSRP submitted to State and approved Nov. 2013. Current expiration is December 2019.
Municipal drainage system maintenance and repair program	City strives to keep municipal drainage facilities (storm drains swales, culverts, stream channels, etc.) in good operating condition	City-wide	Generally effective	Improved understanding and coordination needed between DPW and Conservation Commission on stream channel maintenance
Street sweeping and catch basin cleaning program	DPW sweeps city streets and cleans catch basins on a regular basis	City-wide	Effective	None
Tree limb removal program	City Tree crew works closely with National Grid to remove dead and diseased tree limbs that pose a threat to public safety and utility lines	City-wide	Generally effective	None
Fire safety alert program	City Fire Dept. notifies city residents (via newspapers, cable t.v.) of elevated wildfire/brush fire risks during extended dry periods	City-wide	Effective	None

Table 6-9. TOWN OF NEWBURY Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Town participation in the National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	None
Local Wetlands Protection By-Law and Regulations	Regulates development activity on barrier beach to conserve fragile natural resources	Plum Island	Effective	None
Stormwater Management By-Law and Regulations	Regulates development activity encompassing one acre or more within Urban Areas, consistent with NPDES permit program	Urbanized Areas of Newbury as identified by U.S. Census	Effective	Regulations being updated to incorporate more current stormwater mgmt. techniques and encourage Low Impact Development; update intended to apply to all areas of Town, not just urbanized areas
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Effective	Being revised and updated; will reference updated Stormwater Regulations
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	Town-wide	Moderately effective	Planning in progress for update of 2006 Master Plan. Update to include sections on hazard mitigation and climate change
Local Open Space & Recreation Plan (OSRP)	Proactive plan to preserve and protect Town's open space and natural resources, but does not focus on flood hazard areas specifically	Town-wide	Moderately effective	Planning in progress of update of OSRP. Update to give increased attention to preserving undeveloped flood-prone areas and bordering uplands and to impact of climate change on natural resources
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
Open Space Residential Development Bylaw	Promotes cluster style residential development where appropriate to limit impervious surfaces and preserve open space and natural resources	Town-wide	Moderately effective	None
Estuary Management Plan	Promotes prudent use and conservation of natural resources in Newbury portion of Great Marsh ACEC	Area of Critical Environmental Concern	Moderately effective	More personnel and funding resources needed to carry out and monitor action recommendations; currently exploring possibility of participating in regional plan
Water Supply Protection Overlay District	Zoning By-Law regulates development and other activities in municipal water supply areas	Aquifer recharge areas	Generally effective	None

Table 6-9. TOWN OF NEWBURY Existing Protections Matrix (cont'd)

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs within the Town-owned Rights-of-Way	Town-wide	Generally effective	Additional funding would allow for greater effectiveness
Comprehensive Emergency Management Plan (CEMP)	Details procedures to be followed in the event of an emergency of any type	Town-wide	Generally effective	Maintain CEMP on regular basis to ensure its applicability;
Merrimack River Beach Alliance Participation	Coastal community partnership (Newbury/Newburyport/Salisbury); Forum for community outreach, project prioritization, advocacy. Through partnership, communities have coordinated planning & implementation of projects including beach sand replenishment on Plum Island in 2009; South Jetty repair in 2014, north jetty repair in 2015 and through the Army Corps of Engineers Section 103 program, ongoing sand replenishment & embankment stabilization	Newbury/Newburyport/Salisbury	Effective	Potential expansion of partnership model to encompass other North Shore communities.

Table 6-10. CITY OF NEWBURYPORT Existing Protections

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
City participation in the National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	None
Local Citywide Wetlands Protection Ordinance and Regulations	Regulates development activity throughout the City to conserve fragile natural resources	Wetland designated areas and buffer zones	Effective—ordinance updated 6/25/2012	None
Stormwater Management Ordinance and Regulations	Regulates development activity encompassing one acre or more within Urban Areas, consistent with NPDES permit program	Urbanized Areas of Newburyport as identified by U.S. Census	Effective—ordinance updated 2010; Rules & Regs Adopted April 2014;	EPA issued draft MS Permit Fall 2014; Final permit will require review/assessment of existing ordinance for MS4 compliance.
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	City-wide	In process of updating 2014/15	Update needed
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	City-wide	To Be updated 2015	As appropriate, integrate hazard mitigation in 2015 plan update
Local Open Space & Recreation Plan	Proactive plan to preserve and protect City's open space and natural resources, but does not focus on flood hazard areas specifically	City-wide	Effective	Plan updated and valid to 2019.
Municipal drainage system maintenance and repair program	City strives to keep municipal drainage facilities (storm drains swales, culverts, stream channels, etc.) open and in good working condition. Participating in Merrimack Valley Stormwater Collaborative	City-wide	Moderately effective	More public works personnel and funds would increase overall effectiveness of program
Open Space Residential Overlay District	Promotes cluster style residential development where appropriate to limit impervious surfaces and preserve open space and natural resources	Overlay District area*	Moderately effective	None
Estuary Management Plan—8 Towns & the Bay	Promotes prudent use and conservation of natural resources in Newburyport portion of Great Marsh/Parker River ACEC	Area of Critical Environmental Concern	Moderately effective	More personnel and funding resources needed to carry out and monitor action recommendations; Participating in regional plan

Table 6-10. CITY OF NEWBURYPORT Existing Protections Matrix (cont'd)

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
GIS Infrastructure Inventory	Data-driven asset management system inc. MIMAP parcel/infrastructure info	DPS Engineering with MVPC	Effective	Additional data layers and updates.
Regional Shelter	Collaboration with Salisbury, Newbury and Salvation Army in regional shelter services in emergency responses	Emergency Management	Effective	Formalize arrangement with MOU agreement
Portable Generators	Newburyport EMS has 3 portable generators available. Addl available through DPS	Emergency Management/DPS	Effective	None
Early warning systems	Code Red in place and active social media use for communications as well as Seabrook Plant sirens at EMS Communications Center	Emergency Management	Effective	None

Table 6-11. TOWN OF NORTH ANDOVER Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness	Improvements Needed
Town participation in the National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	None
Floodplain zoning district bylaw	Requires all development, including structural and non-structural activities, be in compliance with state building code requirements for construction in floodplains	FEMA flood zones	Generally effective for new construction, but some older structures pre-date bylaw	None
Local Wetlands Protection Bylaw and Regulations (Chapter 178)	Prohibits building on: - Wetlands - 100-ft buffer zones - 200-ft riverfront protection area - Any land subject to storm flowage, or flooding by groundwater or surface water	Town-wide	Effective - actively enforced	Currently working with consultant to revise regulations to conform to new state stormwater management standards and NPDES Phase II.
Subdivision Rules & Regulations, Section 6.14 (Stormwater)	Determines manner in which land parcels may be divided, and the specific storm water/flooding mitigation that is required	Town-wide	Effective - actively enforced	None
Town Zoning Bylaw, 1972 (amended 2002) - Section 7 Dimensional Requirements - Section 8.3 Site Plan Review - Section 8.10 Lot /Slope requirements (prohibit slopes>3:1)	Promotes the health, safety, and welfare of Town residents. Cited sections detail the requirements relating to lot size, setbacks, contiguous buildable area, site plan review, and lot/slope requirements	Town-wide	Effective - actively enforced	None
Master Plan, Community Development Plan, Open Space & Recreation Plan	Provide guidance for community growth and preservation of open space and natural resources	Town-wide	Effective—Updated 2015 Open Space Plan	As appropriate, integrate hazard mitigation in future plan updates
Reverse 911 phone notification capability	Emergency calls to Police are forwarded to DPW pagers	Town-wide	Effective – actively enforced	More comprehensive warning system needed to alert public to pending floods and other emergencies
Comprehensive Emergency Management Plan	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective - actively enforced	Maintain CEMP on regular basis to ensure its applicability

Table 6-11. TOWN OF NORTH ANDOVER Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness	Improvements Needed
Rae's Pond & Winter St. Pumping Station flood mitigation	Pumping station elements at Rae's Pond and Winter St. raised to ensure pumping stations remain isolated from floodwaters during even extreme flood events	Rae's Pond, Winter St., Lake Cochichewick	Effective	None - monitor
Rae's Pond floodwater alleviation	Wall along Great Pond Rd. between Rae's Pond and Lake Cochichewick removed to prevent floodwaters from backing up in Rae's Pond. Clearing existing culvert under Rt. 133.	Rae's Pond	Effective	None - monitor
Lake Cochichewick outlet	Water level in Lake Cochichewick is controlled by a sluice	Lake Cochichewick and surrounding areas	Effective	Completed. New outlet structure Built
Stevens Pond outlet	Water level in Stevens Pond is controlled by a weir	Stevens Pond and surrounding areas	Effective	None - monitor
Mosquito Brook improvement plan	Analysis of drainage and flooding problems along and around Mosquito Brook	Mosquito Brook catchment	Pending	Completed.
Lost Pond improvement plan	Analysis of drainage and flooding problems around Lost Pond	Lost Pond catchment	Pending	Completed.
Storm drain system maintenance	Regular clearing and cleaning of culverts and storm drains as part of Town storm water infrastructure maintenance program	Town-wide	Moderately effective	More rigorous cleaning program needed
Beaver mitigation measures	North Andover's beaver population has a significant influence on flooding risks. The Town implements several measures, such as "Beaver Deceivers", to mitigate beaver-related flooding	Town-wide	Moderately effective	None—Monitor

Table 6-11. TOWN OF NORTH ANDOVER Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness	Improvements Needed
Community Preservation Act	As opportunities arise, CPA funds are used to purchase and protect key open space parcels, especially in the Lake Cochichewick watershed	Town-wide	Effective	None
Land Disturbance Bylaw & Regulations	Regulates activities that result in land disturbance & creation of stormwater. Required by NPDES	Town-wide	Effective	None
Updated Open Space Plan	Plan update in progress. Complete by June 2015.	Town-wide	Pending	Complete
Update Site Plan Review Zoning	Update SPR Zoning to be consistent with Wetlands Bylaw & Land Disturbance Permit. NPDES Requirement	Town-wide	Pending	None
Update Watershed Zoning	Update Watershed Zoning to be consistent with Wetlands Bylaw & Land Disturbance Permit. NPDES Requirement	Town-wide	Pending	None
Update Floodplain District in Zoning	Update Floodplain Zoning to reflect new 2012 maps	Town-wide	Effective	None
Beaver Deceivers	DPW and outside contractor regularly monitor and maintain.	Town-wide	Effective	None

Table 6-12. TOWN OF ROWLEY Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Town participation in the National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Town joined NFIP on 12/3/09	None
Floodplain District – Protective Zoning Bylaw	Regulates development and construction activities in designated flood areas	FEMA flood zones A1-30 and V1-30; plus areas below elevation 15 ft. and areas below the elevation 10 ft. above thalweg (riverbed centerline) of a named river or stream	Effective	None
Stormwater Mgmt. and Erosion Control Bylaw & Regulations – General Bylaw	Regulates stormwater management and soil disturbance	Covers land disturbance >20,000 s.f., or 10,000 s.f. or more on slopes > 15%	Effective	None
Local Wetland Protection Bylaw – General Bylaw	Regulates activities near wetland resource areas	Protective of wetlands, buffer zones, vernal pools, and drinking water Approved Zone II	Effective	Accompanying regulations needed
Municipal Water Supply Protection District – Zoning Bylaw	Regulates development and other activities	Designated public water supply wells and recharge areas	Effective	None
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Effective	None
Master Plan, Community Development Plan, Open Space & Recreation Plan	Provide guidance for community growth and development as well as preservation of open space and natural resources	Town-wide	Effective	As appropriate, integrate hazard mitigation in future plan updates
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
Comprehensive Emergency Management Plan (CEMP)	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective – actively enforced	Maintain CEMP on regular basis to ensure its completeness and relevance
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs within the Town-owned Rights-of-Way	Town-wide	Generally effective	Additional funding would allow for greater effectiveness
Earth Removal Bylaw – General Bylaw	Regulates earth (soils) removal and transport w/ operation and restoration plans required	Town-wide	Effective	None

Table 6-12. TOWN OF ROWLEY Existing Protections Matrix (cont'd)

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Personal Service Wireless Facilities Protective Zoning Bylaw	Regulates development and other activities associated with wireless communication facilities	Town-wide	Effective	None
Beaver mitigation measures	Rowley's beaver population has a significant influence on flooding risks. The Town, through coordinated efforts of BOH, Con Com, Water Dept., and Highway Dept., implements several measures, such as "Beaver Deceivers", to mitigate beaver-related flooding	Town-wide	Moderately effective	Additional funding needed to support more rigorous beaver mitigation program

Table 6-13. TOWN OF SALISBURY Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Participation in National Flood Insurance Program (NFIP)	Federal program provides flood insurance for structures in flood-prone areas	FEMA flood zones town-wide	Very effective	Work on participating in CRS Program
Floodplain Overlay District Zoning	Zoning bylaw regulates development in flood hazard areas	Zones A, A1-30 and V on the Flood Insurance Rates Maps	Very effective	Zones need to be reviewed and updated by FEMA
Storm Water Management	Implementation of EPA Phase II storm water requirements	Large construction sites before Planning Board & Conservation Commission	Somewhat effective	Local bylaw needed to address sites not being reviewed now
Local Wetlands Protection Bylaw & Regulations	Local bylaw more restrictive than MA Wetlands Protection Act regulation	Town-wide	Very effective	Additional commissioner training needed
Watershed Protection Overlay District	Zoning bylaw regulates development and other activities in municipal water supply areas	Aquifer recharge areas	Very effective	None
Local Open Space Plan	Plan targets purchase of available floodplain and wetlands buffers for protection	Town-wide	Effective	Recently completed update; looking for funding options to assist with implementation
Regulation of Communication and Wireless Communication Towers	Zoning bylaw addresses height and construction issues	Town-wide	Very effective	None
Earth Filling and Earth Removal Bylaws	Zoning bylaws regulate earth movement, both as an import and export product, as well as earth stabilization	Town-wide	Very effective	None
Sewer Commissioner Regulations	Bylaws and regulations in place to protect the waste stream coming into the treatment plant.	Town-wide	Somewhat effective	Policy and regulations updated Spring 2001
Disaster and Emergency Notification Program	Adoption of program to provide notification to town in event of emergency or disaster	Town-wide	Very effective	Enhanced notification program needed
Educational Outreach on Natural Hazards Preparedness, Mitigation, and Response	Town provides outreach via information and links on website, notices on community access TV channel, and display of educational materials at Town Hall	Town-wide	Very effective	Portable Message Board for emergency announcements to public
No Net Increase in Runoff	Subdivision and Site Plan Special Permits require no net increase in site runoff from pre-construction runoff conditions	Town-wide	Very effective	Subdivision Rules & Regulations currently being reviewed for updating

Table 6-13. TOWN OF SALISBURY Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Capital Improvement Programs	Identification and budgeting of projects that mitigate natural hazards as appropriate	Town-wide	Effective	Seek increased funding via outside sources
Municipal Drainage System Maintenance	Town DPW routinely inspects and cleans drainage systems to ensure proper operation	Town-wide	Very effective	Increased funding to cover costs of proper cleaning
Private Drainage System Maintenance	Private Storm water Management Plans (SWMPs) filed with Planning Board and Conservation Commission dictate required procedures to maintain private drainage systems	New development projects town-wide	Somewhat effective	None
Street Sweeping Program	Routine street sweeping to remove sand & debris before they enter the storm drain system	Town-wide	Somewhat effective	Funding needed for replacing existing 1984 street sweeper
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs in collaboration with power company and upon notification by property owners	Town-wide	Very effective	Needs to be routine; additional funding required
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Effective	None
Town Zoning Bylaw	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	Somewhat effective	Need additional enforcement
Beach Management Plan		Salisbury Beach (barrier beach) and Merrimack River	Somewhat effective	
MA Wetlands Protection Bylaw and Regulations	Regulates development and other land alteration activities with 100-ft buffer zone	Town-wide	Somewhat effective	Needs additional enforcement

Table 6-14. TOWN OF WEST NEWBURY Existing Protections Matrix

Type of Existing Protection	Description	Area Covered	Effectiveness or Enforcement	Improvements or Changes Needed
Participation in National Flood Insurance Program (NFIP)	Federal program provides flood insurance for structures in mapped flood-prone areas	FEMA flood zones town-wide	Effective	None
Floodplain District Bylaw	Regulates properties which are subject to seasonal or periodic flooding in mapped flood hazard areas	Town-wide (see bylaw for specific areas)	Effective	None
Storm Water Management	Large and small construction sites are reviewed by Planning Board and/or Con. Com.	Town-wide	Effective	None
Earth Removal Bylaw	Limits and regulates removal of soil from Town	Town-wide	Somewhat Effective	Small projects need better supervision
Septic Regulations	Regulations to protect the residents from on-site subsurface sanitary sewage disposal systems	Town-wide	Effective	None
No Net Increase In Runoff	Subdivision and Site Plan review require no net increase in site runoff from pre- to post- development	Town-wide	Effective	None
Regulation of Communication and Wireless Communication Towers	Zoning bylaw addresses height and construction issues	Town-wide	Very Effective	None
Groundwater Protection Overlay District Bylaw	Preserves and protects the Town's drinking water sources and recharge areas, as well as natural resources	Town-wide (see bylaw for specific areas)	Somewhat Effective	Need to address existing sites
West Newbury Open Space Recreation Plan	Plan to preserve the ecological integrity of the Town's open spaces and natural resources, as well as community character and quality of life	Town-wide	Effective	None
Municipal Drainage System Maintenance	Town DPW routinely inspects and cleans drainage systems to ensure proper operation	Town-wide	Somewhat Effective	Increased funding to cover costs of proper cleaning
Street Sweeping Program	Routine street sweeping to remove sediment & debris	Town-owned paved parking lots	Somewhat Effective	Additional funding needed to expand the program to cover more areas
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs within the Town-owned Rights-of-Way	Town-wide	Somewhat Effective	Additional funding would allow for greater effectiveness
Subdivision Rules and Regulations	To maintain the rural character and natural resources of the Town	Town-wide	Effective	None
Town Zoning Bylaw	Promotes the health, safety, and well-being of Town residents	Town-wide	Effective	None

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 the Merrimack Valley region. From 1991 through 2014, there have been 23 Presidential disaster declarations that included Essex County, as summarized in **Table 7-1**.

Since 2008, when the region’s last Hazard Mitigation Plan was prepared, there have been six Presidential disaster declarations in Essex County, four of which were the result of severe winter storms (two with flooding) and a third flooding event occurring in springtime. The vulnerability and risk assessment for the region has been based on the frequency of disasters, data provided in the local CEMPS and the 2013 *Massachusetts State Hazard Mitigation Plan*, and the Hazard Assessment outlined in Sections 4 and 5 of this document.

TABLE 7-1. DISASTER DECLARATIONS FOR ESSEX COUNTY (1991 – 2014)		
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
Severe Storms and Flooding	FEMA-1124-DR-MA (HMGP) and FY1998 CDBG	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	FEMA-1364-DR-MA (IFG)	Counties of Bristol, Essex, Middlesex, Norfolk,

TABLE 7-1. DISASTER DECLARATIONS FOR ESSEX COUNTY (1991 – 2014)

DISASTER NAME (DATE OF EVENT)	DISASTER NUMBER (TYPE OF ASSISTANCE)	DECLARED AREAS
(March 2001)		Suffolk, Plymouth, Worcester
	FEMA-1364-DR-MA (HMGP)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)
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

Key:

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

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

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

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

7.2 Potential Flood Damage as a Measure of Vulnerability

All municipal jurisdictions within the Merrimack Valley region have hazard-prone areas. The most common and costly hazard is *flooding*. Estimates of the potential impact of flooding on the Merrimack Valley region were calculated as one means of measuring the region's vulnerability to a particular natural hazard. Among all the hazards considered by this Plan, flooding is the one that is both most widespread and measurable. In addition, methodologies to measure the geographic impact of flood events are well developed, and mitigation practices to reduce flood impacts are well understood.



The methodology utilized by MVPC estimated the total value of buildings within the 100-year floodplain using assessed value data from the 2013 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) datalayers were obtained from MassGIS showing the 100-year floodplains (Zones A, A1-30, and AE). MVPC superimposed on these datalayers the building location data for each municipality. The building location data were derived from a comprehensive, region-wide point file created by MVPC from recent digital aerial photography. 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 datalayers, MVPC was able to determine both the total number of buildings in each community'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** on the following page.

The last column of the table shows the total value of buildings within the 100-year floodplain in each community. 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. Assessed Value of Buildings in the 100-Year Floodplain						
City/Town	Number of Buildings	Assessed Building Value by Land Use Type				Total Assessed Value
		Residential	Commercial	Industrial	Institutional	
Andover	210	110,568,400	30,467,800	42,040,700	70,700	183,147,600
Boxford	77	16,615,000	-	-	1,198,500	17,813,500
Georgetown	221	47,897,200	2,779,300	2,144,600	17,817,000	70,638,100
Groveland	92	12,007,700	789,100	8,292,100	281,100	21,370,000
Haverhill	586	107,947,400	17,705,800	9,008,100	76,216,900	210,878,200
Lawrence	673	75,535,700	26,317,800	73,511,300	104,081,800	279,446,600
Merrimac	72	8,040,200	-	-	0	8,040,200
Methuen	215	58,415,600	7,542,600	10,373,000	3,270,800	79,602,000
Newbury	517	75,242,800	2,660,700	307,000	403,000	78,613,500
Newburyport	802	144,415,500	19,860,600	7,056,900	18,074,200	189,407,200
North Andover	264	132,607,500	24,415,600	42,976,700	395,082,500	595,082,300
Rowley	52	4,055,800	2,436,900	-	164,900	6,657,600
Salisbury	1710	319,640,822	96,897,400	170,400	1,679,900	418,388,522
West Newbury	41	8,129,000	-	-	777,700	8,906,700
MVPC Region	5532	\$1,121,118,622	\$231,873,600	\$195,880,800	\$619,119,000	\$ 2,167,992,022

Source: MVPC digital imagery and local assessor records

While the above figures provide an estimate of the building values, they do not include the estimated cost of replacing building contents. According to HAZUS, the value of building contents depends on the type of building. The contents of residential buildings have a replacement cost of approximately 50% of the building value. Commercial building contents cost approximately 100% of the building value to replace and industrial building contents cost about 125%. For purposes of this analysis, the commercial rate was applied to governmental and institutional buildings. The estimated costs of contents replacement for structures located in the 100-year floodplain by community can be found in **Table 7-3** on the following page. As can be seen from Tables 7-2 and 7-3, the replacement cost of all buildings totals over \$2.1 billion, while building contents costs exceed \$1.6 billion. Thus, the combined estimated value of property and contents located within the 100-year floodplain exceeds \$3.7 billion for the 14 communities participating in this regional Hazard Mitigation Plan.

