Merrimack Valley Region

Natural Hazards Pre-Disaster Mitigation Plan

Action Plan to Reduce or Eliminate the Long-term Risk to Human Life and Property from Natural Hazards

Prepared for:

Boxford, Georgetown, Groveland, Haverhill, Lawrence, Merrimac, Methuen, Newbury, North Andover, Rowley, Salisbury, West Newbury, MA

Prepared by:

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November 2008

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EXECUTIVE SUMMARY

The Merrimack Valley Region in northeastern Massachusetts is susceptible to a wide array of natural hazards including: floods, severe thunderstorms, winter storms, tornadoes, earthquakes, and hurricanes. The economic cost of these disasters can be staggering. In addition, such disasters can bring social and emotional upheaval to our communities. A **Natural Hazards Pre-Disaster Mitigation Plan** outlines actions that our communities can take now to reduce the impact of these natural disasters when and if they occur later. Pre-Disaster mitigation breaks the costly cycle of recurrent damage and increasing reconstruction costs.

The Merrimack Valley Planning Commission (MVPC) has developed a regional multi-hazard mitigation plan in partnership with the thirteen (13) municipalities of Andover, Boxford, Georgetown, Groveland, Haverhill, Lawrence, Merrimac, Methuen, Newbury, North Andover, Rowley, Salisbury, and West Newbury. This Regional Pre-Disaster Mitigation Plan is prepared in accordance with the federal Disaster Mitigation Act (DMA) of 2000. The purpose of the Plan is to mitigate potential damage from those natural hazards that are deemed to be a threat to the Merrimack Valley region.

The Plan contains goals and objectives for developing the Plan, an assessment and inventory of natural hazard risks, a vulnerability analysis based on the geographic location of critical infrastructure and facilities, and an existing protections matrix. Through discussions with local officials and the Multi Hazard Community Planning Team, a list of hazard mitigation actions and projects has been developed for future implementation. As required by federal regulation, the Plan will be reviewed and updated every five years to keep it both current and relevant.

The completion and scheduled updating of the Plan will maintain the region's eligibility for certain types of federal funds to implement mitigation initiatives that may be funded under the Hazard Mitigation Grant Program and Pre-Disaster Mitigation Grant Program. The Plan also will reduce the region's vulnerability to natural disasters by effectively identifying appropriate projects for the limited amount of funding that is made available in the future. This Plan also attempts to link community planning and pre-disaster planning, incorporating information from the local Pre-Disaster Mitigation Plans, where available.

Development of a regional mitigation plan before disaster strikes will result in the most efficient and effective means of reducing the loss of life and property in the Valley region. Mitigation assists in helping minimize or prevent damage to structures, infrastructure, and other resources. The regional nature of this plan helps to ensure that mitigation strategies and actions are coordinated across municipal boundaries. Enhanced coordination among communities should also help to ensure that *post*-disaster recovery efforts proceed in a collaborative, efficient, and timely manner.

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SECTION 1. INTRODUCTION

This section provides a general introduction to the **Merrimack Valley Region Natural Hazards Pre-Disaster Mitigation Plan** (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 must have a Multiple Hazards Mitigation Plan in place in order to qualify for future federal disaster mitigation grants following a Presidential disaster declaration.

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 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 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 multi-jurisdictional **Merrimack Valley Region Natural Hazards Pre-Disaster Mitigation Plan** 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 strategies 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 play;
- 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.

A number of state and federal grant programs mandate that local governments develop and maintain 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.

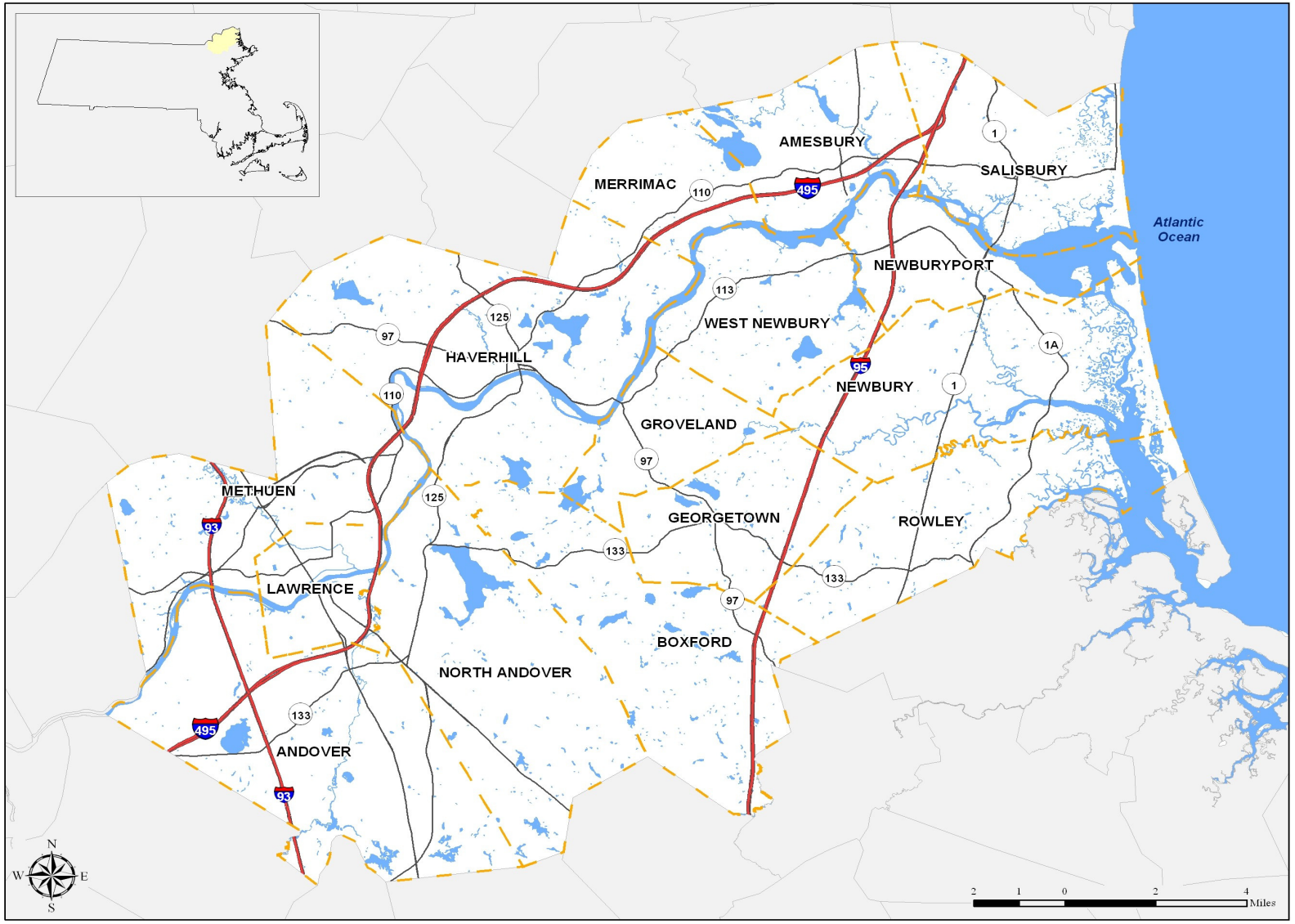
1.4 Geographic Scope

The geographic scope of this Plan is the Merrimack Valley Planning Region in northeastern Massachusetts (see **Figure 1-1**). The region as a whole covers 267 square miles and includes 15 municipalities with a combined resident population of 318,556 (U.S. Census 2000). 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.

Thirteen (13) of the region's 15 cities and towns participated in the development of this Regional Hazard Mitigation Plan. These 13 communities are: Town of **Andover**, Town of **Boxford**, Town of **Georgetown**, Town of **Groveland**, City of **Haverhil**l, City of **Lawrence**, Town of **Merrimac**, City of **Methuen**, Town of **Newbury**, Town of **North Andover**, Town of **Rowley**, Town of **Salisbury**, and Town of **West Newbury**.

The two non-participating communities – Amesbury and Newburyport – have elected to prepare individual local natural hazard mitigation plans on their own.

Figure 1-1. Merrimack Valley Region



SECTION 2. PLANNING PROCESS

This section of the Plan describes the planning process undertaken by the Merrimack Valley Planning Commission and its constituent communities to develop the **Merrimack Valley Region Natural Hazards Pre-Disaster Mitigation Plan**.

2.1 Coordinating Role of Regional Planning Agency

The Merrimack Valley Planning Commission coordinated and facilitated the development of the Hazard Mitigation Plan in partnership with 13 of the region's 15 member communities. 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.*

2.2 The Planning Process

In preparation for the Plan, MVPC staff met with Massachusetts Emergency Management Agency (MEMA), Federal Emergency Management Agency (FEMA), and Department of Conservation and Recreation (DCR) staff, consulted with other regional planning commissions, attended conferences, and reviewed state and federal documents and regulations relative to development of a 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. A *Local Mitigation Plan Crosswalk*, found in Appendix A, provides a detailed summary of FEMA's current minimum standards of acceptability for a plan's compliance with the Disaster Mitigation Act of 2000.

2.3 Phased Approach to Plan Development

The development of the Plan was conducted in two phases under the overall direction of MVPC:

Phase I: Regional and Local Natural Hazards Risk Assessment consisted of the following elements:

- Assembling the planning team of local officials representing each of the participating communities;
- Conducting meetings of the Regional Multiple Hazard Community Planning Team (RMHCPT) and Local Multiple Hazard Community Planning Teams (LMHCPTs);
- Identifying and assessing the natural hazards that affect the Merrimack Valley region and its communities; and
- Inventorying and mapping critical facilities and infrastructure.

Phase II: Development of the Hazard Mitigation Strategies and Preparation of the Plan consisted of the following elements:

- Continuing the planning process through meetings of the RMHCPT and through individual meetings with officials from each of the communities;
- Developing an existing protections matrix;
- Conducting a risk assessment for each of the natural hazards identified in Phase 1;
- Developing hazard mitigation goals, strategies, and actions; and
- Outlining Plan maintenance and Plan implementation responsibilities and procedures.

Assembling the Planning Team. The MVPC staff assembled members of a Regional Multiple Hazard Community Planning Team (RMHCPT) to serve as the primary local liaisons to MVPC, to assist in the development of the Plan, and to provide the foundation for the establishment of local planning teams. A notice from MVPC was sent to the chief elected official of each of the participating communities, requesting that he or she appoint a representative to the regional planning team. In addition, each community's appointed delegate to MVPC's governing board was invited to participate, as the Commission's monthly meetings served as the principal public forum for selected RMHCPT deliberations, including regular project updates.

The regional team representatives include:

Regional Planning Team Members

- Tom Carbone, Public Health Director, Andover;
- John Dold, Public Works Director, Boxford;
- Jean Dewberry, resident and MVPC Delegate, Boxford;
- Sarah Buck, Town Planner and MVPC Delegate, Georgetown;
- John Moultrie, Highway Surveyor, Georgetown;
- Robert Arakelian, Highway Superintendent, Groveland;
- Robert O'Hanley, Planning Board and MVPC Delegate, Groveland;
- James Michitson, Emergency Management Director, Haverhill;
- Orlando Salazar, Planning Board and MVPC Delegate, Haverhill;
- Ezra Glenn, Community Development Director, Lawrence;
- Ralph Spencer, Fire Chief/EMD, Merrimac;
- Raymond Gingras, Planning Board and MVPC Delegate, Merrimac;
- Judith Tymon, Town Planner and MVPC Delegate, Newbury;
- Jeff Coco, Emergency Management Director, North Andover;
- James Broderick, Fire Chief/EMD, Rowley;
- Robert Cook, Emergency Management Director, Salisbury;
- Robert Straubel, Planning Board and MVPC Delegate, Salisbury; and
- Rob Phillips, Planning Board (former) and MVPC Delegate, West Newbury

Regional Planning Team Meetings. Following a brief introductory session at MVPC on February 16, 2006, the first major RMHCPT meeting was held on March 2, 2006 as part of a project "kick-off" workshop held at Northern Essex Community College (NECC) in Haverhill. The purpose of this workshop was to introduce the planning team members to the planning process and to provide an overview of the Disaster Mitigation Act of 2000. The meeting outlined the respective roles of MVPC and RMHCPT members in coordinating and assisting the communities in meeting their obligations under the DMA of 2000. The meeting began with a PowerPoint presentation that described the DMA of 2000 and the need for local communities to have an approved plan in place. It then proceeded to a general discussion of the types of natural disasters common to the region, and solicited participant input based on local experience in responding to natural disasters. Further discussion focused on the types of disaster mitigation actions communities may take prior to a disaster in order to mitigate potential impacts to public safety, property, and the environment.

Subsequent regional meetings were held at the MVPC Offices in Haverhill to identify and assess natural hazard occurrences and risks, critical facilities inventorying and mapping, and potential disaster mitigation strategies. 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 Regional Plan. The meetings were conducted as part of MVPC's monthly public meetings, which are broadly advertised via direct mailings, municipal

postings, and MVPC's website, and which are well attended by municipal officials, staff, and various other stakeholders from throughout the Merrimack Valley region. In addition to these meetings, MVPC also participated as facilitator and presenter at two special regional forums focused on the May 2006 "Mothers Day" Flood, a disaster event that severely impacted many areas of the Merrimack Valley and Essex County. At these two sessions – an MVPC-sponsored workshop at NECC in Haverhill and the Essex County Highway Association's annual meeting in Andover – MVPC environmental and GIS staff presented a series of ground photos and high-resolution digital aerial imagery of a number of the region's worst flood areas. The aerial imagery was produced by Pictometry International, Inc., from a special fly-over of the region commissioned by MVPC for the purpose of documenting the disaster event for future use in flood mitigation planning.

Regional meeting notices, agendas, and attendance lists are provided in Appendix B.

Municipal Meetings. Following the initial kick-off workshop, individual meetings were held with representatives of each community. An average of two meetings per community were held. 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. Local meeting agendas and lists of attendees are provided in Appendix C.

MVPC staff contacted each of the communities by phone and/or e-mail. The Planning Committee members were the primary contacts for the planning process. Meetings were attended by the primary contacts and other key municipal 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. In some cases, MVPC staff met with the Planning Committee staff (or their representative) alone, if other staff was 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 and in engaging many of the individuals who will be responsible for the Plan's implementation.

In addition to updating and correcting the draft hazard area and critical facilities maps, the local meetings were used to circulate and fill out 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 additional opportunity to underscore the value of engaging in the local pre-disaster mitigation planning process, both by reviewing the benefits of such plans and by pointing out the social and economic consequences of not having a plan in place.

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's Natural 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.

Developing the Existing Protections Matrix. The existing protection 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 included in Appendix D.

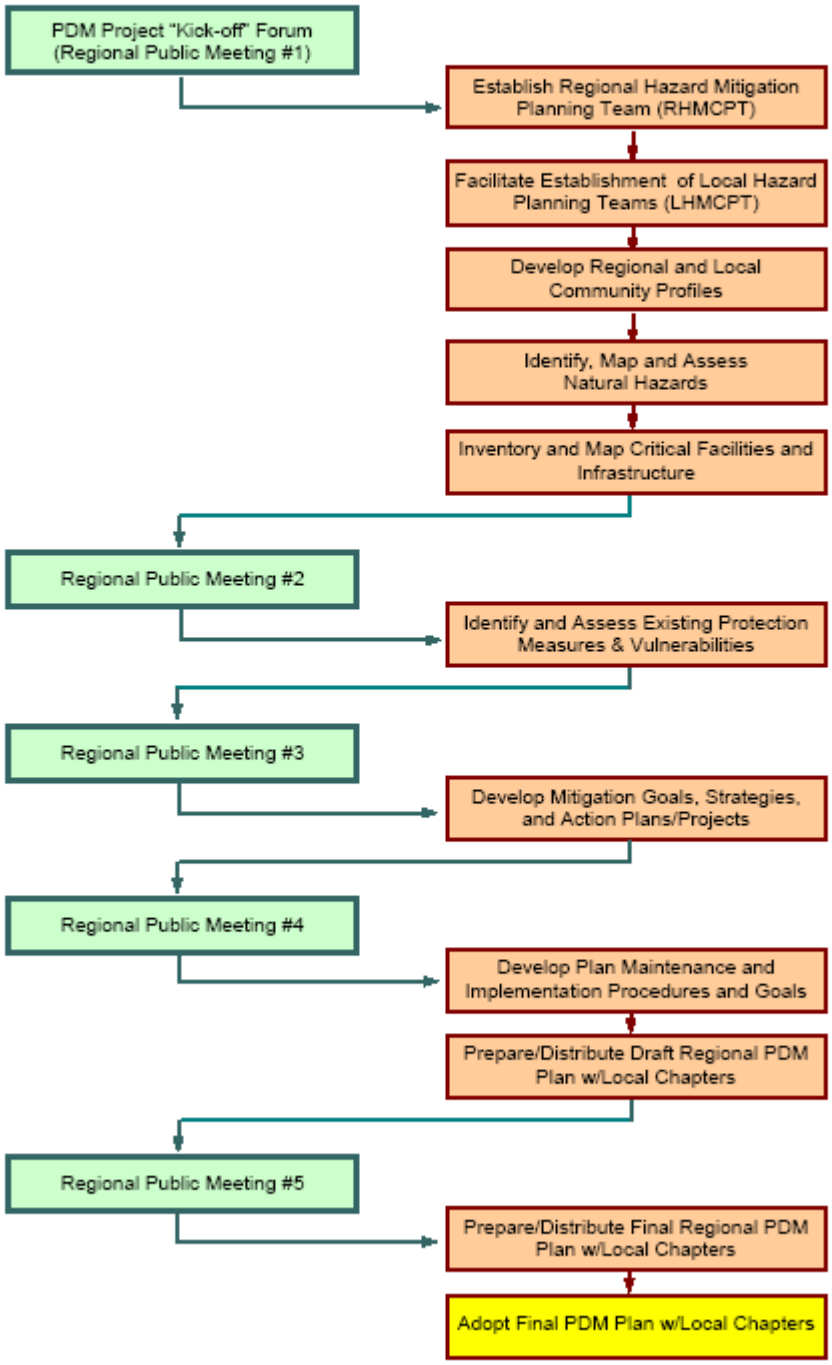
The questionnaire was used as a tool to facilitate each community's examination of the adequacy of its programs, policies, bylaws, and regulations relative to natural hazards mitigation. The questionnaire was emailed in advance to the contact person

on the Planning Team and was discussed at the individual meetings with local municipal staff, as described above. Finally, the information derived from the questionnaires and the meeting discussions was summarized in an Existing Protections Matrix.

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 goals and measures that were subsequently incorporated into the Plan.

A flow chart depicting the various phases of the hazard mitigation planning process is presented in **Figure 2-1** on the following page.

Figure 2-1. Hazard Mitigation Planning



SECTION 3. REGIONAL PROFILE

This section of the Plan provides an overview of the Merrimack Valley region, and includes information on the region's population and economy, land use, transportation network, and water resources. It is intended to provide context for the natural hazard characterizations, assessments, and mitigation actions which follow later in the Plan.

3.1 Population, Housing, and Employment

Population. The Merrimack Valley region's 15 cities and towns cover 267 square miles and have a resident (year-round) population of 318,556 (U.S. Census 2000). 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 less than 280 in semi-rural Newbury to over 10,000 in densely-developed Lawrence, and averages 1,200 region-wide. Together, the two central cities of Haverhill and Lawrence account for over 40% of the region's total population.

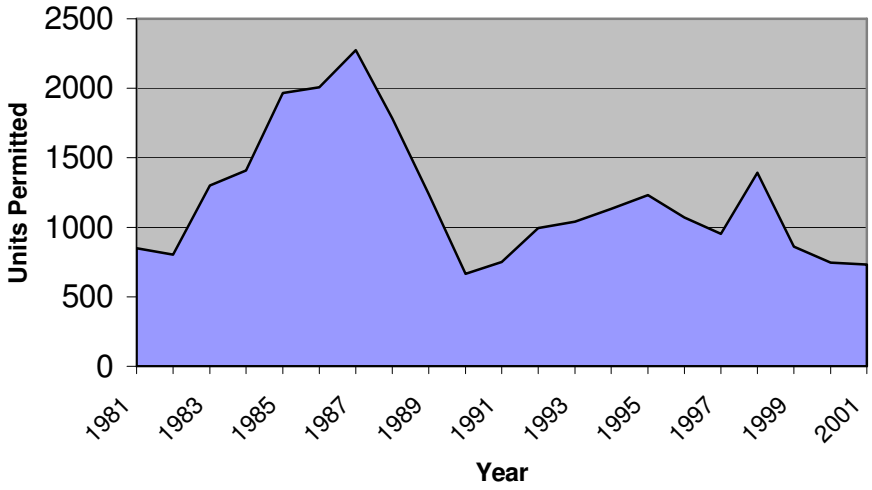
In 2002, the Merrimack Valley Planning Commission conducted a "buildout" analysis for each of the 15 communities. (Buildout is a calculation of a community's maximum land development potential under current zoning.) Based on these analyses, MVPC projects a *maximum regional population of 406,149* if all remaining residential building sites are developed. This represents a 27.5% increase over the current (2000) 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 20-year period 1981-2001. 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. Between 1981 and 2001, a total of 25,198 dwelling units were permitted, an average of 1,260 units per year.

Since the 1980s, there has been a major shift in the types of new development taking place in the Valley. During the 1980s, multi-family units accounted for between 16 percent and 46 percent of new development in any given year. Since 1992, multi-family units have accounted for less than 10 percent of the overall units being built. 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 20 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. While 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, 1981-2001



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. Today, the region’s economy is more diversified than ever, and is better positioned to weather future downturns in any particular sector.

The occupations of employed persons living in the Valley region in 2000 are shown in **Table 3.1-2** on the following page. Forty percent (59,508) were Management and Professional; 25.3% (37,819) Sales and Office; 14.4%(21,628) Production, Transportation and Material Handling; 13% (19,497) Service; and 7.3% (10,946) Construction, Extraction and Maintenance. Combining the above occupations into general labor skills categories, the region’s labor force is made up of 65% “white collar”, 13% “service”, and 22% “blue collar” workers.

Figure 3.1-2. Number of Employed Persons by Occupation (2000)							
	Employed Civilian Population 16 Years and Over						
Area	Employed Civilians 16 years and over	Management & Professional	Service	Sales and Office	Farming, Fishing & Forestry	Construction, Extraction & Maintenance	Production, Transportation, and Material Moving
Massachusetts	3,161,087	1,298,704	444,298	818,844	6,642	235,876	356,723
Essex County	349,835	137,746	47,724	94,374	1,076	25,688	43,227
MVPC Region	149,702	59,508	19,497	37,819	304	10,946	21,628
Amesbury	8,571	3,396	1,073	2,155	31	767	1,149
Andover	15,145	9,691	944	3,369	0	506	635
Boxford	3,879	2,403	227	1,000	0	134	115
Georgetown	3,861	1,725	561	925	0	349	301
Groveland	3,177	1,283	493	706	8	317	370
Haverhill	29,676	10,170	4,149	7,892	9	2,414	5,042
Lawrence	25,772	5,322	5,000	6,225	115	1,932	7,178
Merrimac	3,353	1,249	478	853	6	367	400
Methuen	20,810	7,487	2,671	5,649	18	1,778	3,207
Newbury	3,547	1,692	349	863	16	331	296
Newburyport	9,339	4,710	1,055	2,167	15	576	816
North Andover	13,273	6,881	1,368	3,642	24	604	754
Rowley	3,034	1,348	306	714	32	277	357
Salisbury	4,064	1,009	606	1,061	22	504	862
West Newbury	2,201	1,142	217	598	8	90	146
Sources: U.S. Census 2000 and Merrimack Valley Planning Commission							

A summary of current (2000) population, housing, and employment data for the region and its constituent communities is presented in **Table 3.1-3** below.

Table 3.1-3. Merrimack Valley Population, Housing, and Employment (2000)

Community	Area (sq. mi.)	Population	Population Density (persons/sq. mi.)	Households	Employment
Amesbury	12.4	16,450	1,326	4,228	8,571
Andover	31.0	31,247	1,008	8,490	15,145
Boxford	24.0	7,921	330	2,255	3,879
Georgetown	12.9	7,377	570	2,025	3,861
Groveland	8.9	6,038	675	1,707	3,177
Haverhill	33.3	58,969	1,769	14,858	29,676
Lawrence	7.0	72,043	10,351	16,905	25,772
Merrimac	8.5	6,138	720	1,699	3,353
Methuen	22.4	43,789	1,955	11,541	20,810
Newbury	24.2	6,717	277	1,815	3,547
Newburyport	8.4	17,189	2,050	4,429	9,339
North Andover	26.7	27,202	1,021	6,904	13,273
Rowley	18.7	5,500	294	1,468	3,034
Salisbury	15.4	7,827	507	1,991	4,064
West Newbury	13.5	4,149	307	1,183	2,201
MVPC Region	267.3	318,556	1,192	81,498	149,702

3.2 Regional Land Use

The Merrimack Valley encompasses 267 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 land uses. Commercial and industrial uses constitute less than 4% of the land in the region.

Table 3.2-1 on the following page presents the latest available (1999) land use information for the 15 cities and towns in the Valley. The information was developed based on 1999 aerial photography that was interpreted by the University of Massachusetts Department of Forest Resources. It is 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 that constitute significant percentages of 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" saltmarsh 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 "GREAT MARSH"
(Photo courtesy of Stephan Gersh, Eight Towns & the Bay)

Figure 3.2-1. Merrimack Valley Land Use By Percent

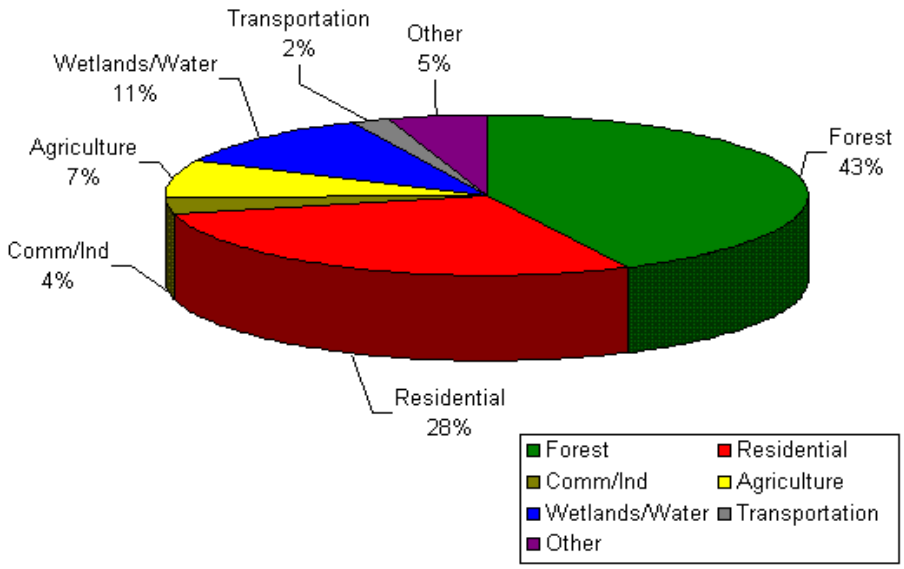


Table 3.2-1. Merrimack Valley Land Use (1999)															
	Forest		Residential		Commercial & Industrial		Agricultural		Wetlands & Water		Transportation		Other		Total
Community	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Amesbury	3161	39.3	2169	27.0	355	4.4	1101	13.7	687	8.5	217	**2.7**	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.


