Commonwealth of Massachusetts
State Hazard Mitigation Plan
2010

Prepared by Massachusetts Emergency Management Agency and Department of Conservation and Recreation

October 2010

Deval Patrick	**Tim Murray**
Governor	**Lt. Governor**
Kurt Schwartz	**Richard Sullivan**
Acting Director, MEMA	**Commissioner, DCR**

Cover Photograph Credits:

Center; Boston Globe, Staff Photographer, Lakeville RT. 140, March 2010.

Lower Left: Scott Macleod, Weymouth, June 2007.

Lower Center; Cape Cod Times, Chatham North Beach, January 2008.

Lower Right; Scott Macleod, Becket Brooker Hill Rd, September 2008

All photographs are used with permission.

Plan Design and Layout: Sarah White, Massachusetts Emergency Management Agency

Acknowledgments

This document has been compiled by the State Hazard Mitigation Team, comprised of staff from the Massachusetts Emergency Management Agency and Department of Conservation and Recreation:

Richard Zingarelli	Scott Macleod	Sarah White
Sherry Leung	Chris Markesich	Eric Carlson

Special appreciation is extended to the individuals who participated in this update by contributing on a Workgroup and working session. Your dedication and feedback made this update more comprehensive and set the high-quality standards for the drafts and revisions.

Linda Alexander	Rebecca Haney	Robert Ryan
Tom Barnaby	Chris Hatfield	Rob Sousa
Nicole Belk	Erica Heidelberg	James Sprague
Myles Brown	Ben Hiltunen	Michael Stroman
Scott Calisti	Linda Hutchins	Robert Thompson
Fran DeNicola	Rich Klein	Jeffery Trask
John Ebel	Steve Patriarco	Gregor Trinkaus-Randall
Glenn Field	Joe Pelczarski	Beverly Woods
Ed Fratto		

Representatives from the following agencies provided valuable contributions toward the content and development of the hazard mitigation plan.

- Executive Office of Energy and Environmental Affairs
- Department of Conservation and Recreation
- Department of Environmental Protection
- Office of Coastal Zone Management
- Department of Agricultural Resources
- Department of Fish and Game
- Massachusetts Emergency Management Agency
- Department of Public Safety
- Department of Public Health
- Division of Capital Asset Management
- Massachusetts Historical Commission
- Board of Building Regulation & Standards
- Massachusetts Board of Library Commissioners
- Massachusetts Association of Regional Planning Agencies
- US Army Corp of Engineers, New England District
- Federal Emergency Management Agency
- National Weather Service
- Natural Resource Conservation Service
- Northeast States Emergency Consortium
- American Red Cross
- Weston Observatory at Boston College
- US Geologic Survey
- New England Disaster Recovery Exchange
- Franklin Regional Council of Governments
- University of Massachusetts

Table of Contents

Appendices Listing

1. **Planning Process and Coordination**
    a. Coordination Description/Process
    b. Key Terms & Acronyms
    c. Executive Staff Briefing
    d. Workgroup Members
    e. Workgroup Descriptions
    f. Agendas, Sign-ins, and Meeting Notes
    g. Public Outreach Info Documentation
    h. Plan Revisions Guide 2010
    i. Interagency Committee Membership Listing
    j. Mitigation Action Prioritization Sheet
2. **State Legislation**
    a. Executive Orders 144- Amends Civil Defense Act of 1950 (Electronic copy only, See CD)
    b. Executive Orders 149- Designates Water Resources Commission (Electronic copy only, See CD)
    c. Executive Orders 181- Barrier Beach Protection (Electronic copy only, See CD)
    d. Executive Orders 242- Amends Civil Defense Act of 1950 (Electronic copy only, See CD)
    e. Executive Orders 438- State Sustainability Program (Electronic copy only, See CD)
    f. 301 CMR 11 Massachusetts Environmental Policy Act (Electronic copy only, See CD)
3. **Federal Legislation**
    a. Hazard Mitigation Planning And Hazard Mitigation Grant Program 44 CFR Parts 201 & 206 (Electronic copy only, See CD)
    b. Disaster Mitigation Act Of 2000: Public Law 106–390—Oct. 30, 2000 (Electronic copy only, See CD)
    c. Bunning-Bereuter-Blumenauer Flood Insurance Reform Act Of 2004: Public Law 108–264—June 30, 2004 (Electronic copy only, See CD)
4. **2010 Hazard Maps**
    a. Hazard Mitigation Grant Awards thru FY08
    b. Dam Locations
    c. Drought Occurrences
    d. Earthquake Risk Map
    e. Major Flood Events
    f. Frozen Precipitation Events
    g. Annual Mean Total Snowfall
    h. Historic Hurricane and TS Tracks w/ Wind Load Zones
    i. Ice Storm Events
    j. Ice Jams
    k. Reported Landslides Occurrences
    l. Multi-Hazard Mitigation Plan Status
    m. NFIP Total Claim Payment Amounts
    n. FEMA Q3/DFIRM Flood Insurance Rate Maps (11 in series)
    o. SLOSH (8 in series)
    p. Snow Loads
    q. Reported Tornado Occurrences
    r. Watersheds
    s. Wildland Fires
5. **Natural Hazard Documentation and Information**
    a. National Flood Insurance Program Policy And Claims Data
    b. Dams
    c. Drought
    d. Data Layer Description and Notes