Table 7-3. Estimated Contents Replacement Costs for Buildings in the 100-Year Floodplain

City/Town	Residential Contents Value	Commercial Contents Value	Industrial Contents Value	Government/ Institutional Contents Value	Total Value
Andover	\$ 5,284,200	\$ 30,467,800	\$ 52,550,875	\$ 70,700	\$ 138,373,575
Boxford	\$ 8,307,500	\$ -	\$ -	\$ 1,198,500	\$ 9,506,000
Georgetown	\$ 23,948,600	\$ 2,779,300	\$ 2,680,750	\$ 17,817,000	\$ 47,225,650
Groveland	\$ 6,003,850	\$ 789,100	\$ 10,365,125	\$ 281,100	\$ 17,439,175
Haverhill	\$ 53,973,700	\$ 17,705,800	\$ 11,260,125	\$ 76,216,900	\$ 159,156,525
Lawrence	\$ 37,767,850	\$ 26,317,800	\$ 91,889,125	\$ 104,081,800	\$ 260,056,575
Merrimac	\$ 4,020,100	\$ -	\$ -	\$ -	\$ 4,020,100
Methuen	\$ 29,207,800	\$ 7,542,600	\$ 12,966,250	\$ 3,270,800	\$ 52,987,450
Newbury	\$ 37,621,400	\$ 2,660,700	\$ 383,750	\$ 403,000	\$ 41,068,850
Newburyport	\$ 72,207,750	\$ 19,860,600	\$ 8,821,125	\$ 18,074,200	\$ 118,963,675
North Andover	\$ 66,303,750	\$ 24,415,600	\$ 53,720,875	\$ 395,082,500	\$ 539,522,725
Rowley	\$ 2,027,900	\$ 2,436,900	\$ -	\$ 164,900	\$ 4,629,700
Salisbury	\$ 159,820,411	\$ 96,897,400	\$ 213,000	\$ 1,679,900	\$ 258,610,711
West Newbury	\$ 4,064,500	\$ -	\$ -	\$ 777,700	\$ 4,842,200
MVPC 14 Communities	\$ 560,559,311	\$ 231,873,600	\$ 244,851,000	\$ 619,119,000	\$ 1,656,402,911

Source: Local Assessor records, FIRM maps, contents value calculations using HAZUS methodology

It is 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 2013 Massachusetts Hazard Mitigation Plan developed by MEMA, was used to categorize each hazard based on frequency, severity, extent of impact, and area of occurrence. The analysis included input from the regional and local hazard mitigation committees, MEMA, and other stakeholders that were engaged during the plan development process, as discussed in previous chapters of this document. 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 assessment performed

for the region. There have been no significant changes in the region’s vulnerability since the completion of the 2008 Plan.

Table 7-4 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 individual hazard. The key at the bottom of the table provides a description of the criteria used in the assessment.

Table 7.4. The Region’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 of more local jurisdictions
 Local/Municipal: Impact will only be realized within a local jurisdiction or parts of one of 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 of more local jurisdictions
 Local/Municipal: Impact will only be realized within a local jurisdiction or parts of one of 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 7-5** graphically outlines the potential secondary effects of each natural hazard.

Table 7-5. 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

7.4 Impacts of New Growth on Vulnerability

As outlined in earlier sections of this plan, there has been very modest growth throughout the region over the past ten years. The U.S. Census data shows that the region's population increased by 4.7% between 2000 and 2010. On a percentage basis, most of this growth occurred in the suburban communities of Georgetown (10.9%), Methuen (7.9%), Rowley (6.4%), Andover (6.2%), and Groveland (6.2%). This modest growth trend is not expected to change remarkably over the next several years, particularly in light of the struggling economy. This suggests that there will be minimal changes in risk to the region overall. The losses that have been seen over the last several years have occurred in existing structures, most notably in the coastal communities of Newbury and Salisbury where strong winter storms have battered the shoreline causing severe erosion to sections of Plum Island and

Salisbury Beach. New construction has not been significantly impacted given the regulatory requirements in place within the Merrimack Valley communities.

To provide a sense of the development activity in the region since completion of the 2008 Plan, **Table 7-6** details the number of residential building permits issued in each community from 2009 through 2012, along with the total construction costs associated with these permits. For the region overall, a total of 1,156 residential building permits were issued, with associated construction costs of \$332,557,715. Over the previous four years, the three communities of Methuen, North Andover, and Andover had the most residential development activity among the 15 Merrimack Valley communities, together accounting for 482 permits (42%) of the total permits issued.

Table 7-6. Residential Building Permits and Construction Costs (2009-2012)

Community	2009		2010		2011		2012		4-Year Total	
	Number of Permits	Construction Costs	Number of Permits	Construction Costs	Number of Permits	Construction Costs	Number of Permits	Construction Costs	Number of Permits	Construction Costs
Amesbury	7	\$1,125,925	22	\$2,916,810	11	\$1,906,250	23	\$4,263,705	63	\$10,212,690
Andover	16	6,718,911	25	20,948,729	14	5,968,750	56	18,841,575	111	52,477,965
Boxford	3	1,148,400	4	2,541,000	1	83,333	4	1,977,730	12	5,750,463
Georgetown*	18	5,056,686	19	5,337,428	14	3,932,868	16	4,513,779	67	18,840,761
Groveland*	11	3,471,057	13	4,165,271	16	4,945,232	19	6,660,229	59	19,241,789
Haverhill	41	7,578,000	53	9,664,600	28	4,895,000	36	6,420,000	158	28,557,600
Lawrence*	8	1,256,500	13	1,930,130	10	1,636,412	15	1,877,000	46	6,700,042
Merrimac*	5	2,076,360	6	2,479,822	10	4,182,245	8	3,404,846	29	12,143,273
Methuen	43	9,735,980	17	5,367,650	38	9,475,781	102	26,600,954	200	51,180,365
Newbury	4	1,055,000	9	3,020,000	5	1,714,700	17	6,841,200	35	12,630,900
Newburyport	7	2,365,700	13	4,556,853	14	3,292,440	30	6,975,186	64	17,190,179
N. Andover	36	16,108,716	42	11,319,377	39	15,147,558	54	15,264,850	171	57,840,501
Rowley	9	1,466,500	5	1,189,200	8	2,643,640	11	4,123,775	33	9,423,115
Salisbury	7	1,373,000	21	4,811,550	10	2,144,852	15	3,851,840	53	12,181,242
W. Newbury	12	4,270,300	13	3,736,295	14	5,013,185	16	5,187,050	55	18,206,830
Region Total	227	\$64,807,035	275	\$83,984,715	232	\$66,982,246	422	\$116,803,719	1,156	\$332,577,715

*Estimated with imputation

Source: U.S. Census Bureau

To better understand the monetary implications of natural disaster to residential properties, **Table 7-7** below outlines the average residential property value by community for 2010. For each disaster event, damage and associated financial losses are assessed by state and local officials. The most costly disasters to strike the region since completion of the 2008 Plan were the Ice Storm of 2008 and the October 2011 snowstorm.

Table 7-7. Average Residential Property Values by Community - 2010		
Community	Number of Housing Units	Average Property Value
Amesbury	7,011	\$330,200
Andover	12,699	\$552,100
Boxford	2,648	\$656,800
Georgetown	2,808	\$451,100
Groveland	2,310	\$369,700
Haverhill	25,547	\$286,700
Lawrence	28,595	\$258,100
Merrimac	2,482	\$351,800
Methuen	18,368	\$312,000
Newbury	2,945	\$488,200
Newburyport	8,217	\$445,400
North Andover	10,488	\$439,800
Rowley	2,297	\$447,300
Salisbury	4,563	\$326,800
West Newbury	1,511	\$496,000

Source: U.S. Census Bureau, 2006-2010 American Community Survey

Due to the persistent economic recession that has gripped the nation and state in recent years, commercial and industrial development activity in the Merrimack Valley region has been exceedingly slow.

SECTION 8. MITIGATION STRATEGY

This section of the Plan provides the overall strategy for the Merrimack Valley region 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 general consensus of, the Regional and Local Planning Team members, along with the findings and conclusions of the hazard identification and analysis, the regional vulnerability assessment, and the existing protection measures matrix. The purpose of the mitigation strategy is to provide MVPC and the 15 participating communities with the goals that will serve as the guiding principles for future hazard mitigation policy development, planning, and project design and implementation in the Merrimack Valley region.

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 the participating communities, acting individually and in concert. In updating the Hazard Mitigation Plan, the goals of the earlier 2008 plan were reviewed and affirmed. In addition, 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 best available data for conducting hazard risk assessments and developing appropriate mitigation actions.

Goal #3 Increase the financial capability of communities in the Merrimack Valley region to implement hazard mitigation measures through maximizing available outside grant funding opportunities as well as locally available fiscal resources.

Goal #4 Improve existing local policies, plans, regulations, and practices to reduce or eliminate the impacts of known natural hazards.

- Goal #5** Investigate, design, and implement a range of structural projects that will reduce the effects of natural hazards – especially *flooding* – on public and private property throughout the region.
- Goal #6** Increase the general public’s awareness of natural hazard risks in the Merrimack Valley region, while also educating residents and businesses on the mitigation measures available to minimize those risks.
- Goal #7** Develop and implement adaptation strategies and modify local emergency plans 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 the Merrimack Valley region’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 Guide* (July 2008) and the *Multi-Jurisdictional Mitigation Planning Guide* (August 2006)

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 & 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.

In order to determine appropriate mitigation measures for the Merrimack Valley region, MVPC and municipal personnel reviewed the findings of the risk assessment and risk vulnerability, 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 Merrimack Valley region.

SECTION 9. MITIGATION ACTION PLANS

This section of the Hazard Mitigation Plan presents community-specific as well as regional mitigation actions that, effectively implemented, will serve to minimize risks and reduce losses from natural hazards in the Merrimack Valley region. The section is organized in two parts: A) **Local Mitigation Action Plans** to be carried out by the 14 participating communities individually, and B) a **Regional Mitigation Action Plan** that proposes actions to be carried out collaboratively by MVPC, the municipalities, and partnering agencies and organizations on an inter-municipal level.

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

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

Consistency With Goals & Objectives. In developing the mitigation action plans, MVPC and the communities 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;
- Provide alternative drinking water supplies for local communities in the event of contamination or disruption from a natural hazard;
- Increase awareness and support for natural hazard mitigation among municipalities, private organizations, businesses, and area residents through outreach and education;
- Implement a broad range of mitigation measures that protect the region's vulnerable populations and infrastructure;
- Protect critical public facilities and services from damage due to natural hazards;

- Develop a mitigation strategy that considers the needs of area businesses and protects the economic vitality of the region;
- Update and maintain the Plan as resources permit;
- Increase the number of communities participating in the Community Rating System;
- Provide communities with information concerning hazard mitigation funding opportunities, and assist the communities in the identification and development of specific mitigation projects; and
- Increase each community'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 the regional and local planning teams worked cooperatively to prioritize the proposed mitigation actions and projects. The priorities were developed through a consensus-building process that consisted of meetings and conversations among local policy makers, board and commission members, municipal staff, and the RHMPT. 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 City Council or Town Meeting approval, or action by a permitting authority.

The benefits and cost of each project have been weighed using a qualitative method outlined in FEMA's guidance provided in *Using Benefit-Cost Review in Mitigation Planning*.¹ Method A: Simple Listing Technique was utilized and the Planning Team chose to express their priorities through timeframe designations. 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 on a regular basis 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 greenspace. 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 “Short-term” projects will be implemented within one to two years, “medium-term” projects within three to four years, and “long-term” projects in five or more years. The timeframe assigned to each project is indicative of local and regional project priorities and availability of funding.

This Mitigation Action Plan is an update of the 2008 Action Plan. It is organized in a series of matrices. The matrices note whether each particular action was included in the 2008 Plan, and if so, information is provided on the implementation status of the project. Many of the actions contained in the 2008 Plan remain in the updated plan and continue to be a priority for the region. In some instances where priorities have shifted and projects deleted from the plan, those projects are indicated in the Timeframe/Priority column and reasons for change explained in the Project status columns.

The plan has been refined by addition of new projects identified through local planning teams and informed by land use plan updates, engineering studies, local capital budgeting planning processes as well as public and municipal staff review comments. FEMA review comments on the February 2015 plan update draft were received mid-summer 2015. MVPC worked with local planning team coordinators to prepare final edits responding to those comments including updating status and clarifying specific actions and scopes of plan projects. All suggestions and feedback comments were received by MVPC and action plan update recommendations were finalized with the local planning teams and lead coordinators. Communities have completed structural, planning, or prevention projects since adoption of the 2008 Plan, and those projects are listed separately in each community’s action plan matrix with the exception of Newburyport which was not a participating community in the 2008 planning process. The Progress Status column in the table outlines activity progress or change as well as any next steps to implementation. The actions listed as in development and put forth in this current Hazard Mitigation Plan are intended to be implemented as resources are made available.

The 14 individual **Local Mitigation Action Plans** are presented in **Tables 9-1** through **9-14**. The Regional Mitigation Action Plan is presented in **Table 9-15**.

A. Local Mitigation Action Plans

Table 9-1 TOWN OF ANDOVER Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Structural	Develop long-term study of floodplain near Washington Park to identify ways to prevent repetitive flood losses.	Flooding	Washington Park Condominium Association	Completed 2010 (Monitoring gauge installed at North Main Street area)	Private, state/federal agencies—DCR/FEMA tech. assistance	Yes	COMPLETED
Structural	Development long-term study of floodplain near Balmoral Condominiums to identify ways to prevent repetitive flood losses.	Flooding	Balmoral Condominium Association	Completed 2010 (Monitoring gauge installed at North Main Street area)	Private, state/federal agencies—DCR/FEMA tech. assistance	Yes	COMPLETED
Prevention	Encourage distribution and public use of water saving devices & measures	Drought	Municipal Water Dept.	Complete/MED IUM	Municipal/MassDEP /private foundation grants	Yes	COMPLETED—This is existing capacity program. DPW distributes water saving devices to residents at Open House events.
Prevention	Design & implement a sewer backflow prevention program using backflow preventers and one-way valves;	Flooding	Andover Municipal Services-Public Works	Completed—regulation in place requiring in new development	Property owners	Yes	COMPLETED
Prevention	Revise municipal sewer regulations to require installation of backflow prevention on all new sewer connections	Flooding	Andover Board of Health	Completed—regulation in place requiring in new development	Property owners	Yes	COMPLETED
Prevention	Implement routine system of maintenance and cleaning of street drainage systems	Flooding/Storms	Andover Municipal Services—Public Works	Short Term/HIGH	Municipal	Yes	COMPLETED. Non-Mitigation Maintenance Item; Program is in Place
Prevention	Coordination between Power Company and municipal Tree division to remove tree/limb hazards when appropriate to prevent utility outages	Storms/ Power Outages	Tree Dept.	Short Term/HIGH	Municipal/National Grid	Yes	COMPLETED This is existing capacity maintenance program

Table 9-1 TOWN OF ANDOVER Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Prevention	Encourage the use of Low Impact Development techniques in all new development and redevelopment projects. Next Steps include working with developers/private owners on conservation easements for river buffer, planned Shawsheen Riverwalk.	Floods/Drought/Storms	Municipal Planning Board/Conservation Commission	Medium Term/ HIGH	Municipal	Yes	Project in planning.
Prevention	Identify and seek funding for capital improvement projects that reduce the costs associated with flooding. Priorities are to create additional flood storage capacity in the Shawsheen watershed to mitigate flooding in areas including North Main Street and Riverina Road.	Flooding	Municipal Departments	Long Term/HIGH	Municipal	Yes	First step needed is comprehensive planning study of Shawsheen River.
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public.	Flooding	Building Inspection Dept.	Long Term/LOW	Municipal	Yes	Funding, staff resource time constraint.
Prevention	Acquire & protect undeveloped open space in flood hazard areas. Priorities targeted for protection buffer and/or passive recreation are along Shawsheen and Merrimack rivers. Next steps include identifying opportunities and developing financing plans with regional/community land trust partners.	Flooding	Conservation Commission/Andover Village Improvement Society (AVIS); Greenbelt; other regional land trusts	Medium Term/MEDIUM	Municipal	Yes	AVIS recent acquisition of 10 acres on Shawsheen at Andover/Tewksbury line.
Prevention	Enforce and revise as needed current bylaws and rules & regulations designed to minimize the impact of flooding and other natural hazards.	Flooding/Storms/Fires	Municipal Departments	Long Term/MEDIUM	Municipal	Yes	Mill District bylaw enacted 2014. Next steps include review and update per anticipated new MS4 stormwater requirements in 2016.

Table 9-1 TOWN OF ANDOVER Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Prevention	Implement Town's NPDES MS4 Stormwater Management Plan. Next steps include development of Illicit Discharge Detection Program; Infrastructure Inventory Mapping & Formalizing Operating & Maint Plans.	Flooding/Storms	Municipal Services-Public Works	Years 1-5/HIGH	Municipal/Merrimack Valley Stormwater Collaborative	Yes	EPA to finalize MS4 permit in 2016.
Prevention	Enhance early warning information/communication systems	Flooding/Storms/Hurricanes/Tornadoes	Municipal Information Technology, Public Safety Departments	Short-Term/MEDIUM	Municipal	Yes	Implemented Code Red System & Social Media; Need for Municipal Website consolidation/update
Prevention	Work with DCR Office of Dam Safety and private dam owners to ensure timely dam inspections and maintenance	Flooding	Conservation/Municipal Services/Dam Owners	Short Term/MEDIUM	DCR/private/municipal	Yes	Target focus has been Shawsheen dam removal projects
Prevention	Adopt Stormwater Management Bylaw to address issues on properties disturbing one acre or more of land. Next steps include review for compliance with new EPA MS4 permit to be issued 2016	Flooding	Planning/Conservation	Short-Term/MEDIUM	Municipal/Merrimack Valley Stormwater Collaborative	Yes	Bylaw & planning regs adopted but will need to be updated with issuance of EPA MS4 permit in 2016.
Structural	Shawsheen River Restoration Project including removal of Balmoral & Steven St. dams and long-term study/removal of Ballardvale Dam	Flooding	Planning/Conservation/Municipal Services	Short Term/HIGH - 2016 work for Balmoral and Steven St. dams; Ballardvale Dam element of project is Long Term/HIGH;	Municipal/ state EOE/Private Partnerships—Center for Ecosystems Restoration; 2014 US Dept. of Interior Sandy funding award; \$1 million order of magnitude first phase Balmoral & Steven St. cost estimate including permitting/engineering	No. This is new project.	Federal and state permits are pending for Balmoral & Steven Street dam elements-project at 70% design—Jan. 2015; Planned removal work to take place 2016.
Structural	Install Additional Shawsheen River Monitoring Gauge Upstream near Wilmington Town Line	Flooding	Public Safety/Emergency Management Committee	Short Term/MEDIUM	Municipal/State DCR Revolving Fund Cost magnitude medium	No. This is new project.	Funding to be Secured

Table 9-2 TOWN OF BOXFORD Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	Strictly enforce and, as appropriate, upgrade Town zoning bylaw, subdivision rules and regulations and wetlands regulations to minimize incidence and impacts of flooding and other natural hazards	All Natural Hazards	Town departments	Completed	Town	Yes	COMPLETED – Zoning updates adopted 2012.
Prevention	Maintain E-CEMP, Flood Hazard Mitigation Plan, and Boxford components of this Natural Hazards Plan to ensure completeness and relevance in disaster mitigation and response	All Hazards	Town Departments	Completed	Town with advice and assistance from MVPC, DCR and MEMA	Yes	COMPLETED—EXISTING CAPACITY RESOURCE/ MAINTENANCE ACTIVITY
Prevention	Develop and implement timely warning system (local access cable TV, radio, social media) to alert public about pending floods and other hazard emergencies	All Hazards	Boxford Emergency Management	Completed	Town with advice and assistance from DCR and MEMA	Yes (Implemented reverse 911 since last plan)	COMPLETED—TOWN HAS IMPLEMENTED REVERSE 911 SINCE 2008.
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 MEMA and FEMA hazard mitigation websites	All Hazards	Town Departments	Completed	Town with advice from MEMA, DCR and MVPC	Yes	COMPLETED INFO FEATURED ON TOWN website & Local cable tv.
Prevention	Acquire/protect dams at Four Mile Pond & Lowes Pond	Flooding	Conservation Commission/Lakes, Ponds & Streams Committee	Completed/ Change of Local Priorities	Community Preservation Act funds; DCS Self Help Program grants	Yes	Since 2008, discussions have been held between the Town and the owners of these dams regarding possible town purchase, however no agreement was reached due to

Table 9-2 TOWN OF BOXFORD Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
							issues of cost and liability. The Lakes Ponds and Streams Committee is currently working with Four Mile Pond Abutters and the Dam Owner to develop a Dam Management Plan and a Pond Management Plan
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Brushfire	Boxford Fire Dept.	Completed/Change Of local priorities	Town with advice & assistance from DCR	Yes	Town has reviewed and local emergency management team has opted not to pursue implementation given other priorities and local administrative resource constraints of budget and staff.