Route I-95

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 Highway Department 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 MHD 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 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.

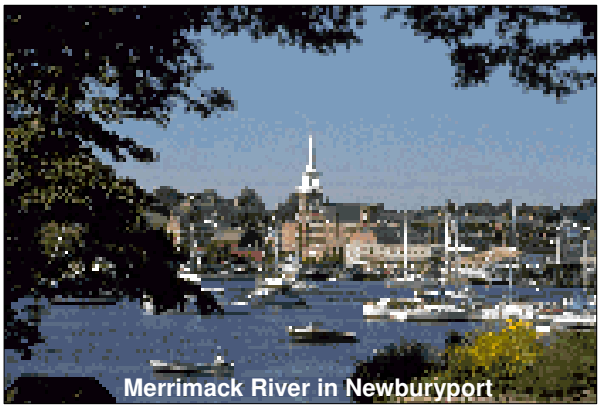

Lawrence Municipal Airport

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 209 aircraft based at this airport, the majority of which are small private planes. The airport witnesses 104,000 takeoffs and landings annually, with summer the busiest flying season.

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

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.


Merrimack River in Newburyport

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** on the following page. 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

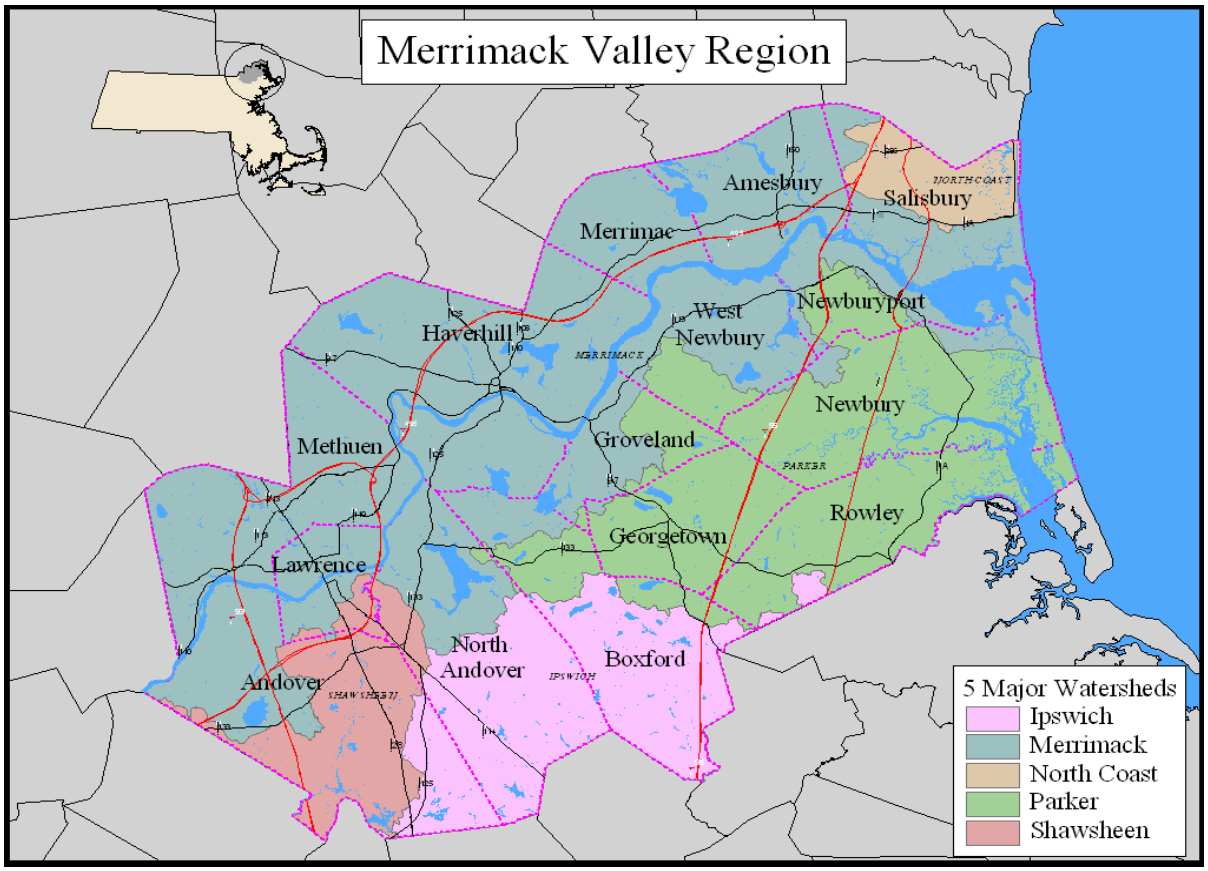


Table 3.4-1 on the following page gives a breakdown of each community's major watershed areas.

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

SECTION 4. NATURAL HAZARDS IDENTIFICATION

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 six categories:

- **Flood-related hazards**
- **Wind-related hazards**
- **Winter-related hazards**
- **Fire-related hazards**
- **Geologic hazards**
- **Other potential hazards**

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, approved by FEMA in 1998 and 2000, as well as additional information gathered by The Dewberry Companies as part of the October 2004 State Hazard Mitigation Plan update.

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.

Shawsheen River Flooding, Lawrence – May 2006

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, forty-nine (49) flood events were reported in Essex County from January 1, 1950 to May 31, 2003. During 1978, flooding occurred throughout New England causing millions of dollars in damage. In 1996, and again in 2006 ("Mothers Day Flood"), flooding ravaged the Merrrimack Valley, resulting in Presidential Declarations of Emergency.

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.

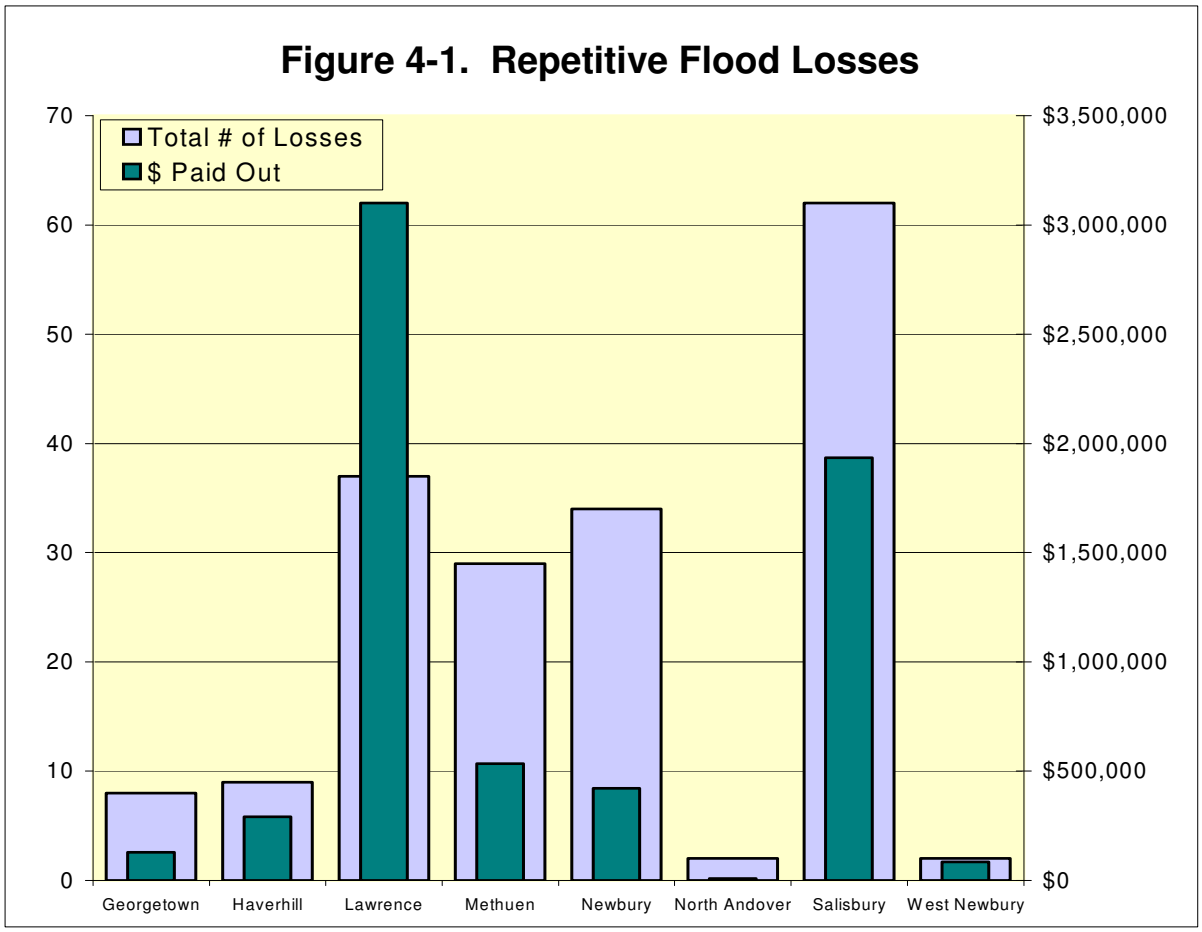

Evacuating a Nursing Home - May 2006

Flood-related hazards were identified in each of the 13 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 13 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

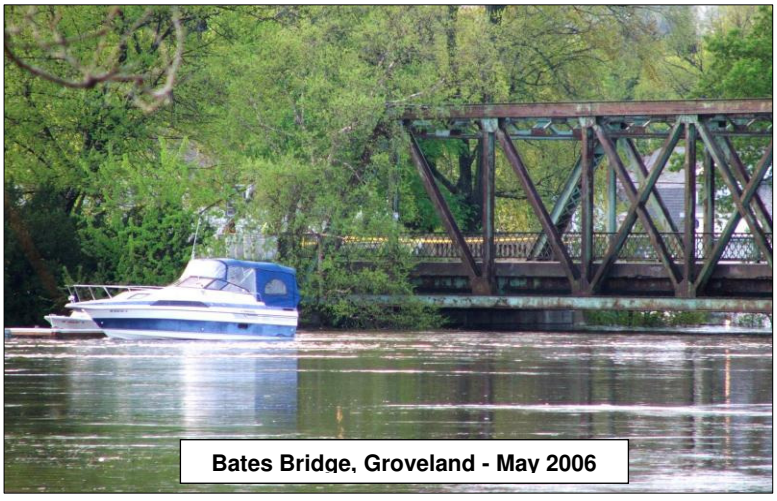
Eight (8) of the 13 participating communities – i.e., Georgetown, Haverhill, Lawrence, Methuen, Newbury, North Andover, Salisbury, and West Newbury – have repetitive loss structures located within their mapped flood hazard areas. Combined, there are 214 such structures. Over the years, flood damage to these structures has resulted in the payment of over $6.5 million in insurance claims. **Figure 4.1** on the following page graphically displays the number of repetitive losses and the money paid out by FEMA in insurance claims under the National Flood Insurance Program (NFIP) for each community.

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 1 being the least compliant with the ideal and 100 being the most compliant. Bridges with an AASHTO rating lower than 50 are considered to be in need of improvement and are placed on a state bridge repair list. Specific bridge deficiencies are also noted. A bridge may be considered "structurally deficient" (i.e., it will not perform to its full design capacity due to age and deterioration), or it may be considered "functionally obsolete", meaning that the roadway carried by the bridge does not meet current


Bates Bridge, Groveland - May 2006

design standards for certain attributes such as roadway width. For the purpose of flood-related hazards, the designation of "structurally deficient" is the more critical concern. Bridges in the Merrimack Valley region located over water with an AASHTO rating at or below 50 are listed by community in **Table 4-1** below.

Table 4-1. Structurally Deficient Bridges Over Water

Town	Roadway	Water Body	Owner	Year Built/ Rebuilt	Status	AASHTO Rating
Groveland	Route 97/113	Merrimack River	State Highway Agency	1951	Under Design Advertise in 2007	9.5
Haverhill	Route 125 (Bridge St.)	Merrimack River	State Highway Agency	1925	State Needs to Initiate Project	37.9
Haverhill	East Main Street	Merrimack River	State Highway Agency	1883 1914	Under Design 2007	26.3
Lawrence	Amesbury Street	Merrimack River	City/Municipal Highway	1918 1982	City Needs to Initiate Project	48.7
Lawrence	E. Haverhill Street	Spicket River	City/Municipal Highway	1866 1899	Under Design	50.8
Lawrence	Canal Street	Spicket River	City/Municipal Highway	1857 1907	Under Design Advertise in 2008	35.3
Methuen	Hampshire Road	Spicket River	State Highway Agency	1959	Under Design	47.9
Newbury	Hay Street	Little River	Town Agency	1946	Under Design	47.9
Newbury	Route 1A	Parker River	State Highway Agency	1930	Construction 2007	32.2

Dams

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.

There are three (3) High Hazard dams located in the Merrimack Valley region's 13 participating communities, as shown in **Table 4-2** below.

Table 4-2. High Hazard Dams

Municipality	Dam Name	Impoundment Name	Date Last Inspection	Date Next Inspection
Haverhill	Millvale Reservoir Dam	Millvale Reservoir	Not Available	Not available
Lawrence	Lawrence Reservoir Dam	Lawrence Reservoir	12/12/2000	12/12/2002*
North Andover	Lake Cochichewick Outlet Dam	Lake Cochichewick	10/05/2006	9/24/2008

*Dam inspection overdue, according to DCR Office of Dam Safety file record

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 building structures, infrastructure, and trees.

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.

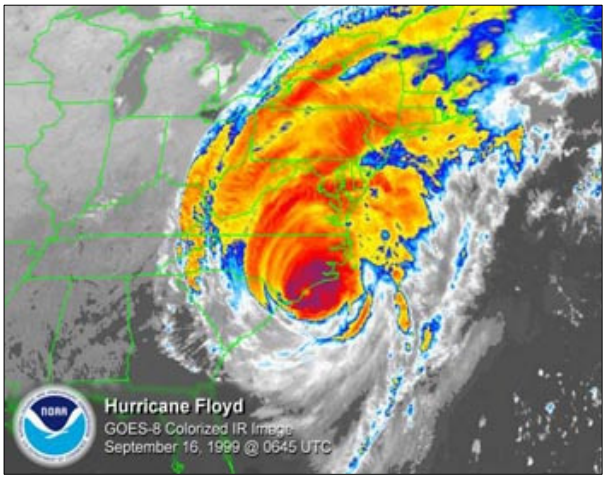
Hurricanes

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.

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

Hurricane force winds can destroy buildings and mobile homes. Debris, such as signs, roofing materials, siding, and lawn furniture can become missiles. Tree branches and even entire trees are downed, and with them 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 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.

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

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

Table 4-4. New England Hurricanes and Tropical Storms (1938-Present)					
Date	**Storm Event**	**Description**	**Deaths**	**Injuries**	**Property Damage**
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 Gurda	Center passed directly over Nantucket with gusts to 140 mph.	NA	NA	NA
8/28/1971	Tropical Storm Doria	Wind gusts to 80 mph. Heavy rains, flooding.	3	NA	NA
9/14/1971	Tropical Storm Heidi	Moderate rainfall, little damage.	0	0	NA
9/3-4/1972	Tropical Storm Carrie	Hurricane force wind gusts. Heavy rainfall	1	NA	$1.2 million
7/27/1975	Hurricane Blanche	Most heavy weather remained offshore	0	NA	NA
8/9-10/1976	Hurricane Belle	Category 1. Forward motion 32 mph. Heavy rainfall causes some flooding.	3	3	NA
9/6/1979	Tropical Storm David	Minor effects	1,100 (Virgin Islands)	NA	$60 million
9/25/1985	Tropical Storm Henri	Minor effects	0	0	
9/27/1985	Hurricane Gloria	Category 2. Forward motion of 72 mph. Gusts to 80 mph.	NA	3	
8/7/1988	Tropical Storm Alberto	Winds of 50 mph.	31	NA	
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	
10/30-11/01/1991	Unnamed “Halloween” storm	Huge storm surge caused extensive damage along the coast	12	NA	
7/13/1996	Hurricane Bertha	Forward motion of 48 mph. Very heavy rainfall and strong gusty winds. Spawned one tornado in Massachusetts	12	NA	
9/02/1996	Hurricane Edouard	Left 40,000 residents without power, 3 inches of rain fell	0	0	
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	

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** below. 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 2003.

Figure 4-2. Historical Tropical Cyclone Tracks

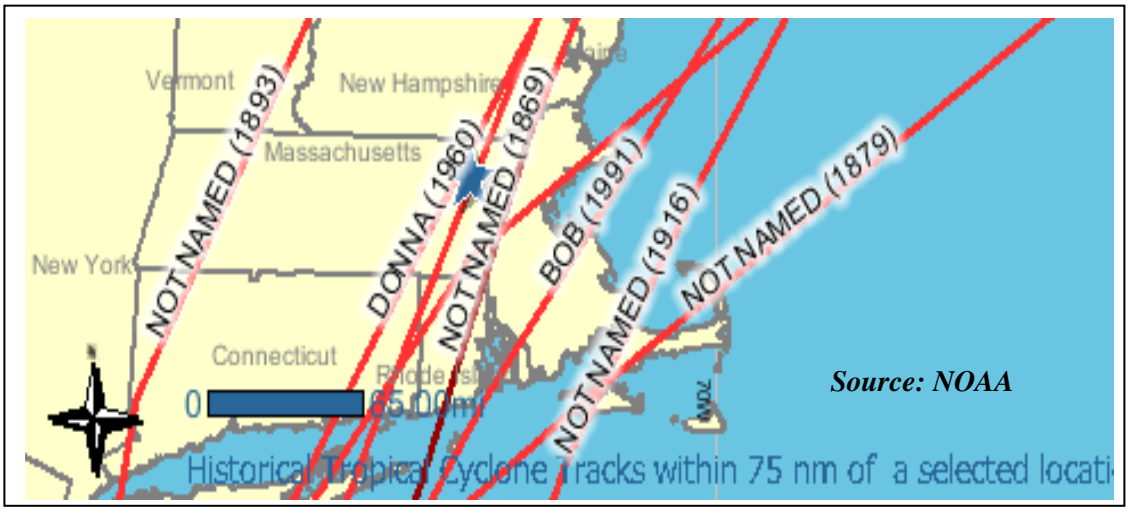
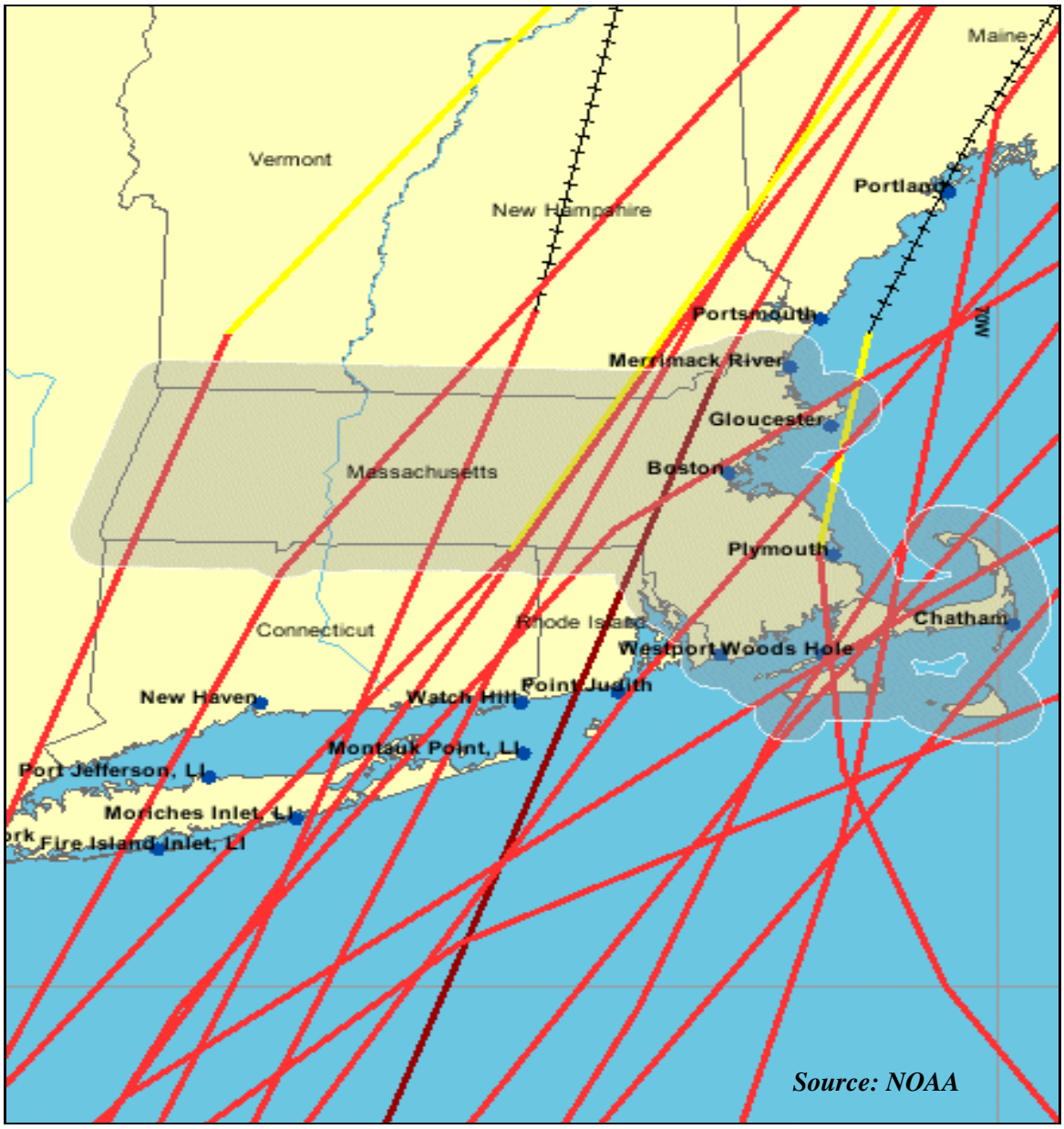


Figure 4-3. Category 1- 5 Hurricanes (1851-2003)



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 2006 population estimates compiled by the Merrimack Valley Planning Commission, an estimated 291,000 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
Andover	33,475
Boxford	8,127
Georgetown	8,110
Groveland	6,769
Haverhill	60,176
Lawrence	70,662
Merrimac	6,392
Methuen	44,259
Newbury	6,954
North Andover	27,198
Rowley	5,875
Salisbury	8,438
West Newbury	4,286
Total	**290,721**

Tornadoes

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

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


NOAA File Photo

The most devastating tornado to occur in New England was the Worcester tornado of July 9, 1953, killing ninety-six people and injuring over thirteen hundred. The most recent tornado to strike New England occurred on May 29, 1995 in Great Barrington, Massachusetts, killing three people and injuring twenty-three. 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.

The Fujita scale is used to measure damage caused by wind, including tornadoes. The F-scale should be viewed with some caution however, as tornado wind speeds are still largely unknown and the wind speeds on the F-scale have never been scientifically tested and proven. The extent of wind damage can depend on how well built a structure is, the wind direction and duration, and the presence of flying debris, as well as several other factors. Furthermore, the process of rating damage is highly subjective. A tornado is classified as significant if it causes F2 or greater damage. **Table 4-6** below provides information on estimated wind speed and typical damage occurring during a tornado based on the Fujita scale categories.

The National Weather Service issues tornado forecasts through each local 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.

Table 4-6. Fujita Tornado Damage Scale		
Scale	**Wind Estimate (MPH)**	**Typical Damage**
F0	**< 73**	**Light damage**. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	**73-112**	**Moderate damage**. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	**113-157**	**Considerable damage**. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	**158-206**	**Severe damage.** Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	**207-260**	**Devastating damage**. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	**261-318**	**Incredible damage**. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yds); trees debarked; incredible phenomena will occur.

Source: American Meteorological Society, Glossary of Meteorology

The Disaster Center evaluated tornado statistics from 1950-1995 by state. When compared with other states across the country, Massachusetts ranks 35th in the frequency of tornadoes, 16th in the number of tornado-related deaths, 21st in the number of injuries, and 12th for the cost of tornado-related damages**.** When these same statistics are examined in terms of tornado frequency per square mile, Massachusetts ranks 14th in overall frequency, and first in terms of fatalities, injuries, and cost per area. On June 9, 1953 one of the most powerful tornadoes ever recorded struck Worcester, Massachusetts, killing 96 people. The damage caused by this one event, relative to the State's small size, accounts for the statistical rankings previously cited.

In Essex County, 14 tornadoes were recorded during the period of 1950-1995 (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.

Tornado of July 5, 1643

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

Severe Thunderstorms

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

It is not unusual for the Merrimack Valley region to experience a few 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 can be very costly in terms of economic losses.

4.3 Winter-Related Hazards

Severe winter storms can produce a wide variety of hazardous weather conditions, including heavy snow, freezing rain, sleet, and extreme wind and cold. A severe winter storm is one that results in four or more inches of snow over 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.

Table 4-7 below details the annual snowfall totals for the City of Newburyport in the Merrimack Valley during the last 50 years (1956 – 2005). 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 4-7. Merrimack Valley Snowfall
(City of Newburyport)

Year	Snowfall (Inches)	Year	Snowfall (Inches)
2005	110.0	1980	26.25
2004	33.0	1979	32.0
2003	83.5	1978	84.75
2002	45.0	1977	71.5
2001	70.75	1976	52.0
2000	28.75	1975	50.75
1999	35.0	1974	38.25
1998	17.5	1973	20.0
1997	50.0	1972	84.25
1996	82.5	1971	70.25
1995	43.25	1970	79.0
1994	60.5	1969	102.25
1993	89.75	1968	48.5
1992	24.25	1967	96.25
1991	27.0	1966	73.25
1990	42.0	1965	32.25
1989	26.5	1964	69.5
1988	46.75	1963	52.0
1987	63.0	1962	46.25
1986	29.25	1961	81.0
1985	32.5	1960	60.0
1984	59.0	1959	57.25
1983	57.0	1958	51.75
1982	44.5	1957	31.25
1981	39.0	1956	120.5

50-Year Annual Average – 55.4 Inches

There have been several disaster declarations related to winter weather, as well as specific "snow emergency", declarations since 1993. A summary of the declarations for Essex County is provided in **Table 4-8** below.