i. Database Files (Electronic copy only, See CD)

e. DFS Fire Tips
f. USGS Flood Frequencies
g. USGS PGA Map
h. Wildland Fire Info

6. Massachusetts Demographics

a. 2005 American Community Survey Summary
b. 2000 American Community Survey Details
c. Population Projections

7. **Disaster Information**

a. All Declarations and SBA Funding
b. FEMA DR 1701- April 2007
c. FEMA DR 1813 – December 2008

8. Hazard Mitigation Funding

a. Hazard Mitigation Projects
b. Hazard Mitigation Grant Matrix
c. Unified HMA Program Brochure
d. Mitigation Grant Program Information
e. Best Practices (series of 7)

9. Hazard Mitigation Local and Regional Plan Integration

a. Local and Regional Plan Integration Workbook (Electronic copy only, See CD)
b. Frequency of Hazards Statewide Analysis
c. Hazard Mitigation Plan Status
d. Local Planning Technical Assistances Guides (2 in series)

10. Plans and Mitigation Documents

a. Massachusetts Mitigation Grants Administrative Plan
b. State Comprehensive Emergency Management Plan
c. Climate Change Implementation Plan
d. Climate Change Protection Plan Workbook (Electronic copy only, See CD)
e. Stormwater Management Plan Workbook (Electronic copy only, See CD)
f. Coastal Hazards Commission Recommendations
g. TACCEI Building Code Revisions Matrix
h. SRL Amendment Package Workbook (Electronic copy only, See CD)
i. NAI in the Coastal Zone Workbook (Electronic copy only, See CD)

Foreword

The Commonwealth of Massachusetts has been considered a leader in the field of hazard mitigation since the beginning of national hazard mitigation strategies more than 25 years ago. Massachusetts joined the National Flood Insurance Program (NFIP) in 1978, the first year of the program. Today, more than 95% of Massachusetts' 351 communities participate in the NFIP program. In 1986, Massachusetts also was one of the first states to receive FEMA approval for its State Hazard Mitigation Plan.

Over the years, staff of both the Massachusetts Department of Conservation and Recreation (DCR) and the Massachusetts Emergency Management Agency (MEMA) have contributed to the success of the statewide hazard mitigation program.

The current process of updating the State Hazard Mitigation Plan, as well as FEMA's ongoing RiskMap (formerly Map Modernization Program), has allowed Massachusetts to research, update, and analyze past and current information, as well as to bring new partners into the statewide planning process.

In addition, the state plan supports Massachusetts' successful hazard mitigation program by incorporating the following information required under the Disaster Mitigation Act of 2000 (DMA 2000), 44 CFR Part 201.4, Interim Final Rule, for State Hazard Mitigation Plans:

An adoption process on the state, regional, and local levels (Sections 2, 3, 6)
Assurances that the state will comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding (Section 2),

A description of an effective statewide planning process used to develop this plan (Section 3),

Identification and risk assessment of natural hazards that provide the factual basis for activities proposed in the mitigation strategy section (Section 4),

A capability assessment of current and past hazard mitigation programs, regulations, plans, resources, and success stories (Section 5),

A statewide mitigation strategy that provides a blueprint for reducing future losses identified in the risk and capability assessments (Section 5),

A process for coordinating local and regional mitigation planning throughout the state (Section 6),

A maintenance process for monitoring, evaluating, and updating the plan, including reviewing and updating the State Mitigation Plan every three years with submittal to FEMA Region I. (Section 7).