Table 9-2 TOWN OF BOXFORD Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural Projects	<p>Implement Drainage Management System improvements action plan. Projects include:</p> <ul style="list-style-type: none"> • Main St/Stiles Pond pipe replacement (completed 2012) • Ipswich Road pipe replacement from Main to North Andover line completed 2013) • Topsfield Road pipe replacement for capacity & headwall (2014-15) • Adams Rd. pipe replacement & headwall repair (2014-2015) • Main St./ Bennet Road Clean pipe & install headwalls (2015) • Kelsey Road Replace 15" pipe with 18" culvert. (2015) • Woodcrest Rd. Replace pipe for capacity, road repair (2015) • Main St by Bayns Hill. Repair headwalls and remove tree (2016) • Main St. replace 12" culvert pipe for capacity & repair headwalls (2016) • Highland Rd. Repair headwalls. (2015) • Kimball Road /Repair 	Flooding	DPW in-house	Year1-5/HIGH See DPW Action Plan schedule	Town match/ state or federal grants if available (MassWorks Infrastructure/ MassDOT); (FEMA HMGP/PDM/Flood Hazard Mitigation); Total program cost estimate: \$146,000	No. Projects are newly defined activities generated through Town's CIP budget planning process.	Town DPW has developed 5-year capital investment program in infrastructure capacity & condition and is implementing per CIP budget schedule.

Table 9-2 TOWN OF BOXFORD Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
	<ul style="list-style-type: none"> headwalls (2016) • King George Road/Pipe replacements for capacity & headwall repairs (2017) • Georgetown Rd by Stagecoach Rd. Repair submerged pipe(2018) • Georgetown Rd by Ipswich Rd. Replace pipe (2018) • Lawrence St. @ Main headwall repair (2019) 						
Prevention	<p>Consistent with pending NPDES MS4 Permit, update & implement Stormwater Management Plan</p> <p>Next steps include Infrastructure Inventory Mapping, Illicit Discharge Detection Program Development, Staff training, and Stormwater Management Plan development.</p>	Flooding/ Storms	Boxford DPW/Conservation Commission	2016-2018/HIGH	Town/Merrimack Valley Stormwater Collaborative	Yes	Anticipated that EPA will issue final MS4 permit in 2016
Prevention	Incorporate hazard mitigation in local policies, plans and programs (e.g. Capital Improvement Program, Master Plan, Open	All Natural Hazards	Town Departments	Partial Completed Master Plan process scheduled 2016-2018/High	Town	Yes	Open Space & Rec Plan update done in 2015; CIP annually; Stormwater Management Plan 2016-2017; Master Plan 2016-2018

Table 9-2 TOWN OF BOXFORD Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
	Space and Recreation Plan, Stormwater Management Plan)						
Prevention	Amend local subdivision rules and regulations to require the maximum practicable use of low impact development techniques in all new development and redevelopment Next steps include clarifying implementation of zoning bylaw driveway construction standards and applicability of stormwater runoff requirements.	Flooding/ Drought/Fire	Boxford Planning Board	2015-2016/LOW	Town with advice and assistance from MVPC, EOEAA/Greenscapes Program (CZM)	Yes	Planning Board regulator review pending.
Structural Project and Prevention	Analyze existing flooding problem areas and design/implement appropriate corrective measures. Priorities areas include Depot Road/Bare Hill Road by Four Mile Pond and Lowe Pond Dams	Flooding	Boxford Public Works	Long-term/LOW	Town, MEMA/DCR technical assistance	Yes	DPW action plan prepared; Lowe Pond street improvements completed 2010. Earthen dam at Stiles Pond outlet rebuilt 2014 including riprap installation and land regarding. Next steps are additional engineering design re Lowe pond dam
Prevention	Create interdepartmental GIS MIMAP database and mapping of municipal facilities and resources to enhance emergency operations and incident management.	All Hazards	Town Departments	Long-term/HIGH	Town with technical assistance from MVPC and possible grant assistance from state/federal sources	Yes	Next step is to organize system in phases with MVPC
Prevention	To mitigate against damage and disruption from high winds, promote to the maximum extent practicable, the use of underground utilities in all new	Power outage/ Storms	Town Departments and private developers	Long-Term/HIGH	Town (for municipal facilities) and private developers	Yes	Planning Board and staff are implementing Subdivision regulation requiring underground utilities in new developments. Next steps are to improve communication/partnership with

Table 9-2 TOWN OF BOXFORD Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
	development and redevelopment						National Grid in retrofitting existing infrastructure network.
Structural Project	Replace collapsed Middleton Road culvert at Crooked Pond stream to reduce flood risk. Project calls for replacing existing 23" diameter corrugated culvert with 6' x 12' concrete box culvert. Project is designed to meet 2014 MA Stream Crossing standards and will accommodate 100-year storm.	Flooding	DPW	Short-Term/High	Town match/Potential FEMA grants—HMGP, PDM, Flood Mitigation	No. Project is a new activity.	Recent infrastructure failure beyond useful life. Town has partnered with Trout Unlimited to identify project and design project concept to expand culvert capacity and relieve flow bottleneck. Next step is to secure funding.
Prevention	Acquire/protect dams at Four Mile Pond & Lowes Pond	Flooding	Conservation Commission/Lakes, Ponds & Streams Committee	Long Term/MEDIUM	Community Preservation Act funds; DCS Self Help Program grants	Yes	Since 2008, discussions have been held between the Town and the owners of these dams regarding possible town purchase, however no agreement was reached due to issues of cost and liability. The Lakes Ponds and Streams Committee is currently working with Four Mile Pond Abutters and the Dam Owner to develop a Dam Management Plan and a Pond Management Plan

Table 9-3 TOWN OF GEORGETOWN Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Implementation Responsibility	Hazard Addressed	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Structural Project and Prevention	Drainage improvements at Middle High School Scope includes interior improvements including sump pumps and exterior improvements of positive drainage and perimeter drain	School Department	Flooding	Completed Project	State/Federal FEMA HMGP Grant	Yes	Completed
Structural Project and Prevention	Drainage improvements at Brook Street Culvert cross-over pipes replaced	Highway Dept.	Flooding	Completed Project	Town	Yes	Completed
Prevention	Develop recommendations for maintaining cleared buffer area between structures and phragmites and other dried vegetation in areas adjoining wetland areas	Highway Department, Fire Department, Conservation Commission	All hazards	Completed Ongoing Administration	Town	Yes	Completed Activity. Administrative protocol established. During inspections Fire Dept. will advise property owners on how to reduce fire potential
Prevention	Maintain list of repetitive Loss properties; encourage property owners to explore and implement appropriate mitigation measures	Highway Department, Fire and Planning Departments	Mitigation of damage to structures-- Flooding	Short Term/ MEDIUM	Town, with advice and information from DCR and MEMA	No, this is a new administrative action item	This is completed. Fire Dept. maintains database of incident responses and inspections made of properties in Town
Structural Project and Prevention	Drainage improvements at Central Street at Nunan's	Highway Department	Flooding	Completed	Town	Yes	Work completed by DPW 2015

Table 9-3 TOWN OF GEORGETOWN Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Implementation Responsibility	Hazard Addressed	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Structural Project and Prevention	Drainage capacity improvements at Andover Street by VFW	Highway Dept.	Flooding	Completed	Town	No, this is a new action item	Work completed 2015
Structural Project and Prevention	Analyze existing flooding problem areas and design/implement appropriate corrective measures, such as re-directing floodwaters to uninhabited areas or wetlands Thurlow Street to be completed Fall 2015 (see below) Central Street is now two culverts	Highway Dept. Fire, Police and Planning Dept. / Fire Dept. support role to Highway and Police in managing flood waters / Ongoing with analysis during rain events with action to problem areas	Flooding	Completed	Town, DCR,	Yes	Work completed 2015 at Thurlow St.; Administrative procedure in place for analysis/monitoring: Fire Dept. support role to Highway and Police in managing flood waters / Ongoing with analysis during rain events with action to problem areas
Structural Project and Prevention	Drainage improvements at Thurlow Street including culvert replacement at Parker River Replace with larger (2' x 7' x 14' sized) culvert	Highway Department / In project queue	Flooding	Completed	Town match / Federal FEMA HMPG Grant \$278,888	No, this is a new action item	Work completed Fall 2015
Structural Project and Prevention	Culvert replacement Central Street at Penn Brook Tributary Replace two culverts and upgrade with dredging	Highway Dept.	Flooding	Completed	Local Match/Federal FEMA grant	No, this is a new action item	Work completed Fall 2015

Table 9-3 TOWN OF GEORGETOWN Mitigation Action Plan

Projects in Development							
Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural Project and Prevention	Installation of beaver deceivers to help manage and prevent flooding during high rain events This is a continual effort and is part of routine maintenance by the Town which employs a licensed beaver trapper.	Highway Department / Conservation Commission / Board of Health	Flooding	1 – 5 year/ High	Town, CPC, Con Com	Yes	Reduced dam construction by beaver population. Installed on as needed basis at culvert locations where beaver activity is seen
Structural Project and Prevention	Improve drainage system and remove obstructions in major waterways to prevent future flooding Priorities include Parker River dredging from Bailey Lane to Rock Pond; Parker River @ West Main St. Also, West Main Street is a priority location and is in the Regional Transportation Plan for MPO transportation funding, project scope to include road drainage capacity upgrade.	Highway Department and Conservation Commission	Flooding	1 – 5 year/ Medium	Town / FEMA Grants-HMGP; PDM; Flood Mitigation; Merrimack Valley MPO-MassDOT Cost Magnitude: High	Yes	Annual evaluation to assess culvert replacement
Structural Project and Prevention	Drainage improvements at Perley School basement Scope includes interior improvements including sump pumps and exterior improvements of positive drainage and perimeter drain	School Department / Design Plan Team	Flooding	Short - term/ HIGH	Town Match/Federal FEMA Hazard Mitigation Grant	Yes	FEMA HMGP funds awarded

Table 9-3 TOWN OF GEORGETOWN Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural Project and Prevention basement	Drainage improvements at Bailey Lane at bridge Replace culvert and dredged material away from Rock Pond outflow	Highway Dept / Conservation Commission / State Mosquito Control	Flooding	Year 1 /HIGH	Town and Chapter 90 funds	No, this is a new action item	Scheduled for Mid- year 2016
Structural Project and Prevention	Drainage improvements at West Main by King Street	Highway Department / In project queue / in design stage	Flooding	Long-term/ MEDIUM	TIP Merrimack Valley MPO Program \$6.6 million road reconstruction cost estimate.	Yes	In project queue for TIP / in design stage; Project in Regional Transportation Plan.
Structural Project and Prevention	Andover Street drainage improvements	Highway Department /	Flooding	Long-term/ MEDIUM	TIP Merrimack Valley MPO Program - MassDOT/ ; Town (\$10 million road improvement cost estimate)	Yes	Project to be designed and scope defined. Coordination will be made with Congregational Church possible transportation funding in 2017
Structural Project and Prevention	Drainage improvements at Parish Road at Town line Coordination Responsibility w Town of Newbury	Highway Department / In project queue / Culvert in Newbury	Flooding	Long-term/ MEDIUM	Town/ State/Federal FEMA Mitigation Grant (HMPG/PDM/Flood Hazard Mitigation)	Yes	Next step design & scope coordination with Town of Newbury
Prevention	Identify and seek funding for capital improvement projects that reduce the costs associated with flooding	Planning Office researching grants and funding resources / Police 5 year Capital Plan for Public Safety Bldg. / School Dept / Highway	Flooding	Year 1-5 / HIGH	Town / FEMA Mitigation Grants	Yes	FEMA grants applied for

Table 9-3 TOWN OF GEORGETOWN Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
		Dept					
Prevention	Encourage the use of Low Impact Development (LID) techniques in all new development and redevelopment projects Next steps: Planning Board review and recommendation of bylaw changes for Annual Town Meeting 2016 Coordination with Town Departments	Planning Board, Zoning Board of Appeals, Conservation Commission / Planning Office researching bylaw changes and implementation of "Cornell numbers"	All hazards	Year 1-5/ HIGH	Town	Yes	Modifications to Subdivision Regulations completed.
Prevention	Continue routine maintenance and cleaning of street drainage systems, swales and channels	Highway Department	Flooding	Year 1-5 Annual/ HIGH	Town	Yes	This is an annual Operations & Maintenance activity
Prevention	Acquire and protect undeveloped open space in flood hazard areas Next steps: Adoption of 2015 Open Space and Recreation Plan by State	Conservation Commission / On-needed basis with project review by ConCom	Flooding	Year 1 to 5/ MEDIUM	Town/Mass. Land & Water Conservation Fund	No, this is a new action item	2015 Open Space and Recreation Plan reviewed and recommended to ConCom. In ConCom review end of year 2015
Prevention	Continue to enforce and revise current bylaws and rules & regulations designed to minimize the impact of flooding	Town Departments	All hazards	(Year 1-5) Short term / High	Town	Yes	On-needed basis as each proposed development

Table 9-3 TOWN OF GEORGETOWN Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
	and other natural hazards Next Steps: Planning Board review and recommendation of bylaw changes for Annual Town Meeting 2016 Coordination with Town Departments including Cornell numbers into Stormwater bylaws						seeks permit review and approval
Prevention	Continue implementation of the Town's Phase II Storm Water Management Plan Next steps to include infrastructure inventory & catchment prioritization, development of illicit discharge detection program, & O&M housekeeping plan.	Town Departments	All hazards	Years 2-5/ HIGH	Town	No, this is a new action item	Future effort with EPA release of MS4 permit for Massachusetts expected in 2016
Prevention	Explore ways to enhance warning systems for winter storms, hurricanes, and tornadoes through possible media uses of Blackboard Connect, the municipal website, the municipal serve list, and cable t.v. local access channels Next steps include N.I.M.S. Training for all and N.I.M.S. Training for Executive Branch	Town Departments / Police	Mitigation of damage to structures— All Hazards	Medium / Years 2 - 5	Town / FEMA training programs	No, this is a new action item	FEMA online courses. No costs incurred
Prevention	Explore ways to link the municipal website to the Town's GIS and FEMA resources concerning all natural hazard emergencies Coordinate with MVPC / determine feasibility with exploring technology requirements and Town	Planning Department / Financial Committee	All hazards	Long - term/ MEDIUM	Town	No, this is a new action item	Secure annual funding if determined to be feasible.

Table 9-3 TOWN OF GEORGETOWN Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
	capabilities						
Prevention	Maintain existing methods of relaying fire safety information via website and other public communications systems	All Town Dept.	All hazards	Short Term/ HIGH	Town	No, this is a new action item	E.M.D. and Blackboard Connect, Improvement Schedule for 2015 implementation. Board of Selectman to finalize Town wide Communication Plan including Website, and presence on all social media
Prevention	Adopt "Steep Slope" regulations to prohibit or strictly regulate development on steep slopes in order to prevent stormwater runoff and erosion.	Planning Board and Conservation Commission /	All hazards	Long - Term/ LOW	Town	No, this is a new action item	To be reviewed by Town in 2016
Prevention	Incorporate hazard mitigation in local plans and initiatives (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan)	Town Departments / Planning Board in lead of bylaw amendments / Part of \$1.5mil. in FEMA grants received	All hazards	Long - Term / HIGH	Town	Yes	Open Space & Recreation Plan Update to be completed fall 2015. Master Plan Update 2017

Table 9-3 TOWN OF GEORGETOWN Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and increase public outreach and awareness	Town Departments / Active in efforts to evaluate, prioritize and replace culverts	Flooding	Year 1 to 5 / HIGH	Town, with advice and assistance from MEMA and DCR. Police annual coordination with DCR Fire Dept. annual coordination with DCR and Rangers	Yes	Annual review by Town departments
Prevention	Increase building inspection efforts and emergency management training Priority personnel capacity initiative by Public Safety Departments with yearly C.L.P. Inspection for P.S.B. needs; MIMS for all employees; EMD Team of 4 Members Annual MIIA inspections and compliance reports	Town Departments	Mitigation of damage to structures	Long-term/ MEDIUM	Town / MIIA grants	No, this is a new action item	Annual mitigation MIIA grants purchase of Equipment covers on fire apparatus and new gas meter leak detection units
Prevention	Develop and adhere to routine inspection, cleaning, and maintenance schedule for drainage/stormwater facilities and stream channels	Highway Department, in consultation and cooperation with Conservation Commission and Agent	Flooding	Ongoing/ MEDIUM	Town	No, this is a new action item	Project is a Non-Mitigation Capacity-O & M activity. As-needed basis with each development application / Routine cleaning of inlet tops prior to storm events
Prevention	Create GIS database and mapping of municipal facilities and resources to enhance emergency operations and incident management /	Town Departments Police / EMD	Mitigation of damage to structures—All Hazards	Long-term/ HIGH	Town/MVPC/Red Cross/FEMA training	No, this is a new planning capacity action item	Annual C.E.M Plan, Red Cross Agreement, MEMA and FEMA Training /

Table 9-3 TOWN OF GEORGETOWN Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
	Planning Office in lead and implementation as need for funding to be secured each fiscal year. Shelter plans established with Red Cross Mutual Aid Agreement NEMA and FEMA training Catch basin GIS database with MVPC.						Catch basins are in GIS database and accessible in Town MIMAP database with MVPC

Table 9-4 TOWN OF GROVELAND Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	Continue NFIP participation & strictly enforce local floodplain regulations, building code and other bylaws and regulations designed to minimize the impact of flooding and other natural hazards; participate in NFIP training	Town Departments	All Hazards	Completed	Town with advice and assistance of MEMA and DCR	Yes	Ongoing administrative capacity
Prevention	Maintain electronic Comprehensive Emergency Management Plan (eCEMP) and local Natural Hazards PDM plan to ensure completeness and relevance in disaster prevention, mitigation & response	Town Departments led by Public Safety/Emergency Management Director	All Hazards	Completed	Town with advice and assistance from MVPC, DCR and MEMA	Yes	Completed Admin Activity
Prevention	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in new development and redevelopment	Town Departments and Private Developers	Power Outage	Completed/ Ongoing Administrative for maintenance	Town, Developers, Municipal Electric Dept.	Yes	Planning Board regs require underground utility standard.

Table 9-4 TOWN OF GROVELAND Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	Strictly enforce and, as appropriate, upgrade Town zoning bylaw, subdivision rules & regulations, and local wetlands regulations to minimize incidence and impacts of flooding and other natural hazards	Town Departments	All Hazards	Completed/Ongoing admin of monitoring & update	Town	Yes	Zoning floodplain ordinance updated April 2012.

Table 9-4 TOWN OF GROVELAND Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources Funding	Project included in 2008 Plan	Project Status
Emergency Management	Install generator at Bagnall School shelter critical facility	Town DPW	All Hazards	Short Term/High	Cost Est. \$100k Local match & FEMA Hazard Mitigation (HMGP)	No	New project. Town seeking to identify/secure funding
Structural/Prevention	Prioritize drainage system improvements needs; seek outside funding for engineering studies, design and construction	Town DPW/municipal departments	Flooding	Medium Term/ Medium	Town with advice and assistance MVPC	Yes	Funding needed for consultant procurement
Emergency Management	Upgrade emergency dispatch center as capacity modernization project.	Public Safety Depts.	All Hazards	Short Term/High	Local & FEMA grants-HMGP; Cost estimate 160k	No	New project. Town seeking to identify /secure funding
Prevention	Identify non-compliant structures in the community; work with elected officials, MEMA and FEMA to correct non-compliance issues and prevent future non-compliance through ongoing communication, training & education.	Town Departments	All Hazards	Short Term/ Medium	Town with advice and technical assistance of MEMA, FEMA and DCR	Yes	Staff resources and time constraints for training.
Prevention	Incorporate hazard mitigation in local policies, plans and programs (eg Capital mprovement Program, Master Plan, Open Space & Recreation Plan, Stormwater Management Plan)	Town Departments	All Hazards	Medium Term/ Medium	Town with advice and assistance of MVPC	Yes	Open Space Plan updated and valid through July 2019. Stormwater Management Plan needed as is Master Plan.