Table 4-8. Winter Weather-Related Federal Disaster and Emergency Declarations for Essex County		
Disaster Name (Date of Event)	**Disaster Number (Type of Assistance)**	**Declared Areas**
March Blizzard (March 1993)	FEMA-3103 (Public)	All 14 counties
January Blizzard (January 1996)	FEMA-1090 (Public)	All 14 counties
March Blizzard (March 2001)	FEMA-3165	Counties of Berkshire, **Essex**, Franklin, Hampshire, Middlesex, Norfolk, and Worcester
February Snowstorm (February 17-18, 2003)	FEMA-3175-EM (Public)	All 14 counties
December Snowstorm (December 5-6, 2003)	FEMA-3191-EM (Public)	Counties of Barnstable, Berkshire, Bristol, **Essex**, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester
January Snowstorm (January 22-23, 2005)	FEMA-3201-EM (Public)	All 14 counties

Source: 2004 Massachusetts Pre-Disaster Mitigation Plan

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.


Plum Island Beach Erosion – April 2007

More recently, 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 saltmarsh 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.

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 most recent ice storm in New England occurred in January 1998, but 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. Regionally, Ice jams have been recorded on the Merrimack River in Lawrence, 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. 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 severe drought condition in Massachusetts began in 2001 and ended in early 2003. During this period, water levels declined significantly, causing concern among the region's water suppliers and forcing extended bans on outdoor watering.

Wildfires

Since 1970, more than 15,000 homes and 21,000 other structures have been lost to wildfires in the United States. According to MEMA, over 3,000 wildfires burned more than 2,600 acres in Massachusetts in 2002. In 2003, there were fewer wildfires, burning over 1,600 acres.

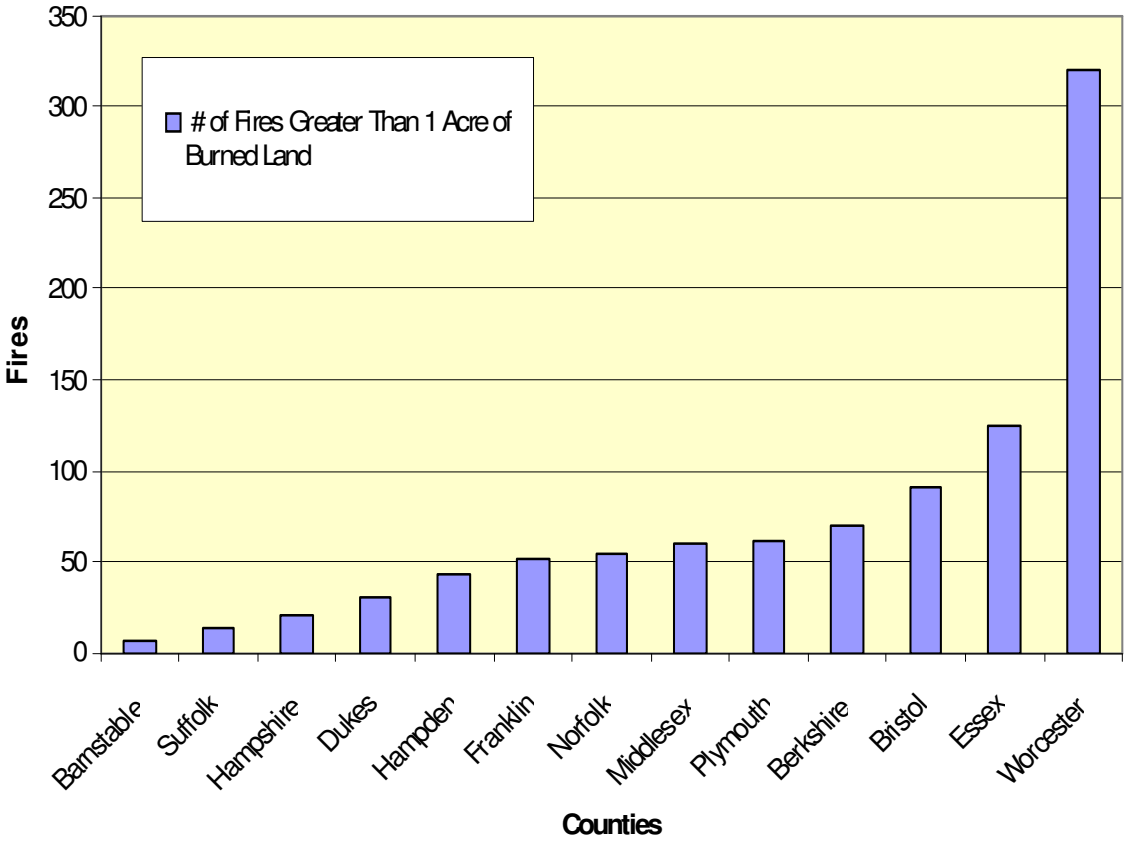
A surface fire is the most common type of wildfire, burning slowly along the floor of a forest, destroying or damaging trees. Lightning typically starts a ground fire, and burns on or below the forest floor; such fires are difficult to detect and extinguish. Crown fires spread quickly along the tops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

A wildfire is an uncontrolled fire that spreads due to the presence of vegetative fuel. These fires often begin unnoticed and spread quickly. *Human beings start four out of every five wildfires through arson or carelessness*; lightning strikes account for 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.

The Massachusetts Department of Conservation and Recreation (DCR), formerly the Massachusetts Department of Environmental Management, Fire Control Division, has maintained monthly records of the number of wildfires within the state since the 1960s. In this area of the country, wildfire season generally begins in March and ends in late November. In 2005, Essex County communities reported 125 brush fires of greater than one-acre of burned land, the second highest total among counties in the state after Worcester County (320 outdoor fires).

Figure 4-4. Reported Outdoor Fires by County - 2005



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 Unites 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. 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 19-28% by the year 2013 and 41-56% by the year 2043.

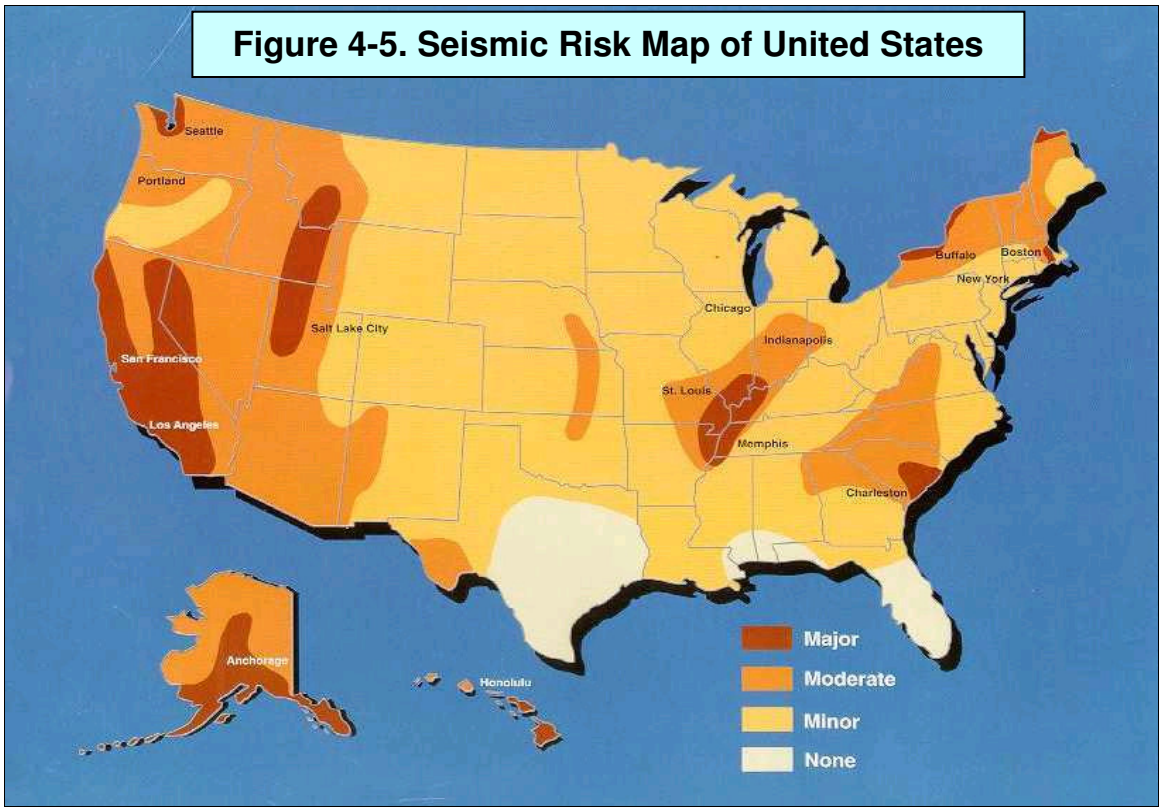


Figure 4-5. Seismic Risk Map of United States

Earthquake magnitude is measured on two scales, the Richter Scale and the Mercali 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 Mercali Scale is measured on a Scale of I to XII and expresses more directly the damaged caused by an earthquake. A Scale I earthquake on the Mercali 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 Mercali 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

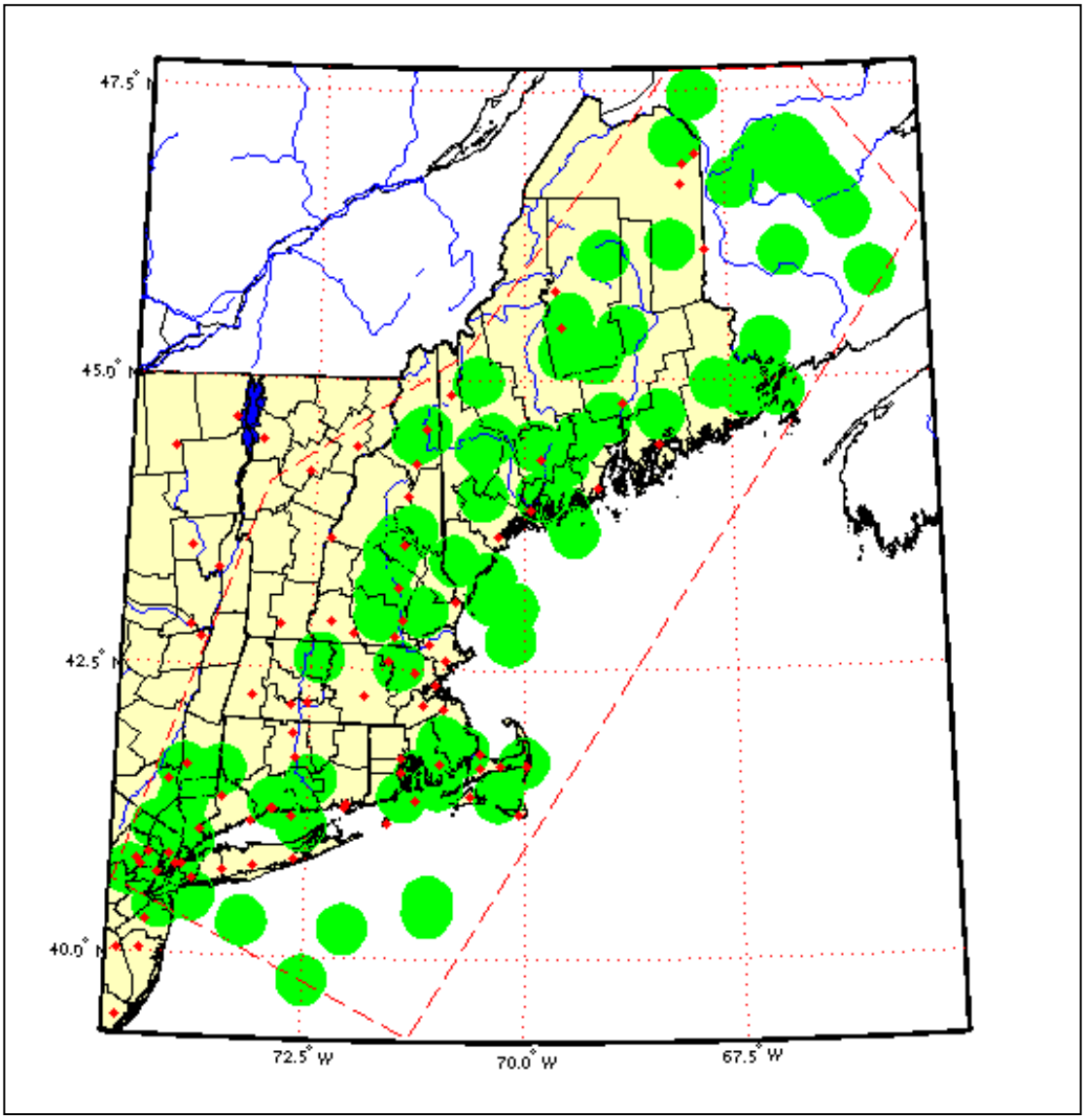
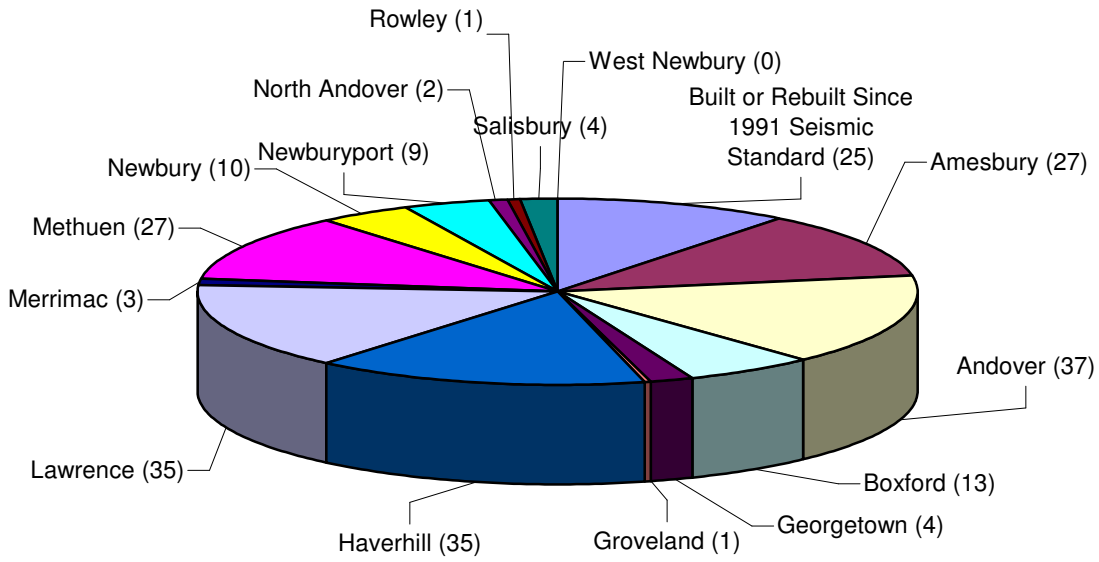


Figure 4-6 above shows the results of an earthquake probability analysis conducted by the Weston Observatory at Boston College. The study examined earthquake activity of magnitude greater than 2.7 between 1975 and 1998. According to the analysis, there is a 66% chance that the next earthquake of magnitude 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, 208 of the 233 federal aid bridges (89%) 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.

Figure 4-7. Federal Aid Bridges Built Prior to 1991 Seismic Criteria



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 **low risk** for this type of natural hazard.

4.6 Other Hazards

Heat Wave/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 black out could have catastrophic results for confined senior citizens and other at-risk populations in the region.

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

This section of the Hazard Mitigation Plan identifies and assesses the natural hazard risks in each of the 13 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.

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.*

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 source of information relative to the critical facilities list was the community's Comprehensive Emergency Management Plan (CEMP) on file with MEMA. 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, 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:

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. Problem "Hotspots", based on local knowledge

The above facilities are part of an electronic database and have been graphically displayed on individual maps for each community. The maps are included in Attachments 1 through 13 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, although they 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.

A relative risk assessment was conducted for each community, based primarily on information contained in the community's CEMP. The individual community information was then aggregated and served as the basis for the regional risk assessment as presented in this PDM Plan. **Figure 5-1** below presents a weighted aggregation of the communities' risk assessments as prepared for the CEMPs, and serves as a tool for focusing attention on key regional issues. In each CEMP, the community assesses nine 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 13 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 "13" (i.e., 1 point per community times the 13 communities). Similarly, the highest possible score a single event could achieve regionally would be "65" (from 5 points per community x 13 communities = 65 points).

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

Natural Hazard	Composite Score	Regional Risk
Floods/Storm Surges	65	HIGH
Winter Storms (blizzard/snow/ice)	65	HIGH
Hurricanes	39	Moderate
Dam Failure	37	Moderate
Wildfire/Brush Fires	36	Moderate
Drought	33	Moderate
Earthquakes	19	Low
Tornadoes	16	Low
Landslides	13	Low

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. Located on the banks of the Merrimack and Shawsheen Rivers, 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 32 square miles of land area and 223 miles of roadways.

Andover 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 from Andover to the metropolitan Boston area provided by the Massachusetts Bay Transportation Authority, and a regional bus service provided by the Merrimack Valley Transit Authority.

Andover's population is 31,247 persons (2000 U.S. Census), and occupies approximately 11,305 households. There are roughly 6,000 students in the public school system, with additional students in private schools at Phillips Andover Academy, Pike School, St. Augustines Grammar School, Andover Montessory School, and others. Merrimack College, located in North Andover, houses students in dormatories located in Andover.

The predominant land uses are forest land (40%) and residential development (38%), followed by commercial & industrial development (6.5%) and wetlands and water (6.1%). Farming, once an important part of the Andover landscape and economy, today constitutes only 500 acres, or less than 3% of the land area.

Public drinking water is supplied by Haggetts Pond, a surface water reservior that 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 roughly 4,000 acres of preserved open space managed by the Commonwealth of Massachusetts, the Andover Conservation Commission, and the Andover Village Improvement Society (AVIS)

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.1-1**, was derived from the Town's current Comprehensive

Emergency Management Plan (CEMP). The locations of these and other critical facilities and infrastructure were entered 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 Attachment 1 of this Plan.

Flood Prone Areas

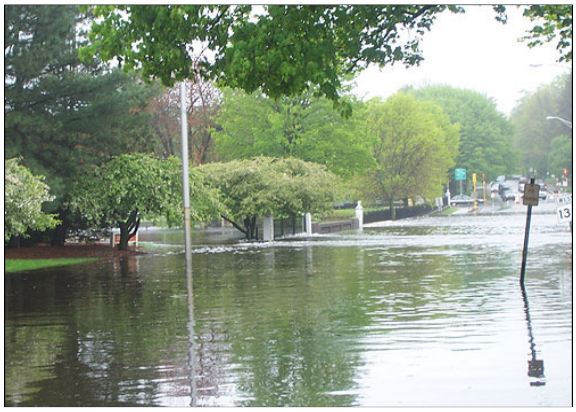
The Town of Andover spans parts of three major watersheds, as defined by the state: Shawsheen River watershed (50% of town), Merrimack River watershed (33%), and Ipswich River watershed (17%).

A GIS analysis of the Town's FIRM flood hazard maps by MVPC has determined that 1,569 acres (2.5 sq. mi.) of land area in town is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 769 acres (1.2 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute over eleven percent (11%) of the total area of the community. Based on an additional analysis by MVPC, 208 acres in these zones are still open and "potentially" developable under the Town's current zoning scheme. Future development of this open space would increase the area's impervious surface cover and stormwater runoff, thereby exacerbating the existing flooding problems.

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:

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. Fish Brook at Greenwood Road
6. Fish Brook at High Plain Road
7. Skug River at Salem Street
8. Unamed stream at River Street (outlet from Fosters Pond)
9. Unamed stream at Woburn Street (outlet from Fosters Pond).



The 1996, 1998, and subsequant floods 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.

Washington Park

Shawsheen Plaza

North Main Street

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.

TThe 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 down stream, 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 13 repetitive loss sites in Andover. Seven of the sites are classified as single-family residential. The remaining sites are a mix of multi-family and non-residential properties. Together, these 13 sites have resulted in the payout of 31 National Flood Insurance Program (NFIP) claims totaling $1,443,839 since 1982.

Structurally Deficient Bridges Over Waterways

According to file data compiled by the Massachusetts Highway Department and recently reviewed by MVPC, there are no bridges over water in Andover that are currently classified as “structurally deficient”.

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**. 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	3/24/2003	3/23/2003*
Brackett Pond Dam	Brackett Pond (142 acre-feet)	1930	Significant	5/09/2006	5/08/2011
Collins Pond Dam	Collins Pond (32.5 acre-feet)	1930	Significant	5/09/2006	5/08/2011
Field Pond Dam	Field Pond (380 acre-feet)	1930	Significant	5/09/2006	5/08/2011
Field Pond Dike	Field Pond (378 acre-feet)	1930	Significant	12/12/2000	6/29/2011
Fosters Pond Dam	Fosters Pond (550 acre-feet)	1913	Significant	11/20/2006	11/19/2011
Haggetts Pond Dam	Haggetts Pond (1750 acre-feet)	1940	Significant	10/26/2006	10/25/2011
Shawsheen River Dam	Shawsheen River (112 acre-feet)	1929	Significant	3/23/1998	3/22/2003*
*Inspection overdue, according to DCR/Office of Dam Safety spreadsheet record					

Natural Hazards Risk Analysis

The Town of Andover'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, Andover considers itself to be at ***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.

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.


Boxford Town Hall

The Town's current (2007) population is 8,827 and the population density is 362 people per square mile. The total number of housing units is 2,743, and the average household size is 3.2 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's population increased by 49% from 1970 to 1990, and it continues to grow today. Under the current zoning scheme, MVPC has projected a maximum Boxford population at build-out of 13,795.

Boxford's predominant land uses are forest and low-density residential development. Agricultural uses constitute about 17% of the town, and the remaining acreage is mostly freshwater wetlands and ponds. Commercial activity is limited to 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 are many large fields, some still used for agriculture. In central and east Boxford, the open lands are mainly small idle or abandoned fields. Many of the once-open fields in town that are longer being farmed have been converted into two-acre single family residential use.


Boxford State Forest

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.

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.2-1**, was derived from the Town's current Comprehensive Emergency Management Plan (CEMP) and from conversations with local emergency management personnel. 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 Attachment 2 of this Plan.

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	N/A	Unknown	Yes	No
	Masconomet Regional HS	20 Endicott Road	N/A	N/A	2,000	Yes	Yes

Surface Waters and Flood Prone Areas

Boxford is blessed with an abundance of surface waters that lie within three major drainage basins: the Merrimack, Parker, and Ipswich River basins. 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.


Stiles Pond

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 Lowe 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 83 acres (0.13 sq. mi.) lies with the 500-Year floodplain. Together, these two flood zones constitute almost twelve (12%) of the total area of the community. Based on an additional analysis by MVPC, approximately six (6) acres in these zones has 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. This analysis revealed the presence of 101 residential structures (collectively valued in 2008 at $20,360,800) in the 100-yr floodplain, and 7 residential structures (valued at $4,720,000) in the 500-yr floodplain.

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 15 flood insurance policies in place for properties located in flood hazard areas. The combined insurance premiums for these properties is $4,405,00 (source: *NFIP Policy Statistics for Massachusetts* - 11/30/08.)

Structurally Deficient Bridges Over Waterways

According to file data compiled and maintained by the Massachusetts Highway Department, 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 (source: *Town of Boxford Open Space and Recreation Plan*, May 2008). Three of these dams – Stiles Pond Dam, Lowe Pond Dam, and Four Mile Pond Dam – are classified by the state as "significant" hazard dams. These three dams are listed **Table 5.2-2** below.

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	Significant	12/06/2006	12/05/2011
Four Mile Pond Dam	Four Mile Pond (200 acre-feet)	1900	Significant	5/10/2001	5/9/2006*
Howe Pond Dam	Howe Pond (40 acre-feet)	1800	Significant	12/06/2006	12/05/2011

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

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 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, and inadequate management of its flashboards causes adverse flow conditions downstream. The dam was inspected in 2006 as a requirement of the state but is still in need of a dam management plan in order to properly operate the flashboards.

Lowe Pond Dam. Lowe Pond Dam is a privately owned dam that was constructed in the late 1950s and was rebuilt in the 1970s. It 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. This lack of a dam management plan needs to be addressed as part of a watershed management plan for Pye Brook.

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.

Howe Pond Dam. Howe Pond Dam is a privately owned 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 last repaired in the fall of 2007.

Based on the relatively large number of dams in the community (13), as well as the potential safety risks of the three "significant hazard" dams listed in Table 5.2-2 above, Town emergency management officials have assigned a ***medium*** risk rating to the hazard of dam failure.

Natural Hazards Risk Analysis

The Town of Boxford'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, Boxford 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.

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 13.1 square miles and a resident population of 8,147 (2007). The population density is 622 people per square mile. The total housing units in 2000 (U.S. Census) was 2,616, which represented an 18% increase over the previous decade. The average household size is 3.1 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 settlement. 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.

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 Attachment 3 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.					Yes
Health and Medical Aid Facilities	Baldpate Hospital	37 Lafayette Rd	Hospital	60		Yes	Yes
	Carleton Home	27 Andover St.	Nursing	8			No
	Erie Fire Station	North St.	Fire Station	20			Yes
	Georgetown Fire Dept	47 Central St	Fire Station	30			Yes
	Country Gate Children's Center, Inc.	20 North Street	Daycare	35			No
	Creative Care Pre K	140 Tenny St.	Daycare	20			No
	Georgetown Intermediate Care Facility	111 Jewett St.	Nursing	16			Yes
	Group Home	294 Andover St.	Group Home	4			Yes
	Limited Group Residence	8 Ordway St.	Group Home	4			No
	Over The Rainbow	29 Summer St.	Daycare	10			No
	Penn Brook	68 Elm Street					
	Pentucket Workshop	22 Pleasant St.					
	Perley Elementary	51 North Street					
	Smith Family Tree House	42 E. Main St.					
	Trestle Way Elderly Housing	Trestle Way	Elderly Housing	134			No
Emergency Shelters	Georgetown Middle/High School	11 Winter Street	Shelter		1250	Yes	Yes
	Penn Brook School	68 Elm Street	Shelter		1200	Yes	No
	Perley Elementary School	51 North Street	Shelter		950	Yes	Yes

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;

Parker River Flooding at West Main Street – May 2006

- **Plough Brook**, a smaller stream which flows from wetlands just east of Georgetown center (between North Street and East Main Street) northward to the Paker 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
- Parker River at West Street
- 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 subdrainage 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 and emergency management officials, there are three recurring flooding problems that are of particular concern and warrant immediate attention in order to protect public safety, private property and towns 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**

Three hundred feet (300') of this roadway near Rock Pond was flooded during the Mothers Day Flood. A section of the roadway has been closed for three years due to an unsafe culvert/bridge. The culvert/bridge needs to be replaced and the roadbed needs to be raised and resurfaced.