Plan Update

The last plan, 2007 State Hazard Mitigation Plan, was approved by FEMA Region 1 on October 18, 2007. For this comprehensive update the changes, modifications, and deletions are discussed in detail in the Plan Revision Guide 2010 located in Appendix 1.

An effective and comprehensive planning process is essential to developing and maintaining a solid plan. The State Hazard Mitigation Team (SHMT) utilized the *Multi-Hazard Mitigation Planning Guidance "Blue Book"*, FEMA, January 2008 and *State and Local Mitigation Planning How-to-Guide Series*. FEMA, 2001-06 together with other planning techniques to create a cohesive and replicable planning process. Beginning in January 2009 the SHMT conducted a series of planning meetings and workshops including local, state and federal agencies to provide education on the planning process and develop a thorough step-by-step plan update for this 2010 State Hazard Mitigation Plan.

Some of the major highlights on this plan update included a modification in the layout and organization of the risk assessment, development of functional workgroups who lead the hazard identification, profile and data collection process for each category of hazard, and inclusion of more information from Presidential Disaster Declarations.

Format

The organization of the risk assessment of the 2007 plan presented the State Hazard Mitigation Team (SHMT) a challenge during the early stages of the update since the layout segregated information and did not allow for ease of review and analysis for each hazard individually. In January 2009, the plan's risk assessment was reorganized to have the hazard identification and the hazard profiles to include consistent levels of information, when available, among each hazard and consolidates the hazard profile to include all related information to the previous occurrences, location, and probability of future events in one section. This change allows for a more useful working document for the Commonwealth and more closely follows the outline of the guidance and the FEMA Review Crosswalk. This new plan format allows for more efficient reviews and improved organization for the current and future updates.

Workgroups

This State Plan update process includes the creation of working groups to revise specific data and make recommendations on updates for sections of the hazard identification, profile, state capabilities and mitigation strategy. The concept behind the Workgroups is to provide perspective as the subject matter expert on that hazard/issue. There were six hazard specific workgroups and one strategy and process workgroup. The charge of the workgroups are to provide information on what, why, and (if available) how information and data that could be included into the 2010 State Hazard Mitigation Plan. Working groups coordinated through emails, meetings and telephone calls to supply relevant information on new data and occurrences that would impact the current plan. This new concept vastly improved the interagency coordination in the planning process and the ongoing plan implementation efforts. The workgroups added to the strength of the program's integration of existing state programs by providing a variety of state and federal agencies an opportunity to become hands on with this planning process.

Disasters and Recovery

There has been one Major Disaster Declaration in the Commonwealth since the 2007 Plan approval and the finalization of this plan in February 2010. This was FEMA-DR-1813-MA, the December 2008 Ice Storm. Information from this disaster has been included in this plan update in the hazard profile and vulnerability assessment. This event was considered when updating the actions and strategies.

In addition, the SHMT partnering with FEMA Region 1 Mitigation and Public Assistance staff, captured information on the previous four Major Disaster Declarations. This information has been included in the vulnerability assessment.

Section 1 Executive Summary

1.1 Background

The Commonwealth of Massachusetts established its commitment to hazard mitigation almost thirty years ago when it joined the National Flood Insurance Program (NFIP) and later when the state developed its first State Mitigation Hazard Mitigation Plan in 1986. Following subsequent disaster declarations, the Commonwealth updated its State Hazard Mitigation Plan in 1989, 1993, 1998, 2000, 2004, 2007 and 2010. Each plan identified natural hazards, assessed vulnerability to the most frequent hazards, examined existing capabilities, developed statewide mitigation goals and strategies, and established a framework for implementing those goals and strategies.

1.2 Natural Hazard Risk

The Commonwealth of Massachusetts is vulnerable to and has experienced damage from several types of natural hazards. For this plan the hazards are in the following categories; Flood Related, Coastal Hazards, Atmospheric and Winter Related, Other Natural Hazards, Geologic Related, and Non-Natural Hazards. **According to the multifaceted risk analysis, the Commonwealth of Massachusetts is most vulnerable to flooding, severe storms, and winter events, which centers the focus of this plan.** This plan also analyzes other natural hazards such as drought, wildland fire, earthquake, landslide, tsunami, and extreme temperatures.

1.3 Disaster Declarations

Massachusetts ranks 38th out of the 50 states and 9 territories for number of FEMA disaster declarations[1]. Massachusetts has had more than 30 major disaster declarations, including federal, or Presidential, disaster declarations and state disaster declarations. Since 1991, more than $558 million in federal aid and state aid has been disbursed to assist Massachusetts residents recover from natural disasters.