Table 9-4 TOWN OF GROVELAND Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources Funding	Project included in 2008 Plan	Project Status
Prevention	Develop and implement stormwater management program and maintenance plan to ensure compliance with MS4 permit, including inspection, cleaning and maintenance of stormwater facilities	Town Departments with Town Highway Dept. lead	Flooding	Years 1-5 /Medium	Town with resource assistance of MVPC and Merrimack Valley Stormwater Collaborative	Yes	EPA to issue final MS4 permit update in 2016; Town to update stormwater plan/program for compliance
Prevention	Update local Subdivision Rules & Regulations to require the maximum practicable use of Low Impact Development techniques in all new development and redevelopment	Planning Board	All Hazards	Year 2 /Medium	Town, with advice and assistance from MVPC	Yes	Next step: Assessment planning regarding pavement requirements as part of stormwater program
Prevention	Develop and implement DCR Fire Wise Program in heavily forested areas and neighborhoods	Fire Department	Brushfire	Long-term/Low	Town, with technical assistance of DCR	Yes	Issue of administrative staff & budget resources. Next steps: Planning/coordination meeting with DCR
Prevention	As opportunities arise, acquire & protect private undeveloped open space in flood hazard areas Priority areas targeted are Johnson's Pond area, Center Street Greenway including Zone 2 Public Water Supply Protection Area Parcels.	Conservation Commission, CPA Committee	Flooding	Long term/Medium	Town with grant assistance from state DCS, Mass. Land & Water Conservation Fund, Essex County Greenbelt Assoc.	Yes	Open Space & Recreation Plan approved; valid through July 2019. Groveland has approved Community Preservation Act option as potential funding source for open space preservation

Table 9-4 TOWN OF GROVELAND Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Implementation Responsibility	Hazards Addressed	Timeframe/ Priority	Resources Funding	Project included in 2008 Plan	Project Status
Prevention	To reduce public risks from all natural hazards, update Town web page for hazard preparedness, mitigation and response Next steps/gaps include establishing alert system for distribution of info/resident notification	Town Departments/Emergency Management Director	All Hazards	Medium Term/Medium	Town with advice from MEMA, DCR and MVPC	Yes	Emergency management including winter weather tips included as tab on Police Dept. website.
Structural/Prevention	Complete design, permitting and construct improvements to the Johnson's Creek Dam Next steps include design & cost estimate development	Town DPW	Dam Failure/ Flooding	Medium Term/High	(HIGH cost projected) Town with state/federal grants including potential FEMA Hazard Mitigation- (HMGP, Flood Mitigation, PDM)	No. This is a new action tem.	Cost estimate in development
Structural/Prevention	Construct storm system improvements including outfall capacity replacement at Main/School Street	Town DPW	Flooding	Short Term/HIGH	Cost estimate for ain/School St. project is \$150k; Local funds and state/federal grants including potential FEMA Hazard Mitigation- (HMGP, Flood Mitigation, PDM)	No. This is a new action item.	Cost estimate/design concept completed.

Table 9-5 CITY OF HAVERHILL Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	Develop and adhered to routine inspection, cleaning and maintenance schedule for drainage/stormwater facilities and stream channels	Flooding	City DPW in cooperation with Conservation Commission	Completed Medium	City	Yes	Completed and ongoing maintenance activity.
Prevention	Adopt and implement "Steep Slope" regulation to prohibit or strictly regulate development on steep slopes in order to prevent stormwater runoff erosion	All Hazards	City Council, in consultation with Planning Board and Conservation Commission	Completed.	City; Ordinance in place	Yes	Regulation in place and effective.
Prevention	Develop and implement DCR Fire Wise Program in forested areas and neighborhoods	Brushfire	City Fire Dept.	Deleted Activity. Change in Priorities from Prior Plan	City with assistance of DCR	Yes	Per Fire Dept., City has investigated participation but has opted not to implement at this time given resource constraints.
Prevention	Continue participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risk & losses and educate public.	Flooding	City—approved from CRS since 2008 plan	Completed	City with advance and assistance from MEMA and DCR	Yes	City's CRS application approved.

Table 9-5 CITY OF HAVERHILL Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in new development and redevelopment.	Power Outage	City Departments and developers	Completed/Ongoing Effort	City and private developers	Yes	Underground utilities required in new development. Work with developers/utilities on existing infrastructure upgrades downtown and in central neighborhoods.
Structural Project	Design & construct Merrimack River streambank stabilization project adjacent to Riverside & Coffin Avenues to prevent further bank erosion and safeguard the integrity of the nearby 54-inch sewer interceptor	Flooding	City Wastewater Dept.	Completed	City/FEMA-HMGP grant	Yes	Project construction completed 2011.
Structural Project	Purchase and house spare pumps and associated electrical components at antiquated Marginal Pump Station to build in operating redundancy and prevent/limit flooding of downtown Haverhill during seasonal high water periods and flood emergencies.	Flooding	City Wastewater Dept.	Completed	City/FEMA-Hazard Mitigation Grant	Yes	Pumps purchased through floodwall recertification project.

Table 9-5 CITY OF HAVERHILL Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural	Work cooperatively with MassDOT Highway to rehabilitate the Route 125 Basiliere Bridge (Note: 2 other formerly Structurally Deficient bridge—Rocks Village & Bates Bridge were rehabbed/replaced in 2013 & 2011)	All Hazards	MassDOT Highway, City, Merrimack Valley MPO	Medium/High	MassDOT/MPO/ City. 2014/15 Status-in design by MassDOT Bridge Section	Yes	Project in design and programmed for construction beyond 2020
Structural	Recertification of Downtown Flood protection system installed in 1930s including: 1)Repairs and 2.5' addition to floodwall; 2)Repairs and cleaning of Little River conduit; and 3) Pump Station improvements including spare pumps purchase	Flooding	City Departments	Short Term/High	City--\$5.4 million project	Yes	Project underway 2015; FEMA approved accreditation; Map amendment is pending.
Prevention	Work with DCR Office of Dam Safety and dam owners to ensure timely dam inspections and maintenance, with next steps special attention to Millvale Reservoir Dam, Crystal Lake Dam, Lake Pentucket Dam, Frye Pond Dam, and Little River Dam	Flooding/ Dam Safety	DCR Office of Dam Safety, City, dam owners	Short-term/ Low	Dam Owners, DCR Office of Dam Safety; City and consultant development dam O & M plan	Yes	Dam management plans need to be prepared/updated.

Table 9-5 CITY OF HAVERHILL Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Prevention	Update Local Subdivision Rules and Regulations to require the maximum practicable use of Low Impact Development (LID) techniques in new development and redevelopment	All Hazards	City Planning Board	Medium Term/Low	City (LID projects approved thru waiver—regs pending)	Yes	LID projects approved thru negotiation waiver. Next step needed is formalizing process requirements with pending regulatory update.
Prevention	Amend local zoning to allow and promote the use of Open Space Residential Design as a tool to minimize impervious surfaces, maximize open space preservation and reduce stormwater runoff	All Hazards	City Council, in consultation with Planning Board and Conservation Commission	Short Term/ Medium	Zoning Review Committee/ Haverhill Planning & Community Development Dept.	Yes	Riverfront zoning overlay district enacted in 2014; Next steps: Zoning update to extend 40R zoning district overlay to Steven Street mill area along Little River.
Prevention	Incorporate hazard mitigation in local plans and initiatives (e.g. Capital Improvement Program, Master Plan, Open Space & Recreation Plan)	All Hazards	City Departments	Years 1-5/ High	City	Yes`	Next steps: Update Open Space & Recreation Plan expiring Oct. 2015
Mitigation/ Prevention	Bank repair/stabilization at Kenoza Lake. Silting from erosion exacerbated by rain events jeopardizes town water supply.	Flooding	City DPW	Medium Term/High	City/State or Federal grants including Mass. Land & Water Conservation Fund, DCS Mass. Energy & Environmental Affairs Drinking Water Supply Program, FEMA HMGP; Prelim construction cost estimate \$350k	No. This is a new action item.	DPW request \$70k for design/permitting funding in FY16 budget; Next steps include review of Winnekenni Park drainage, a contributing factor to erosion problem.

Table 9-5 CITY OF HAVERHILL Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural	Expand stream flow/drainage system capacity at North Avenue bridge/dam on Snow's Brook	Flooding	City DPW/Engineering/MassDOT/Merrimack Valley MPO	Year 1— Complete Design Year 2-- Construction	City/MassDOT/DCR Cost estimate based on prelim design phase \$1.6 million	No this is a new action item	Project in preliminary design phase by City/MassDOT/ 25% review meeting held. Need to program and identify construction funding.
Prevention	Adopt Stormwater Management Ordinance	Flooding	City Council/ Conservation/DPW Wastewater	Short-Term/Medium	MV Stormwater Collaborative/	No, this is a new action item	EPA MS4 permit to be issued 2016. City Ordinance incorporating permit requirements for new development needed.
Prevention	Enact Updates to Water Supply District Zoning for compliance with new requirements of 310 CMR 22. Updates include expanding list of prohibited land uses within Zone A.	All Hazards	City Council /Conservation/ DPW Water	Short-Term /Medium	City/MVPC/ MassDEP technical assistance	No, this is a new action item	Ordinance draft in review pending action. Awaiting MassDEP comment with expectation of submitting to City Council for approval end of 2015

Table 9-6 CITY OF LAWRENCE Mitigation Action Plan

Projects Completed							
Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resource Funding	Project Included in 2008 Plan	Project Status
Prevention	<i>Develop and adhere to routine inspection, cleaning and maintenance schedule for drainage/stormwater facilities</i>	Flooding	City DPW	Completed/ Maintenance Activity	City	Yes	IDDE Program in place 2015. Completed and ongoing maintenance activity.
Structural Project	Working with Mass Highway to replace the Hampshire Road Bridge Spanning the Spicket River near Marion & Erving Avenue.	All hazards	Mass Highway, City	Short term/ High	Mass Highway	Yes	COMPLETED in 2010
Structural Project	Working with Mass Highway to replace the East Haverhill Street Bridge Spanning the Spicket River near Newbury Street	All hazards	Mass Highway City	Short Term/ High	Mass Highway	Yes	COMPLETED in 2012
Structural Project	Lawrence Gateway/ Oxford Paper Mill Site Redevelopment Project to create several million gallons of new flood storage as part of the redevelopment	Flooding	City of Lawrence, Mass Highway, MVRTA	Long term/ Medium	Mass Highway, City of Lawrence, Private Money from Gencorp	Yes—Flood Storage and park phases of project	COMPLETED in 2012
Maintenance/ Emergency Response	Maintain eCEMP, Flood Hazard Mitigation Plan, and City components of this Plan to ensure their completeness and relevance in disaster mitigation and response	All hazards	City Departments	Annual/ HIGH	City, with advice and assistance from MVPC, DCR, MEMA	Yes	Completed Ongoing Maintenance Activity

Table 9-6 CITY OF LAWRENCE Mitigation Action Plan

Projects Completed							
Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resource Funding	Project Included in 2008 Plan	Project Status
Prevention	<i>Develop and adhere to routine inspection, cleaning and maintenance schedule for drainage/stormwater facilities</i>	Flooding	City DPW	Completed/ Maintenance Activity	City	Yes	IDDE Program in place 2015. Completed and ongoing maintenance activity.
Structural Project	Working with Mass Highway to replace the Hampshire Road Bridge Spanning the Spicket River near Marion & Erving Avenue.	All hazards	Mass Highway, City	Short term/ High	Mass Highway	Yes	COMPLETED in 2010
Structural Project	Working with Mass Highway to replace the East Haverhill Street Bridge Spanning the Spicket River near Newbury Street	All hazards	Mass Highway City	Short Term/ High	Mass Highway	Yes	COMPLETED in 2012
Structural Project	Lawrence Gateway/ Oxford Paper Mill Site Redevelopment Project to create several million gallons of new flood storage as part of the redevelopment	Flooding	City of Lawrence, Mass Highway, MVRTA	Long term/ Medium	Mass Highway, City of Lawrence, Private Money from Gencorp	Yes—Flood Storage and park phases of project	COMPLETED in 2012
Maintenance/ Emergency Response	Maintain eCEMP, Flood Hazard Mitigation Plan, and City components of this Plan to ensure their completeness and relevance in disaster mitigation and response	All hazards	City Departments	Annual/ HIGH	City, with advice and assistance from MVPC, DCR, MEMA	Yes	Completed Ongoing Maintenance Activity

Table 9-6 CITY OF LAWRENCE Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resource Funding	Project Included in 2008 Plan	Project Status
Prevention/ Property Protection	Reduce repetitive flood losses by acquiring property in high risk, recurrent flood districts through incentive programs and tax taking.	Flooding	City of Lawrence,	Year 1 to 5/ Low	City of Lawrence, FEMA Flood Mitigation/PDM/HMGP; Mass. Land & Water Conservation Fund; Cost estimate: High	Yes	Next step priorities include parcels along Spicket
Structural Project	Reconstruct/replace structurally deficient Amesbury Street bridge over South Canal	All hazards	MassDOT Highway/City/Merri mack Valley MPO	Long Term/Medium	MassHighway Bridge Program /MVMPO Cost estimate: High	No. This is new project ac tivity.	Identify funding with MassDOT for programming project on TIP.
Structural Project	Replace and reconfigure Daisy Street bridge to eliminate stream flow bottleneck and minimize area flooding hazard	Flooding	City DPW/MVMPO/ Community Development	Long Term/HIGH	City/MassDOT High Order of Magnitude Cost Estimate	No. This is a new project activity priority.	Next steps to include planning/design procurement and funding source identification.
Prevention	Consistent with phase II Program requirements, develop and implement drainage system maintenance plan to ensure regular inspection, cleaning and maintenance of municipal stormwater facilities and waterways	Flooding	Lawrence Public Works Dept., Conservation Commission	Year 1-5/ MEDIUM	City	Yes	EPA anticipated to issue final MS4 permit in 2016
Prevention	Strictly enforce and, as appropriate, upgrade City zoning bylaw, subdivision rules & regulations, and wetlands regulation to minimize incidence and impacts of flooding and other natural hazards	All hazards	Planning Department, ZBA, Planning Board	Medium Term/ HIGH	City	Yes	Next steps include land use regulatory review and update of stormwater ordinance for compliance with new MS4 permit

Table 9-6 CITY OF LAWRENCE Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resource Funding	Project Included in 2008 Plan	Project Status
Prevention	Incorporate hazard mitigation in local policies, plans, and programs (e.g. Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan)	All hazards	Planning Dept., Community Dev. Dept., Cons. Comm.	Medium Term/ MEDIUM	City	Yes	Open Space Plan approved—expires Jan. 2017
Prevention	Amend local subdivision rules & regulations to require the maximum practicable use of low impact development (LID) techniques in all new development and redevelopment	All hazards	Lawrence Planning Board	Short-term/ HIGH	City, With advice and assistance from EOEEA/CZM Smart Growth Staff/MVPC/MassDOT	Yes	Next steps: Implement Complete Streets model policy in upgrading network. Demonstration project in design 2015 is Merrimack St. corridor
Emergency Response	Develop and implement timely warning system (local access cable TV and/or radio) to alert public about pending floods and other hazard emergencies	All hazards	City Departments	Short-term/ LOW	City, with advice and assistance from DCR and MEMA	Yes	City website updated. Emergency management page needs agency links and public alert system.
Structural Project and Prevention	Analyze existing flooding problem areas and design/implement appropriate corrective measures, such as re-directing floodwaters to uninhabited areas or wetlands	Flooding	Lawrence Public Works and engineering Depts.	Long-term/ LOW	City, DCR, EPA Urban Waters Program	Yes	Next step to fund and procure master plan for storm drain improvements.

Table 9-6 CITY OF LAWRENCE Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resource Funding	Project Included in 2008 Plan	Project Status
Structural Project and Prevention	Develop a proactive program to analyze existing sewer backup locations and causes, and to design and implement appropriate corrective measures, rather than reacting to each incident after it occurs	Flooding	Lawrence Public Works and Engineering Depts.	Short-Term/ HIGH	City	Yes	Implementing IDDE Program 2015-16
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in Den Rock Park	Brushfire	Lawrence Fire Dept.	Long-term/ LOW	City, with advice and assistance from DCR	Yes	Next step coordination/consultation with DCR
Prevention/ Emergency Response	Create interdepartmental GIS database and mapping of municipal facilities and resources to enhance emergency operations and incident management	All hazards	City Departments	Long-term/HIGH	City, with technical assistance from MVPC and possible grant assistance from state/federal sources	Yes	Parcel mapping completed with MVPC 2015; implemented web-based mapping data access for municipal depts. Next steps is data collection/assembly of incidents, risk factors.
Prevention	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in all new development and redevelopment	Power Outages	Town Departments and Private Developers	Long-Term/ HIGH	City (for municipal facilities) and private Developers	Yes	Next steps include corridor improvement underground utility placement; coordination with mill redevelopments.

Table 9-6 CITY OF LAWRENCE Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resource Funding	Project Included in 2008 Plan	Project Status
Prevention/ Emergency Response	To reduce public risks from all natural hazards, establish and maintain city web page describing safety “tips and techniques” for hazard preparedness, mitigation, and response, with direct links to the MEMA and FEMA hazard mitigation websites.	All hazards	City Departments	Long-term/ MEDIUM	City, with advice from MEMA, DCR, and MVPC	Yes	City website updated 2015. Links and info need to be included on Emergency Management page.
Prevention/ Emergency Response	Participate in EPA’s “Geographic Response Program” to protect river resources	Flooding/Storms	City of Lawrence, EPA & DEP	Long Term/ MEDIUM	City of Lawrence & EPA	No, this is new action item	Multi-agency Planning process underway.
Structural Project and Prevention	Construct and/or reposition existing pumps along the Shawsheen River basin to improve low and prevent failure during flooding events.	Flooding	DPW, Private Contractor	Short Term HIGH	City of Lawrence, FEMA	No, this is new action item	Project funded and in phased implementation
Structural/ Property Protection	Upgrade capacity & reliability of sewer lifts stations with generators and pumps. Highest priorities are lift stations at Pembroke Drive and Pilgrim Road.	Flooding	DPW	Medium Term/ HIGH	City of Lawrence/MEMA/FEMA—HMGP/PDM Order of magnitude cost estimate is \$1 million per lift station.	No. This is a new activity priority.	Need for funding source to be identified. Potential grant proposal.
Emergency Services Protection	Replace for operational capacity 20+ year old generator at Lawrence Police Station (critical facility)	All hazards	Police Dept./Building Dept.	Medium Term/High	City of Lawrence/MEMA/FEMA-HMGP/PDM Order of magnitude cost estimate is \$100k	No. This is a new activity priority	Funding source to be identified/secured

Table 9-6 CITY OF LAWRENCE Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resource Funding	Project Included in 2008 Plan	Project Status
Emergency Services Protection	Install generators at Park Street and Howard Street fire stations and at City Hall, all critical facilities.	All hazards	DPW/Fire Dept./Building Dept.	Medium Term/High	City of Lawrence/MEMA/FEMA —HMGP/PDM Order of magnitude cost estimate is \$100k per facility	No. This is a new activity priority	Funding source to be identified.
Emergency Services Protection	Design and construct upgrades to South Broadway Fire Station. Critical facility has structural issues that compromise safety and use of facility.	All hazards	Fire Dept./Building Dept.	Long Term/High	City of Lawrence/state & federal grants—Exec Office of Public Safety Cost is projected to be moderate/high.	No. This is a new activity priority	Funding source to be identified. Next step is preliminary design & cost estimate development.
Prevention	Develop municipal facilities plan for comprehensive review and implementation strategy for prioritizing municipal Public Safety Facility upgrades, including potential reuse feasibility of previously closed neighborhood fire stations @ Bailey St. & Engine 8/Ames Street.	All Hazards	City Departments including Police/Fire/Building/Community Development/Mayor	Long Term/HIGH	City/State grants Estimated to cost \$100k to \$250k	No This is a new activity priority	Seed funding needed to initiate.
Prevention/ Emergency Services Protection	Relocate Municipal DPW garage/yard. Critical facility is in Spicket River floodplain and vulnerabilities include environmental risk and limited emergency access during flood events	Flooding	DPW/Community Development/Public Safety Depts.	Long Term/HIGH	City/State & federal grants—State Infrastructure Fund/CDBG Cost estimate is High	No. This is a new activity priority	Initial steps are to review siting options and prepare budget/financing plan.
Prevention	Implement systematic program of regular dam inspections and repairs.	Flooding	Building Commissioner/Community Development/DCR	Short Term/Medium	DCR/City	No. This is a new activity.	Next steps are to update protocols and schedule inspection updates.

Table 9-7 TOWN OF MERRIMAC Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resources Funding	Project included in 2008 Plan	Project Status
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	COMPLETED Years 1-5/HIGH	Town, with advice and assistance from MEMA, DCR and MVPC	Yes	Completed. Town adopted NFIP map change effective 7/3/2012 Ongoing administrative
Prevention	Identify non-compliant structures in the community, work with elected officials, the state, and FEMA to correct compliance issues and prevent future non-compliance through ongoing communication, training and education	All Hazards	Town Departments	COMPLETED	Town, with advice and assistance from MEMA, DCR and FEMA	Yes	Completed capacity and ongoing administrative action. Process in place through Town DPW/Building/ Public Safety review.

Table 9-7 TOWN OF MERRIMAC Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resources Funding	Project included in 2008 Plan	Project Status
Prevention	Maintain & update Comprehensive Emergency Management Plan (eCEMP) and local Natural Hazards PDM Plan to ensure completeness and relevance in disaster prevention, mitigation and response	All Hazards	Town Departments	COMPLETED	Town, with advice and assistance from MVPC, DCR and MEMA	Yes	Completed Project-Ongoing Maintenance Activity
Prevention	Update local Subdivision Rules and Regulations to require the maximum practicable use of Low Impact Development techniques in all new development and redevelopment Completed-No capacity gaps or next steps identified	Flooding/ Power Outages/ Brushfires	Planning Board	Completed/Ongoing review	Town, with advice and assistance from MVPC	Yes	Completed. Horsley Witten Engineering retained as consultant assisting in LID implementation/Planning Board reviews
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 outage/ Storms	Town Departments and private developers	Completed— Ongoing Capacity/Standard Practice	Town (for municipal facilities) and private developers	Yes	COMPLETED (Ongoing standard) Town as standard practice is requiring underground utilities in new developments per Town regulations.