- **Parker River @ West Street**

One hundred thirty feet (130') of this roadway floods with regularity during high water events. The existing culvert needs to be replaced and the roadbed needs to be raised and resurfaced.

Flooding Vulnerability Assessment

A GIS analysis of the town's FIRM flood hazard areas by MVPC has determined that 1,297 acres (2.03 sq. mi.) of land area in Georgetown is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 270.5 acres (0.42 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 190 residential, commercial, and industrial structures (collectively valued in 2008 at $42,629,100) in the 100-yr floodplain, and four residential structures (valued at $2,835,400) in the 500-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 three repetitive flood loss sites in Georgetown. All are single-family residences located, respectively, on Heather Road, Rock Pond Avenue, and Spofford Street. Flooding incidents at these three sites have resulted in the payout of eight National Flood Insurance Program (NFIP) claims totaling $127,546 since 1996. Town-wide, there are 32 flood insurance policies for properties located in flood hazard areas. The combined insurance premiums for these properties is $7,538,200 (source: *NFIP Policy Statistics for Massachusetts* - 11/30/08.)

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** below.

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	8/24/2004	8/23/2009

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

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.

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 9.4 square miles and has a resident population of 6,038 (Census Bureau 2000). The population density is 642 people per square mile, and the average household size is 2.9 people. The median age of town residents is 31 years, and about 10% of the population is aged 60 or over. The Merrimack Valley Planning Commission (MVPC) predicts a rise in the population to 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 (48%) and residential development (27%), followed in turn by wetlands/water (7%) and agriculture (5%). Commercial and industrial uses combined constitutes 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.

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 Attachment 4 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	253 School Street	N/A	N/A	250-300	Yes	Yes
	Pentucket Regional Middle School (Gymnasium)	Main Street	N/A	N/A	150	Yes	Yes

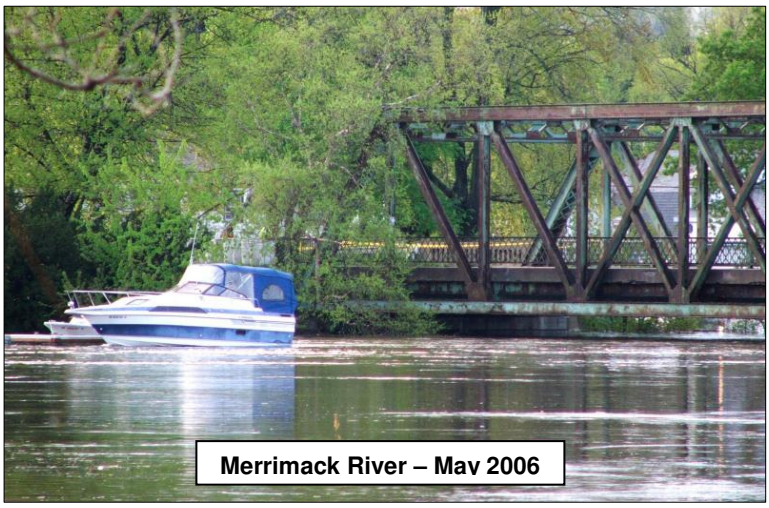
Surface Waters and Flood Prone Areas

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.



Merrimack River – Mav 2006

- **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 **s**maller 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 1,089 acres (1.7 sq. mi.) of land area in Groveland is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 204 acres (0.32 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 122 residential, commercial, and industrial structures (collectively valued in 2008 at $24,924,400) in the 100-yr floodplain, and 52 residential, commercial, and industrial structures (valued at $6,188,000) in the 500-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

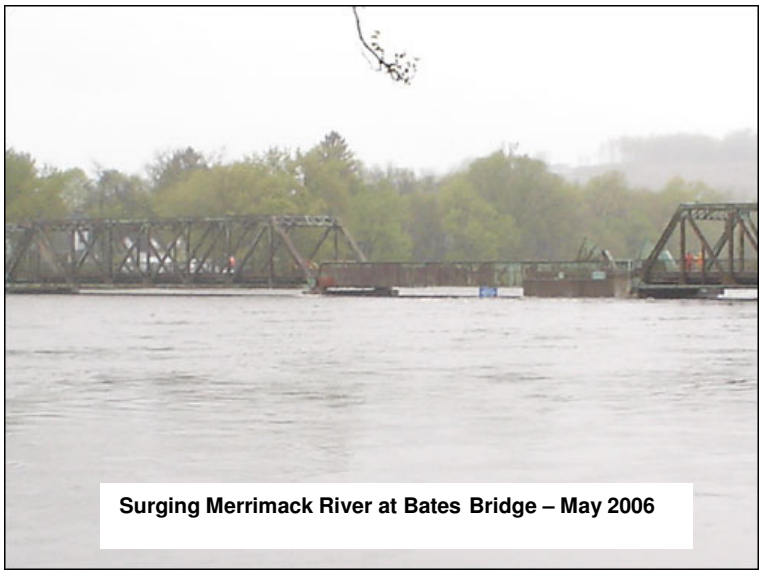
According to data compiled by the MA Department of Conservation and Recreation, there currently are no repetitive flood loss sites in the Town of Groveland. Town-wide, there are 24 flood insurance policies for properties located in FIRM flood hazard areas. The combined insurance premiums for these properties is $4,659,300 (source: *NFIP Policy Statistics for Massachusetts* - 11/30/08.)

Structurally Deficient Bridges Over Waterways

According to file data compiled by the Massachusetts Highway Department, the Town of Groveland has one "Structurally Deficient" bridge over water. This is the

Bates Bridge, also called the "Groveland Bridge" by some. This bridge is shown and described below.

Bates Bridge



Surging Merrimack River at Bates Bridge – May 2006

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

The AASHTO Bridge Rating for the structure in May 2007 was only 2.0 (out of 100), the *lowest rating* of any bridge in the Merrimack Valley region. It is not uncommon for this structure to be periodically closed to traffic while the Massachusetts Highway Department performs short-term repairs. MassHighway has also posted the bridge with a weight limit. Despite its safety shortcomings for automotive traffic, however, the bridge still has a functioning draw mechanism, which allows larger watercraft to proceed upstream as far west as downtown Haverhill.

The Bates Bridge carries approximately 20,600 vehicles/day (MVPC, August 2007). Many of these are commuters, heading to Route I-95 through Groveland and Georgetown from their homes in Haverhill and even southern New Hampshire. Others are Groveland residents who shop at Rivers Edge Plaza, or are emergency vehicles from Groveland, West Newbury, and Georgetown crossing the Merrimack River to Merrimack Valley Hospital in Haverhill. Much of this traffic would have to be re-routed to downtown Haverhill over the Basiliere Bridge into Bradford and Salem Street if the Bates Bridge. Other drivers would seek to use the Rocks Village Bridge between Haverhill and West Newbury as an alternate route. However, both of these bridges are also classified by the state as "Structurally Deficient". (The Rocks Village Bridge is slated for rehabilitation in 2009 or 2010.)

Given the high importance of the Bates Bridge to the region's transportation network and economic vitality, MassHighway is moving ahead with plans to build a replacement bridge. The plan to build a new bridge just 50-60 feet downstream from the current structure was developed in recognition of the fact that the Route 97/113 corridor could not be closed to traffic. Design work on the project is virtually complete and MassHighway anticipates advertising this bridge for construction in the spring of 2009. The project appears in the 2007-2010 Merrimack Valley Metropolitan Planning Organization Regional Transportation Plan as well as in the Merrimack Valley MPO's Transportation Improvement Program.

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. These two 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.

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.

5.5 CITY OF HAVERHILL Natural Hazard Risk Assessment

Community Profile

The City of Haverhill covers an area of 35 square miles and has a resident population of 58,969, according to the 2000 U.S. Census. The population density is 1,769 people per square mile. There are 17,500 housing units in the City, and the average household size is 3.4 people. 14.2% of the City's population is 65 years of age or older. There are 7,597 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 160 full-time public safety personnel, including 76 uniformed police officers and 84 fire fighters.


Haverhill City Hall

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.5-1**, 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 Haverhill map series that is presented in Attachment 5 of this Plan.

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:

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	70 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
	Griffith-White	170 Main St.	Nursing			Yes	No
	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		Rehab	45	60	Yes	No
Shelters	Citizen's Center	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 School	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

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
   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

Street Flooding in Haverhill – May 2006

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 3,531 acres (5.52 sq. mi.) of land area in Haverhill is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 868 acres (1.36 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, 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

According to Haverhill public safety officials, two recurring flooding problems are of particular concern, and warrant 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 proposes 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 would be armored with protective bio-vegetation mats and riprap. The City is seeking outside funds (HMGP grant) to help finance the project.

- **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. Among other potential options, the City is proposing to address this problem by providing spare motor and electrical control components that can be installed in the event of a system failure. The City is exploring outside funds to help finance the project.

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 (2007) Assessor's records, are listed in **Table 5.5-2**.

Table 5.5-2. Critical Facilities in Flood Hazard Areas – Haverhill

Facilities in *100-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2007 Buildings Valuation**
Haverhill Water Street Fire Station	207-2-2 / 131 Water Street	$447,900
Merrimack Valley Reg'l Transit	712-684-8 / 85 Railroad Avenue	$1,455,400
Haverhill Park & Ride Lot	408-2-5 / 225 Lincoln Avenue	$1,510,900 (land value)
Mass. Electric Company Substation	207-2-4 / 165 Water Street	$834,200
Facilities in *500-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2007 Buildings Valuation**
Haverhill Moody School	505-246-2 / 59 Margin Street	$1,354,400
Pennacook Place Nursing Home	207-1-2 / 150 Water Street	$3,227,000
Boisvert Day Care Facility	536-17-5 / 1035 Western Avenue	$211,700
Phoenix Row Elderly Housing	308-1-8 / 12 Phoenix Row	$725,400
Washington Square Elderly Housing	300-52-2 / 250 Washington Sq.	$2,406,800
MVRTA Washington Sq. Bus Station	308-1-10 / 12 Washington Sq.	$512,500
Marginal Sewage Pumping Station	308-1-10 / 12 Washington Sq.	$182,200

According to City 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 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 four repetitive loss locations in Haverhill. Three of these sites are on the north side of the Merrimack River – one on Boardman Street (single-family residence) and two on South Kimball Street (single-family residence and a non-residential property). The fourth repetitive loss site is in the Bradford section of the City on the south side of the Merrimack River. Together, these four sites have resulted in the payout of nine National Flood Insurance Program claims totaling $292,130 since October 1991. According to the City's emergency management director, these repetitive losses stem from recurring localized drainage problems rather than larger-scale riverine flooding from the Merrimack River or its tributaries.

Structurally Deficient Bridges Over Waterways

Haverhill has two bridges over waterways that are presently classified as structurally deficient. The Route 125 ("Basiliere") Bridge was built in 1925 and has an AASHTO rating of 37.9 (out of 100). This state highway bridge spans the Merrimack River in downtown Haverhill, and is the major access route connecting Haverhill to New Hampshire 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.

May 2006 Flooding at Friend's Landing, Haverhill
(Rt. 125 Bridge visible in upper right corner of photo)

The East Main Street ("Rocks Village") Bridge was built in 1883 and was reconstructed in 1914. It has an AASHTO rating of 26.3. This bridge spans the Merrimack River near the City's border with the Towns of Merrimac and West Newbury. Due to concerns over its poor condition and uncertain weight-bearing capacity, the bridge is closed to heavy vehicles such as tractor-trailers and will remain so until it can be reconstructed. The project is listed in the region's Transportation Improvement Program and is in the design phase.

Hazard Potential of Dams

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

Table 5.5-3. High Hazard and Significant Hazard Dams – Haverhill					
Dam Name	**Impoundment Name** (maximum capacity in acre-feet)	**Year Completed**	**Hazard Class**	**Last Inspection Date**	**Next Inspection Due**
Millvale Reservoir Dam	Millvale Reservoir (558 acre-feet)	1898	High	Not Recorded	Not Recorded
Crystal Lake Dam	Crystal Lake (1,000 acre-feet)	1930	Significant	12/30/1999	12/28/2004*
Frye Pond Dam	Frye Pond (90 acre-feet)	Not Recorded	Significant	12/30/1999	12/28/2004*
Lake Pentucket Dam	Lake Pentucket (412 acre-feet)	1920	Significant	12/23/1999	12/21/2004*
Little River Dam	Little River (25 acre-feet)	1870	Significant	12/23/1999	12/21/2004*
*Inspection overdue, according to DCR/Office of Dam Safety spreadsheet record					

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); ***medium risk*** from hurricanes, droughts, wildfire, dam failures, and power outages; and ***low risk*** from earthquakes, tornadoes, and landslides.

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 6.7 square miles and has a resident population of 72,043 (Census 2000). The City has the highest population density (10,752 persons per sq. mi.) in the Merrimack Valley region, and among the highest in the Commonwealth. There are 25,601 housing units, with an average household size of 2.9 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%).


Lawrence City Hall

The school age population is served by one senior high school, five regional schools serving K-8, and several smaller neighborhood schools that serve a variety of age groups. The City also has a number of private parochial and charter schools that serve the Greater Lawrence area.

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 a recently constructed 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). There are 294 public safety personnel in the community, including 156 police officers and 138 fire fighters.

Critical Facilities

A list of selected critical facilities (emergency operations, health care facilities, public shelters), as shown in **Table 5.6-1**, was derived from the City's current Comprehensive Emergency Management Plan (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 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 Attachment 6 of this Plan.

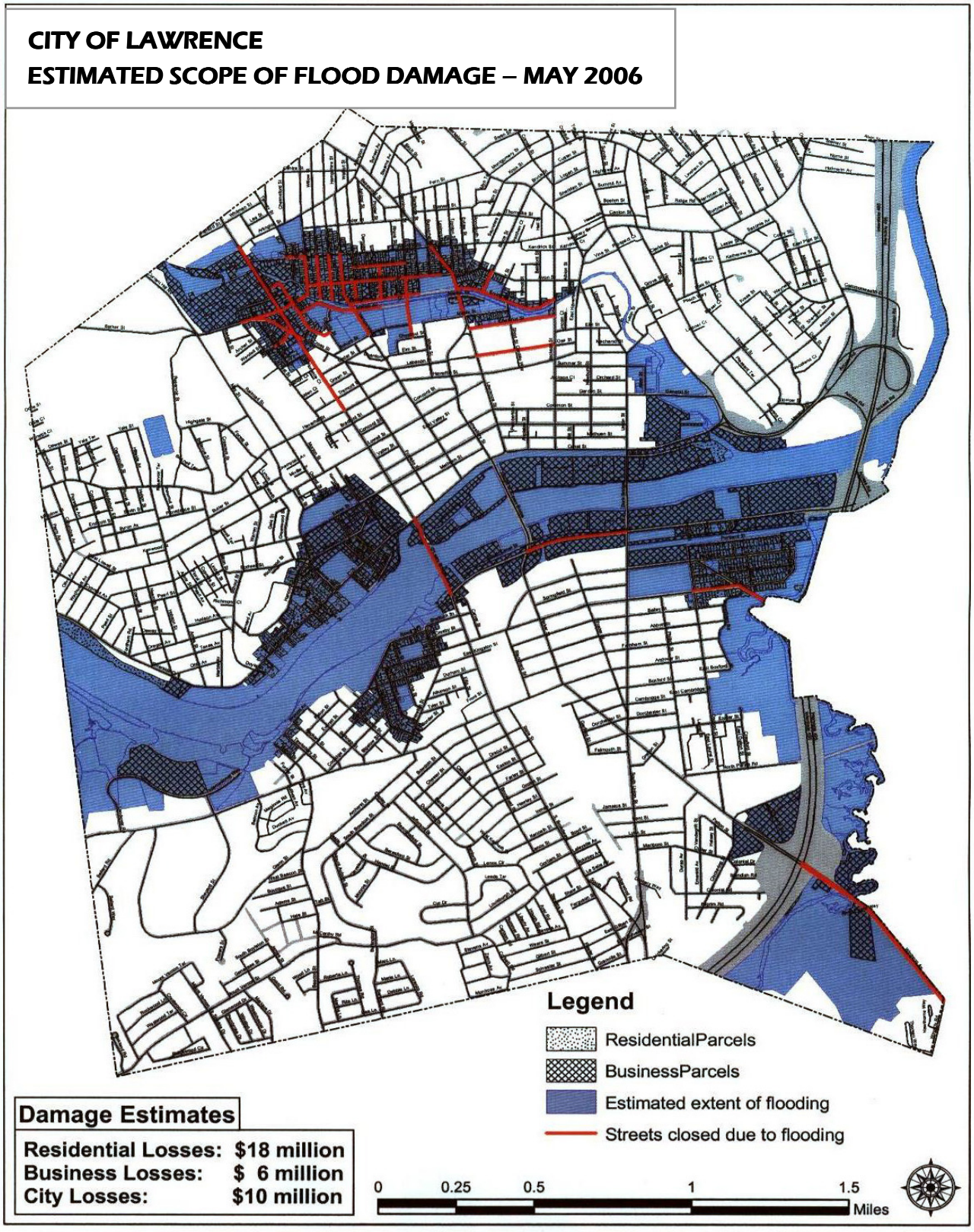
Table 5.6-1. LAWRENCE Emergency Operations, Health Care Facilities, and Shelters							
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Average Daily Patient Capacity**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations Center(s)	Lawrence Fire Alarm Hdqrtrs	66 Bodwell Street	N/A	N/A	N/A	N/A	Yes
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
Shelters	Daybreak Shelter	Winter Street	Shelter	45	50	70	No
	Lazarus House	Holley Street	Shelter	22	41	50	Yes
	Casa Nueva Vida	57 Jackson Street	Shelter	Opens this fall	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 predominately 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
Legend
ResidentialParcels
BusinessParcels
Estimated extent of flooding
Streets closed due to flooding
Damage Estimates
Residential Losses: $18 million
Business Losses: $ 6 million
City Losses: $10 million
0
0.25
0.5
1
1.5
Miles

Special Flooding Concerns

Lawrence public safety officials cite five recurring flooding problem areas that are of particular concern and warrant immediate attention in order to better 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 one eighth of a 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 River backs up into a local neighborhood affecting 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 this busy public thoroughfare.

- **Spicket River @ Daisy Street Bridge**

The Spicket River routinely backs up at this bridge, flooding Holly, Daisy, Spruce and Myrtle Streets. The City recently purchased 9 homes adjacent to this bridge using FEMA money, and along with land owned by Central Catholic High School created a recreational park with increased flood storage.

- **Spicket River @ Hampshire Street Bridge (currently being replaced)**

The Spicket River routinely backs up at this bridge, flooding Hampshire Street and Marion Avenue.

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

The Bloody Brook routinely backs up due to inadequately sized culverts and increased development upstream. Several homes in the flood area have been demolished and the property is now owned by the City of Lawrence.

As extensive as it was, the 2006 flood damage along parts of the lower Spicket River would have been even worse had the City not previously partnered with federal and state emergency management authorities to convert some densely-developed floodplain acreage into open space. In 2003, FEMA's largest New England land acquisition was completed in Lawrence, with 22 property owners and tenants relocated out of the flood-prone Arlington Neighborhood at a cost of $1,411,430. A FEMA Hazard Mitigation Grant Program (HMGP) award to the City paid for 75% of the project cost, and a HUD Community Development Block Grant (CDBG) covered the remaining 25%. MEMA and the MA Department of Conservation and Recreation (DCR) provided extensive planning and technical assistance throughout the project. During the 2006 flood, the project's reclaimed grassed fields provided sorely needed flood storage along the Spicket River. When the floodwaters receded, the open land quickly returned to an attractive vegetated buffer, replete with blooming red clover and butterflies. On the strength of the success of this project, City officials have plans to create a more expansive greenway along the banks of the Spicket River.


Nursing Home Evacuation – May 2006

The 2006 flood was but the latest in a series of such episodes. Other recent significant floods occurred in March/April 2004, Spring 2001, Spring 1998, and October 1996, again the result of overtopping of the Merrimack, Shawsheen, and Spicket Rivers. Each of these flood events resulted in impacts similar to those of the May 2006 Mothers Day Flood, although they were of shorter duration and less costly.

Flooding Vulnerability Assessment

A GIS analysis of the City's FIRM flood hazard area maps by MVPC has determined that 814.2 acres (1.27 sq. mi.) in Lawrence is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 462.9 acres (0.72 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute over one-quarter (26.8%) of the total area of the community. Based on an additional analysis by MVPC, 65 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 (2007) Assessor's records, are listed in **Table 5.6-2** on the following page**.**

Table 5.6-2. Critical Facilities in Flood Hazard Areas – Lawrence		
Facilities in *100-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2007 Buildings Valuation**
Lawrence Dept. of Public Works	148-0-5 / 31 Auburn Street	$1,228,400
Mary Immaculate Nursing Home	Lawrence Street	$14,303,000
Pump Stations	Salem Tnpke/Shawsheen River	Unknown
GLSD Pumping Station	Behind Wood Mill/250 Merrimack	Unknown
Lawrence Housing Authority	Auburn Street/Hampshire Street	$846,000
Leahy Grammar School	100 Erving Avenue	$638,000
Facilities in 5*00-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2007 Buildings Valuation**
Park Street Fire Station	171-0-149 / 290 Park Street	$171,300
Central Catholic High School	169-0-42 / 300 Hampshire Street	$2,472,500
Hennessy Grammar School	184-0-47 / 122 Hancock Street	$1,280,600

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

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 file data provided by the MA Department of Conservation and Recreation (DCR), there were 22 repetitive flood loss locations in Lawrence as of March 2008. Most of these sites are classified as multi-family residential. Together, the 22 sites have resulted in the payout of 55 National Flood Insurance (NFIP) claims totaling $6.95 million since 1978. This is the highest claim *amount* among the Merrimack Valley region's 15 communities, and is the second highest *number* of claims (the Town of Salisbury currently tops the list at 62 claims).

Structurally Deficient Bridges Over Waterways

The Massachusetts Highway Department's bridge list from June 3, 2008 identifies six bridges over waterways in Lawrence as being "structurally deficient". Three of these bridges span the Spicket River and three cross the Merrimack River. These six bridges are identified below, along with a brief description of the actions the state is taking to repair or eplace them:

#1. East Haverhill Street over the Spicket River

AASHTO Rating: 49.3 (out of 100)
Estimated Average Daily Traffic Volume: 7,836 (count taken in 2006)
Status: Bridge design complete; project anticipated to be advertised for construction in FY 2009. Substructure of new bridge will be built behind that of the existing one.

#2. Hampshire Street over the Spicket River

AASHTO Rating: 74.8
Estimated Average Daily Traffic Volume: 7,600 (count taken in 2004)
Status: 25% Design Plans have been approved and the permitting process has started for a bridge rehabilitation project. Estimated advertising date in 2012.

This bridge is located very close to Central Catholic High School and provides access between the cities of Lawrence and Methuen.

#3. Amesbury Street over the Merrimack River

AASHTO Rating: 51.6
Estimated Average Daily Traffic Volume: None Available
Status: Project not yet included in MHD Bridge Program. This bridge is slated to be repaired under a District-wide bridge contract. It appears that the problem involves scour that is occurring at the abutments.

This is the central bridge of the three primary bridges over the Merrimack River in the downtown area: the Broadway Bridge (western edge of downtown), the Amesbury Street Bridge, and the "Duck" Bridge (see below). All three bridges are structurally deficient and all are slated for repairs. The Amesbury Street Bridge will likely remain open during the repairs to the abutments.

#4. Union Street ("Duck") Bridge over the Merrimack River

AASHTO Rating: 21.8
Estimated Average Daily Traffic Volume: 15,720 (count taken in 2003)
Status: Bridge rehabilitation project to begin in 2009. The bridge will be closed at times during the project.

This bridge is located in the east central section of the City and is an important connector between the eastern end of downtown and South Lawrence. Area served includes the new McGovern Transportation Center and former mill space now being rehabbed for residential/commercial use. The bridge will also provide access to the new Gateway Project, located off Canal Street.

#5. Route 28 (Broadway) over the Merrimack River

AASHTO Rating: 57.6
Estimated Average Daily Traffic Volume: 22,000 (count taken in 2003)
Status: Status: Project advertised for construction; rehabilitation work to begin in late 2008, including the repair of concrete piers. At least one sidewalk and one lane will remain open on the structure during reconstruction.

Route 28 is the primary north/south route through the City and connects the community to downtown Methuen to the north and downtown Andover to the south.

#6. Canal Street Bridge over the Spicket River

AASHTO Rating: 34.3
Estimated Average Daily Traffic Volume: 8,400 (count taken in 2004)
Status: Project approaching 100% design. A new structure will be built and will consist of a triple arch bridge over the Spicket River. The existing structure will be retained and used as a community garden. The project is expected to be advertised for construction in FY 2010.

Construction of this bridge is to be, to the extent feasible, coordinated with other bridge repair/replacement projects that affect this section of the City including the so-called Lawrence Gateway Project. The other bridge projects include the repair of the Amesbury Street Bridge over the North Canal (now under construction), rehabilitation of the Union Street Bridge over the Merrimack River, and rehabilitation work that will soon be undertaken on the Route 28 Bridge over the Merrimack.

Hazard Potential of Dams

The DCR Office of Dam Safety includes three Lawrence dams on its active dam classification list: the Great Stone Dam (also called "Essex Dam"), Lower Locks Dam ("North Canal Outlet Dam"), and 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 and is now "run-of-the-river".) Of the three operating dams, only the Stevens Pond Outlet Dam is classified as either a "high" or "significant" hazard dam. This dam is listed in **Table 5.6-3** below.