Table 9-7 TOWN OF MERRIMAC Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resources Funding	Project included in 2008 Plan	Project Status
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 St.; • 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 DPW	Long –Term/HIGH	Town with state and/or federal grant support including MassDOT, FEMA (HMGP, PDM, Flood Mitigation)	Yes	<p>Of priority projects listed in 2008 Plan:</p> <p>*River Road abandoned as right of way in 2013 by Commonwealth given repetitive flood damage;</p> <p>*Mythical Street culvert replaced in 2009 by Town DPW</p>

Table 9-7 TOWN OF MERRIMAC Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resources Funding	Project included in 2008 Plan	Project Status
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	Town Departments	Long Term/Medium	Town, with advice and assistance from MVPC	Yes	Open Space & Recreation Plan has expired and needs update. Master Plan update to be organized based on funding.
Prevention	Consistent with most current MS4 permit for Massachusetts, prepare Stormwater Management Plan and implement to ensure regular inspection, cleaning and maintenance of municipal stormwater facilities and waterways. Next steps are to gear up for compliance with new MS4 requirements including inventory & Illicit discharge detection program development .	Flooding	Town DPW	Year 1-5/MEDIUM	Town, regional Stormwater Collaborative with MVPC	Yes	EPA anticipated to issue final MS4 Permit in 2016
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Brushfires	Fire Department	Long-term/LOW	Town, with advice and assistance of DCR	Yes	Staffing and budget issues. Need to coordinated with DCR as next step.

Table 9-7 TOWN OF MERRIMAC Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resources Funding	Project included in 2008 Plan	Project Status
Prevention	As opportunities arise, acquire and protect private undeveloped open space in flood hazard areas.	All Hazards	Conservation Commission, Open Space & Recreation Committee	Ongoing/MEDIUM	Town, with assistance of state DCS, Essex County Greenbelt, MVPC	Yes	Town has implemented LID tools including cluster development zoning & Water Resources Protection Area Overlay (updated 2011). Priority is to leverage open space/conservation restrictions in overlay district.
Public Education & 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	Town Departments	Long-term/MEDIUM	Town with advice from MEMA, DCR and MVPC	Yes	Website page has been formed including setup of Code Red but links need to be updated.
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	All Hazards	DPW/ School Dept./ Council on Aging/	Medium term/HIGH	Town with FEMA/MEMA grant assistance, potential HMGP Cost estimate approx. \$100k per facility.	No. This is a new project activity & priority.	Next step is to identify funding sources

Table 9-13 TOWN OF METHUEN Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention Maintenance	Develop and adhere to routine inspection, cleaning, and maintenance schedule for drainage/stormwater facilities and stream channels	Flooding	City DPW, in consultation and cooperation with Conservation Comm.	Completed-maintenance	City	Yes	Completed. This is ongoing Maintenance Project
Prevention	Work with DCR Office of Dam Safety and dam owners to ensure timely dam inspections and maintenance, with special attention to the City's three "significant hazard" dams: Spicket River Dam (Lowell St.), Forest Lake Dam, Searles Pond Dam	Flooding	DCR Office of Dam Safety, City, dam owners	Completed-maintenance	Dam owners, DCR Office of Dam Safety	Yes	This is ongoing maintenance activity coordinated between City & DCR
Prevention	Amend local zoning ordinance to allow and promote the use of Open Space Residential Design (OSRD) as a means to minimize impervious surfaces, maximize open space preservation, and reduce stormwater runoff	All Hazards	City Council, in consultation and cooperation with Planning Board and Conservation Commission	Short-term/ Low	Completed in 2008	Yes	OSRD adopted in 2008.
Prevention	Incorporate hazard mitigation in local plans and initiatives (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan)	All Hazards	City Departments	Completed/Ongoing Existing Capacity	City	Yes	Open space plan updated 2012-13 and valid thru Dec. 2019. Master planning update process completed 2007.CIP process annual.

Table 9-13 TOWN OF METHUEN Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in all new development and redevelopment	Power Outages/Storms	City Departments and Private Developers	Completed	City (for municipal facilities) and Private Developers	Yes	Subdivision Rules & Regs require underground utilities in new development.
Prevention/ Emergency Services Response	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 the MEMA and FEMA hazard mitigation websites.	All Hazards	City Departments	Completed	City, with advice for MEMA, DCR, and MVPC	Yes	City Web site updated 2015 with public safety links including MEMA, storm tips, power outage info. Methuen Police also has active social media with Twitter/Facebook alerts.

Table 9-13 TOWN OF METHUEN Mitigation Action Plan

Projects in Process

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Property Protection	Reduce repetitive flood losses along the Spicket River through flood-proofing and/or property acquisition Next steps are to organize planning process to identify and prioritize properties for protection.	Flooding	Property owners, City	Long-term/ HIGH	Property owners, City, FEMA-HMGP/PDM/Flood Mitigation, Mass. Land & Conservation Fund (tech. assistance and land acquisition funding)	Yes	No activity. Funding and staff resource limitations.
Property Protection/ Prevention	Work collaboratively with MA and NH state and municipal officials and upstream Spicket River dam operators to establish and implement an effective protocol for regulating river flow to prevent flooding Next step needs are to reestablish communications/coordination between DPW/Emergency Mgmt personnel in Methuen & Salem, NH.	Flooding	City, MA and NH state and municipal officials, dam owners/operators	Long-term/ HIGH	City, FEMA, MEMA, DCR, with coordinating assistance from MVPC	Yes	Protocols had been in place but have lapsed in recent years with change in personnel.
Structural Project	Design and construct drainage improvements to reduce Spicket River flooding at the Guilford RR Bridge "choke" point Next steps are for design and funding to incorporate bridge replacement into Rail Trail improvement project.	Flooding	City, MEMA, FEMA	Short-term/ HIGH	City, FEMA Mitigation-HMGP/PDM/Flood Mitigation, MassDOT Surface Transportation	Yes	City has received early phase funding for rail trail improvement.

Table 9-13 TOWN OF METHUEN Mitigation Action Plan

Projects in Process

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural Project	Design and construct drainage improvements to remedy recurring flooding along Bloody Brook in the vicinity of Swan and Jackson Streets	Flooding	City, MEMA FEMA	Short-term/ HIGH	City, FEMA Mitigation-HMGP/PDM/Flood Mitigation	Yes	Culvert capacity improvement completed between Curtis and Swan Streets in 2011/12. Downstream system capacity improvement needed in Methuen and Lawrence.
Structural Project	Work cooperatively with MassHighway to rehabilitate the "structurally deficient" Hampshire Road Bridge spanning the Spicket River near the Methuen - Salem NH town line. Next steps are to seek design funding and TIP programming through MPO & MassDOT Highway for bridge rehab and flow capacity improvement.	All Hazards	MassHighway, City, MVPC/Merrimack Valley MPO	Short-term/ HIGH	MassDOT Highway	Yes	No action as project not funded in Regional Bridge Program.
Prevention	Amend local Subdivision Rules and Regulations to require the maximum practicable use of Low Impact Development (LID) techniques in all new development and redevelopment projects Next steps are to establish LID standards by Community Development Board.	All Hazards	City Community Development Board/staff	Short-term/ LOW	City	Yes	Subdivision Regulations amended to incorporate LID practice/principles. Standards for LID needed.
Prevention	Adopt "Steep Slope" regulation to prohibit or strictly regulate development on steep slopes in order to reduce stormwater runoff and erosion	All Hazards	City Council, in consultation and cooperation with Planning Board and Conservation Commission	Short-term/ MEDIUM	City	Yes	No action to date because of other priorities.

Table 9-13 TOWN OF METHUEN Mitigation Action Plan

Projects in Process

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
	Next steps: Community Development Dept. Board draft and review						
Prevention	Develop and implement Fire Wise Program for forested areas and neighborhoods in cooperation with DCR	Brush fire	City Fire Department	Long-term/ MEDIUM	City, with assistance from DCR	Yes	No action to date because of other priorities/staff & budget constraints Next steps for consideration would be to coordinate with DCR technical assistance.
Emergency Services Protection	Replace 97-year-old East fire station building at Salem/East Stret with new, expanded capacity facility	All Hazards	Fire Dept/Community Development/Bldg Dept.	Long Term/High	City/State Public Safety agency grants Order of magnitude cost is \$6.5 million	No. This is a new project activity	Next steps to include developing finance plan, design & site selection.
Emergency Services Protection	Upgrade Central Fire Station for space and communications capacity	All Hazards	Fire Dept.	Medium Term/High	City/State Public Safety grants	No. This is a new project activity	Next steps to include finance plan and concept design.
Emergency Services Protection	Develop plan program of upgrading/replacing City emergency vehicle fleet including fire pumper, ladder truck, ambulances.	All Hazards	Fire Dept.	Medium Term/High	City/State Public Safety grants Fleet upgrade needs project to total more than \$6.5 million over 6 years.	No. This is a new project activity.	Next steps involve finance plan for authorization.
Structural	Drainage system capacity improvements including resized pipes at area of Tobey Ave/Grandview Road	Flooding	DPW	Medium Term/Medium	City/FEMA HMGP/PDM/Flood Mitigation	No. This is a new project activity	Next steps include design/funding justification.
Public Education & Awareness	Develop & implementation city-wide emergency notification system (Code Red of Reverse 911)	All Hazards	City Departments	Short Term/High	City/ State Public Safety	No. This is a new project activity	Priority for updating City Public Safety communication. Police App in place 2015 with site links to FEMA. Next step for Public Safety Depts to investigate public notification options with IT staff consultants.

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	Continue to participate in the NFIP and strictly enforce local floodplain regulations, building code, and other by-laws 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	Building Commissioner/ Floodplain Manager; Conservation Commission; Planning Department; Emergency Management Director	COMPLETED	Town with Advice and assistance from MEMA and DCR; Low order of magnitude cost	Yes	COMPLETED with ongoing Administration.. Town continuing to participate in NFIP; by-laws in place; some regulations currently being revised (see below).
Prevention	Revise Town's Flood Hazard Overlay District By-Law to incorporate FIRM updates	Flooding	Planning Department/ Planning Board	COMPLETED	Town with assistance from DCR/ Low order of magnitude cost (public hearing)	No	Updates for 2012 and 2014 FIRM COMPLETE
Prevention	Identify non-compliant structures in the community; work w/ elected officials, the state, and FEMA to correct compliance issues and prevent future non-compliance through ongoing communication, training, and education.	Flooding	Building Commissioner/ Floodplain Manager; Conservation Commission; Highway Department	COMPLETED	Town, with advice and assistance from MEMA, DCR and FEMA; Low to Medium order of magnitude cost	Yes	Process in place/ongoing administrative activity
Prevention	Maintain current list of flood damaged properties and buildings, including Repetitive Loss properties; encourage property owners	Flooding	Building Commissioner/ Floodplain Manager; Conservation Commission; Police Chief/Emergency	COMPLETED	Town, with advice and information from DCR, FEMA, and MEMA; Low order of	Yes	Process in place/ongoing administrative activity

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
	to explore and implement appropriate mitigation measures		Management Director; Planning Department		magnitude cost estimate		
Prevention	Provide information to residents regarding FEMA elevation and acquisition grant programs; assist residents interested in applying for grants	Flooding	Emergency Management Director; Conservation Agent; Town Planner	COMPLETED	Town, with advice and assistance from MVPC, DCR, MEMA; Low order of magnitude cost estimate	No	Info system procedure in place. Ongoing administration / Reviewed for each grant round
Prevention	Maintain CEMP and Newbury components of this Natural Hazards Pre-Disaster Mitigation Plan to ensure their completeness and relevance in disaster preparedness, mitigation, and response	All Hazards	Planning Department; Police Department/ Emergency Management Director; Inspectional Services; Fire Department; Health Department; Highway Department	COMPLETED	Town, with advice and assistance from MVPC, DCR, MEMA; Low order of magnitude cost estimate	Yes	COMPLETE and ongoing; reviewed bi-annually
Prevention	Amend Rules and Regulations for Stormwater Management, Illicit Discharge, and Erosion Control to require LID drainage design in both upland and wetland areas for all projects not specifically excluded by the Mass DEP Stormwater Handbook, including projects to be built under the Subdivision Rules and Regulations	Flooding	Planning Board; Planning Department; Conservation Commission	COMPLETED	Town Boards and Committees/ Merrimack Valley Stormwater Collaborative	No.	COMPLETE

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Structural Project/ Prevention	Install new culvert at Middle Road to mitigate chronic flooding of roadway and adjacent properties	Flooding	Town Administrator; Highway Department; Conservation Commission	Complete 2014	Town, with advice and assistance from professional engineers/	No, This is a new activity not included in 2008 plan.	COMPLETE
Prevention	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in all new development and redevelopment;	Wind/Storm/ Power Outage	Planning Department; Conservation Commission; Health Department; and Private Developers	Years 1-5/ MEDIUM	Town (for municipal facilities) and Private Developers; Order of Magnitude Cost to Town-Low	Yes	COMPLETE; Required in Subdivision Rules and Regulations
Prevention	To reduce risk and incidence of localized stream flooding, implement proactive program of beaver management in concert with replacement of culverts to increase capacity (e.g. Wolf Brook at Scotland Road) where needed	Flooding	Conservation/ Health Dept.	Completed/ Beaver mgmt program in effect	Town	No	Board of Health and Conservation Dept have program in place and contract with animal trapper.

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Prevention	Amend local Subdivision Rules and Regulations to incorporate Town's Stormwater Regulations and require the maximum practicable use of Low Impact Development (LID) techniques in all new development and redevelopment	Flooding	Planning Board; Planning Department	Short Term-To Be complete 2015-16 / MEDIUM	Town, with advice and assistance from MVPC; Low order of magnitude cost	Yes	In Process; final draft to be issued for review . Draft includes changes in ROW requirements, updates administration process, and applies stormwater requirements consistent with local bylaw.
Prevention	In coordination with Newburyport, conduct comprehensive watershed study of the Little River to identify flow restrictions causing flooding in the Newburyport Industrial Park and develop plan to address hydro-barriers to mitigate flooding in this area without shifting flood hazard to other developed areas downstream	Flooding	Town Administrator; Conservation Commission; Highway Department; Planning Department	Short-Term/ HIGH	Town, in cooperation with Newburyport and with advice and assistance from professional engineers/ Medium-High cost estimate	No, new activity	Next Steps: Define planning scope with Newburyport/regional partners; secure funding; procure consulting services.
Prevention/ Emergency Management	Enhance warning systems for all natural hazards and emergencies through real time updates on Police Department webpage and FaceBook and through continued use of Code Red system	All Hazards	Town Departments, esp. Police and Emergency Management Director	Years 1-5/Maintain existing capacity and develop media pages	Town	No	Code Red implemented 2011; webpage and FaceBook pages in development

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural Project/ Prevention	Identify drainage system capacity improvement needs in areas subject to flooding; seek grants to fund engineering studies, alternatives analyses, project design, and construction. <ul style="list-style-type: none"> • Middle Road (completed with new culvert 2014 at cost of \$38,880 Town funds) • Scotland Road at Wolf Brook, at Highfield Rd. intersection, and at Pikul Field • Hanover Street at Little River • Larkin Road at bridge • Hay Street at Quill Pond and south of Newman Rd. • Newburyport Tpk. north of Old Newbury Golf Course 	Flooding	Town Administrator; Highway Department, Conservation Commission; Stormwater Committee	Years 1-5/ MEDIUM	Town with grant writing assistance from MVPC/ FEMA hazard mitigation grants (HMGP/PDM/Flood Mitigation) for construction with local Town match Order of magnitude Cost-Medium to High	Yes (with specific locations identified for 2015 Plan update)	Newbury is included in the PIE-Rivers stream continuity project administered by the Ipswich River Watershed Association. Barriers to wildlife passage have been identified, and constraints on the proper functioning of the Town drainage system are presently being studied. This study will be used in the application for construction grants when completed.
Prevention	Participate in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate the public	Flooding	Building Inspector/ Floodplain Manager	Annual/ MEDIUM	Town, with advice and assistance from MEMA and DCR Order of Magnitude Cost-Low	Yes	Next steps: Program evaluation by Building Inspector.
Prevention	Incorporate hazard mitigation in local policies, plans, and programs (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan)	All Hazards	Planning Department; Planning Board; Capital Improvement Committee; Conservation Commission; Open Space Committee; Stormwater Management Team; Highway Dept.	Short-Term/ MEDIUM	Town, with advice and assistance from MVPC; Order of Magnitude Cost-Low	Yes	Master Plan Update in process (to be completed 2016); hazard mitigation to be addressed in the various Plan elements. Open Space & Recreation Plan Update to follow.

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural Project/ Prevention	<p>Continue to actively pursue funding and evaluate/implement appropriate corrective and preventive measures to address current and long-term Plum Island beach erosion and flooding problems:</p> <ul style="list-style-type: none"> • Encourage participation in FEMA Hazard Grant Mitigation Program • Assist interested residents in applying for elevation and land acquisition grants • Participate in UNH dune restoration project (north of Plum Island Center) 	Flooding & Erosion	Board of Selectmen; Emergency Management Team; Conservation Commission; Planning Department; Merrimack River Beach Alliance (MRBA)	Years 1-5/ HIGH	Town, in cooperation with and with support from Army Corps of Engineers, FEMA , DCR, DEP and other appropriate entities ; Order of Magnitude Cost-High	Yes	Next steps include resident outreach and property prioritization through partners including MRBA forums/planning
Prevention	<p>Work cooperatively among town boards and departments and with property owners in flood hazard and coastal storm surge zones to identify and implement effective hazard mitigation measures; incorporate climate change/sea level rise adaptation considerations in future hazard mitigation planning and implementation</p> <ul style="list-style-type: none"> • Representatives from all relevant Town Boards and Committees are participating in the Great Marsh Coastal Community Resiliency Project Task Force (Sandy Grant) and have contributed to the 	Flooding	Conservation Commission; Building Commissioner/ Floodplain Manager; Planning Department/Planning Board; Board of Health; Highway Department	Years 1-5/ HIGH	Town, in cooperation with and with support from CZM Storm Smart Coast Program, DCR, MVPC, Eight Towns and the Great Marsh, MRBA; also, for Coastal Resiliency Project, National Wildlife Federation; Ipswich River Watershed Association/ Order of Magnitude Cost-Medium to High/Resiliency Project funded through Sandy Resiliency Planning Grant	Yes	Great Marsh Coastal Community Resiliency Planning Project currently ongoing; Task Force report completion 2016

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
	<p>identification of climate change/sea level rise vulnerabilities. Project will result in Adaptation Plan to be incorporated into future hazard mitigation and master planning</p>						
Prevention	<p>Through MRBA, seek State and Federal funding to dredge sand from rivers and streams in North Shore communities and southern New Hampshire (e.g. Essex, Ipswich, Agawam, and Piscataqua Rivers) for Plum Island Beach nourishment</p>	Flooding & Erosion	Board of Selectmen; Town Administrator; Conservation Commission;	Years 1-5/ HIGH	Town, MRBA, Army Corps of Engineers, DCR, Seacoast Economic Council Program, State Legislators/Order of Magnitude Cost – High	No, new activity	Next steps include funding advocacy work of MRBA and permitting
Prevention	<p>Reduce storm vulnerability and increase resiliency through restoration of Great Marsh habitat:</p> <ul style="list-style-type: none"> • Eliminate invasive species such as pepperweed and phragmites australis • Study water-flow patterns and the movement of sediment • Assess and prioritize of barriers that can affect river flow 	Flooding/ Storm Damage	Board of Selectmen; Conservation Commission	1-2 years/ HIGH	<p>National Wildlife Federation; Ipswich River Watershed Association; University of New Hampshire; Great Marsh Revitalization Task Force; MVPC/ Hurricane Sandy Coastal Resiliency Competitive Grant Program; \$1.2 million grant executed by MVPC & National Wildlife Federation Jan. 2015</p>	No, new activity	Activities initiated in 2015 with Sandy Grant funding. To be completed 2017.

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Prevention	Consistent with NPDES Phase II Program requirements, develop and implement drainage system maintenance plan to ensure regular inspection, cleaning and maintenance of municipal stormwater facilities and waterways. Next steps include development of Stormwater Management Plan, development of Illicit Discharge Detection Program and infrastructure inventory.	Flooding	Highway Department, Conservation Commission; Stormwater Management Team	Years 1-5 MEDIUM	Town, Merrimack Valley Stormwater Collaborative/Order of Magnitude Cost-Medium	Yes	EPA MS4 Permit anticipated to be issued in 2016. Town Stormwater Committee is in place.
Prevention/ Emergency Management	To reduce public risks from all natural hazards, establish and maintain Town web page and Police Department web page and FaceBook page offering safety “tips and techniques” for hazard preparedness, mitigation, and response, with direct links to the MEMA and FEMA hazard mitigation websites.	All Hazards	Conservation Commission; Building Commissioner/Floodplain Manager; Town Clerk; Police; Emergency Management Director	Immediate, with Quarterly updates/ MEDIUM	Town, with advice from MEMA, DCR, and MVPC; Order of Magnitude Cost-Low	Yes	Website updates and social media launch are pending.
Emergency Management	Complete feasibility study and seek Town Meeting and ballot approval to proceed with design and construction of new Public Safety Facility.	Emergency Response	Board of Selectmen; Town Administrator; Municipal Building Committee; Finance Committee; Capital Planning Committee	Years 1-5/ HIGH	Tax Override – Debt Exclusion/Order of Magnitude Cost -- HIGH	No, This is a new activity	Funding approved for additional study, to be presented at April 2016 ATM
Prevention/Emergency Management	Make residents aware of emergency procedures and resources, through publications such as “Public Health Emergency Preparedness Handbook”	All Hazards, and public health emergencies	Board of Health; Emergency Management	Years 1-5/ MEDIUM	Town/ Funding magnitude Low	No	Handbook complete. Next step to include distribution plan for residents.

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Brushfire	Fire Department	Long-term/ LOW	Town, with advice and assistance from DCR/ Order of Magnitude Cost-Low	Yes	No action taken on this activity because of resource constraints, other priorities. Next step for consideration is review with DCR.
Prevention	Finalize Highway Operations and Safety Manual outlining roadway maintenance practices and procedures to be followed for stormwater management	Flooding	Conservation Commission; Highway Department; Stormwater Committee	Short-Term/ HIGH	Town/ Order of Magnitude Cost-Medium	No, this is a new action item.	Preparation of an O & M Plan for Town Facilities relative to stormwater management is being prepared by Stormwater Committee and volunteers. This document will deal with inspection, maintenance, and improvement of the Town's drainage system and will become part of the Stormwater Pollution Prevention Plan for Town Facilities
Emergency Response	Purchase TriTech Perform Fire software to create integrated and efficient emergency response network among Police, EMA, EMS, and Fire	All Hazards	Fire, Police, EMA, EMS	Year 1/ Medium	Donation from Governor's Academy and funding from Town	No, this is new activity	Funding approved; software to be purchased
Emergency Management	Complete design and construction of emergency access route on Plum Island north of PI Center; seek funding for construction	All Hazards	Town Administrator; Board of Selectmen; Conservation Commission	Years 1-5/ High	Town in cooperation with State Legislators and agencies/Merrimack Valley MPO state/federal transportation funding HIGH	No, new activity	Survey work underway; funding needed for design and construction

Table 9-9 TOWN OF NEWBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Prevention	Seek funding to implement recommendations of 2010 Gomez and Sullivan feasibility study regarding the Larkin Mill Dam on the Parker River – permitting, design, and breach/partial removal of the dam. Breach will prevent uncontrolled failure and allow for sediment transport downstream to raise elevations in the Great Marsh and thereby aid in Marsh adaptation to sea level rise	Flooding/ Dam Failure	Town Administrator; Board of Selectmen; Conservation Commission	Years 1-5/ MEDIUM	Town in cooperation with MDCR, Gulf of Maine Council/National Estuary Program, and NOAA, FEMA Hazard Mitigation Grants HIGH	No, new activity	Grant opportunities to be pursued including FEMA Hazard Mitigation Grant or Pre-Disaster Mitigation Program potential with 25% local match

Table 9-10 CITY OF NEWBURYPORT Mitigation Action Plan

Projects in Development							
Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Emergency Response	Review & update mutual aid agreements with adjacent towns (Essex County) and state (MA and Southern NH) for accuracy and sufficiency	All Hazards	Fire, Police, DPS	Short Term/HIGH	City Legal	No/ Newburyport was not participating community in 2008 region plan	In Process of department legal review
Prevention	Update zoning and building codes; consider enacting stricter standards for new development in terms of storm drainage, wind bracing, and floodplain development	All Hazards	Planning/Zoning Boards	Medium-Term/Moderate	Professional Planning Department	No	Zoning review process underway 2015 inc. consideration of waterfront overlay district;
Planning	Prepare Municipal Resiliency Plan for Sea Level Rise/Storm Surge Climate Change (plan for 2 to 5 feet sea level rise by 2100) Next steps include hiring resiliency coordinator, adding municipal or regional circuit rider staff capacity to lead effort.	Flooding	Conservation/Engineering	Short-Term/High	EPA technical assistance workshops; MVPC, CZM Grants/Community foundations/ Local; cost estimate \$70,000	No	Two initiatives: Sandy Resiliency Project planning to be complete 2017; EPA workshops/charette Fall 2015;
Planning	Update Stormwater Management Program for compliance with pending EPA MS4 permit and identify sustainable funding source for implementation	Flooding	DPS/Engineering	Short-Term/High	EPA technical assistance/ City/ Merrimack Valley Stormwater Collaborative; Local/ Cost range Medium to High for implementation	No	Action pending issuance of EPA final MS4 permit in 2016
Planning/Regulatory	Maintain natural resource buffer zones and increase capacity for enforcement of environmental regulations	Flooding/ Storms	Planning/Conservation	Short-Term/High	Local ordinances/staffing	No	
Public Education & Awareness	Education programs and outreach on Natural Hazard preparedness and mitigation	All Hazards	Emergency Mgmt	Short-Term/HIGH	Local Emergency Management Team/ MVPC/MEMA/Storm Surge civic group/ Merrimack River Beach Alliance	No	Next steps include Sandy Coastal Resiliency planning forums; EPA, Flood Resilience workshops-Fall 2015; non profit sponsored community presentations
Emergency Response	Review & update mutual aid agreements with adjacent towns (Essex County) and state (MA and Southern NH) for accuracy and sufficiency	All Hazards	Fire, Police, DPS	Short Term/HIGH	City Legal	No/ Newburyport was not participating community in 2008 region plan	In Process of department legal review

Table 9-10 CITY OF NEWBURYPORT Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Prevention	Update zoning and building codes; consider enacting stricter standards for new development in terms of storm drainage, wind bracing, and floodplain development	All Hazards	Planning/Zoning Boards	Medium-Term/Moderate	Professional Planning Department	No	Zoning review process underway 2015 inc. consideration of waterfront overlay district;
Planning	Prepare Municipal Resiliency Plan for Sea Level Rise/Storm Surge Climate Change (plan for 2 to 5 feet sea level rise by 2100) Next steps include hiring resiliency coordinator, adding municipal or regional circuit rider staff capacity to lead effort.	Flooding	Conservation/Engineering	Short-Term/High	EPA technical assistance workshops; MVPC, CZM Grants/Community foundations/ Local; cost estimate \$70,000	No	Two initiatives: Sandy Resiliency Project planning to be complete 2017; EPA workshops/charette Fall 2015;
Planning	Update Stormwater Management Program for compliance with pending EPA MS4 permit and identify sustainable funding source for implementation	Flooding	DPS/Engineering	Short-Term/High	EPA technical assistance/ City/ Merrimack Valley Stormwater Collaborative; Local/ Cost range Medium to High for implementation	No	Action pending issuance of EPA final MS4 permit in 2016
Planning/Regulatory	Maintain natural resource buffer zones and increase capacity for enforcement of environmental regulations	Flooding/ Storms	Planning/Conservation DPS	Short-Term/High	Planning/Conservation Dept; DPS	No	Local Wetlands Protection Ordinance in place and effective. Gap to be addressed is need for additional inspection staffing for effective enforcement.
Public Education & Awareness	Education programs and outreach on Natural Hazard preparedness and mitigation	All Hazards	Emergency Mgmt	Short-Term/HIGH	Local Emergency Management Team/ MVPC/MEMA/Storm Surge civic group/ Merrimack River Beach Alliance	No	Next steps include Sandy Coastal Resiliency planning forums; EPA, Flood Resilience workshops-Fall 2015; non profit sponsored community presentations
Structural	Replace culvert Parker/Scotland at city line with additional capacity as recommended in the Malcolm Hoyt Road Drainage Improvement Flood Study Dec. 2011	Flooding	DPS/Engineering	Medium Term/High	Local/State grants; cost estimate \$750k	No	Highest priority storm drain mitigation project

Table 9-10 CITY OF NEWBURYPORT Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural	Improve drainage capacity at Business & Technology Park watershed area: Improvements to include short-term swale restoration and culvert upgrades. Areas targeted are Graf Road/Quail Run Hollow/Malcolm Hoyt Dr.; Hale St by pump station.	Flooding/ Storms	DPS	Long-Term/HIGH	Stormwater Improvement Plan developed; City/State Infrastructure grants	No	2 nd Highest priority storm drain capacity project
Structural	Investigate feasibility of elevating Plum Island Turnpike key access roadway vulnerable to flooding/sea level rise	Flooding/ Storms	DPS	Long-Term/MEDIUM	City/State Infrastructure planning/design grants	No	Funding for engineering study needs to be identified.
Structural	Improve drainage capacity with storage/culvert improvements at Cashman Park area.	Flooding/ Storms	DPS	Long-Term/MEDIUM	Stormwater Improvement Plan developed; City/State Infrastructure grants inc. Seaport Economic Council program grants.	No	Included in 2011 Stormwater Management Plan DPS
Structural	Evaluate and correct drainage capacity structural problem @ Market Square.	Flooding	DPS/Engineering	Short-Term/High	Local/ State grants including MassDOT/Economic Affairs-MassWorks Infrastructure.	No	Immediate term solution is construction of swale to be constructed by DPS in-house staff 2015-2016
Structural	Roadway improvements including drainage capacity upgrade at Merrimac St in area of Mersen USA & pump station.	Flooding	DPS/Engineering	Long-Term/MEDIUM	Local/ State & Federal grants—MassDOT Surface Transportation; FEMA HMGP/PDM/Flood Mitigation	No	Localized flooding problem at this location which is key access gateway route to downtown. Project included in drainage master plan.
Structural	Feasibility study of options to protect Wastewater Treatment Plan, now vulnerable to sea level rise. Options to include elevation, relocation, or barrier protection.	Flooding	DPS/Engineering	Medium Term/High	Local/State grants—DEP State Revolving Fund for Wastewater.	No	Issue raised in climate change resilience planning forums
Structural	Floodproof sewage pump stations	Flooding	DPS	Long-Term/HIGH	City/State (MassWorks)/FEMA including HMGP/PDM/ grants	No	As many as 9 potentially vulnerable with sea level rise
Prevention	Thin overcrowded forests	Brushfires	Fire/DPS	Long-Term/MEDIUM	Local/ State DCR	No	Focus vulnerable wooded areas March's Hill, Maudslay.

Table 9-10 CITY OF NEWBURYPORT Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Emergency Services	Renovate DPS facility to accommodate City employees during severe weather events & disasters. Facility has had long-term use of "temporary" office trailers.	All Hazards	DPS	Medium Term/MEDIUM	Local	No	Next step is develop revised bid package or seek additional funding after project bids came in over budget 2015.
Emergency Services	Purchase firefighting equipment—Two fire trucks in procurement 2015	All Hazards	Fire	Short Term/HIGH	Local	No	Action is emergency services response need.
Structural	Provide redundant water and sewer systems. Target focus of Plum Island which is vulnerable to breach.	All Hazards	DPS	Long-Term/MEDIUM	Local/State Infrastructure Fund	No	Next step of feasibility study/design
Structural	Extend T1 hardware communications between municipal communication systems to DPS facility and PITA Hall	All Hazards	DPS	Short-Term/HIGH	Local/State grants—Exec. Office of Public Safety. Order of magnitude cost est. \$50k to \$100k	No	ID budget funding.

Table 9-11 TOWN OF NORTH ANDOVER Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Structural Project	Design and construct physical upgrades to 37 sewer manholes that flow to Rae's Pond sewer lift station to prevent recurring sewer surcharging and potential degradation of Lake Cochichewick, Town's primary drinking water source	Flooding	Town Engineering and Public Works Departments	Completed	FEMA, MEMA Hazard Mitigation Grant Program, Town	Yes	COMPLETED 2010
Structural Project	Design and construct physical improvements to sewer manholes that flow to Winter Street lift station to prevent recurring sewer surcharging and potential degradation of Lake Cochichewick	Flooding	Town Engineering and Public Works Departments	Completed	FEMA, MEMA, Hazard Mitigation Grant Program, Town	Yes	COMPLETED 2010
Structural Project	Rebuild sluice outlet controlling Lake Cochichewick water level	Flooding	Town Engineering and Public Works Departments	Completed	Town	Yes	COMPLETED 2007/8
Structural Project	Refurbish Lake Cochichewick outlet dam		Town Engineering and Public Works Departments	Completed	Town	Yes	COMPLETED 2007/8
Prevention	Amend local subdivision rules & regulations to require the maximum practicable use of low impact development (LID) techniques in all new development and redevelopment	All Hazards	North Andover Planning Board	Completed	Town, with advice and assistance from EOEEA/CZM Smart Growth staff	Yes	Completed. Subdivision regs and Planning Board practice incorporate LID standards. Monitor and review.
Prevention	Maintain CEMP, Flood Hazard Mitigation Plan, and North Andover components of this Plan to ensure their completeness and relevance in disaster mitigation and response	All Hazards	Town departments	Completed	Town, with advice and assistance from MVPC, DCR, MEMA	Yes	This is a Completed ongoing emergency response agency activity
Prevention	Minimize impervious surfaces and decrease stormwater runoff through use of LID.	Flooding	North Andover Conservation Commission Planning Board	Completed	Town	No	Completed. Subdivision regs and Planning Board practice incorporate LID standards. Monitor and review.

Table 9-11 TOWN OF NORTH ANDOVER Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	Issue General Permit (Order of Conditions) to DPW to assist with routine maintenance.	Flooding	North Andover Conservation Commission	Completed	Town	No	Completed. General maintenance permit issued.
Prevention/ Public Education & Awareness	Conservation Commission education through MACC – educating Commission members to increase enforcement of state and local wetland laws.	Flooding	North Andover Conservation Commission	Completed	Town	No	Completed. Town staff and Commission members are active participants in MACC training programs. Ongoing effort.
Prevention/ Emergency Services	Develop and implement timely warning system (local access cable TV and/or radio) to alert public about pending floods and other hazard emergencies	All Hazards	Town departments	Completed	Town, with advice and assistance from DCR and MEMA	Yes	Completed. Blackboard Connect Communication system in place for resident notification
Structural Project and Prevention	Implement drainage improvements to remedy recurring flooding problems along and around Mosquito Brook	Flooding	North Andover Public Works and Engineering Depts., Conservation Commission	Completed	Town	Yes	Project completed 2009. \$500,000 project included repair, resizing of culverts at Winter St., Foster St., and Rocky Brook Road.
Structural Project and Prevention	Implement drainage improvements to remedy recurring flooding problems along and around Lost Pond	Flooding	North Andover Public Works and Engineering Depts., Conservation Commission	Completed	Town	Yes	Project completed with Mosquito Brook improvements 2009.
Prevention	Maintain current list of Repetitive Loss properties; encourage property owners to explore and implement appropriate mitigation measures	Flooding	North Andover Public Works and Engineering Depts.	Completed/in place	Town, with advice and information from DCR and MEMA	Yes	Completed Activity. Ongoing administrative capacity effort.

Table 9-11 TOWN OF NORTH ANDOVER Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in all new development and redevelopment	Power Outages/Storms	Town Departments and Private Developers	Completed.	Town (for municipal facilities) and Private Developers	Yes	Completed. Planning Board practice and regulations require underground utilities standard.
Prevention	To mitigate against damage from earthquakes and landslides, actively enforce applicable state and municipal building codes	Earthquakes/ Landslides	North Andover Building Inspection Dept.	Completed/In place	Town	Yes	Completed. This is on ongoing administrative capacity effort.

Table 9-11. TOWN OF NORTH ANDOVER Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Structural Project	Replacement of the Raes Pond sewer pump station and relocation out of floodplain. The existing 1992 pump station is under capacity for the service area and during extreme wet weather, potential for overflow threatens contamination of the adjacent Town water supply.	Flooding	Town Engineering and Public Works Departments	Short-Term/High Priority	Town Sewer Capital Fund Cost Est. \$1.65 million	No. New activity.	Project is designed and programmed in capital budget. Out for construction bid 2015; 9 months to construct.
Prevention	Acquire/protect undeveloped open space in flood hazard areas, with special attention to properties in Lake Cochichewick watershed Next step priorities include appraisal, negotiations, funding identification targeted for watershed including Rockwell property available and adjacent to Half Mile Hill & Edgewood	Flooding	North Andover CPA Committee and Conservation Commission	Years 1 to 5 /Medium	Community Preservation Act funds; DCS Self-Help Program grants, conservation restriction easements	Yes	Accomplishments since 2008 include: *Conservation restriction at Rolling Ridge secured in 2011 with DEP Water Supply grant & CPA funding; *3.3 acre parcel at Wintergreen by Rocky Brook & Mosquito Brook donated to Town for conservation; *Conservation restriction at Maplewood Reserve abutting Harold Parker State Forest secured 2015
Prevention	Consistent with Phase II Program requirements, develop and implement drainage system maintenance plan to ensure regular inspection, cleaning, and maintenance of municipal	Flooding	North Andover Public Works Dept., Conservation Commission	Years 1 to 5 /Medium	Town/ Merrimack Valley Stormwater Collaborative/ Greenscapes	Yes	Anticipated that EPA will issue final MS4 permit in 2016

Table 9-11. TOWN OF NORTH ANDOVER Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
	stormwater facilities and waterways Next steps include update of Stormwater Management Plan, development of O & M facility plans, preparation of system inventory, and organization of Illicit Discharge Detection Program.						
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 Next steps in Town's regulatory structure includes streamlining stormwater standards & requirements among Town's zoning, wetlands, subdivision bylaws & regulations.	All Hazards	Town departments	Years 1 to 5 /Medium	Town	Yes	Town's zoning, subdivision rules incorporate LID practice.
Prevention	Incorporate hazard mitigation in local policies, plans, and programs (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan) Next steps include setting up schedule, tasks for Master Plan Update	All Hazards	Town departments	Year 2-5/Medium	Town	Yes	Open Space Plan updated 2015; CIP prepared annually; Stormwater Management Plan to be updated with issuance of new MS4 permit by EPA (in Year 2)

Table 9-11. TOWN OF NORTH ANDOVER Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	Explore participation in NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public Next step is to review program, options with MEMA/DCR staff	Flooding	Town	Long-term/Low	Town, with advice and assistance from DCR and MEMA	Yes	Limited staff time, availability to advance this activity; Other more pressing priorities.
Structural Project and Prevention	Analyze existing flooding problem areas and design/implement appropriate corrective measures, such as re-directing floodwaters to uninhabited areas or wetlands	Flooding	North Andover Public Works and Engineering Depts.	Long-term/Low	Town, /DCR— Fish & Game- Division of Ecological Restoration	Yes	Next steps include budgeting & procuring services for feasibility studies/master plan.
Structural Project and Prevention	Develop a proactive program to analyze existing sewer backup locations and causes, and to design and implement appropriate corrective measures, rather than reacting to each incident after it occurs	Flooding	North Andover Public Works and Engineering Depts.	Long-term/High	Town	Yes	Next Steps involve budgeting & procurement of engineering services.
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Brushfire	North Andover Fire Dept.	Long-term//Low	Town, with advice and assistance from DCR	Yes	Staff time and budget constraints. Advance next step by follow-up with DCR staff.
Prevention/Em ergency Services	To reduce risks from all natural hazards, establish and maintain Town web page describing "tips and techniques" for hazard preparedness, mitigation, and response, with links to the MEMA and FEMA hazard mitigation websites.	All Hazards	Town Departments	Short- Term/High	Town, with advice from MEMA	Yes	Police/Fire Public Safety websites set up with social media of FB and Twitter. Need to update page links to include MEMA/FEMA

Table 9-11. TOWN OF NORTH ANDOVER Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Emergency Services Protection	Generator capacity upgrade at North Andover High School to provide emergency heat. (Existing generator only provides power source for lighting)	All Hazards	North Andover Public Works/ Building Inspection Dept.	Short Term/ HIGH	Town; Cost estimate of \$3k	No. This is a new action item	Funding needs to be identified & budgeted.
Structural Project	Flats Bridge culvert replacement at Great Pond Road by Raes Pond pump station	Flooding	North Andover Public Works & Engineering Depts.	Short Term/ HIGH	Town/State grants State Revolving Fund, Cost Estimate of \$348k	No. This is a new action item	Project 100% designed. Funding to be identified.

Table 9-12 TOWN OF ROWLEY Mitigation Action

Projects Completed							
Category of Action	Description of Action	Hazard Type	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Status
Prevention	Strictly enforce and, as appropriate, upgrade Town zoning bylaw, subdivision rules & regulations, and wetlands regulation to minimize incidence and impacts of flooding and other natural hazards	All Hazards	Town departments	Completed existing capacity	Town	Yes	Completed. Standards/ Open Space Residential development regulations in place. Monitor and periodically review
Prevention	Maintain CEMP and Rowley component of Merrimack Valley Natural Hazards Pre-Disaster Mitigation Plan to ensure their completeness and relevance in disaster mitigation and response	All Hazards	Town departments	COMPLETED/	Town, with advice and assistance from MVPC, DCR, MEMA	Yes	Completed. These plans are in place and existing resources.
Emergency Services	Explore development of timely warning system (local access cable TV and/or radio) to alert public about pending floods and other hazard emergencies	All Hazards	Town Fire and Police Depts in collaboration w/ Northern Essex Emergency Planning Committee	COMPLETED/	Town, with advice and assistance from DCR and MEMA	Yes	Completed Town has implemented and is currently using Reverse 9-1-1 Notification System
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	Completed	Town, with advice and assistance from MEMA, DCR and MVPC	Yes	Process in place. Planning Board SPGA for floodplain activity.
Prevention	Identify non-compliant structures in the community, work with elected officials, the state, and FEMA to correct compliance issues and prevent future non-compliance through ongoing communication, training and education	All Hazards	Town Departments	Completed /Existing Capacity	Town, with advice and assistance from MEMA, DCR and MVPC	Yes	Completed Ongoing capacity.