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, this dam was last inspected in March 2008 and is classified as a "low hazard" dam. It is inspected by FERC every three years and is scheduled to be inspected again in 2011.

Table 5.6-3. High or Significant Hazard Dams – LAWRENCE

Dam Name	Impoundment Name (maximum capacity in acre-feet)	Year Completed	Hazard Class	Last Inspection Date	Next Inspection Due
Stevens Pond Outlet Dam	Stevens Pond (112 acre-feet)	1877	High	9/07/2006	8/27/2008*
*Inspection overdue, according to DCR/Office of Dam Safety spreadsheet record					

Based on the relatively small number of active dams in the community, as well as the high hazard classification of the Stevens Pond Outlet Dam, City emergency

management officials have assigned a ***moderate-high*** risk rating to the hazard of dam failure in Lawrence.

Natural Hazards Risk Analysis

The City of Lawrence'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, Lawrence considers itself to be at ***high risk*** from riverine flooding, winter storms (blizzards/snow/ice storms), and power outages; ***moderate-high risk*** from dam failure; ***moderate risk*** from hurricanes, earthquakes, and urban fires; ***low-moderate risk*** from tornadoes and forest fires; and ***low risk*** from drought and landslides.

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 9 square miles and accessible via interstate Route I-495 and regional Route110.

The Town has a resident population of 6,138 and 2,223 households (Census 2000). The population density is approximately 680 people per square mile, and the average household size is approximately 2.8 people.

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 (50%) and residential development (18%), followed in turn by wetlands/water (17%) and agriculture (12%). Commercial and industrial uses combined constitute just over 1% 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.

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.6-1**, was derived from the town's current CEMP and conversations with 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 Methuen map series that is presented in Attachment 7 of this Plan.

Table 5.6-1. 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
	Town Hall (Secondary EOC)	4 School Street	N/A	N/A	N/A	N/A	No
Health and Medical Aid Facilities	NONE						
Emergency Shelters	Donaghue School	Union Street	N/A	N/A	1500	Yes	No
	Dr. Sweetsir School	104 Church Street	N/A	N/A	1500	Yes	No
	Council on Aging	28 School Street	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 Town 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 417 acres (0.65 sq. mi.) of land area in Groveland is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 234 acres (0.37 sq. mi.) lies with the 500-Year floodplain. Together, these two flood zones constitute 11.5% of the total area of the community. Based on an additional analysis by MVPC, 18 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 79 residential structures (collectively valued in 2008 at $13,503,100) in the 100-yr floodplain, and 17 residential structures (valued at $3,824,500) in the 500-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 ten 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.

- **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**. Part of River Road, an important connector road to neighboring Haverhill and Amesbury, is still closed to traffic due to serious damage from the May 2006 and April 2007 floods. The bridge at the intersection of River Road and Middle Road is in need of extensive repair or replacement.
- **Mythical Street**. The 2006 and 2007 major storm events combined to wash out the existing culvert, and a new, larger culvert needs to be installed. This 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 13 flood insurance policies in place for properties located in FIRM flood hazard areas. The combined insurance premiums for these properties is $3,120,800 (source: *NFIP Policy Statistics for Massachusetts* - 11/30/08.)

Structurally Deficient Bridges Over Waterways

According to Massachusetts Highway Department records, 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 to West Newbury and the Bates Bridge connecting Haverhill to Groveland – are located in neighboring communities and impact greatly on Merrimac's transportation system efficiency. 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.

As of May 2007, the Rocks Village Bridge had an AASHTO rating of 26.3 (out of 100) and carried approximately 6,500 vehicles/day in 2007. Due to its deteriorating condition, the bridge has been posted with weight restrictions. MassHighway is now in the process of completing the design of improvements to the bridge structure. Included in this design are plans to construct a bicycle/pedestrian that would be cantilevered on the upstream side of the superstructure. MassHighway anticipates advertising this project for construction in FY 2009 or 2010.

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 May 2007 was 2.0 (out of 100), the ***lowest*** rating for any bridge in the Merrimack Valley region. It is not uncommon for the structure to be periodically closed to traffic while MassHighway performs 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 be rerouted to downtown Haverhill over the Basilliere Bridge (Route 125) into Bradford and Salem Street. Other drivers would seek to use the Rocks Village Bridge between Haverhill and West Newbury as an alternate route. Both of these bridges are also classified by the state as being "Structurally Deficient", and the Rocks Village Bridge is slated for rehabilitation in 2009 or 2010.

Given the importance of the Bates Bridge to the region's transportation network and the condition of the structure, MassHighway is moving ahead with plans to build a replacement bridge. The plan to build a new bridge just downstream from the current structure was developed in recognition of the fact that the Route 97/113 corridor could not be closed to traffic. Current plans call for the existing structure to be replaced with a new bridge to be built 50-60 feet downstream. Design work on the project is virtually complete and MassHighway anticipates advertising this bridge for construction in the spring of 2009. This project appears in the 2007 Merrimack Valley Metropolitan Planning Organization Regional Transportation Plan as well as in the Merrimack Valley MPO's Transportation Improvement Program.

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 lower 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***.

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 power outages; and ***low risk*** from earthquakes, tornadoes, dam failure, and landslides.

5.8 CITY OF METHUEN Natural Hazard Risk Assessment

Community Profile

The City of Methuen covers an area of 22.4 square miles and has an estimated 2005 resident population of 45,476 (*Methuen Master Plan 2007*). The population density is 2,030 people per square mile. There are 16,723 housing units in the City, and the average household size is 2.7 people. The public school system includes four large K-8 schools and one senior high school (grades 9 – 12), and has a current total student enrollment of 7,474. The predominant land uses are residential development (42.4%) and forest land (26.6%), followed by wetlands (5.9%) and vacant land (5.3%). Commercial and industrial uses combined account for 5.5% of the total land area. Agriculture, once an important part of the Methuen landscape and economy, today constitutes only 3% of City land. During the 20-year period between 1985 and 2005, over 1200 acres of open forest and farmland were developed, most for residential use. 73.4% 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 10 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.


Methuen City Hall (Searles Building)

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 Attachment 8 of this Plan.

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,

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)	Methuen City Hall (Searles)	41 Pleasant Street	N/A	N/A	N/A	N/A	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
	Methuen Health & Rehab. Center	480 Jackson street	Nursing	107			Yes
	Nevins Manor	110 Broadway	Nursing	46			Yes
	Sunshine Health & Rehab	281 Broadway	Rehab	50			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 Nursing	10-12 Burnham Road	Nursing	150			Yes
Shelters	Methuen High School	1 Ranger Road			2000		Yes
	Comprehensive Grammar Sch.	100 Howe Street			350		Yes
	Tenney Grammar Sch.	75 Pleasant St.			350		Yes
	Timony Middle School	45 Pleasant View St.			350		Yes
	Marsh Corner School	311 Pelham Street			1000		Yes

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's CEMP, the Merrimack River generally floods along Armory and Lowell Streets. The Spicket River generally floods where it approaches Methuen on Hampshire Road, the center of the city along Pine Street, Horne Street, Bentley Circle, and occasionally on Cross and Pelham Streets.

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 Guilford Railroad Bridge, 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 RR bridge causes a major backup (ponding) 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 – most recently the May 2006 Mothers Day Flood – 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 is seeking outside 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 but the latest in a series of such episodes. Other significant flooding events occurred in March/April 2004, spring 1998, and October 1996. Each of these flood events resulted in impacts similar to those of the May 2006 Mother Day Flood, although they were of shorter duration.


Jackson Street Flooding – May 2006

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 FIRM flood hazard area maps by MVPC has determined that 1,969 acres (3.1 sq. mi.) of land area in Methuen is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 737 acres (1.1 sq. mi.) lies within 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, 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 (2007) 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**	**2007 Buildings Valuation**
Methuen Water Supply Intake Structure	518-162-28 / 41 Pleasant Street	$2,234,900
Methuen Water Pumping Station	320-166-25 / 106 Lowell Blvd	Not assessed
Mass. Electric Power Substation	512-124-39 / 141 Pelham Street	$6,100
Methuen Sewage Pumping Station	218-130-18AA / 56 Hidden Road	$250,100
Methuen Sewage Pumping Station	610-59-20D / 5 Kimball Circle	$152,000
Methuen Sewage Pumping Station	1212-110C-12 / Merriline Avenue	$215,400
Creative Learning Day Care	318-166-4 / 602 Lowell Street	$134,100
Facilities in *500-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2007 Buildings Valuation**
Methuen DPW Garage	512-146-20 / 33 Lindberg Avenue	$542,000
Mariner Health Care Nursing Home	814-41-23F / 480 Jackson Street	$1,193,700
Methuen Sewage Pumping Station	Lowell Street	Not assessed
Methuen Sewage Pumping Station	418-153B-70C / 1111 Riverside Dr	$759,800
Day Care Facility	816-97-57 / 103 Jackson Street	$142,500

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

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 nine repetitive flood loss locations in Methuen. Seven of the sites are classified as single-family residential. The remaining two sites are non-residential. Together, these nine sites have resulted in the payout of 29 National Flood Insurance Program claims totaling $534,411 since 1979.

Structurally Deficient Bridges Over Waterways

Methuen has one bridge over a waterway that is presently classified by the Massachusetts Highway Department as “structurally deficient”. 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 the Massachusetts Highway Department. It

serves as an important 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 47.9 (out of 100) due to the structural deficiency of its footings. A project to repair the bridge is listed in the region's Transportation Improvement Program and is in the design phase.

Hazard Potential of Dams

The DCR Office of Dam Safety includes 11 Methuen dams on its dam classification list. Of these, three 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
Spicket River Dam (Lowell Street)	Spicket River (210 acre-feet)	1860	Significant	11/21/2003	11/19/2008
Forest Lake Dam	Forest Lake (224 acre-feet)	Not Recorded	Significant	8/02/2001	8/01/2001*
Searles Pond Dam	Searles Pond (63 acre-feet)	1960	Significant	8/02/2001	5/01/2007*

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

The City's concern over the Spicket River Dam was borne out during the May 2006 Mothers Day Flood, when the river's surging floodwaters began to overtop the dam and threaten 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

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 urban fires; ***low-moderate risk*** from tornadoes and forest fires; and ***low risk*** from drought and landslides.

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 on the west; Rowley to the south; and the Atlantic Ocean on 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/Upper Green**: Located in the northern end of town, Old Town retains a character and development pattern typical of a New England Village. It is anchored by a classic village green surrounded by historic homes, farmhouses, municipal buildings, and a few businesses. Since the 1950s, new development has slowly radiated from the village center in a form that is less dense and more "suburban" in character along Parker and Hanover Streets and High Road.
- **Byfield**: Located around the intersection of Central and Main Streets in the southwestern corner of town, Byfield is another relatively dense cluster of houses, small service-oriented businesses, and municipal facilities. In a fashion similar to Old Town, development since World War II has crept away 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 in the northeastern corner of the town. The entire village of Plum Island includes area in both Newbury and Newburyport, and reflects the character of a one-time vacation retreat with small ("postage stamp") lots and many modest "summer camp" style homes. Almost all of the original homes have been converted or demolished and rebuilt as year-round residences.


Aerial View of Plum Island

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 35 years, Newbury has maintained a consistent overall rate of growth, consuming approximately 30+ acres of land every year on average. The current (2007) population is 6,926. The population is expected to rise to 8,177 by 2020. In 2000, there were 2,514 households, and the average household size was 2.66 people. A build-out analysis conducted by MVPC estimated that there is 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 along 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 a majority of town residents by either the Byfield Water District or the City of Newburyport Water Department. 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.

Critical Facilities

Selected critical facilities in Newbury (emergency operations centers, 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 Attachment 9 of this Plan.

Table 5.9-1. NEWBURY 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 Center	Newbury Police Dept.	25 High Road	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	N/A	1,500	Yes	Yes
	Newbury Elementary School	Hanover Street	N/A	N/A	500	Yes	Yes
	Governors Academy	1 Elm Street	N/A	N/A	1,000	Yes	Yes
	Byfield Elementary School	Lunt Street	N/A	N/A	800	Yes	Yes
	Newbury Town Hall	25 High Road	N/A	N/A	74	Yes	Yes

Surface Waters and Flood Prone Areas

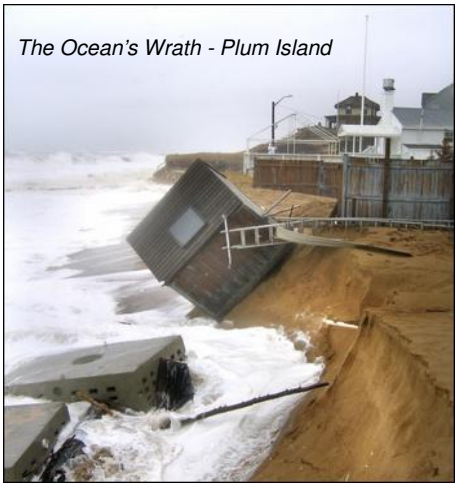
Newbury is blessed with an abundance of surface waters, ranging from the Parker River that bisects the lower third of the community, to the Atlantic Ocean that forms the town's eastern border, to the innumerable small tidal creeks that interlace the vast Great Marsh lying behind Plum Island. Fresh water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

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; an active landfill in Newbury; agricultural land; and protected open space. While the amount of undeveloped land has remained roughly constant during the 1990s, the

amount of residential land in the watershed has increased from 996 acres in 1991 to 1,592 acres in 1999 – a 60% increase. Impervious cover was about 10.5% in 1999.

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 Governors 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.


The Ocean's Wrath - Plum Island

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 ocean-side structures.

Town Conservation and Highway Department personnel have documented numerous 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

- Plum Island Turnpike – roadway flooding, ice cakes, high winds, zero visibility
- Plum Island Center – overtopping, flooding
- Middle Road – flooding @ Tolman's Auto and @ Stubbs
- Scotland Road – flooding @ Wolf Brook and @ Highfield Road intersection
- River Road – dam failure and flooding
- Newman Road – flooding
- Hanover Street – flooding @ Little River
- Pine Island Road – flooding, ice cakes, high winds, zero visibility
- Larkin Road – flooding @ bridge
- Orchard Street – flooding of Cart Creek
- Central Street – dam failure and flooding

Flooding Vulnerability Assessment

A GIS analysis of the town's FIRM flood hazard areas by MVPC has determined that a total of 6,659 acres (10.4 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 126 acres (0.2 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute over forty-three percent (43%) of the total area of the community. Based on an additional analysis by MVPC, 148.5 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.


Surging Parker River - Byfield

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 393 residential and industrial structures (collectively valued in 2008 at $41,057,200) in the 100-yr floodplain, and 22 residential structures (valued at $1,790,500) in the 500-yr floodplain. Within the SLOSH zone, MVPC identified 800 residential and industrial structures valued at $87,053,000.

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.


Little River Flooding – Newman Road

Repetitive Flood Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there are 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 40 National Flood Insurance Program claims totaling $461,686 since 1978. Town-wide, there are 244 flood insurance policies in place for properties located in FIRM flood hazard areas. The combined insurance premiums

for these properties is $59,960,600 (source: *NFIP Policy Statistics for Massachusetts* - 11/30/08.)

Structurally Deficient Bridges Over Waterways

Until recently, 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.

Hazard Potential of Dams

The DCR Office of Dam Safety lists nine (9) 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; Larkin Road 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.


Central Street Dam

None of these 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.

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 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.

5.10 TOWN OF NORTH ANDOVER Natural Hazard Risk Assessment

Community Profile

The Town of North Andover covers 27.8 square miles and has an estimated current (2005) population of 27,155. The population density is 977 people per square mile. There are 9,943 housing units in the Town, and the average household size is 2.7 people. 13.4% of the population is 65 years of age or older. The public school system includes five elementary schools, one middle school, and one high school, and has total student enrollment of 4,634. North Andover also has several private educational facilities, including an elementary school, a high school, and Merrimack College. The predominant land uses are forest land (49.8%) and residential development (28.7%), followed by wetlands/water (6.1%) and agriculture (6.1%). Commercial and industrial uses combined account for 4.2% of the Town area. Farming, once a major part of the North Andover landscape and economy, today constitutes only 1,050 acres – down 710 acres (40%) 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

Critical Facilities

A list of selected critical facilities (emergency operations, health care, shelters), as shown in **Table 5.10-1**, 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 Attachment 10 of this Plan.

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".

Table 5.10-1. 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 Police Station	566 Main Street					Yes
Health and Nursing Facilities	Meadows of Edgewood	575 Osgood Street	Assisted Living/ Nursing		313		Yes
	Heritage House	700 Chickering Road	Assisted Living		93		No
	Sutton Hill Center	1801 Turnpike Street	Nursing		142		No
	Prescott House	140 Prescott Street	Nursing		126		No
Emergency Shelters	Senior Center	120 (Rear) Main Street			200	200	Yes
	Middle School	495 Main Street			500	500	No
	Osgood Landing	1600 Osgood Street			4000	4000	Yes

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 Shawheen and Merrimack Rivers; and the Shawsheen Street and Salem Street area along the lower Shawsheen River.


Residential Flooding – May 2006

According to Town officials, during extreme flood events, there are typically three 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; and 3) the Riverview and North Main Street neighborhood on the south bank of the Merrimack River in the north section of town. 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 Rae'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.

Rae's Pond lies immediately adjacent to Lake Cochichewick and is directly connected to the Lake through an approximately 50-foot long conduit under Great Pond Road (Rt. 133). 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 Rae'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 five years, North Andover has experienced five sewer surcharging events that together required 11 days of pumping to prevent contaminated releases to Lake Cochichewick. These events occurred on 3/22/01, 4/1/04, 4/4-8/05, 10/15-17/05, and 5/13-15/06. All five events were caused by excessive rainfall or snowmelt conditions, the magnitudes (recurrence intervals) of which were not recorded.

The most recent event of May 13-15, 2006 ("Mothers Day Flood") was characterized as a 100-year flood event. This event caused severe surcharging of the Rae's Pond and Winter Street lift stations, and cost the town $7,799.00 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 seeking outside funds (HMPG grant) to help finance permanent structural solutions to these two recurring lift station surcharging problems that place Lake Cochichewick and the public health at risk. By making the sewer manholes that flow to the Rae's Pond and Winter Street lift stations impervious to infiltrating floodwaters, the surcharging problems will be mitigated and Lake Cochichewick will be better protected from raw sewage contamination.

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 Rae's Pond overtopped the road. In response to this latter problem, Town engineering and public works officials have proposed drainage improvements at the Rae's Pond and Winter Street sewer lift stations. These improvements are aimed at eliminating the infiltration of floodwaters into the municipal sewer system that leads to recurring surcharging. The Town is seeking a state HMGP grant to help finance these two high priority mitigation projects.

Flooding at Great Pond Road – May 2006

Flooding Vulnerability Assessment

A GIS analysis of the Town's FIRM flood hazard area maps by MVPC has determined that 3,079 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 380 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 current (2007) Assessor's records, are listed in **Table 5.10-2** 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 5.10-2. Critical Facilities in Flood Hazard Areas – North Andover		
Facilities in *100-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2007 Buildings Valuation**
North Andover Water Pumping Station	35-0-21	$111,100
Coachman's Lane Sewage Pumping Station	37.A-0-29	Not Available
Facilities in 5*00-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2007 Buildings Valuation**
Hawthorne Place Sewage Pumping Station	26-0-16 / 41 Hawthorne Place	$297,400

Repetitive Flood Loss Structures

According to data provided by the MA Department of Conservation and Recreation, there is one repetitive flood loss site in North Andover, a single-family residence at Crossbow Lane. Flooding incidents at this site have resulted in the payout of two National Flood Insurance Program claims totaling $8,942 since 1979. According to the Town's Flood Hazard Mitigation Plan (June 2004), town-wide, there are 47 flood insurance policies for properties located in flood hazard areas. The total insurance coverage for these properties is $10,047,200.

Structurally Deficient Bridges Over Waterways

According to file data compiled by the Massachusetts Highway Department and recently reviewed by MVPC, 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 5.10-3** 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-high*** risk rating to the hazard of dam failure.

Table 5.10-3. 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	High	10/05/2006	9/24/2008
Cochichewick River Dam	Cochichewick River (32.4 acre-feet)	Not Recorded	Significant	10/01/2000	9/30/2005*
*Inspection overdue, according to DCR/Office of Dam Safety spreadsheet record					

Natural Hazards Risk Analysis

The Town of North Andover'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 pose a 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-high risk*** from dam failure; ***moderate risk*** from hurricanes, earthquakes, and structural fires; ***low-moderate*** risk from tornadoes and forest fires; and ***low risk*** from drought and landslides.

5.11 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 19 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. In 2000, the year-round resident population was 5,500 (U.S. Census), an increase of 25% from 1990. There were 1,958 households in 2000 and the town-wide population density was 289 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* – 5,659 acres (46.5%); *salt marsh* – 2,270 acres (18.7%); *residential development* – 1,844 acres (15.2%); and *agriculture* – 847 acres (7.0%). Commercial and industrial uses combined comprise under 200 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.

Critical Facilities

A list of selected critical facilities (emergency operations, nursing/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 Rowley map series that is presented in Attachment 11 of this Plan.

Table 5.11-1. 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.	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;
- **Bachelder** 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 Bachelder 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.


Dodge Road Bridge Damage – May 2006 Flood

The May 2006 "Mothers Day" Flood in particular caused extensive, 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 Bachelder 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 3,986 acres (6.23 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 800 acres (1.25 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute over thirty-nine percent (39%) 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. 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 96 residential and commercial structures (collectively valued at $10,047,800 in 2008) in the 100-yr floodplain, and 24 residential and commercial structures (collectively valued at $5,355,900) in the 500-yr floodplain. Within the SLOSH zone, MVPC identified 54 residential structures valued at $2,410,200. No industrial structures were identified in the mapped hazard areas.

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.

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.

Structurally Deficient Bridges Over Waterways

According to file data compiled and maintained by the Massachusetts Highway Department (MHD), there are no bridges over water in Rowley that are currently classified as "structurally deficient". Until recently, 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 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, only the Jewel Mill Dam, an impoundment of Bachelder Brook, is classified as a "significant hazard" dam. This dam is a run-of-the-river dam with a channel that was used to direct water to the mill when the mill was operational.

Table 5.11-3. Significant Hazard Dam – Rowley					
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)	Bachelder Brook (16.5 acre-feet)	Not Identified	Significant	12/13/1999	12/11/2004
*Inspection overdue, according to DCR/Office of Dam Safety spreadsheet record					

Although only the Jewel Mill Dam is classified as a "significant hazard" dam, in view of the relatively large number of dams in the community, Town emergency management personnel have assigned a ***low-moderate risk*** rating to the overall hazard of dam failure.

Natural Hazards Risk Analysis

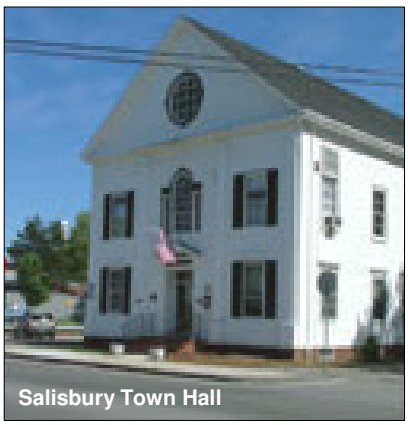
The Town of Rowley's Comprehensive Emergency Management Plan (CEMP) identifies and describes many of the natural hazards that are addressed by this Plan. The CEMP information, together with material compiled by MVPC and input from local emergency management personnel, provides the basis for a general 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 their occasional associated power outages; ***moderate risk*** from hurricanes, brush fires/wildfires, and drought; ***low-moderate risk*** from dam failure; and ***low risk*** from tornadoes, earthquakes, and landslides.


Haverhill Street (Rt. 133) Flooding

5.12 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 2006 year-round resident population of 8,438 (MVPC Data Center). The population density is approximately 548 people per square mile. MVPC projects a maximum residential population of 10,853 at full buildout.


Salisbury Town Hall

Development is generally concentrated in four distinct areas:

- *Salisbury Beach*, a 3.8-mile long barrier beach and salt marsh complex surrounding 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%). Vast salt wetlands (2,670 acres) cover 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 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.


Salt Marsh Habitat

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 3,100 residential, commercial, and industrial accounts, including 150 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 municipal sewer system serves approximately 50% 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.

Critical Facilities

Selected critical facilities in Salisbury (emergency operations center(s), health and medical aid facilities, emergency shelters) are listed in **Table 5.12-1** 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 Attachment 12 of this Plan.

Table 5.12-1. 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. *Alternate EOC*: Salisbury Elementary School	37 Lafayette Rd 100 Lafayette Rd					No Yes
Health and Medical Aid Facilities	Salisbury Fire Dept.	37 Lafayette Rd	First Aid	35		No	No
	Salisbury Police Dept.	24 Railroad Ave	First aid		93	No	No
	Assisted Living Center, Inc.	19 Beach Road	Assisted Living		30	Yes	No
Emergency Shelters	Hilton Center	39 Lafayette Rd	N/A	N/A	135	Yes	Yes
	Salisbury Elementary School	100 Lafayette Rd	N/A	N/A	210	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, and U.S. Route 1, are described in the highlighted blue boxes on the following four pages.

Salisbury Flood Scenes – April 2007

Salisbury Beach Pavilion

Salisbury Beach Erosion (South End)

Flooded Business on Route 1

Breached RR Berm @ Town Creek

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.

In the Patriot's Day 2007 Storm, the Beach sustained high winds and waves coupled with high spring tides that 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. The DCR spent approximately $1 million in 2007 to purchase sand and construct sacrificial dunes in the hardest hit area, but a longer term plan for beach protection and replenishment is needed.

Needs Assessment: The DCR recently released a draft long-term beach management plan and the Town is cooperating on developing and implementing the plan. The Town will also explore participating in a long-term regional beach replenishment and dredging program with State agencies and other North Shore communities. Such a program has been highly successful in providing both beach replenishment and harbor and channel maintenance on Cape Cod. The recent Coastal Hazards Commission Report recommended implementing beach replenishment programs on a wider basis. State or Federal funding will be needed to study the feasibility of such a program along the North Shore.

- **Storm Overwash 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.

Needs Assessment: The boardwalk and deck at Salisbury Beach Center should be designed to include elements that will protect the Beach Center against overwash. In the meantime, it will be important to develop an emergency response plan that will allow the Town DPW to build temporary sand barriers across the part of the Center that is not protected by the sacrificial dunes. In addition, as part of a long-term beach management plan, future erosion of the existing sacrificial dunes should be monitored and their profile should be maintained.