Table 9-12 TOWN OF ROWLEY Mitigation Action

Projects Completed							
Category of Action	Description of Action	Hazard Type	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Status
Prevention	Maintain Interdepartmental GIS database and mapping of municipal facilities and access routes to enhance emergency operations and incident management	All Hazards	Town Departments	Completed /Existing Capacity	Town, with advice and assistance from MEMA, DCR and FEMA	Yes	Participates in MIMAP regional GIS initiative
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 MEMA and FEMA hazard mitigation websites	All Hazards	Town Departments	Completed/ MEDIUM	Town (for municipal facilities) and private developers	Yes Web page updated & maintained	Completed

Table 9-12 TOWN OF ROWLEY Mitigation Action

Projects In Development							
Category of Action	Description of Action	Hazard Type	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Status
Structural Project	Design and construct drainage system improvements to alleviate chronic flooding due to undersized culverts/structures at following locations: 1) Newbury Road near Harrison Circle-- Completed ; 2) Haverhill Street (Rt. 133) at Bradford Street-- Completed ; 3) Wethersfield Street at Wild Pasture Lane; 4) Glen Street bridge replacement at Jewell Mill Dam over Mill River-- new priority project	Flooding	Town Highway Dept.	Short-term/ HIGH	FEMA Hazard Mitigation (HMGP/PDM/Flood Mitigation), Town match	Yes Note Glen Street bridge replacement is new priority project	Since 2008 plan, Newbury Road work completed as well as intake sleeve & headwall repair at Haverhill/Bradford St.; Next steps are study/engineering of potential culvert replacement at Wethersfield/Wild Pasture Lane (though no flooding prob. At location since 2006); and design work to replace old, undersized crossing new priority project Glen Street bridge at Mill River.
Structural Project	Design and construct drainage improvements at Hillside Street to alleviate occasional flooding that renders the street impassable. This may involve elevating the road for a stretch of approximately 150 ft. and installing a larger culvert	Flooding	Town Highway Dept.	Short-term/ HIGH	FEMA, MEMA, Town	Yes	Funding has been issue. Need for planning/design as next step.
Prevention	Consistent with Phase II MS4 Program requirements, develop and implement drainage system maintenance plan to ensure regular inspection, cleaning, and maintenance of municipal stormwater facilities Next steps are to prepare NOI in compliance with permit, Stormwater Management Plan including development of Illicit Discharge Detection Program and Infrastructure Inventory.	Flooding	Town Highway Dept., Conservation Commission	Years 1-2/ MEDIUM	Town/Merrimack Valley Stormwater Collaborative	Yes	EPA final MS4 permit expected to be issued 2016 after lengthy delay

Table 9-12 TOWN OF ROWLEY Mitigation Action

Projects In Development							
Category of Action	Description of Action	Hazard Type	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Status
Prevention	Incorporate hazard mitigation in local policies, plans, and programs (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan) Master Plan dated 2003 and due for update	All Hazards	Town departments	Medium Term/ MEDIUM	Town	Yes	Open Space Plan has expired- Committee reformulated to update in Years 1-2;
Prevention	Amend local subdivision rules & regulations to require the maximum practicable use of low impact development (LID) techniques in all new development and redevelopment	All Hazards	Town Planning Board	Short-term/ HIGH	Town, with advice and assistance from EOEEA/CZM Smart Growth staff and MVPC	Yes	Completed Open Space Residential Development reg in place
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods Next steps: Program development coordination with DCR	Brushfires	Town Fire Dept.	Long-term/ LOW	Town, with advice and assistance from DCR	Yes	Has been low priority constrained by budget and staff time availability.
Prevention	As opportunities arise, continue to acquire and protect private undeveloped open space in flood hazard areas.	All Hazards	Conservation Commission, Open Space & Recreation Committee	Years 1-5 /MEDIUM	Town, with advice and assistance of MVPC in updating, enhancing MIMAP features	Yes	Significant accomplishment with Mass Audubon/Greenbelt acquisition and preservation of 222 acre Rough Meadow Sanctuary in 2012. Next steps are to update Open Space Plan for state grant eligibility and target priority properties at stream corridors of Bachelor Brook and Mill River.

Table 9-12 TOWN OF ROWLEY Mitigation Action

Projects In Development

Category of Action	Description of Action	Hazard Type	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Status
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 outage/ Storms	Town Departments and private developers	Long term/HIGH	Town, with assistance of state DCS, Essex County Greenbelt, MVPC	Yes	Completed. Underground utilities required in Planning Board regulations.

Table 9-13 TOWN OF SALISBURY Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Structural Project and Prevention	Study and reconstruct rail bed and culvert at Town Creek to protect against tidal flooding of US Route 1 and local businesses and to eliminate flooding from restrictions on fresh water runoff.	Flooding	Town Manager, Board of Selectmen, DPW, Planning Department, Conservation Commission	Completed / HIGH	FEMA, EOE Project cost \$1.2 million	Yes	COMPLETED -- Project construction close-out Fall 2014
Structural Project and Prevention	Seek easement to permit repair of culvert on private property to relieve flooding of Viking and Juno Streets	Flooding	Salisbury DPW, Conservation Commission, Planning Board	Completed/ HIGH	Town/Private	Yes	COMPLETED PROJECT Work Completed. Town took land in tax title. Removed debris and precast drain manhole. Cost = \$6000
Prevention	Identify and seek funding for capital improvement projects that reduce the costs associated with flooding	Flooding	Town Departments	Completed/ Ongoing	Town	Yes	COMPLETED This is ongoing administrative function.
Prevention	Explore ways to link the municipal website to FEMA resources concerning all natural hazard emergencies	All Hazards	Salisbury Planning Department	Completed	Town	Yes	COMPLETED PROJECT- Town website updated with Flood Page 2014.
Prevention	Incorporate hazard mitigation in local plans and initiatives (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan)	All Hazards	Town departments	Complete/ Short-Medium Term/ HIGH	Town	Yes	Open Space Plan update and Beach Management Plan in development --2015; Master Plan completed 2008, Harbor Management Plan completed 2008
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management,	Flooding	Town departments	Complete/ HIGH	Town, with advice and assistance from MEMA and DCR	Yes	Completed Activity. Town submitted application to FEMA 2015; currently under review.

Table 9-13 TOWN OF SALISBURY Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
	reduce flood risks and losses, and educate public						
Prevention	Maintain CEMP, Flood Hazard Mitigation Plan, and Salisbury components of this Plan to ensure their completeness and relevance in disaster mitigation and response	All Hazards	Town departments	Completed/ Ongoing Administration	Town, with advice and assistance from MVPC, DCR, MEMA	Yes-	Completed—Existing Capacity
Prevention	Develop recommendations for maintaining cleared buffer area between structures and phragmites and other dried vegetation in areas adjoining marshes	Flooding	Fire Department, Conservation Commission	Complete/ MEDIUM	Town	Yes	Completed—Fire Dept. and Conservation Office established 10' cutting buffer exemption guideline for streamlining process.
Prevention	Continue to enforce and revise current bylaws and rules & regulations designed to minimize the impact of flooding and other natural hazards	All Hazards	Town departments	Complete/ Existing capacity/ Ongoing	Town	Yes-Ongoing	COMPLETED This is ongoing administrative project.
Prevention/ Emergency Services Response	Explore ways to enhance warning systems for winter storms, hurricanes, and tornadoes through possible media uses of Reverse 911 , the municipal website, the municipal serve list, and cable t.v. local access channels	All Hazards	Town departments	Complete/ Existing capacity/ Ongoing	Town	Yes	COMPLETED PROJECT. Project completed with implementation of Code Red in 2010.

Table 9-13 TOWN OF SALISBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural Project and Prevention	Explore development of long-term regional beach replenishment dredging program. Next steps: Establish North Shore region planning group; Prioritize action based on data generated through Coastal Resiliency Sandy Grant project of hydrodynamic sediment transfer modeling	Flooding	Town Manager, Board of Selectmen, DPW, Conservation Commission, MVPC	Establish North Shore community partnership 2015-16; Modeling work to be complete 2016 HIGH	Army Corps of Engineers, State DCR, U.S. Dept of Interior Sandy Coastal Resiliency Grant to MVPC (\$1.2 million award in Jan. 2015) and Town	Yes	Town is active participant in Merrimack River Beach Alliance, public forum for agenda-setting on beach erosion issues for Salisbury/Newbury/Newburyport. Prelim discussion held on expansion of MRBA model for intermunicipal coordination on regional dredging program.
Structural Project and Prevention	Study and reconstruct State Route 1A (Beach Road) to permit emergency access and evacuation at Salisbury Beach	Flooding	Salisbury DPW, MADOT/Merrimack Valley MPO	Long Term/ HIGH	MADOT/Army Corps of Engineers/Merrimack Valley MPO	No	Town staff has reviewed project concept with Army Corps of Engineers; Next step is to seek funding for planning & design phase needed to make case for funding justification of implementation phase
Structural Project and Prevention	Construct floodwall to protect low-lying neighborhoods against tidal flooding from Blackwater River	Flooding	Town Manager, Board of Selectmen, DPW and Conservation Commission	2015-2016/ HIGH	Army Corps of Engineers, State DCR and Town Project cost is \$6 million 75% from grant with local match split between Town and DCR state environmental bond bill	Yes	Project in procurement. Schedule work 2015-2016.
Structural Project and Prevention	Install larger culverts at Ferry Road and March Road to facilitate tidal flow in adjacent marshes; encourage building floodwalls or elevating buildings to protect against coastal flooding	Flooding	Salisbury DPW, Conservation Commission	1-3 years study; long term implementation/ MEDIUM	State Grants/FEMA Town match; Potential funding programs include MassWorks Infrastructure; FEMA Flood Hazard Mitigation or HMGP	Yes	Need to identify and secure funding for next step of funding project planning study; order of magnitude cost is \$300k

Table 9-13 TOWN OF SALISBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
	along Route 1 South ; study elevating roadways to increase flood protection				programs.		
Structural Project	Relocate 86-year old Police Station and reduce vulnerability and access limitation of critical facility currently at 24 Railroad Avenue in coastal zone. New facility is planned for construction at 175 Beach Road by Town water & booster station.	All Hazards	Town Manager/Police Chief/Planning Dept.	2015-2017/HIGH	Town/\$11.5 million local bond	No this is a new project.	Town Meeting authorized financing in 2015. Project out to construction bid with construction start scheduled Fall 2015. To be complete in 2017.
Structural Project and Prevention	Consider enlarging Smallpox Brook culvert under US Route 1 Next step: Undertake evaluation/assessment planning study	Flooding	Mass Highway	Long-Term/ MEDIUM	Mass DOT	Yes	Need to identify & secure funding. Estimated cost of planning phase approx. \$300k Washout failure at culvert occurred in Winter 2014/15; MassDOT completed emergency repair 2015 (no capacity improvement done)
Structural Project and Prevention	Improve drainage system on Central Avenue and Old Town Way	Flooding	Salisbury DPW	Long-term/ MEDIUM	Town/State grants including MassWorks, State Infrastructure	Yes	Design 100%.. No work performed to date. Need pump station. Estimated costs need to be updated.
Structural Project and Prevention	Install new culvert and improve drainage system on Jaklen Drive to prevent future flooding	Flooding	Salisbury DPW, Conservation Commission	Long term/ MEDIUM	Town	Yes	No Funding available Work needed - Installation of 400 ft of drain pipe with 2 catch basins, removal of debris at the outfall at house #15, and paving of roadway. Estimated cost is \$40,000.

Table 9-13 TOWN OF SALISBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural Project and Prevention	Rebuild Merrimack River North Jetty	Flooding	MRBA/Conservation	2015-2016/Medium	Army Corps of Engineers \$10 million	Yes	Construction Start Spring 2015. To be completed 2016
Prevention	Encourage the use of Low Impact Development (LID) techniques in all new development and redevelopment projects Steps: Town planning/conservation staff meet early with developers at proposal stage to identify resources impacted and mitigation needs.	All Hazards	Planning Board, Conservation Commission	Short Term/ HIGH	Town	Yes	Subdivision Control regulations updated October 2013 PB regulations reflect MA stormwater standards and EPA MS4, last updated in October 2012.
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Brush Fire	Salisbury Fire Department	Long-term/ LOW	Town, with advice and assistance from DCR	Yes	No Funding available Fire dept working with DCR in preliminary meetings to work on implementing Fire Wise program.
Prevention	Update as needed fire safety information via website and other public communications systems	Brush Fire	Salisbury Fire Department	Short-term/ HIGH	Town	Yes	Website updated in 2009 with safety information. Update coming in 2015.
Prevention	Continue to encourage the distribution and use of water saving devices and water conservation measures	All Hazards	Salisbury Water Department	Ongoing/ MEDIUM	Town, Mass. DEP, other sources	Yes	Non-essential water use restrictions are implemented based on the Parker River water level/flow readings. Odd/Even watering days (based on address) before 9am and after 5pm. We announce restrictions through reverse 911, town website and newspaper.

Table 9-13 TOWN OF SALISBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Prevention	Adopt "Steep Slope" regulation to prohibit or strictly regulate development on steep slopes in order to prevent stormwater runoff and erosion	All Hazards	Planning Board and Conservation Commission	Long-term/ LOW	Town	Yes	No Funding/staff timing available
Prevention	Incorporate hazard mitigation in local plans and initiatives (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan)	All Hazards	Town departments	Short-Medium Term/ HIGH	Town	Yes	Open Space Plan update and Beach Management Plan in development –2015; Master Plan completed 2008, Harbor Management Plan completed 2008
Prevention	Increase building inspection efforts and training	All Hazards	Town departments	Long-term/ MEDIUM	Town	Yes	FEMA training for coastal construction September 2015. Increased required documentation for floodplain construction per CRS enrollment 2015.
Prevention	Develop and adhere to routine inspection, cleaning, and maintenance schedule for drainage/stormwater facilities and stream channels Next step: Develop 3-5 year maintenance plan document Continue routine maintenance and cleaning of street drainage systems	All Hazards	Salisbury DPW, in consultation and cooperation with Conservation Comm.	Ongoing/ MEDIUM	Town	Yes	Since 2008, improved collaboration and regular communication between Town Conservation office and DPW in strategy development & permitting coordination on specific neighborhood-focused infrastructure maintenance. Next step is formalizing 3-5 year town-wide plan. DPW undertakes street sweeping/catch basin cleaning 2x year.

Table 9-13 TOWN OF SALISBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Prevention	Acquire and protect undeveloped open space in flood hazard areas Next steps: Prioritize areas for acquisition/protection	Flooding	Conservation Commission/Planning/Ipswich River Watershed Association/MVPC	Planning phase thru 2016; Long term implementation/ Medium	Town, MVPC/Ipswich River Watershed Association/ National Wildlife Federation/Sandy Grant Funding Award	Yes	Participating in Great Marsh Coastal Community Resiliency Planning Project with Sandy Grant funding; Planning project begun 2015; To be complete Dec. 2016 Town has received deed restrictions through Conservation Commission/MassDEP permitting process. Properties acquired include: Friedenfels open space parcels (59 acre and 12 acre) adjacent to Merrimack River donated to the Town in 2010,
Prevention	Implement the Town's Phase II Storm Water Management Plan	Flooding	Town departments/Merrimack Valley Stormwater Collaborative	2016-2021/ HIGH	Town/Merrimack Valley Stormwater Collaborative/MVPC	Yes	EPA issued draft MS4 permit in Fall 2014 after much delay. Anticipate final MS4 permit to be issued 2016 with expanded planning/housekeeping requirements for stormwater management. Salisbury in 2014 joined Merrimack Valley Stormwater Collaborative of 15 communities in regional approach to issue including shared procurements, joint training & education outreach. Next steps include update of Town's Stormwater bylaw after MS4 final permit issuance.

Table 9-13 TOWN OF SALISBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Structural Project and Prevention	Analyze existing flooding problem areas and design/implement appropriate corrective measures, such as re-directing floodwaters to uninhabited areas or wetlands	Flooding	Salisbury DPW and Planning Department	Long-term/ LOW	Town, Mass DOT	Yes	No funding available
Structural Project and Prevention	Develop an assistance program for raising homes in the floodplain to be in compliance with floodplain regulations	Flooding	Salisbury Building Dept, Conservation Commission and Planning Department	Long-term/ HIGH	Town-Local homeowner match/FEMA—Flood Hazard Mitigation; Pre-Disaster Mitigation/HMGP	No. This is a new project priority.	Seeking available funding sources
Prevention	Maintain current list of Repetitive Loss properties; develop local program to implement appropriate mitigation measures including raising elevation of at-risk properties	Flooding	Salisbury Building Inspector and Planning Department	1-3 years/ HIGH	DCR, FEMA and MEMA	Yes	CRS program pending; Town intends to seek funding eligibility for property owner assistance in structure elevations.
Prevention	Create interdepartmental GIS database and mapping of municipal facilities and resources to enhance emergency operations and incident management	All Hazards	Town Departments	Long-term/ HIGH	Town, MVPC, Ipswich River Watershed Association, Sandy Grant and possible grant assistance from state/federal sources	Yes	Coastal Resilience planning project underway in 2015. To be completed in 2016 and will include expanded mapping component. Funding needs to be identified for municipal GIS.

Table 9-14 TOWN OF WEST NEWBURY Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Property Protection/ Prevention	Continue to enforce local floodplain management regulations	Flooding	Town Departments	Completed/Existing Capacity	Town	Yes	Town Depts. make sure that any new construction will not impact the floodplain. Town planner position upgraded 2015 to coordinate development/regulatory review.
Erosion & Sediment Control	Stabilize eroding/erosive Merrimack River streambank along River Road	Flooding	DPW, Con. Comm. & Selectmen	COMPLETED ACTIVITY	ACOE & State	Yes	DPW completed/ongoing maintenance.& monitoring
Prevention	Continue routine maintenance and cleaning of street drainage systems.	Flooding	DPW	COMPLETED/ Ongoing admin.	Town	Catch basins are cleared on an annual basis	Catch basins are cleared on an annual basis
Prevention	Educate residents on high groundwater problems & how to implement stormwater management on a homeowner level.	Flooding	DPW, Con. Comm, & Planning Board, MVPC-MV Stormwater Collaborative	COMPLETED/ Ongoing admin.	Town	Yes	Town Dept. educate homeowners and builders during the construction permitting process; Stormwater Collaborative formed in 2014 providing training and coordination of public education.
Prevention	Strictly enforce and, as appropriate upgrade Town zoning bylaw, subdivision rules & regulations, and wetlands regulation to minimize incidence and impacts of flooding and other natural hazards.	All Hazards	Town Departments	COMPLETED/ Ongoing admin.	Town	Yes	Town Planner position upgrade in 2015 to assist Town Depts as needed. Consultant engineer also on hand as needed.
Prevention	Encourage the use of Low Impact Development (LID) techniques in all new development and redevelopment projects	All Hazards	Planning Board, Conservation Commission, Building Inspector, MVPC	Completed/ Ongoing Admin Practice	Town	Yes	Town Depts. educate developers during the construction permitting process; MVPC provide staff & volunteer training.

Table 9-14 TOWN OF WEST NEWBURY Mitigation Action Plan

Projects Complete

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources Funding	Project Included in 2008 Plan	Project Status
Prevention	Maintain eCEMP, Flood Hazard Mitigation Plan, and Town components of this Plan to ensure their completeness and relevance in disaster mitigation and response	All Hazards	Town Departments	Completed/ Ongoing administrative action	Town, with advice and assistance from MVPC, DCR, MEMA	Yes	eCEMP and emergency management protocols in place & updated
Prevention	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in all new development and redevelopment	Power Outages/Storms	Town Departments and Private Developers	Completed/ Ongoing administrative action	Town (for municipal facilities) and Private Developers	Yes	Homeowners & developers are encouraged to utilize underground utilities
Prevention/ Emergency Services Response	To reduce public risks from all natural disasters, establish and maintain Town web page describing safety "tips & techniques" for hazard preparedness, mitigation, and response, with direct links to the MEMA and FEMA hazard mitigation websites	All Hazards	Town Departments	Completed	Town, with advice and assistance from MVPC, DCR, MEMA	Yes	Town utilizes the Code RED notification system during emergencies; www.wnema.org Local Emergency Management website updated with links, info graphics.

Table 9-14 TOWN OF WEST NEWBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Property Protection/ Prevention	Explore participation in NFIP's Community Rating System to enhance floodplain management and reduce flood risks and losses. Next steps-application review coordination with MEMA and MVPC.	Flooding	Town Departments, NFIP	Long-term/ MEDIUM	Town Technical assistance from MEMA, FEMA & MVPC Low Cost Impact	Yes	Staff resources have been limited; planning capacity recently enhanced with upgrade of professional planner position.
Structural Project and Prevention	Replace undersized culverts, swales, and drainage systems on an as needed basis. Next steps: Planning and survey to inventory & prioritize in CIP	Flooding	DPW, Con. Comm.	YEARS 1 TO 5 / MEDIUM	State Infrastructure Revolving Fund/MassDOT & Local Medium/High Cost	Yes	Culverts have been replaced on Middle & Bachelor Streets, Installed over 1,000 feet of subdrains on Middle & Stewart Street; Developer & DPW constructed drainage improvements at Sullivans Court.
Prevention	Develop and implement Fire Wise Program for forested areas and neighborhoods in cooperation with DCR. Next steps—Technical assistance/initiative review with DCR.	Brush Fire	Fire Department	Long-term / MEDIUM	Town, State, & Dept. of Fire Services Low Cost but Staff Capacity issue	Yes	No action to date as limited staff, budget and other higher priorities.
Prevention	Incorporate hazard mitigation in local policies, plans, and programs (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan)	All Hazards	Town Departments	Long Term/ MEDIUM	Town Medium Cost	Yes	Open Space Plan expires in July 2016; issues including parking, package septic treatment and village economic development in 2004 community development plan to be reviewed and plan recommendations updated.

Table 9-14 TOWN OF WEST NEWBURY Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority	Resources/ Funding	Project in 2008 Plan?	Project Status
Emergency Services Protection	Install generators at critical facilities of Town Offices, Annex and Senior Housing complex	All Hazards	DPW, Finance	Medium term /MEDIUM	Town/State Public Safety &/or FEMA Hazard Mitigation (HMGP) Cost Magnitude. = \$100k per facility.	No. This is new activity enhancing emergency service capacity.	Funding to be identified and budgeted

B. Regional Mitigation Action Plan

Table 9-15 REGIONAL Mitigation Action Plan

Projects Completed

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Prevention	Work with Federal/State agencies and communities to develop improved mapping and estimates of structures located within 100-year floodplains and SLOSH zones	Flooding	FEMA, MEMA, DCR, CZM, NOAA, MVPC and communities	Completed	State/Federal agencies, Communities, MVPC	Yes	FIRM maps updated 2012 & 2014. CZM releasing updated coastal Sea Level Rise inundation maps late 2015.
Emergency Services	Work with MassDOT Highway, local DPW and public safety officials to ensure that regional and state intelligent transportation system (ITS) consider the needs of hazard mitigation and emergency response	All hazards	MVPC, MassDOT, Cities & Towns, Merrimack Valley MPO	COMPLETED/ ONGOING MAINTNANCE	MassDOT Highway, Cities & Towns, MPO	Yes	Municipal websites updated; Code Red systems implemented for public alerts. Through MassDOT, dynamic message signs used and Go Time guide signs planned ion I-495 & I-93 installation in 2015.

Table 9-15 REGIONAL Mitigation Action Plan

Projects In Deveopment

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Prevention	Provide technical assistance to communities in the development, adoption and maintenance of local multi-hazard mitigation plans and projects Next steps—Coastal Resiliency Plan development and information outreach	All hazards	MVPC and local communities	Year 1 to 5/ HIGH	DCR/MEMA/Watershed Associations/National Wildlife Federation/Communities	Yes	Regional structure developed includes Mayors & Managers Coalition; DPW/Stormwater Collaborative (2014)
Prevention	Encourage municipalities to integrate hazard mitigation considerations in other local planning initiatives (e.g. Master Plans, Capital Improvement Plans, Open Space and Recreation Plans)	All hazards	MVPC and local communities	Years 1 to 5/ HIGH	MVPC and communities	Yes	Master plan development in process in Newbury, Newburyport; Open space plans expired or expiring 2015 in Andover, Haverhill, Rowley, Merrimac & Salisbury.
Prevention	Work with Federal/State agencies, partner organizations, and communities to educate municipal officials, residents, & businesses about projected sea level rise impacts and potential management solutions	All hazards	FEMA, MEMA, DCR, MVPC, 8Towns&Bay and communities	Years 1-5/ MEDIUM	State/Federal agencies, Great Marsh Coalition, 8Towns & Bay, MVPC	Yes	Forum opportunities include Regional Sea Level Rise/Climate Change symposium held annually in Fall in partnership with MassBays, MEMA training workshops.

Table 9-15 REGIONAL Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Prevention & Emergency Services	Promote the development of an agreement between MA and NH state agencies and communities to better coordinate dam operations and flood control activities in order to minimize downstream flooding (e.g. Spicket River)	Flooding/ Dam Failure	MA and NH state environmental agencies, communities, and MVPC	Short-term/HIGH	Local emergency management agencies; state agencies, MVPC	Yes	No interstate agreement after initial interest; Continued need for formalized intermunicipal & interstate coordination
Structural Projects	Work with MassHighway and MPO to prioritize repair of structurally deficient bridges over waterways through the Transportation Improvement Program process.	All hazards	MassDOT and Merrimack Valley MPO	Long Term/ MEDIUM	MassDOT Planning and MVPC	Yes	Through MPO Program and MassDOT Accelerated Bridge Program, all but one of the region's structurally deficient bridges over waterways have been repaired/replaced since 2008.
Prevention	Identify and pursue public & private sources of technical assistance and funding for residents, business, and municipalities to implement sound hazard mitigation measures throughout the region	All hazards	MVPC & local communities	Years 1 to 5/ HIGH	MVPC and local emergency management teams	Yes	Intermunicipal partnership in place with Merrimack River Beach Alliance. Need for inland riverine community coordination and advocacy.

Table 9-15 REGIONAL Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Prevention	Incorporate natural hazard mitigation and best planning practices into MVPC's regional planning work and activities	All hazards	MVPC, local planning offices	Years 1 to 5/ HIGH	MVPC	Yes	<p>Regional Priority Growth Strategy updated 2015.</p> <p>Next steps: Update MVPC website info on Regional Hazard Mitigation Programs and Activities. Implement public outreach strategy including social media use.</p>
Prevention	Assist communities in the identification & implementation of strategies aimed at protecting cultural and historic resources from natural hazards	All hazards	MVPC, local historic commissions, Mass. Historical Commission, National Park Service, 8Towns& Bay	Long-term/ MEDIUM	State agencies, Local arts/historic commissions	Yes	<p>Regional Priority Growth Strategy includes identification of Priority Preservation Areas. coordination with Heritage Preservation/The National Institute for Conservation</p>

Table 9-15 REGIONAL Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Prevention	Work with MVPC communities to encourage the incorporation of Low Impact Development techniques in subdivision regulations and site/neighborhood redevelopment plans	All hazards	MVPC, local communities	Years 1-2/ MEDIUM	MVPC, state agencies, local planning departments	Yes	<p>Regional Stormwater Collaborative established 2014; Regional Planning Day Summits held; LID workshops sponsored by MVPC.</p> <p>Next steps: Develop annual program of training with input from Mayors & Managers.</p>
Prevention	Work with the Office of Dam Safety and local communities to ensure that DCR records are up to date and reflects work accomplished by the communities and private parties to inspect, repair, and renovate dam structures	Flooding	MVPC, DCR, local communities	Years 1-2/ HIGH	DCR, local communities, dam owners	Yes	Need for next step follow-up in reestablish process for infdata for data/information sharing with DCR Office of Dam Safety.

Table 9-15 REGIONAL Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Emergency Services	Develop agreement on siting convenient, accessible regional shelter in Lawrence/Methuen/Haverhill area; and formalizing agreement in coastal communities	All hazards	Local communities	Short-Term/HIGH	Red Cross, Salvation Army, Local emergency management teams.	No, This is a new action need.	Next steps are to set up intermunicipal/sub region discussion on issue.
Emergency Services	Develop emergency access and evacuation plans for neighborhoods subject to isolation from flooding or by blockage from railroad lines	All hazards	MVPC, municipalities	Medium Term/ HIGH	Merrimack Valley MPO, local agencies	Yes	Seek program funding for this activity.
Prevention	Provide training to local Conservation Commission and other local land use regulatory board members on enforcement and model bylaws/ordinances	All hazards	MVPC, , Municipalities,	Years 1 to 5/ MEDIUM	MVPC, Citizen Planner Training Collaborative, Mass. Association of Conservation Commissions	No. This is new action item.	Seek program funding for this activity.
Prevention	Review & Update local regulations and implement management practices to comply with updated MS4 Stormwater Permit	Flooding	Municipalities	Short-Term/HIGH	Regional Stormwater Collaborative of 15 communities	No. This is new action item with MS4 permit from EPA expected to be finalized 2015	Develop program templates and financing models of Stormwater Utility
Prevention	Work cooperatively with the District 5 Fire Warden to inventory and map access roadways through the region's state forests	Brushfires	DCR Fire District 5; Local municipalities	Long Term/ MEDIUM	DCR Fire District 5 and municipal fire/emergency management departments	Yes	Seek program funding for this activity.

Table 9-15 REGIONAL Mitigation Action Plan

Projects In Development

Category of Action	Description of Action	Hazard Addressed	Implementation Responsibility	Timeframe / Priority	Resource Funding	Was action included in 2008 Plan?	Project Status
Prevention	Educate public and landowners on importance of removing vegetative detritus in or near forested areas to reduce risk of wildfire.	Brushfires	Municipal Fire Departments/ Emergency Management	Long Term/ MEDIUM	Municipalities, DCR	Yes	Include in information distribution/website updates
Prevention	Organize planning process for Regional Climate Change Adaptation & Resiliency	All hazards	MVPC, municipal planning departments	Short-Term/HIGH	MVPC; State agencies; federal agencies including EPA Planning & FEMA; Regional partners including Storm Surge and MassBays Program	No. This is new action item.	Seek program funding for this activity to build off work of Sandy Grant Coastal Resiliency planning; Expand information distribution methods and civic engagement outreach going beyond public meeting/workshop formats.

C. Mitigation Success Stories in the MVPC Region

Since completion of the 2008 Plan, a number of local hazard mitigation projects have been designed and implemented. This section describes several of the most successful mitigation projects that have been completed over the past five years.

Haverhill Merrimack River Bank Stabilization Project

The City of Haverhill applied for and was awarded funding through FEMA's Hazard Mitigation Grant Program (HMGP-1642) to address severe erosion problems along the north bank of the Merrimack River near Riverside and Coffin Avenues. The banks of the Merrimack River at these two locations had significantly eroded over time due to periodic high river flows and unstable soils, and the erosion was greatly accelerated by the damaging "Mothers Day Flood" of 2006. As a result of the 2006 flood, the riverbank at Riverside Avenue was within 10 feet of exposing the City's 54-inch sewer interceptor located beneath the centerline of the street. It was feared that any future flood event would further erode the riverbank to a point where the interceptor would be exposed and possibly ruptured, spilling untreated sewage into the Merrimack River.

A similar situation existed near 62 Coffin Avenue, where a sewer lift station is located on the bank of the Merrimack River. The bank had eroded to within one foot of the electrical panel that feeds this lift station. Further bank erosion would undermine the electrical panel supports, causing them to fall into the river. This in turn would short out the electrical panel, causing the lift station to fail and spilling untreated sewage into the Merrimack River.

With a HMGP grant of \$370,000 from FEMA and local funding of \$125,000, the City was able to hire engineering and construction contractors to stabilize, reconstruct, and armor almost 2,000 linear feet of eroded riverbank using bio-vegetation mats and stone riprap.

Because these reaches of the riverbank included sensitive Bordering Land Subject to Flooding (BLSF), Riverfront Area, and rare species habitat (Bald Eagle and Short-nose Sturgeon), the project was designed with input from numerous state and federal environmental agencies and incorporated numerous mitigation measures:

- addition of a Cape Cod berm along the southern edge of pavement on Riverside Avenue to restrict overbank runoff that contributes to bank erosion;
- planting of aquatic vegetation and installation of woody debris at the toe of the slope to enhance habitat for short-nose sturgeon;
- removal of existing invasive plant species;
- planting of white pine trees to support bald eagle nesting;
- installation of best management practices to control erosion;
- use of an environmental monitor during construction.

Salisbury Town Creek Flood Hazard Mitigation Project

The Town of Salisbury applied for and was awarded a FEMA grant (PDMC-10) in the amount of \$786,000 to address flooding and wetland degradation problems along Town Creek, an important tributary of the Merrimack River just upstream from Newburyport Harbor. The FEMA grant was matched by \$240,000 in state funding from the Environmental Bond Bill.

The trestle and culvert at Town Creek were washed out in storms occurring in 2005, 2006 and 2008 and the resulting flood waters impacted homes businesses along Route 1 as well as the Eastern Marsh Rail Trail. The construction project, completed in Fall 2014, included rail trail repair and the installation of two culverts and tidal gate structures with monitoring gauges. The work has helped not only to prevent flooding of area roadways and property, but also has restored water flow and wildlife habitat in the 55-acre Town Creek marsh area.

Boxford, through its DPW, has been phasing in implementation of town-wide culvert repairs per its 5-year Action Plan. Work completed includes culvert replacement on Main Street by Stiles Pond and replacement of five culverts along Ipswich Road from Main Street to the North Andover town line, done in 2013.

Georgetown in 2014 completed upgrades to its Penn Brook School shelter including installation of emergency generators. The Town also was awarded funding \$1,029,750 in FEMA Hazard Mitigation Grants for three projects of culvert and roadway upgrades a Thurlow Street/Parker River; West Street/Parker River, and Central Street/Penn Brook.

North Andover and **Andover** also have been upgrading their facilities. **Andover** has undertaken construction of the Andover Youth Center (rear of Town Hall & Doherty School). The Center will be used as the Town's main shelter and is scheduled to open in 2015.

North Andover is under construction with a modern, state-of-the-art Fire Station on Route 125, due to be complete in 2015. In addition, the Town used FEMA grants for installing waterproof sewer manhole covers and conducting flow analysis in risk assessment of Rea's Pond.

Lawrence has installed floodwater retention facilities as part of riverway recreation trail improvements along the Spicket River including at Oxford Mill Park.

Merrimac has also constructed flood mitigation improvements including 2009 culvert replacement at Mythical Street which had been washed out in 2006 and 2007 flooding and limited access to Valley and Chestnut streets. The Town also repaired the bridge at the intersection of River Road and Middle Road at Cobblers Brook. Other notable drainage infrastructure improvements by The Town included outlet pipe replacement at Champion Street and installation of 300 feet of drain line and structures to minimize area flooding and sedimentation control at Lake Attitash.

Methuen has used local funding to replace undersized culverts and enhance drainage infrastructure capacity in the Hawkes Brook an areas of East Methuen.

Newbury has upgraded its emergency management facilities and equipment and through its DPW has undertaken major drainage improvement projects on Longbrook Road and Parker Street.

Newburyport has been implementing elements of its 2007 Stormwater Improvement Plan blueprint. Improvements completed have included 2010 replacements of culverts at Plum Island Turnpike completed in 2010 with \$135,975 in FEMA grant funding matched by \$45,325 in local funds. The City also used \$450,000 in MEMA mitigation funding to complete study of Little River area flood mitigation and constructed roadway drainage improvements at Malcolm Hoyt Drive and Scotland Road.

Rowley has undertaken a number of infrastructure projects and equipment purchases for Police, Fire and DPW, including generators, Fire pumper truck and DPW backhoe and dump trucks. Bridges at Dodge Road and Wethersfield Street (Taylor Bridge and Bachelder Bridge), all damaged in the 2006 Mother's Day Storm were replaced with funding assistance from FEMA. Bridges were opened in 2009. Drainage improvements included culvert work at Newbury Road and Haverhill Street/Route 133 near intersection of Bradford Street.

All Merrimack Valley communities have expanded their public communication/early warning systems adopting Code Red Emergency Notification registration and/or using social media and local cable tv to inform residents.

Much work has taken place throughout the region since 2008 with the assistance of MassDOT in replacing/repairing structurally deficient bridges. Major bridge infrastructure projects over waterways were completed in **Lawrence, Newbury, Groveland/Haverhill, Newburyport, and West Newbury/Haverhill**. Major Construction is underway to replace the Route 95 Whittier Bridge over the Merrimack River in **Newburyport and Amesbury**.

All participating communities in 2014 signed onto the Merrimack Valley Stormwater Collaborative formed to develop regional approaches to effective stormwater management. The Collaborative is developing training programs, public education outreach materials and model regulations for municipal stormwater facility maintenance and operation, all toward compliance with the pending final Muncipal Separate Storm Sewer System Permit for Massachusetts communities expected to be finalized by EPA in **2016**.

SECTION 10. PLAN ADOPTION AND MAINTENANCE

This section discusses how the Merrimack Valley Region Multi-Hazard Mitigation Plan Update 2015 will be adopted by MVPC and the region’s participating local jurisdictions, 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 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 prior to seeking formal adoption of the plan by the local communities and the Merrimack Valley Planning Commission. FEMA reviewers document their evaluation of the Plan using the Local Mitigation Plan **Review Tool**. A copy of the **Review Tool** is included in Appendix G.

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. In the event that 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 affirmative vote of the community’s city council or board of selectmen. A resolution signed by the council president or selectmen 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 Merrimack Valley Region Multi-Hazard Mitigation Plan Update 2015 and its local plan annexes will be the number of identified mitigation actions implemented, either wholly or in part. In order for the region and its communities to become more disaster 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, a scheduled annual review of the plan by each community's Local Hazard Mitigation Planning Team (LHMPT) will be conducted at a meeting called by the mayor or town manager/administrator. The meeting will be attended and facilitated by MVPC's hazard mitigation planning staff. At this meeting, the local hazard mitigation 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 hazard mitigation 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 in accordance with the Disaster Mitigation Act of 2000, or following any significant natural hazard disaster. Any new problems that arise will be reviewed by the hazard mitigation team and incorporated into the updated hazard mitigation plan. 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 mayor or town manager/administrator will oversee the local hazard mitigation 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 LHMPT. 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 city council or board of selectmen. Notification will be done through posting of meeting agendas in city/town hall and on the community's website.

The communities, assisted by MVPC, will be responsible for updating the local components (annexes) of the Plan. MVPC will be responsible for updating the regional components of the Plan, and will incorporate each community's updated local annex into the comprehensive regional plan.

SECTION 11. PLAN IMPLEMENTATION

11.1 Pivotal Role of Local Governments

The implementation of the Merrimack Valley Region Multi-Hazard Mitigation Plan Update 2015 will take place at the State, Regional, and Local levels of government. However, local governments in particular will play a pivotal role in hazard mitigation, especially in the area of floodplain management. The municipal Building Departments, Conservation Commissions, and Boards of Health have legal responsibilities to implement local floodplain bylaws, the National Flood Insurance Program (NFIP), construction standards incorporated into the Massachusetts State Building Code, floodplain guidelines incorporated into the Wetlands Protection Act, and Title 5 of the State Environmental Code (on-site wastewater disposal). **Table 11-1** 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.

Each municipality participating in the Plan will be responsible for implementing its own community-specific mitigation actions. To the extent possible, these actions have been directed toward a particular department or board in order to assign responsibility and accountability and to increase the likelihood of implementation. This approach will enable individual municipalities to implement and update their unique Local Mitigation Action Plan as needed without affecting other communities' plans, and without altering the broader focus of the *Regional* Mitigation Action Plan. The separate adoption of locally-specific actions also ensures that each municipality will not be held responsible for monitoring and implementing the local actions of the other municipalities involved in the planning process.

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. 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 bylaws. The state building code also contains sections on wind, snow, structural loads, and seismic retrofitting.	Insures that NFIP standards and other mitigation standards are uniformly applied across the community and region.
Public Works Department and/or City/Town Engineer	The Public Works Department and/or engineer are primarily responsible for municipal drainage and stormwater management issues, taking the lead in ensuring compliance with EPA Phase II Stormwater Regulations.	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 Rivers Protection Act of 1996 (MGL Chapter 258, 310 CMR 10.58), and the Wetlands Protection Act (MGL Chapter 131, Section 40, 310 CMR 10.00). The Conservation Commission reviews, approves or denies applications for projects in the 100-year floodplain, in the floodplain of a small water body not covered by a FEMA study, within 100 feet of any wetland or 200 feet of any river or stream (except in the case of densely developed urban areas such as Lawrence, where it is within 25 feet of a river or stream).	These regulations contain performance standards which address flood control and storm damage prevention.
Planning Board and Planning Department	The Planning Board has authority under MGL Chapter 41, and implements local subdivision regulations. The Planning Board ensures that new development incorporates state and federal stormwater management "best management practices". In most communities, the Planning Board is responsible for maintaining local floodplain bylaws and ordinances.	In many communities, the Planning Department coordinates the hazard mitigation planning process and the implementation of hazard mitigation plans.
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. Some communities opt to adopt 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.
City Council or Board of Selectmen	In the Merrimack Valley region, the Cities of Amesbury, Haverhill, Lawrence, Methuen, and Newburyport are governed by a City Council, and the Towns by a Board of Selectmen.	The City Council or Board of Selectmen must adopt the local Pre-disaster Mitigation Plan. In addition, their approval is necessary for hazard mitigation grant applications and potential projects.
Emergency Management Department	Each community has an emergency management director who is responsible for local emergency response and recovery, as well as mutual aid.	Emergency managers play a primary role in the development of the Comprehensive Emergency Management Plan (CEMP), as well as other plans required by MEMA and FEMA.

SECTION 12. FUNDING SOURCES

Appropriate action is needed to ensure that financial resources are available to implement hazard mitigation projects. Such projects need to be included in capital improvement programs at the state and local levels. Federal funding programs are available to qualifying municipalities. The availability of current federal funding sources changes regularly and is dependent upon Congress' ongoing budget appropriations process. In 2003, the federal government established two comprehensive websites that track available funding from federal agencies: www.fedgrants.gov and www.grants.gov. In addition, federal appropriations from Congress may be tracked through the Federal Registers at www.thomas.loc.

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

Table 12-1. FEMA 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
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

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 Pre-Disaster Mitigation Program (PDM). All of 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 eligible 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, in order for property owners to be eligible for purchasing flood insurance, their respective community must be participating in the NFIP and in compliance with the NFIP.

Communities participating in the NFIP must:

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

The NFIP standards are contained in the Massachusetts State Building Code (Section 3107), which is implemented at the local level by municipal building inspectors. In Massachusetts, 344 out of 351 (98%) of Massachusetts municipalities participate in the NFIP.

SEVERE REPETITIVE LOSS PROGRAM (SRL)

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 risk of flood damage to repetitive loss structures.

The program is 100 percent federal 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 Systems (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 (FMA)

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 pursuant to 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.

Proposals for funding 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 PROGRAM

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. Funding for the program is provided through the National Pre-Disaster Mitigation Fund to assist States and local governments (to include Indian Tribal governments) in implementing cost-effective hazard mitigation activities that complement a comprehensive mitigation program. 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). In addition, the community must not be suspended or on probation from the NFIP.

SMALL BUSINESS ADMINISTRATION (SBA) 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. In addition, 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.

Volunteer Fire Assistance Grants

Volunteer Fire Assistance (VFA) is a Federal grant program that provides funds for fire equipment, training, and initial fire department organization to fire departments serving small communities under 10,000 in population. Congressionally appropriated VFA funds are provided to the State forestry agencies through the USDA Forest Service. The State forestry agencies pass this money on to needful fire departments within their states. A fire department may buy equipment, pay for training or training materials, or cover the cost of department incorporation, as long as the funds are matched. VFA funds are granted on a 50/50 matching basis.

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. Since 1995, there have been 15 state disaster declarations and has provided over \$7,177,251 in funding to aid communities affected by natural disasters

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 dollars 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.