- **Blackwater River Flooding**

Background: The Blackwater River is a tidal river that drains a large area of salt marsh 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 the Army Corps of Engineers study. The Town anticipates that its contribution to construction of the floodwall will be obtaining necessary easements from private landowners as well as providing in-kind services by its Department of Public Works.

- **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 abandoned 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) has reimbursed the Town for 75% of the cost of the repair.

The Town has a 99-year lease on the rail bed to build a rail trail that will be part of a regional trail network, and is designing the trail using programmed Federal Transportation Enhancements funding. After some preliminary engineering analysis and consideration of alternatives, the Town believes that raising the level of the rail bed through the Town Creek marsh and paving the rail trail will help to protect against future breaches and flood damage. MassHighway has determined that the rail trail project, with an estimated cost of $2 million, is eligible for Federal Aid CMAQ funding. The project is programmed in the Statewide Transportation Improvement Program for funding in FY 2008. It is important to proceed with construction as soon as feasible because of the significant risk of another breach and additional major flood damage and public safety disruption.

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 are conducting coordinated studies to: 1) design a permanent repair of the breach, 2) determine the proper materials for construction of the rail trail so that it will withstand flooding, 3) determine an appropriate finished elevation for the rail trail to take account of flooding risks, and 4) determine the proper culvert size and tide gate arrangement that will facilitate runoff drainage while protecting low-lying properties from tidal flooding.

The Town plans to apply for a Flood Hazard Mitigation Grant to perform the work recommended by the studies.

- **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 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.

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.

- **Juno and Viking Street Flooding**

Background: During the May 2006 storm, the low-lying areas of Juno and Viking Streets flooded. This area has been subject to flooding in other substantial rain and snow events. The flooding is caused by a collapsed culvert on adjacent private property. The Town DPW has been seeking an easement that would permit it to repair the culvert, but the adjacent property owner has thus far refused.

Needs Assessment: The Town will continue to seek the necessary easement and, if and when the adjacent property is developed, the Planning Board and Conservation Commission should require appropriate drainage improvements as permitted under their authority to solve the flooding problem along Juno and Viking Streets.

- **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 4,683 acres (7.3 sq. mi.) is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 187 acres (0.3 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute over 40 percent of the total area of the community. Based on an additional analysis by MVPC, 53.1 acres in these zones were found to be still open and "potentially developable" under the Town's current zoning bylaw. Further development of this open space would increase the area's impervious surface cover and generate additional stormwater runoff, thereby exacerbating the existing flooding problems. 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 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 5.12-2** on the following page, together with their locations and values as derived from the current (2007) Assessor's records and the Town's current (FY08) GASB 34 Report.

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*SLOSH (Sea, Lake, and Overland Surge from Hurricanes) Zones are projected inundation zones mapped by the U.S. Army Corps of Engineers in cooperation with FEMA. They represent potential flooding from "worst case" combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. They do not include riverine flooding caused by hurricane surge or inland fresh water flooding.

Table 5.12-2. Critical Facilities in Flood Hazard Areas – Salisbury

Facilities in *100-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2007 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
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
Facilities in *500-Year* Floodplain*		
Facility Name	**Parcel ID / Street Location**	**2007 Buildings Valuation**
*No Critical Facilities Identified in 500-Year Floodplain		
Facilities in SLOSH Zones		
Facility Name	**Parcel ID / Street Location**	**2007 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
Harbor Schools, Inc.	24-13 / 12 Garfield Street	$130,700
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	7-56 / 15 Second Street	$150,000
Sewage Pumping Station	3-55 / 7 Grover Street	$150,000
Sewage Pumping Station	5-49 / 13 Lynne Avenue	$150,000

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.

Repetitive Loss Structures

According to file data provided by the MA Department of Conservation and Recreation, there were twenty-one (21) repetitive flood loss sites in Salisbury as of May 2006. (Data for events occurring subsequent to May 2006, such as the highly damaging storm and tidal surge of April 2007, are not yet available). 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 a mix of property types: single-family homes, multi-family residences, and businesses. Altogether, flood incidents at these 21 loss sites have resulted in the payout of 62 National Flood Insurance Program (NFIP) claims totaling $1,935,030 since 1978. This is the *highest number* of claims among the 15 communities in the Merrimack Valley Planning District, and the *second highest* claim amount. (Only Lawrence, with 37 claims totaling $3,100,888, exceeds the Salisbury claim amount.)

The total number of active NFIP policies in Salisbury is currently 747 (DCR). These policies have a combined insurance value of $135,771,800. The total (combined) annual cost of the insurance premiums is $566,528, and the average annual premium cost to policy holders is $758.

Structurally Deficient Bridges Over Waterways

The Town of Salisbury does not have any bridges classified as "structurally deficient" within its own borders. However, two such bridges – Whittier Bridge (Rt. I-95) and Main Street Bridge (Amesbury) – are both located close by and impact greatly on Salisbury's transportation system volumes and efficiency. These bridges are described below.


Whittier Bridge (I-95) Over Merrimack River

<u>Whittier Bridge</u>

The Whittier Bridge carries Interstate Route 95 over the Merrimack River between Amesbury and Newburyport. Route 95 is a major interstate roadway that connects virtually every major urbanized area located on the eastern seaboard. Although it is not located in Salisbury, I-95 quickly crosses into Salisbury north of the river and there are two interchanges (Route 110 and Route 286) in town. Average Daily Traffic (ADT) for this bridge is approximately 72,000 vehicles/day. However, summer weekend traffic

volumes on the bridge are often far in excess of this figure, with a great deal of that traffic consisting of heavy commercial vehicles.

The bridge was built in 1954 and has an AASHTO bridge rating of 36.3 (out of 100). Closure of the bridge or the introduction of lane closures/restrictions due to construction activity would dramatically impact travel in the Route 95 corridor. Access to Salisbury and the Salisbury Beach area from points to the south would be particularly affected with traffic diverted to both the Main Street Bridge over the Merrimack (and then north to Route 110 in Salisbury) and to Route 1. These diversions would result in substantially greater congestion along Beach Road and in Salisbury Square, which already experience congestion during the peak travel periods.

This project appears in the Regional Transportation Plan, and the Massachusetts Highway Department has begun preliminary design work.

Main Street Bridge

Like the Whittier Bridge, the Main Street Bridge connects Amesbury and Newburyport at a point just southwest of the Salisbury town line. However, Main Street in Amesbury meets Merrill Street less than 400 feet north of the bridge. Merrill Street continues north to Route 110 in Salisbury at the Amesbury line.

The bridge was most recently rebuilt in 1966 and has an AASHTO rating of 16.5. Summer traffic volumes on the Main Street Bridge can exceed 20,000 vehicles per day. Residential and business related traffic from the western part of Salisbury uses Merrill Street, the Main Street Bridge and the Chain Bridge to travel to both the downtown and West End sections of Newburyport. This bridge will be closed during the reconstruction.

The Main Street Bridge was effectively closed during the closure and reconstruction of the Chain Bridge that took place in 2001-2002. It remained open at that time to maintain access to Deer Island and allow construction vehicles to access the western end of the Chain Bridge. It is expected that the traffic impacts observed elsewhere in Salisbury during that period would be repeated when the Main Street Bridge is closed. At that time, traffic volumes on Route 110 in both Salisbury and Amesbury increased over the pre-closure levels.

This project appears in the region's Transportation Improvement Program and the Regional Transportation Plan.

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.

"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 – 4/20/07

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.

5.13 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 (2006) estimated population is 4,286 (MVPC Data Center), and the population density is 317 people per square mile. There are approximately 1,400 households, and about 9% of the population is 65 years and over.

West Newbury's predominant land uses are forest land (50%) and low density residential development (22%), followed by agriculture (18%) and wetlands/water (6%). Commercial and industrial uses combined account for less than 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 900 dwellings, from two sources. The major source (57%) 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 (43%) is water purchased from the neighboring City of Newburyport, which draws its water from both the Artichoke Reservoir system and from city wells. Currently, West Newbury's average daily water demand is 222,000 gallons per day (gpd). Its maximum daily demand during the height of the growing season (when lawn watering peaks) is 450,000 gpd. The Water Department recognizes the need for additional in-town water sources to meet present and future demands, but has not been successful in its explorations to date. However, two bedrock sources currently being investigated – the Knowles Well on Chase Street

and the Andreas Well on Indian Hill Street – may hold potential as future drinking water sources.

Critical Facilities

Selected critical facilities in West Newbury (emergency operations centers, health and medical aid facilities, emergency public shelters) are listed in **Table 5.13-1** below. 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 Attachment 13 of this Plan.

Table 5.13-1. 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)	*Primary EOC*: West Newbury EMA /Public Safety Complex *Alternate EOC*: MEMA Region 1	401 Main Street Region 1 365 East St. Tewksbury, MA					Yes
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 1,096 acres (1.71 sq. mi.) in West Newbury is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 623 acres (0.97 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute nearly one-fifth (18%) 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 31 residential structures (valued in 2008 at $9,766,400) in the 100-yr floodplain, and 72 residential structures (valued at $17,301,300) in the 500-yr floodplain. In addition, there are eight (8) residential structures, valued at $909,800, in the SLOSH zone.

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), and resulted in the payout of two National Flood Insurance Program (NFIP) claims totaling $84,232. Town-wide, there are 14 flood insurance policies for properties located in flood hazard areas. The combined insurance premiums for these properties is $3,867,000 (source: *NFIP Policy Statistics for Massachusetts* - 11/30/08.)

Structurally Deficient Bridges Over Waterways

The Town of West Newbury has only one bridge within its borders that is classified as "structurally deficient". This is the Rocks Village Bridge that spans the Merrimack River between West Newbury and Haverhill. However, two other structurally deficient bridges – the Bates Bridge in Groveland and the Whittier (Route 1-95) Bridge in Newburyport – are located in neighboring communities and impact greatly on West Newbury's transportation system volumes and efficiency. All three bridges are described below.

Rocks Village Bridge

The historic Rocks Village Bridge connects West Newbury to the Rocks Village area of Haverhill. 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.

As of May 2007, the Rocks Village Bridge had an AASHTO rating of 26.3 (out of 100) and carried approximately 6,500 vehicles/day in 2007. Due to its deteriorating condition, the bridge has been posted with weight restrictions. MassHighway is now in the process of completing the design of improvements to the bridge structure. Included in this design are plans to construct a bicycle/pedestrian that would be cantilevered on the upstream side of the superstructure. MassHighway anticipates advertising this project for construction in FY 2009 or 2010.

Closure of the structure would require traffic to travel almost four miles to the south and west to use the Bates Bridge to cross the Merrimack River between Haverhill and Groveland or over six miles to the northeast to use either the Whittier Bridge (I-95) or the Chain Bridge over the Merrimack between Amesbury and Newburyport.

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 May 2007 was 2.0 (out of 100), the ***lowest*** rating for any bridge in the Merrimack Valley region. It is not uncommon for the structure to be periodically closed to traffic while MassHighway performs 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 be rerouted to downtown Haverhill over the Basilliere Bridge (Route 125) into Bradford and Salem Street. Other drivers would seek to use the Rocks Village Bridge between Haverhill and West Newbury as an alternate route. Both of these bridges are also classified by the state as being “Structurally Deficient”, and the Rocks Village Bridge is slated for rehabilitation in 2009 or 2010.

Given the importance of the Bates Bridge to the region's transportation network and the condition of the structure, MassHighway is moving ahead with plans to build a replacement bridge. The plan to build a new bridge just downstream from the current structure was developed in recognition of the fact that the Route 97/113 corridor could not be closed to traffic. Current plans call for the existing structure to be replaced with a new bridge to be built 50-60 feet downstream. Design work on the project is virtually complete and MassHighway anticipates advertising this bridge for construction in the spring of 2009. This project appears in the 2007 Merrimack Valley Metropolitan Planning Organization Regional Transportation Plan as well as in the Merrimack Valley MPO's Transportation Improvement Program.

Whittier Bridge

The Whittier Bridge carries Interstate Route 95 over the Merrimack River between Amesbury and Newburyport. Route 95 is a major interstate roadway that connects virtually every major urbanized area located on the eastern seaboard. Although it is not located in West Newbury, I-95 quickly crosses into West Newbury south of the river. Average Daily Traffic (ADT) for this bridge is approximately 72,000 vehicles/day. However, summer weekend traffic volumes on the bridge are often far in excess of this figure, with a great deal of that traffic consisting of heavy commercial vehicles.

The bridge was built in 1954 and has an AASHTO bridge rating of 36.3 (out of 100). Closure of the bridge or the introduction of lane closures/restrictions due to construction activity would dramatically impact travel in the Route 95 corridor. Access to West Newbury from points to the north would be particularly affected.

This project appears in the Merrimack Valley Regional Transportation Plan, and the Massachusetts Highway Department has begun preliminary design work.

Hazard Potential of Dams

The DCR Office of Dam Safety includes four (4) 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 5.13-2.** 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 5.13-2. Significant Hazard Dam – WEST NEWBURY					
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					

Natural Hazards Risk Analysis

The Town of West 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 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, 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.

SECTION 6. EXISTING PROTECTIONS MATRIX

This section of the Plan presents an **Existing Protections Matrix** for each community. The matrix is an inventory of existing measures, programs, projects, and activities already in place that are related to natural hazard mitigation. Such an inventory allows gaps and deficiencies to be identified. This process is further described in Step 3 of the Massachusetts Community Planning Guide (*Natural Hazards Mitigation Planning: A Community Guide, January 2003*). In order to accomplish this task, a detailed questionnaire was prepared and distributed among knowledgeable local personnel in each community. A copy of the questionnaire is provided in Appendix D.

Enhanced Runoff Control via
Open Space Residential Development (OSRD)

The questionnaire was used as a tool to facilitate each community's examination of the adequacy of its programs, policies, and bylaws relative to natural hazard mitigation. The questionnaire was sent to the contact person on the Regional Multiple Hazard Community Planning Team (RMHCPT) and discussed at the individual meetings with local officials, as described in greater detail in Section 5. Following the local meetings, MVPC staff followed up on the questionnaire through phone conversations and emails, in order to expand on or clarify responses by various town departments. A matrix is provided for each of the 13 communities in **Tables 6-1** through **6-13**. The tables have been prepared using the format suggested in the Massachusetts Emergency Management Agency's Pre-Disaster Mitigation Plan 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	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 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	Bylaw needs to be reviewed and updated
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				
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 souces
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	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	Somewhat 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

Table 6-2. TOWN OF BOXFORD Existing Protections Matrix				
Type of Existing Protection	**Description**	**Area Covered**	**Effectiveness**	**Improvements 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	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	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
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	Ineffective	More rigorous beaver mitigation program needed
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	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, 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 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

Type of Existing Protection	Description	Area Covered	Effectiveness	Improvements 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**	**Improvements 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	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		5-year plan update completed 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	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				
Type of Existing Protection	**Description**	**Area Covered**	**Effectiveness**	**Improvements 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**	**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	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 cont'd. CITY OF HAVERHILL Existing Protections Matrix				
Type of Existing Protection	**Description**	**Area Covered**	**Effectiveness**	**Improvements 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 widfire/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**	**Improvements Needed**
City Participation in the National Flood Insurance Program	Provides Flood Insurance for structures located in flood-prone areas	FEMA Flood Zones	Effective	None
Established Local Wetlands Ordinance	Local ordinance stricter than State Wetlands Protection Act (WPA) and Regulations	City-wide	Effective	Periodic training of Board members to improve understanding and enforcement of wetland ordinance
Local Open Space & Recreation Plan	Protects open space and recreation districts from development.	City-wide	Generally effective	
Annual Spicket River Clean-up	The City in partnership with a local non-profit group annually cleans the Spicket River of debris.	The Spicket River and its banks	Effective	Increase pollution awareness to prevent 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/remove homes from flood area	City purchased 9 homes which flooded on a regular basis and demolished them, creating permanent open space in process.	Spicket River along Marion Avenue	Effective	Continue policy of property acquisition for distressed properties in repetitive flood areas
Creation of public 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
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 considerations in future plan updates
Comprehensive Emergency Management Plan	Details procedures to be followed in the event of an emergency of any type	City-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	City-wide	Moderately effective	More resources needed to increase reach and effectiveness of program

Table 6-7. TOWN OF MERRIMAC Existing Protections Matrix				
Type of Existing Protection	**Description**	**Area Covered**	**Effectiveness**	**Improvements 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				
Type of Existing Protection	**Description**	**Area Covered**	**Effectiveness**	**Improvements 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		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.) 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 widfire/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**	**Improvements 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 development activity on barrier beach to conserve fragile natural resources	Plum Island	Effective	None
Stormwater Management Bylaw and Regulations (under development)	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	In Progress	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	Provides guidance for community growth and preservation of open space and natural resources	Town-wide	Moderately effective	As appropriate, integrate hazard mitigation in future plan updates
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	Moderately effective	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
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
Waters Supply Protection Overlay District	Zoning bylaw regulates development and other activities in municipal water supply areas	Aquifer recharge areas	Generally effective	None
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

Table 6-10. 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	None
Subdivision Rules & Regulations, Section 6.14 (Stormwater)	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Effective – actively enforced	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	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	Moderately effective	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
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

Table 6-10. TOWN OF NORTH ANDOVER Existing Protections Matrix				
Type of Existing Protection	**Description**	**Area Covered**	**Effectiveness**	**Improvements Needed**
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	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	New outlet structure to be constructed 2007-2008
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	Mitigation project to start July 2007
Lost Pond improvement plan	Analysis of drainage and flooding problems around Lost Pond	Lost Pond catchment	Pending	Mitigation project to start July 2007
Storm drain system maintenance	Regular clearing and cleaning of culverts and storm drains as part of Town stormwater 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	More rigorous beaver mitigation program 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

Table 6-11. TOWN OF ROWLEY 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	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 6-11. TOWN OF ROWLEY Existing Protections Matrix				
Type of Existing Protection	**Description**	**Area Covered**	**Effectiveness**	**Improvements Needed**
Personal Service Wireless Facilities Protective Zoning Bylaw	Regulates development and other activities associated with wireless communication facilities	Town-wide	Effective	None
Soil Suitability – Protective Zoning Bylaw	Regulates development and other construction activities on impermeable soils and on areas with depth to groundwater < 6 feet	Town-wide	Effective	None

Table 6-12. TOWN OF SALISBURY 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, 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	Review and update to current DEP standards; expand district to cover watershed of new well(s)
Local Open Space Plan	Plan targets purchase of available floodplain and wetlands buffers for protection	Town-wide	Effective	Recently completed update; awaiting official state approval
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 are in the process of being updated
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	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

Table 6-12. TOWN OF SALISBURY Existing Protections Matrix				
Type of Existing Protection	**Description**	**Area Covered**	**Effectiveness**	**Improvements 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	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	Somewhat 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
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Effective	Updating regulations
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 better enforcement

Table 6-13. TOWN OF WEST NEWBURY 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 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	Review and update regulations to coincide with revisions to the State Environmental Code, 310 CMR 15.00
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 the 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	Effective	Increased funding to cover costs of proper cleaning
Street Sweeping Program	Routine street sweeping to remove sand & 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	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	Regulations are currently being revised
Town Zoning Bylaw	Promotes the health, safety, and well-being of Town residents	Town-wide	Effective	Bylaws are currently being revised

SECTION 7. VULNERABILITY/RISK ASSESSMENT

7.1 Overview of Natural Hazards Vulnerability

Previous sections of the Hazard Mitigation Plan identify and describe the natural hazards that have occurred, or are most likely to occur, in the Merrimack Valley region. Since 1991, there have been 16 Presidential disaster declarations for Essex County, as summarized in **Table 7-1** on the following page. The frequency of occurrence of these disasters, supplemented by the data extracted from the local CEMPs and from the Hazard Assessment presented in Section 4 of this document, has been utilized to develop the risk and vulnerability assessment for the region.

7.2 Potential Flood Damage as a Measure of Vulnerability

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 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.

Spicket River Flood, Methuen - May 2006

The methodology utilized by MVPC estimated the total value of buildings within the 100-year floodplain using assessed value data from the 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, institutional – and is presented in **Table 7-2**.

TABLE 7-1. DECLARED DISASTER AREAS IN ESSEX COUNTY (1991 – 2006)

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)
No-Name Storm (October 1991)	FEMA-920 (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	FEMA-920 (Individual)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
March Blizzard (March 1993)	FEMA-3103 (Public)	All 14 counties
January Blizzard (January 1996)	FEMA-1090 (Public)`	All 14 counties
October Flood (October 1996)	FEMA-1142 (Public)	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk
	FEMA-1142 (Individual)	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk (36 projects)
(1997) from October 1996 event	Community Development Block Grant – HUD	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk
June Flood (June 1998)	FEMA-1224 (Individual)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (19 projects)
(1998) from June 1998 event	Community Development Block Grant – HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
March Flood (March 2001)	FEMA-1364 (Individual)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)
March Blizzard (March 2001)	FEMA-3165 (Public)	Counties of Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, Worcester
February Snowstorm (February 17-18, 2003)	FEMA-3175-EM (Public)	All 14 counties
December Snowstorm (December 3-4, 2003)	FEMA-3191-EM (Public)	Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, Worcester
April Floods (April 22, 2004)	FEMA-1512 (Individual)	Counties of Essex, Middlesex, Norfolk, Suffolk, Worcester
May Rainstorm/Flood (May 12-23, 2006)	FEMA-1642-DR-MA (PA) (IHP) (HMGP)	Counties of Essex, Middlesex Counties of Essex, Middlesex, Suffolk All 14 counties

Sources: 1) Massachusetts Emergency Management Agency, Disaster Recovery Discussion Report, 2004
2) Sarah Zingarelli, MEMA (personnel communication)

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 by Community and Building Code

Town	Number of Buildings	Assessed Building Value by Land Use Type				Total Assessed Value
		Residential	Commercial	Industrial	Institutional	
Andover	270	$33,081,800	$18,623,100	$31,891,200	-	$83,596,100
Boxford	101	$20,360,800	-	-	-	$20,360,800
Georgetown	190	$37,159,800	$528,500	$4,940,800	-	$42,629,100
Groveland	122	$18,396,400	$2,094,700	$4,433,300	-	$24,924,400
Haverhill	707	$98,098,700	$29,253,300	$6,455,400	-	$133,807,400
Lawrence	993	$95,816,457	$27,397,151	$37,943,017	-	$161,156,625
Merrimac	79	$13,503,100	-	-	-	$13,503,100
Methuen	464	$62,378,200	$8,146,200	$11,583,300	$5,422,800	$87,530,500
Newbury	393	$39,500,500	-	$1,556,700	-	$41,057,200
Newburyport	327	$18,014,700	$3,149,900	$7,564,200	-	$28,728,800
North Andover	359	$110,203,000	$19,362,400	$38,034,100	-	$167,599,500
Rowley	96	$9,435,500	$612,300	-	-	$10,047,800
Salisbury	1,063	$80,289,600	$18,029,100	-	-	$98,318,700
West Newbury	31	$9,766,400	-	-	-	$9,766,400
Region	5,195	$646,004,957	$127,196,651	$144,402,017	$5,422,800	$923,026,425

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 chart has been developed. The following criteria, adapted from the Massachusetts Pre-Disaster Mitigation Plan developed by MEMA, were used for frequency categorization:

- **Very Low Frequency**: Events that occur less frequently than once in 1,000 years (less than 0.1% per year);
- **Low Frequency**: Events that occur from once in 100 years to once in 1,000 years (0.1 to 1% per year);
- **Medium Frequency**: Events that occur from once in 10 years to once in 100 years (1% to 10% per year);

- **High Frequency**: Events that occur more frequently than once in 10 years (greater than 10% per year).

The criteria used for severity categorization, based on past hazard events includes the following:

- **Minor**: Limited and scattered property damage; no damage to public infrastructure (roads, bridges, parks, etc.); contained geographic area (i.e., one or two communities); essential services (utilities, hospitals, schools) not interrupted; no injuries of fatalities.

- **Serious**: Scattered major property damage; some minor infrastructure damage; wider geographic area (several communities); essential services are briefly interrupted; some injuries and/or fatalities.

- **Extensive**: Consistent major property damage; major damage to public infrastructure (taking up to several days for repair); essential services are interrupted from several hours to several days; many injuries and fatalities;

- **Catastrophic**: Property and public infrastructure destroyed; essential services stopped; hundreds of injuries and fatalities.

Table 7-3 below lists the 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.

Table 7-3. Merrimack Valley Region: Potential Vulnerability to Future Natural Hazards

Hazard	Frequency	Severity
Flood	High	Extensive
Dam Failure	Medium	Extensive
Hurricane and Tropical Storms	Medium	Serious
Severe storms (wind, hail, lightning)	Medium	Serious
Tornadoes	Medium	Extensive/Catastrophic
Severe Winter Weather (snow, ice, wind)	High	Extensive
Drought	Medium	Serious
Earthquake	Low	Catastrophic
Wildfire	Medium	Serious
Landslide	Low	Minor
Heat Wave	Medium	Serious

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 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 protections matrix and measures. The purpose of the mitigation strategy is to provide MVPC and the 13 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 first step in designing the mitigation strategy includes the establishment of *regional mitigation goals.* Regional mitigation goals represent broad statements that are achieved through the implementation of more specific, action-oriented initiatives by the participating communities. These initiatives include both hazard mitigation policies (such as the regulation of land in known hazard areas through a local ordinance or bylaw), and hazard mitigation projects that seek to address specifically targeted hazard risks (such as the acquisition and relocation of a repetitive loss structure).

The overarching goal of this 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.

8.2 Mitigation Measures

The second step in formulating the Merrimack Valley region's mitigation strategy involves identifying the range of mitigation activities – and within these categories, the specific mitigation *actions* – that can help to achieve the regional goals cited above, as well as the specific hazard concerns of the individual communities.

All mitigation activities considered in the planning process can be classified under one of the following six categories of mitigation techniques:

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
- Erosion and sediment control

4. Structural Projects

Structural mitigation projects are intended to lesson 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

Although not typically considered a “mitigation” technique, emergency service measures can and do minimize the impact of a hazard event on people and property. These commonly are actions taken immediately to, during, or in response to a hazard event. Examples include:

- Warning systems
- Evacuation planning and management
- Emergency Response training and exercises
- Sandbagging for flood protection
- Installing temporary shelters for wind protection

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
- 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 suggesting possible areas for mitigation enhancement. These proposed enhancement actions are detailed in Section 9 of the Plan.

SECTION 9. MITIGATION ACTION PLANS

This section of the Hazard Mitigation Plan presents regional as well as community-specific 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: 1) a ***Regional*** **Action Plan** that proposes actions to be carried out in concert by MVPC, the municipalities, and partnering agencies and organizations on an inter-municipal level; and 2) individual ***Local*** **Action Plans** to be carried out by the 13 participating communities.

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. In doing so, the participants considered a number of different criteria, based to a large degree on the STAPLEE criteria:

1) **S**ocial: Is the action compatible with present and future regional/local community needs and values?
2) **T**echnical: Is the action feasible with available regional/local resources (or as supplemented by outside resources as necessary)?
3) **A**dministrative: Do the region and its constituent communities have the administrative capacity to implement the action?
4) **P**olitical: Is there strong public support to implement and maintain the action?
5) **L**egal: Do the region and its constituent communities have the legal authority to implement the action?
6) **E**conomic: Is the action cost-effective (i.e., do its anticipated benefits to the region and/or community outweigh its costs?)
7) **E**nvironmental: Does the action impact environmental resources (land, water, habitat, etc.), and is the impact positive, negative, or neutral?

During the prioritization process, although unanimity of opinion on any particular mitigation action was rarely achieved, it was nonetheless possible through discussion among the various team members and local department heads to reach general agreement (consensus) on each action's relative merits. Owing to the large number of actions ultimately identified – not only within communities but among them (regionally) – it was agreed that, for practical purposes, the actions should be characterized as "High", "Medium", or "Low" priority. However, it was further agreed that while this current prioritization scheme reflects the planning teams' best collective judgment at this time, the prioritizations could (and should) change as better information becomes available or as future circumstances in the communities change.

The **Regional Mitigation Action Plan** is presented in **Table 9-1** on the following page. The 13 individual **Local Mitigation Action Plans** are presented in **Tables 9-2** through **9-14**.

Table 9-1. REGIONAL Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	Provide technical assistance to communities in the development, adoption, and maintenance of local multi-hazard mitigation plans and projects	MVPC and local communities	Immediate/ HIGH	DCR/MEMA and communities
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)	MVPC and local communities	Immediate/ HIGH	MVPC and communities
Prevention	Work with Federal/State agencies and communities to develop improved mapping and estimates of structures located within 100-year floodplains and SLOSH zones	FEMA, MEMA, DCR, CZM, MVPC, and communities	Short-term/ MEDIUM	State/Federal agencies, communities, and MVPC
Prevention	Work with Federal/State agencies, partner organizations, and communities to educate municipal officials, residents, and businesses about projected sea level rise impacts and potential management solutions	FEMA, MEMA, DCR, CZM, NOAA, MVPC, and communities	Ongoing/ LOW	State/Federal agencies, Great Marsh Coalition, 8T&B, MVPC
Prevention and Emergency Services	Promote the development of an agreement between Massachusetts and NH state officials and communities to better coordinate dam operations and flood control activities in order to minimize downstream flooding (e.g., Spicket River)	Massachusetts and NH state agencies, communities, and MVPC	Short-term/ HIGH	Massachusetts and NH state agencies, communities, and MVPC
Structural Project	Work with MassHighway and the MPO to prioritize repair of structurally deficient bridges over water through the Transportation Improvement Program process	MassHighway, and the Merrimack Valley MPO	Ongoing/ MEDIUM	MassHighway and the MPO process
Prevention	Identify opportunities for MVPC to serve as liaison between FEMA, MEMA/DCR, and local communities on natural hazard mitigation issues	MVPC, MEMA, DCR, FEMA, and local communities	Ongoing/ MEDIUM	FEMA, MEMA, DCR, MVPC, and communities
Prevention	Identify and pursue public & private sources of technical assistance and funding for residents, businesses, and municipalities to implement sound hazard mitigation measures throughout the region	MVPC and local communities	Ongoing/ HIGH	MVPC and communities
Prevention	Incorporate natural hazard mitigation and best planning practices into MVPC's regional planning work and activities	MVPC	Ongoing/ HIGH	MVPC
Prevention	Assist communities in the identification and implementation of strategies aimed at protecting cultural and historic resources from natural hazard damage	MVPC, local historic commissions, libraries, Mass. Historical Commission, ENHA, National Park Service.	Long-term/ MEDIUM	Massachusetts Historical Commission, Massachusetts Board of Library Commissioners
Emergency Services	Work with MassHighway, local highway departments, and local public safety officials to ensure that the regional and state Intelligent Transportation System (ITS) considers the needs of hazard mitigation and emergency response	MVPC, MassHighway, local highway departments and public safety officials	Ongoing/ MEDIUM	MassHighway and local communities
Prevention	Organize and conduct a workshop on the Community Rating System for municipal planners, city/town managers, emergency management directors, public safety officials, and conservation administrators	MVPC	Short-term/ HIGH	MVPC, MEMA/DCR
Prevention	Work with the MVPC communities to encourage the incorporation of Low Impact Development (LID) techniques in local subdivision regulations and site/neighborhood redevelopment plans	MVPC, local communities	Ongoing/ MEDIUM	MVPC, local communities, state environmental agencies

Table 9-1. REGIONAL Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	Encourage local communities and MassHighway to routinely clean and maintain drainage infrastructure	MVPC, local communities, MassHighway	Ongoing/ HIGH	MVPC, local communities, MassHighway
Prevention	Reduce risk of prolonged power outages by identifying powerlines at risk and trimming tree branches that could down powerlines during a storm event. Pay special attention to protecting the power supply for critical infrastructure and emergency services	National Grid, municipalities	Ongoing/ MEDIUM	National Grid, municipalities
Prevention	Work with the DCR Office of Dam Safety, dam owners, and local communities to ensure that high hazard and significant hazard dams are inspected according to the prescribed schedule, that up-to-date evacuation plans are in place, and that needed repairs are documented and implemented in a timely manner	MVPC, DCR Office of Dam Safety, dam owners, municipalities	Ongoing/ HIGH	DCR Office of Dam Safety, dam owners, municipalities, MVPC
Prevention	Work with DCR Bureau of Fire Control and local communities to develop a uniform reporting system for wildfires	DCR, local communities, MVPC	Short-term/ MEDIUM	DCR
Prevention	Work with the DCR Office of Dam safety and local communities to ensure that DCR records are up-to-date and reflect work accomplished by the communities and private parties to inspect, repair, and renovate dam structures	MVPC, DCR, local communities	Ongoing/ HIGH	DCR, local communities, private dam owners
Emergency Services	Encourage municipalities to develop emergency access and evacuation plans for neighborhoods subject to isolation from flooding or by blockage of railroad lines	MVPC, municipalities	Short-term/ HIGH	MVPC, municipalities
Property Protection	Flood-proof or relocate critical municipal facilities located in floodplains and SLOSH zones	Municipalities	Ongoing/ HIGH	Municipalities, State and Federal agencies
Structural Project	Ensure that new and existing critical facilities meet state building code for high winds, earthquakes, fire safety, and snow loading	Municipalities	Ongoing/ HIGH	Municipalities. State and Federal agencies
Emergency Services	Develop standards for emergency shelters; require all new and existing shelters to comply with all requirements including the provision of emergency generators or backup power	Municipalities, MEMA	Long-term/ MEDIUM	Municipalities, MEMA
Prevention	Provide training to local Conservation Commission Board members to increase enforcement of the state and local wetland regulations	Municipalities, EOEA	Ongoing/ MEDIUM	Municipalities, MACC, DEP
Prevention	Review and update local regulations to comply with Phase II stormwater management requirements	Municipalities	Short-term/ HIGH	Municipalities
Prevention	Encourage local communities to revise local building codes to require fire-proof roofing materials in areas adjacent to forested land	Municipalities	Short-term.	Municipalities
Prevention	Encourage municipalities to participate in the DCR/ Fire Wise Program	Municipalities, DCR	Ongoing/ MEDIUM	Municipalities, DCR
Prevention	Encourage local officials to work cooperatively with the District 5 Fire Warden to inventory, map, and characterize all access roadways through the region's state forests	DCR, District 5, local municipalities	Ongoing/ MEDIUM	DCR, District 5 and local communities
Prevention	Educate public and private landowners on the importance of removing vegetative detritus (fuel) in or near forested areas to reduce the risk of wildfire	Municipalities	Ongoing/ MEDIUM	Municipalities, DCR

Table 9-2. TOWN OF ANDOVER Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Structural	Develop long-term study of floodplain near Washington Park to identify ways to prevent repetitive flood losses	Washington Park Condominium Association	Ongoing/ HIGH	Private, state/federal agencies
Structural	Develop long-term study of floodplain near Balmoral Condominiums to identify ways to prevent repetitive flood losses	Balmoral Condominium Association	Ongoing/ HIGH	Private, state/federal agencies
Prevention	Encourage the use of Low Impact Development (LID) techniques in all new development and redevelopment projects	Municipal Planning Board / Conservation Commission	Ongoing/ HIGH	Municipal
Prevention	Identify and seek funding for capital improvement projects that reduce the costs associated with flooding	Municipal Departments	Ongoing/ HIGH	Municipal
Prevention	Continue routine maintenance and cleaning of street drainage systems	Municipal Public Works Department	Ongoing/ HIGH	Municipal
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public	Municipality	Long-term/ LOW	Municipal
Prevention	Acquire and protect undeveloped open space in flood hazard areas	Conservation Commission	Ongoing/ MEDIUM	Municipal
Prevention	Continue to enforce and revise current bylaws and rules & regulations designed to minimize the impact of flooding and other natural hazards	Municipal Departments	Ongoing/ MEDIUM	Municipal
Prevention	Continue implementation of the Town's Phase II Storm Water Management Plan	Municipal Departments	Ongoing/ HIGH	Municipal
Prevention	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	Municipal Departments	Long-term/ LOW	Municipal
Prevention	Explore ways to link the municipal website to FEMA resources concerning all natural hazard emergencies	Municipal Information Technology Department	Short-term/ MEDIUM	Municipal
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Municipal Fire Department	Long-term/ LOW	Municipal, with advice and assistance from DCR
Prevention	Maintain existing methods of relaying fire safety information via website and other public communications systems	Municipal Fire Department	Ongoing/ HIGH	Municipal
Prevention	Continue to encourage the distribution and use of water saving devices and water conservation measures	Municipal Water Department	Ongoing/ MEDIUM	Municipal, Mass. DEP, other sources
Prevention	Work with DCR Office of Dam Safety and private dam owners to ensure timely dam inspections and maintenance	Municipality, dam owners	Ongoing/ MEDIUM	DCR, private owners

Table 9-2. TOWN OF ANDOVER Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	Design and implement a sewer backflow prevention program using backflow preventers and one-way valves	Municipal DPW	Long-term/ MEDIUM	State/federal sources
Prevention	Revise municipal sewer regulations to require the installation of backflow prevention on all new sewer connections	Municipal Board of Health	Short-term (Fall of 2007)/ HIGH	Municipal
Prevention	Continue working with power company and municipal tree division to remove hazardous trees and limbs when appropriate to prevent utility outages		Ongoing/ HIGH	Municipal, utility companies
Prevention	Adopt Storm Water Management Bylaw to address runoff issues on properties disturbing one (1) acre or more of land	Andover Town Meeting	Short-term (next Town Meeting)/ HIGH	Municipal

Table 9-3. TOWN OF BOXFORD Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Structural Project	Design and construct physical upgrades to manholes	Town Public Works Department	Short-term/ HIGH	FEMA, MEMA, Town
Prevention	Acquire/protect dams at Four Mile Pond and Lowes Pond	Conservation Commission	Ongoing/ MEDIUM	Community Preservation Act funds; DCS Self-Help Program grants
Prevention	Consistent with Phase II Program requirements, continue implementation of drainage system maintenance plan	Boxford Public Works Dept., Conservation Commission	Ongoing/ MEDIUM	Town
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	Town departments	Ongoing/ HIGH	Town
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)	Town departments	Ongoing/ MEDIUM	Town
Prevention	Explore participation in NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public	Town	Long-term/ LOW	Town, with advice and assistance from DCR and MEMA
Prevention	Amend local subdivision rules & regulations to require the maximum practicable use of low impact development (LID) techniques in all new development and redevelopment	Boxford Planning Board	Short-term/ HIGH	Town, with advice and assistance from EOEEA/CZM Smart Growth staff
Prevention	Maintain CEMP, Flood Hazard Mitigation Plan, and Boxford components of this Plan to ensure their completeness and relevance in disaster mitigation and response	Town departments	Ongoing/ HIGH	Town, with advice and assistance from MVPC, DCR, MEMA
Prevention	Develop and implement timely warning system (local access cable TV and/or radio) to alert public about pending floods and other hazard emergencies	Town departments	Short-term/ LOW	Town, with advice and assistance from DCR and MEMA
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	Boxford Public Works	Long-term/ LOW	Town, MEMA/DCR
Prevention	Maintain current list of flood damaged properties and buildings, including Repetitive Loss properties; encourage property owners to explore and implement appropriate mitigation measures	Boxford Public Works	Ongoing/ MEDIUM	Town, with advice and information from DCR and MEMA
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Boxford Fire Dept.	Long-term/ LOW	Town, with advice and assistance from DCR
Prevention	Create interdepartmental GIS database and mapping of municipal facilities and resources to enhance emergency operations and incident management	Town Departments	Long-term/ HIGH	Town, with technical assistance from MVPC and possible grant assistance from state/federal sources

Table 9-3. TOWN OF BOXFORD Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
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.	Town Departments	Ongoing/ HIGH	Town, with advice and assistance from MEMA and DCR
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.	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MEMA, DCR, and FEMA

Table 9-4. TOWN OF GEORGETOWN Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Structural Project and Prevention	Install beaver deceivers to help manage and prevent flooding during high rain events.	Highway Department, Conservation Commission	Ongoing	Town, CPC, Con Com
Structural Project and Prevention	Improve drainage system and remove obstructions in major waterways to prevent future flooding	Highway Department, Conservation Commission	Ongoing/ MEDIUM	Town
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	Highway Department, Fire, Police, Planning Department	Long-term/ MEDIUM	Town, MEMA/DCR
Structural Project and Prevention	Drainage improvements at Perley School basement	School Department	Ongoing/ HIGH	Town, MEMA/DCR
Structural Project and Prevention	Drainage improvements at Bailey Lane at the bridge	Highway Dept / Conservation	Long-term/ HIGH	Town and MHD Chapter 90
Structural Project and Prevention	Drainage improvements at Central Street by Nunans	Highway Dept	Long-term/ MEDIUM	Town, MEMA/DCR
Structural Project and Prevention	Drainage improvements at West Main Street by King Street	Highway Dept.	Long-term/ HIGH	TIP Grant, MEMA/FEMA mitigation grant
Structural Project and Prevention	Andover Street drainage improvements	Highway Dept	Long-term/ MEDIUM	TIP Grant
Structural Project and Prevention	Drainage improvements at Parish Road at town line	Highway Dept	Long-term/ MEDIUM	State/Federal
Structural Project and Prevention	Drainage improvements at Brook Street	Highway Dept	Long-term/ MEDIUM	Town
Structural Project and Prevention	Drainage improvements at West Street at Parker River	Highway Dept	Long-term/ HIGH	MEMA/FEMA mitigation grant
Structural Project and Prevention	Drainage improvements at Andover Street by the VFW	Highway Dept	Long-term/ MEDIUM	Town
Prevention	Identify and seek funding for capital improvement projects that reduce the losses & costs associated with flooding	Town Departments	Ongoing/ HIGH	Town
Prevention	Encourage maximum practicable use of Low Impact Development (LID) techniques in all new development and redevelopment projects	Planning Board, Zoning Board of Appeals, Conservation Commission	Ongoing/ HIGH	Town
Prevention	Implement Phase II stormwater management program, including routine maintenance and cleaning of street drainage systems, swales, and channels	Highway Department	Ongoing/ HIGH	Town
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	Ongoing/ MEDIUM	Town

Table 9-4. TOWN OF GEORGETOWN Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	Acquire and protect undeveloped open space in flood hazard areas	Conservation Commission	Ongoing/ MEDIUM	Town, state DCS grants
Prevention	Continue to participate in NFIP and 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.	Town Departments	Ongoing/ HIGH	Town
Prevention	Explore development and implementation of Fire Wise Program for heavily forested areas and neighborhoods, in cooperation with DCR	Fire Department	Long-term/ MEDIUM	Town, with assistance from DCR
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate the public	Town	Long-term/ MEDIUM	Town, with advice and assistance from MEMA and DCR
Prevention	Maintain up-to-date inventory of flood damaged properties and buildings, including repetitive loss structures, and inform owners of mitigation options.	Town	Long-term/ MEDIUM	Town, with advice and assistance from MEMA and DCR
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)	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MVPC
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.	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MEMA, DCR, and FEMA
Prevention	Maintain Comprehensive Emergency Management Plan (CEMP) and local Natural Hazards PDM Plan to ensure their completeness and relevance in disaster prevention, mitigation, and response	Town Departments	Ongoing/ HIGH	Town, with advice and assistance from MVPC, DCR, MEMA
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	Town Departments and Private Developers	Ongoing/ HIGH	Town (for municipal facilities) and Private Developers
Prevention	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	Town Departments	Long-term/ MEDIUM	Town, with advice and assistance from MVPC, DCR, MEMA

Table 9-5. TOWN OF GROVELAND Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Structural	Replace "structurally-deficient" Bates Bridge, connecting Groveland and Haverhill across Merrimack River	MassHighway	Short-term/ HIGH	State EOT/MHD
Structural/ Prevention	Identify drainage system improvement needs in areas subject to flooding; seek outside grants to fund engineering studies, alternatives analyses, project design, and project construction.	Town DPW	Ongoing/ MEDIUM	Town, with grant writing assistance from MVPC
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.	Town Departments	Ongoing/ HIGH	Town, with advice and assistance from MEMA and DCR
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate the public	Town Departments	Long-term/ MEDIUM	Town, with advice and assistance from MEMA and DCR
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.	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MEMA, DCR, and FEMA
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)	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MVPC
Prevention	Maintain Comprehensive Emergency Management Plan (CEMP) and local Natural Hazards PDM Plan to ensure their completeness and relevance in disaster prevention, mitigation, and response	Town Departments	Ongoing/ HIGH	Town, with advice and assistance from MVPC, DCR, MEMA
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	Town DPW	Ongoing/ MEDIUM	Town
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	Planning Board	Short-term/ MEDIUM	Town, with advice and assistance from MVPC
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Fire Department	Long-term/ LOW	Town, with advice and assistance from DCR

Table 9-5. TOWN OF GROVELAND Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	As opportunities arise, acquire and protect private undeveloped open space in flood hazard areas	Conservation Commission, CPA Committee	Ongoing/ MEDIUM	Town, with assistance from state DCS, ECGA
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	Town Departments and Private Developers	Ongoing/ MEDIUM	Town (for municipal facilities) and Private Developers
Prevention	Strictly enforce and, as appropriate upgrade Town zoning bylaw, subdivision rules & regulations, and local wetlands regulation to minimize incidence and impacts of flooding and other natural hazards.	Town Departments	Ongoing/ HIGH	Town
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 the MEMA and FEMA hazard mitigation websites.	Town Departments	Long-term/ MEDIUM	Town, with advice from MEMA, DCR, and MVPC

Table 9-6. CITY OF HAVERHILL Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Structural Project	Design and construct Merrimack River streambank stabilization project adjacent to Riverside and Coffin Avenues to prevent further bank erosion and safeguard the integrity of nearby 54-inch sewer interceptor	City Wastewater Dept.	Short-term/ HIGH	City, FEMA, MEMA
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	City Wastewater Dept.	Short-term/ HIGH	City, FEMA, MEMA
Prevention	Develop and adhere to routine inspection, cleaning, and maintenance schedule for drainage/stormwater facilities and stream channels	City DPW, in consultation and cooperation with Conservation Comm.	Ongoing/ MEDIUM	City
Structural Project	Work cooperatively with MassHighway to rehabilitate the City's two "structurally deficient" bridges spanning the Merrimack River: Rt. 125 ("Basiliere") Bridge and Rocks Village Bridge	MassHighway, City, MVPC/Merrimack Valley MPO	Short-term/ HIGH	MassHighway
Prevention	Work with DCR Office of Dam Safety and dam owners to ensure timely dam inspections and maintenance, with special attention to the "high hazard" Millvale Reservoir Dam and four "significant hazard" dams: Crystal Lake Dam, Lake Pentucket Dam, Frye Pond Dam, Little River Dam	DCR Office of Dam Safety, City, dam owners	Ongoing/ LOW	Dam owners, DCR Office of Dam Safety
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	City Planning Board	Short-term/ LOW	City
Prevention	Amend local zoning ordinance to allow and promote the use of Open Space Residential Design (OSRD) as a tool to minimize impervious surfaces, maximize open space preservation, and reduce stormwater runoff	City Council, in consultation and cooperation with Planning Board and Conservation Commission	Short-term/ MEDIUM	City, with possible State "Smart Growth" grant
Prevention	Adopt "Steep Slope" regulation to prohibit or strictly regulate development on steep slopes in order to prevent stormwater runoff and erosion	City Council, in consultation and cooperation with Planning Board and Conservation Commission	Long-term/ LOW	City
Prevention	Develop and implement DCR Fire Wise Program in forested areas and neighborhoods	City Fire Department	Long-term/ MEDIUM	City, with assistance from DCR
Prevention	Incorporate hazard mitigation in local plans and initiatives (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan)	City Departments	Ongoing/ HIGH	City

Table 9-6. CITY OF HAVERHILL Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public	City	Ongoing/ HIGH	City, with advice and assistance from MEMA and DCR
Prevention	Increase building inspection and emergency management staffing levels and training to meet growing needs of City's large geographic area and expanding population	City	Long-term/ MEDIUM	City
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	City Departments and Private Developers	Ongoing/ MEDIUM	City (for municipal facilities) and Private Developers
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 the MEMA and FEMA hazard mitigation websites.	City Departments	Long-term/ MEDIUM	City, with advice from MEMA, DCR, and MVPC

Table 9-7. CITY OF LAWRENCE Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Property Protection	Reduce repetitive flood losses by acquiring property in high risk, recurrent flood districts through incentive programs and tax taking	City of Lawrence	Ongoing/Low	City of Lawrence, FEMA
Property Protection/ Prevention	Continue participation in NFIP's Community Rating System to enhance floodplain management, and reduce flood risks and losses.	City of Lawrence, NFIP	Long-term/ MEDIUM	City
Prevention	Develop and adhere to routine inspection, cleaning and maintenance schedule for all municipal drainage/stormwater facilities	City DPW	Ongoing/ MEDIUM	City
Structural Project	Work with MassHighway to replace the Hampshire Road Bridge Spanning the Spicket River near Marion & Erving Avenue	Mass Highway, City	Short-term/ HIGH	Mass Highway
Structural Project	Work with MassHighway to replace the East Haverhill Street Bridge Spanning the Spicket River near Newbury Street	Mass Highway City	Short-term/ HIGH	Mass Highway
Structural Project	Lawrence Gateway/ Oxford Paper Mill Site Redevelopment Project to create several million gallons of new flood storage as part of the redevelopment	City of Lawrence, Mass Highway, MVRTA	Long-term/ MEDIUM	Mass Highway, City of Lawrence, private money from Gencorp
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	Lawrence Public Works Dept., Conservation Commission	Ongoing/ MEDIUM	City
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	Planning Department, ZBA, Planning Board	Ongoing/ HIGH	City
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)	Planning Dept., Community Devel. Dept., Conservation Comm.	Ongoing/ MEDIUM	City
Prevention	Amend local subdivision rules & regulations to require the maximum practicable use of low impact development (LID) techniques in all new development and redevelopment	Lawrence Planning Board	Short-term/ HIGH	City, with advice and assistance from EOEEA/CZM Smart Growth Staff

Table 9-7. CITY OF LAWRENCE Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	Maintain CEMP, Flood Hazard Mitigation Plan, and City components of this Plan to ensure their completeness and relevance in disaster mitigation and response	City Departments	Ongoing/ HIGH	City, with advice and assistance from MVPC, DCR, MEMA
Prevention	Develop and implement timely warning system (local access cable TV and/or radio) to alert public about pending floods and other hazard emergencies	City Departments	Short-term/ LOW	City, with advice and assistance from DCR and MEMA
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	Lawrence Public Works and Engineering Depts.	Long-term/ LOW	City, MEMA/DCR
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	Lawrence Public Works and Engineering Depts.	Long-term/ HIGH	City
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested Den Rock Park	Lawrence Fire Dept.	Long-term/ LOW	City, with advice and assistance from DCR
Prevention	Create interdepartmental GIS database and mapping of municipal facilities and resources to enhance emergency operations and incident management	City Departments	Long-term/ HIGH	City, with technical assistance from MVPC and possible grant assistance from state/federal sources
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	Town Departments and Private Developers	Ongoing/ HIGH	City (for municipal facilities) and private developers
Prevention	To reduce public risks from all natural hazards, establish and maintain City web page offering safety “tips and techniques” for hazard preparedness, mitigation, and response, with direct links to the MEMA and FEMA hazard mitigation websites.	City Departments	Long-term/ MEDIUM	City, with advice from MEMA, DCR, and MVPC

Table 9-8. TOWN OF MERRIMAC Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Structural/ Prevention	Assess drainage system improvement needs in areas subject to chronic flooding, and institute appropriate mitigation/remediation measures. (See "Special Flooding Concerns" chart in Merrimac "Flooding Vulnerability Assessment."	Town DPW	Long-term/ HIGH	Town, with state and/or federal grant support
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.	Town Departments	Ongoing/ HIGH	Town, with advice and assistance from MEMA and DCR
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate the public	Town Departments	Long-term/ MEDIUM	Town, with advice and assistance from MEMA and DCR
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.	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MEMA, DCR, and FEMA
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)	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MVPC
Prevention	Maintain Comprehensive Emergency Management Plan (CEMP) and local Natural Hazards PDM Plan to ensure their completeness and relevance in disaster prevention, mitigation, and response	Town Departments	Ongoing/ HIGH	Town, with advice and assistance from MVPC, DCR, MEMA
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	Town DPW	Ongoing/ MEDIUM	Town
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	Planning Board	Short-term/ MEDIUM	Town, with advice and assistance from MVPC
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Fire Department	Long-term/ LOW	Town, with advice and assistance from DCR

Table 9-8. TOWN OF MERRIMAC Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	As opportunities arise, acquire and protect private undeveloped open space in flood hazard areas	Conservation Commission, Open Space & Recreation Committee	Ongoing/ MEDIUM	Town, with assistance from state DCS, ECGA
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	Town Departments and Private Developers	Ongoing/ MEDIUM	Town (for municipal facilities) and Private Developers
Prevention	Strictly enforce and, as appropriate upgrade Town zoning bylaw, subdivision rules & regulations, and local wetlands regulation to minimize incidence and impacts of flooding and other natural hazards.	Town Departments	Ongoing/ HIGH	Town
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 the MEMA and FEMA hazard mitigation websites.	Town Departments	Long-term/ MEDIUM	Town, with advice from MEMA, DCR, and MVPC

Table 9-9. CITY OF METHUEN Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Property Protection	Reduce repetitive flood losses along the Spicket River through flood-proofing and/or property acquisition	Property owners, City	Long-term/ HIGH	Property owners, City, FEMA, MEMA (tech. assistance and land acquisition funding)
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	City, MA and NH state and municipal officials, dam owners/operators	Long-term/ HIGH	City, FEMA, MEMA, DCR, with coordinating assistance from MVPC
Structural Project	Design and construct drainage improvements to reduce Spicket River flooding at the Guilford RR Bridge "choke" point	City, MEMA, FEMA	Short-term/ HIGH	FEMA, MEMA
Structural Project	Design and construct drainage improvements to remedy recurring flooding along Bloody Brook in the vicinity of Swan and Jackson Streets	City, MEMA FEMA	Short-term/ HIGH	FEMA, MEMA
Prevention	Develop and adhere to routine inspection, cleaning, and maintenance schedule for drainage/stormwater facilities and stream channels	City DPW, in consultation and cooperation with Conservation Comm.	Ongoing/ MEDIUM	City
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	DCR Office of Dam Safety, City, dam owners	Ongoing/ MEDIUM	Dam owners, DCR Office of Dam Safety
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	MassHighway, City, MVPC/Merrimack Valley MPO	Short-term/ HIGH	MassHighway
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	City Planning Board	Short-term/ LOW	City
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	City Council, in consultation and cooperation with Planning Board and Conservation Commission	Short-term/ Low	City, with possible State "Smart Growth" grant
Prevention	Adopt "Steep Slope" regulation to prohibit or strictly regulate development on steep slopes in order to reduce stormwater runoff and erosion	City Council, in consultation and cooperation with Planning Board and Conservation Commission	Short-term/ MEDIUM	City
Prevention	Develop and implement Fire Wise Program for forested areas and neighborhoods in cooperation with DCR	City Fire Department	Long-term/ MEDIUM	City, with assistance from DCR
Prevention	Incorporate hazard mitigation in local plans and initiatives (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan)	City Departments	Ongoing/ MEDIUM	City
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public	City	Long-term/ MEDIUM	City, with advice and assistance from MEMA and DCR

Table 9-9. CITY OF METHUEN Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
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	City Departments and Private Developers	On-going/ MEDIUM	City (for municipal facilities) and Private Developers
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 the MEMA and FEMA hazard mitigation websites.	City Departments	Long-term/ MEDIUM	City, with advice fro MEMA, DCR, and MVPC

Table 9-10. TOWN OF NEWBURY Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	Continue to participate in the 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.	Town Departments	Ongoing/ HIGH	Town, with advice and assistance from MEMA and DCR
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.	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MEMA, DCR, and FEMA
Prevention	Maintain current list of flood damaged properties and buildings, including Repetitive Loss properties; encourage property owners to explore and implement appropriate mitigation measures	Town Departments	Ongoing/ MEDIUM	Town, with advice and information from DCR and MEMA
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	Town departments	Ongoing/ HIGH	Town, with advice and assistance from MVPC, DCR, MEMA
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	Planning Board	Short-term/ MEDIUM	Town, with advice and assistance from MVPC
Structural/ Prevention	Identify drainage system improvement needs in areas subject to flooding; seek outside grants to fund engineering studies, alternatives analyses, project design, and project construction.	Highway Department, Conservation Commission	Ongoing/ MEDIUM	Town, with grant writing assistance from MVPC
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate the public	Town Departments	Long-term/ MEDIUM	Town, with advice and assistance from MEMA and DCR
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)	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MVPC
Prevention	As opportunities arise, acquire and protect private undeveloped open space in flood hazard areas	Conservation Commission, Open Space & Recreation Committee	Ongoing/ MEDIUM	Town, with assistance from state DCS, ECGA
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	Town Departments and Private Developers	Ongoing/ MEDIUM	Town (for municipal facilities) and Private Developers

Table 9-10. TOWN OF NEWBURY Mitigation Action Plan				
Structural/ Prevention	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	Town Boards and Departments	Ongoing/ HIGH	Town, in cooperation with and with support from Army Corps of Engineers, MEMA, DCR, other appropriate entities
Prevention	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	Town Boards and Departments	Ongoing/ HIGH	Town, in cooperation with and with support from CZM Storm Smart Coast Program, DCR, MVPC, and Eight Towns and the Bay (8T&B)
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	Highway Department, Conservation Commission	Ongoing/ MEDIUM	Town
Prevention	To reduce public risks from all natural hazards, establish and maintain Town web page offering safety “tips and techniques” for hazard preparedness, mitigation, and response, with direct links to the MEMA and FEMA hazard mitigation websites.	Town Departments	Long-term/ MEDIUM	Town, with advice from MEMA, DCR, and MVPC
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Fire Department	Long-term/ LOW	Town, with advice and assistance from DCR

Table 9-11. TOWN OF NORTH ANDOVER Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
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	Town Engineering and Public Works Departments	Short-term/ HIGH	FEMA, MEMA, Town
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	Town Engineering and Public Works Departments	Short-term/ HIGH	FEMA, MEMA, Town
Prevention	Acquire/protect undeveloped open space in flood hazard areas, with special attention to properties in Lake Cochichewick watershed	North Andover CPA Committee and Conservation Commission	Ongoing/ MEDIUM	Community Preservation Act funds; DCS Self-Help Program grants
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	North Andover Public Works Dept., Conservation Commission	Ongoing/ MEDIUM	Town
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	Town departments	Ongoing/ HIGH	Town
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)	Town departments	Ongoing/ MEDIUM	Town
Prevention	Explore participation in NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public	Town	Long-term/ LOW	Town, with advice and assistance from DCR and MEMA
Prevention	Amend local subdivision rules & regulations to require the maximum practicable use of low impact development (LID) techniques in all new development and redevelopment	North Andover Planning Board	Short-term/ HIGH	Town, with advice and assistance from EOEEA/CZM Smart Growth staff
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	Town departments	Ongoing/ HIGH	Town, with advice and assistance from MVPC, DCR, MEMA
Prevention	Develop and implement timely warning system (local access cable TV and/or radio) to alert public about pending floods and other hazard emergencies	Town departments	Short-term/ LOW	Town, with advice and assistance from DCR and MEMA
Structural Project and Prevention	Implement drainage improvements to remedy recurring flooding problems along and around Mosquito Brook	North Andover Public Works and Engineering Depts., Conservation Commission	Short-term/ HIGH	Town
Structural Project and Prevention	Implement drainage improvements to remedy recurring flooding problems along and around Lost Pond	North Andover Public Works and Engineering Depts., Conservation Commission	Short-term/ HIGH	Town

Table 9-11. TOWN OF NORTH ANDOVER Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
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	North Andover Public Works and Engineering Depts.	Long-term/ LOW	Town, MEMA/DCR
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	North Andover Public Works and Engineering Depts.	Long-term/ HIGH	Town
Prevention	Maintain current list of Repetitive Loss properties; encourage property owners to explore and implement appropriate mitigation measures	North Andover Public Works and Engineering Depts.	Ongoing/ MEDIUM	Town, with advice and information from DCR and MEMA
Structural Project	Rebuild sluice outlet controlling Lake Cochichewick water level	North Andover Public Works and Engineering Depts.	Short-term (Fall 2007)/ HIGH	Town
Structural Project	Refurbish Lake Cochichewick outlet dam	North Andover Public Works and Engineering Depts.	Short-term (Fall 2007)/ HIGH	Town
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	North Andover Fire Dept.	Long-term/ LOW	Town, with advice and assistance from DCR
Prevention	Create interdepartmental GIS database and mapping of municipal facilities and resources to enhance emergency operations and incident management	Town Departments	Long-term/ HIGH	Town, with technical assistance from MVPC and possible grant assistance from state/federal sources
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	Town Departments and Private Developers	Ongoing/ HIGH	Town (for municipal facilities) and Private Developers
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 the MEMA and FEMA hazard mitigation websites.	Town Departments	Long-term/ MEDIUM	Town, with advice from MEMA, DCR, and MVPC

Table 9-12. TOWN OF ROWLEY Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Structural Project	Design and construct drainage system improvements to alleviate chronic flooding due to undersized culverts at following locations: 1) Newbury Road near Harrison Circle; 2) Haverhill Street (Rt. 133) at Bradford Street; 3) Wethersfield Street at Wild Pasture Lane; 4) Fennel Drive ; 5) Daniels Road	Town Highway Dept.	Short-term/ HIGH	FEMA, MEMA, Town
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.	Town Highway Dept.	Short-term/ HIGH	FEMA, MEMA, Town
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	Town Highway Dept., Conservation Commission	Ongoing/ MEDIUM	Town
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	Town departments	Ongoing/ HIGH	Town
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)	Town departments	Ongoing/ MEDIUM	Town
Prevention	Explore participation in NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public	Town departments	Long-term/ MEDIUM	Town, with advice and assistance from DCR and MEMA
Prevention	Amend local subdivision rules & regulations to require the maximum practicable use of low impact development (LID) techniques in all new development and redevelopment	Town Planning Board	Short-term/ HIGH	Town, with advice and assistance from EOEEA/CZM Smart Growth staff and MVPC
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	Town departments	Ongoing/ HIGH	Town, with advice and assistance from MVPC, DCR, MEMA
Prevention	Explore development of timely warning system (local access cable TV and/or radio) to alert public about pending floods and other hazard emergencies	Town Fire and Police Depts in collaboration w/ Northern Essex Emergency Planning Committee	Short-term/ MEDIUM	Town, with advice and assistance from DCR and MEMA
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Town Fire Dept.	Long-term/ LOW	Town, with advice and assistance from DCR

Table 9-12. TOWN OF ROWLEY Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	Continue to participate in the 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.	Town Departments	Ongoing/ HIGH	Town, with advice and assistance from MEMA and DCR
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.	Town Departments	Ongoing/ MEDIUM	Town, with advice and assistance from MEMA, DCR, and FEMA
Prevention	Maintain current list of flood damaged properties and buildings, including Repetitive Loss properties; encourage property owners to explore and implement appropriate mitigation measures	Town Departments	Ongoing/ MEDIUM	Town, with advice and information from DCR and MEMA
Prevention	As opportunities arise and as outside funding sources become available, seek to acquire and protect private undeveloped open space in flood hazard areas	Conservation Commission, Open Space & Recreation Committee	Ongoing/ MEDIUM	Town, with assistance from state DCS, ECGA
Prevention	Create interdepartmental GIS database and mapping of municipal facilities and access routes to enhance emergency operations and incident management	Town Departments	Long-term/ HIGH	Town, with technical assistance from MVPC and possible grant assistance from state/federal sources
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	Town Departments and Private Developers	Ongoing/ HIGH	Town (for municipal facilities) and Private Developers
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 the MEMA and FEMA hazard mitigation websites.	Town Departments	Long-term/ MEDIUM	Town, with advice from MEMA, DCR, and MVPC

Table 9-13. TOWN OF SALISBURY Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Structural Project and Prevention	Explore development of long-term regional beach replenishment dredging program	Town Manager, Board of Selectmen, DPW, Conservation Commission	Ongoing/ HIGH	Army Corps of Engineers, MA DCR, Town
Structural Project and Prevention	Construct floodwall to protect low-lying neighborhoods against tidal flooding from Blackwater River	Town Manager, Board of Selectmen, DPW and Conservation Commission	Ongoing/ HIGH	Army Corps of Engineers, MA DCR, Town
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.	Town Manager, Board of Selectmen, DPW, Planning Department, Conservation Commission	Ongoing/ HIGH	FEMA, Mass Highway, MA DCR, Town
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 along Route 1 South; study elevating roadways to increase flood protection	Salisbury DPW, Conservation Commission	Ongoing/ MEDIUM	MA CZM, FEMA, Town
Structural Project and Prevention	Seek easement to permit repair of culvert on private property to relieve flooding of Viking and Juno Streets	Salisbury DPW, Conservation Commission, Planning Board	Ongoing/ HIGH	Town/Private
Structural Project and Prevention	Consider enlarging Smallpox Brook culvert under US Route 1	Mass Highway	Long-Term/ MEDIUM	Mass Highway
Structural Project and Prevention	Improve drainage system on Central Avenue and Old Town Way	Salisbury DPW	Long-term/ MEDIUM	Town
Structural Project and Prevention	Install new culvert and improve drainage system on Jak-Len Drive to prevent future flooding	Salisbury DPW, Conservation Commission	Ongoing/ MEDIUM	Town
Prevention	Identify and seek funding for capital improvement projects that reduce the costs associated with flooding	Town Departments	Ongoing/ HIGH	Town
Prevention	Encourage the use of Low Impact Development (LID) techniques in all new development and redevelopment projects	Planning Board, Conservation Commission	Ongoing/ HIGH	Town
Prevention	Continue routine maintenance and cleaning of street drainage systems	Salisbury DPW	Ongoing/ HIGH	Town
Prevention	Develop recommendations for maintaining cleared buffer area between structures and phragmites and other dried vegetation in areas adjoining marshes	Fire Department, Conservation Commission	Ongoing/ MEDIUM	Town
Prevention	Acquire and protect undeveloped open space in flood hazard areas	Conservation Commission	Ongoing/ MEDIUM	Town

Table 9-13. TOWN OF SALISBURY Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Prevention	Continue to enforce and revise current bylaws and rules & regulations designed to minimize the impact of flooding and other natural hazards	Town departments	Ongoing/ MEDIUM	Town
Prevention	Continue implementation of the Town's Phase II Storm Water Management Plan	Town departments	Ongoing/ HIGH	Town
Prevention	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	Town departments	Long-term/ LOW	Town
Prevention	Explore ways to link the municipal website to FEMA resources concerning all natural hazard emergencies	Salisbury Planning Department	Short-term/ MEDIUM	Town
Prevention	Explore feasibility of developing and implementing DCR Fire Wise Program in heavily forested areas and neighborhoods	Salisbury Fire Department	Long-term/ LOW	Town, with advice and assistance from DCR
Prevention	Maintain existing methods of relaying fire safety information via website and other public communications systems	Salisbury Fire Department	Ongoing/ HIGH	Town
Prevention	Continue to encourage the distribution and use of water saving devices and water conservation measures	Salisbury Water Department	Ongoing/ MEDIUM	Town, Mass. DEP, other sources
Prevention	Adopt "Steep Slope" regulation to prohibit or strictly regulate development on steep slopes in order to prevent stormwater runoff and erosion	Planning Board and Conservation Commission	Long-term/ LOW	Town
Prevention	Incorporate hazard mitigation in local plans and initiatives (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan)	Town departments	Ongoing/ HIGH	Town
Prevention	Explore participation in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate public	Town departments	Ongoing/ HIGH	Town, with advice and assistance from MEMA and DCR
Prevention	Increase building inspection efforts and emergency management training	Town departments	Long-term/ MEDIUM	Town
Prevention	Develop and adhere to routine inspection, cleaning, and maintenance schedule for drainage/stormwater facilities and stream channels	Salisbury DPW, in consultation and cooperation with Conservation Comm.	Ongoing/ MEDIUM	Town
Prevention	Maintain CEMP, Flood Hazard Mitigation Plan, and Salisbury components of this Plan to ensure their completeness and relevance in disaster mitigation and response	Town departments	Ongoing/ HIGH	Town, with advice and assistance from MVPC, DCR, MEMA

Table 9-13. TOWN OF SALISBURY Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
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	Salisbury DPW and Planning Department	Long-term/ LOW	Town, MEMA/DCR
Structural Project and Prevention	Develop a proactive program to analyze existing sewer backup locations and causes; design and implement appropriate corrective measures	Salisbury DPW and Planning Department	Long-term/ HIGH	Town
Prevention	Maintain current list of Repetitive Loss properties; encourage property owners to explore and implement appropriate mitigation measures	Salisbury DPW and Planning Department	Ongoing/ MEDIUM	Town, with advice and information from DCR and MEMA
Prevention	Create interdepartmental GIS database and mapping of municipal facilities and resources to enhance emergency operations and incident management	Town Departments	Long-term/ HIGH	Town, and possible grant assistance from state/federal sources
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	Town Departments and Private Developers	Ongoing/ HIGH	Town (for municipal facilities) and Private Developers

Table 9-14. TOWN OF WEST NEWBURY Mitigation Action Plan				
Category of Action	**Description of Action**	**Implementation Responsibility**	**Timeframe/ Priority**	**Resources/ Funding**
Property Protection/ Prevention	Continue to enforce local floodplain management regulations	Town Departments	Ongoing/ HIGH	Town
Property Protection/ Prevention	Explore participation in NFIP's Community Rating System to enhance floodplain management and reduce flood risks and losses.	Town Departments, NFIP	Long-term/ MEDIUM	Town
Structural Project and Prevention	Stabilize eroding/erosive Merrimack River streambank along River Road	DPW, Con. Comm. & Selectmen	Ongoing / HIGH	ACOE & State
Structural Project and Prevention	Replace undersized culverts, swales, and drainage systems on an as needed basis.	DPW, Con. Comm.	Ongoing / MEDIUM	State & Local
Prevention	Continue routine maintenance and cleaning of street drainage systems.	DPW	Ongoing / MEDIUM	Town
Prevention	Educate residents on high groundwater problems & how to implement stormwater management on a homeowner level.	DPW, Con. Comm, & Planning Board	Ongoing / MEDIUM	Town
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.	Town Departments	Ongoing / HIGH	Town
Prevention	Encourage the use of Low Impact Development (LID) techniques in all new development and redevelopment projects	Planning Board, Conservation Commission	Ongoing/ HIGH	Town
Prevention	Develop and implement Fire Wise Program for forested areas and neighborhoods in cooperation with DCR.	Fire Department	Long-term / MEDIUM	Town, State, & Dept. of Fire Services
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)	Town Departments	Ongoing/ MEDIUM	Town
Prevention	Maintain CEMP, Flood Hazard Mitigation Plan, and City components of this Plan to ensure their completeness and relevance in disaster mitigation and response	Town Departments	Ongoing/ HIGH	Town, with advice and assistance from MVPC, DCR, MEMA
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	Town Departments and Private Developers	Ongoing/ HIGH	Town (for municipal facilities) and Private Developers
Prevention	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	Town Departments	Long-term/ MEDIUM	Town, with advice and assistance from MVPC, DCR, MEMA

SECTION 10. PLAN ADOPTION AND MAINTENANCE

This section discusses how the Merrimack Valley Hazard Mitigation Plan 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

Adoption of the Plan signifies that the plan's recommendations have been considered and approved in accordance with state and federal requirements. Prior to its adoption locally and regionally, the Plan will be sent to the State for review. Upon its review and approval by MEMA/DCR, the Plan is then sent to FEMA. Upon FEMA's conditional approval, the Plan is then presented for formal review and adoption by MVPC's governing board and each participating community.

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.*

10.2 Plan Maintenance

The Disaster Mitigation Act of 2000 stipulates that regions and municipalities must not only develop a Pre-Disaster Mitigation Plan, but also take steps to ensure that the Plan is implemented and updated as needed. The following steps will be taken to monitor and maintain the Plan, assuming that adequate funding is available:

- MVPC will distribute an annual survey form to members of the Regional Multiple Hazard Community Planning Team, local emergency managers, city/town planners, public works departments, town engineers, and conservation administrators. The survey will focus on the community's progress in implementing the regional and local actions of the Hazard Mitigation Plan. In addition, any new or changing information such as new or changing critical facilities, hazard conditions, or refined vulnerability assessments will provide the basis for altering or enhancing elements of the Plan;

- In addition to the 5-year update, the Regional Hazard Mitigation Plan will be updated on an as-needed basis as infrastructure projects are identified or as priorities change. It is anticipated that both regional and local infrastructure improvement projects will be identified over time, and it is of critical importance that these specific projects be included in the list of action items so that funding sources can be pursued as soon as the need for them becomes apparent;

- Should the Region experience a significant natural disaster, the Hazard Mitigation Plan will be evaluated and updated as warranted to reflect the collective experience and knowledge gained from that event;

- Should Federal or State hazard mitigation regulations and requirements change, the Plan will be updated accordingly;

- In order for communities to qualify for hazard mitigation funding, the Plan will be amended to incorporate new mitigation projects as they are identified by the local communities;

- The ongoing monitoring and updates of this Plan will include public participation utilizing MVPC's regularly scheduled monthly meetings, which are broadly advertised public meetings, as well as the MVPC website;

- The Merrimack Valley Planning Commission intends to update this Plan five years from the date of adoption, as resources permit. Therefore, the first update will be undertaken in 2012. As started above, the update will focus on the successes and failures of the current plan as documented through surveys and reports from the local communities, as well as any new or changing information deemed relevant to the Plan.

Future Plan revisions will generally follow the same planning process that created the original plan. Members of each participating community will be invited to provide input into the revised plan through "hands on" working meetings, and stakeholders will be kept apprised of the revision process and products through various regional public forums and the MVPC website.

SECTION 11. PLAN IMPLEMENTATION

11.1 Pivotal Role of Local Governments

The implementation of the Merrimack Valley Hazard Mitigation Plan 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 Regional and Local 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.

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.*

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 plans, capital improvement 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.

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
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 now 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.

FEMA currently is offering additional pre-disaster hazard mitigation initiatives through the Pre-Disaster Mitigation (PDM) Program. 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, 345 out of 351, or 98%, of Massachusetts municipalities participate in the NFIP.

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.

44 CFR Part 201, Hazard Mitigation Planning, establishes criteria for State and local hazard mitigation planning authorized by §322 of the Stafford Act, as amended by §104 of the DMA. After November 1, 2004, local governments and Indian Tribal governments applying for PDM funds through the States will have to have an approved local mitigation plan prior to the receipt of local mitigation project grants. States will also be required to have an approved Standard State mitigation plan in order to receive PDM funds for State or local mitigation projects after November 1, 2004. Therefore, the development of State and local multi-hazard mitigation plans is key to maintaining eligibility for future PDM funding. For current information on available Pre-Disaster Mitigation Program, refer to FEMA's website at http://www.fema.gov/fima/pdm.shtm.

SMALL BUSINESS ADMINISTRATION (SBA) MITIGATION LOANS

The SBA's Pre-Disaster Mitigation Loan Program was developed in support of FEMA's Pre-Disaster Mitigation program. SBA's pilot loan program was authorized at a level of $15 million for each of five fiscal years from 2000 to 2004 to provide loans to small businesses for the purpose of implementing mitigation measures to protect their property from disaster-related damage. Eligible small businesses may borrow up to $50,000 each fiscal year at a fixed interest rate of four percent per annum or less for mitigation measures approved in the loan request.

Businesses proposing mitigation measures to protect against flooding must be located in a Special Flood Hazard Area (SFHA). FEMA publishes maps indicating a community's flood hazard areas and the degree of risk in those areas. Flood insurance maps usually are on file in a local repository in the community, such as the planning and zoning or engineering offices in the town hall or the county building. FEMA's Map Service Center provides online access to flood maps: **FEMA's Map Service Center.** Businesses may consult these 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. The National Flood Insurance Program (NFIP) **General Program Information** web page provides additional information on mapping and a link to the State coordinating agency contacts.

To apply for a pre-disaster mitigation loan, a business must submit a complete Pre-Disaster Mitigation Small Business Loan Application within the 30-day application period announced by the SBA. SBA will publish a Notice of Availability of Pre-disaster Mitigation Loans in the Federal Register announcing the availability of pre-disaster 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. A business' proposed mitigation measure as described in the application must conform to the priorities and goals of the mitigation plan for the community in which the business is located.

For more information on this program, the Small Business Administration (SBA) published a Final Rule on their Pre-Disaster Mitigation Loan Program in the Federal Register on October 7, 2002. The **Federal Register** may be viewed online.

INFRASTRUCTURE SUPPORT PROGRAM

The Federal Emergency Management Agency's Infrastructure Support 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.

For the latest updates on this FEMA program, refer to the FEMA website at **www.fema.gov**.

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. In other words, the department must match the dollars, dollar for dollar, in money, time, or equipment. Most grants are $5,000 or less. Actual amounts depend on the VFA funding allocated to the particular State, which in turn depends on Congressional action.

ASSISTANCE TO FIREFIGHTERS GRANTS PROGRAM - FIRE PREVENTION & SAFETY GRANTS

This grant program awards grants to national, regional, State, local, or community organizations (including fire departments) that are recognized for their experience and expertise in fire prevention or safety programs and activities. Private non-profit and public organizations are eligible to apply for funding for these grants. Fire departments that have received or applied for training, equipment, vehicles, etc. under the FY 2004 Assistance to Firefighter Grant Program are eligible to apply for the fire prevention grants in this application period. However, funding to any organization is limited to a $750,000 Federal share per program year.

Matching FEMA Assistance

Following presidential disaster declarations, the state contributes half, or 12½%, of the 25% local share of federal Infrastructure Support funds. Since 1991, the state has contributed $12,528,157 to match FEMA's funding following declared presidential disasters.

Special Appropriations Following State Disasters

Although there is no separate state disaster relief fund in Massachusetts, the state legislatures will enact special appropriations for those communities sustaining

damages following a natural disaster that are not large enough for a presidential, disaster declaration. Since 1991, Massachusetts has made 10 state disaster declarations and has provided $7,177,251 in funding to aid communities affected by natural disasters.

State Revolving Fund

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

State Land Acquisition & Conservation Program

Through the Massachusetts Executive Office of Environmental Affairs, this annual multi-million dollar program purchases private property for open space, wetland protection and floodplain preservation purposes. For instance, in 1998, the state set an ambitious goal of protecting 200,000 acres of open space in the Commonwealth by 2010. In August 2001, less than three years later, the state announced that the Commonwealth and its land protection partners had reached the halfway mark in achieving that goal - 100,000 acres.

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.

Natural Resource Conservation Service (NRCS) PL566 Flood Control Dams

The state funds the necessary engineering technical assistance and funding to operate and maintain the 25 PL566 flood control dams located on state property.

NFIP Staff Funding

The state does a one-on-one match of one staff position to FEMA's funding of the National Flood Insurance Program staffing. This state match translates into 2 full-time staff positions in the Flood Hazard Management Program within the Department of Conservation and Recreation. These positions, which report directly to the federally funded NFIP Manager's position, are involved in implementing the NFIP program throughout Massachusetts.

Hazard Mitigation Project Support

The state also provides ongoing, extensive technical support to communities in developing, completing and evaluating hazard mitigation projects and plans.