1.4 Coordination and Planning

One of the strongest partnerships that has grown out of this mitigation program has been the daily, cooperative relationship between the Massachusetts Emergency Management Agency (MEMA) and the Department of Conservation and Recreation (DCR). These agencies comprise the State Hazard Mitigation Team and lead the State Interagency Hazard Mitigation Committee. These groups are the foundation of the mitigation program in Massachusetts. It is their dedication to protecting, and expertise in, analyzing the risks to

[1] As of December 2009. http://www.fema.gov/news/disaster_totals_annual.fema

the citizens and infrastructure in Massachusetts, which allow for a successful mitigation program.

1.5 Project Implementation

With the NFIP and the state planning strategies serving as a mitigation program cornerstone and with the establishment of federal mitigation grant programs in the mid-1990s, Massachusetts has been successful in leveraging federal funding for 217 hazard mitigation projects totally nearly $66 million, between 1991 and 2008.

1.6 Goals and Actions

The Statewide Hazard Mitigation Strategy for Massachusetts is:

To reduce the statewide loss of life, property, infrastructure, and cultural resources from natural disasters through a comprehensive hazard mitigation program, that involves planning, awareness, coordination, and project development.

The specific goals outlined in Section 5 of the State Hazard Mitigation Plan include:

> Meet the planning requirements for hazard mitigation plans contained in the Disaster Mitigation Act of 2000.
>
> Increase awareness of the cost-savings and public safety benefits of hazard mitigation projects.
>
> Increase coordination and cooperation between state agencies in implementing sound hazard mitigation planning and project development.
>
> Fund cost-effective hazard mitigation projects through available federal grants and local cost share, PDM, HMGP, FMA, SRL, and 406 Mitigation Programs.
>
> Monitor, evaluate, and disseminate information on the effectiveness of completed hazard mitigation projects, especially after disaster events.

Section 2 Introduction and Overview

2.1 Purpose

The purpose of this plan is to help the Commonwealth of Massachusetts and its residents understand when, where, why, and how natural hazards occur; minimize their impacts; and reduce the cost of recovery and rebuilding. This plan also outlines specific actions that should be taken by the federal, state, and local governments as well as the general public in order to manage the risks of natural hazards and reduce future costs of rebuilding.

This document is an update of the 2007 Massachusetts State Hazard Mitigation Plan, in compliance with the Disaster Mitigation Act of 2000, or DMA 2000, (Public Law 106-390), and implementing regulations found at 44 CFR Parts 201 and 206. Massachusetts had received FEMA Region I approval of its State Hazard Mitigation Plan in 1998, 2000, 2004, and 2007 in compliance with the requirements at that time of 44 CFR 206.405, specifically Subpart M, Hazard Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

This update is intended to incorporate the hazard mitigation lessons learned following recent disasters to be better prepared for future events as well as meeting the DMA 2000 state mitigation planning requirements. This plan also accomplishes the following:

Expands the Commonwealth's statewide, natural hazards risk assessment;

Documents the statewide strategy for regional and local hazard mitigation planning mandated under the DMA 2000;

Gives an overview of the state's current capabilities, areas of improvement, and strategies to improve hazard mitigation throughout the state; and

Provides an overview of more than a decade of successful hazard mitigation projects funded through the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA), and the Pre-Disaster Mitigation (PDM) Program.

2.2 Authority and Scope

Prior to 2000, Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288, as amended) was the impetus for the involvement of

state and local governments in evaluating and mitigating natural hazards as a condition of receiving federal disaster assistance. A requirement of the Stafford Act's Section 409 was the development of a state hazard mitigation plan.

Under Section 409 of the Stafford Act, a state was required to update its State Hazard Mitigation Plan following every Presidential disaster declaration. Massachusetts updated and received FEMA approval of its state plan following Presidential disaster declarations in 1986, 1987, 1989, 1993, and 1998. In addition, Massachusetts' State Hazard Mitigation Plan was again reviewed and approved by FEMA Region I in 2000, 2004, and 2007.

The Disaster Mitigation Act of 2000 (Public Law 106-390) , signed by the President on October 30, 2000, with its Interim Final Rules, 44 CFR Part 201 and 206, Hazard Mitigation Planning and Hazard Mitigation Grant Program, eliminating the state mitigation update requirement following each Presidential disaster declaration. Currently, states must complete, and receive FEMA approval, of its updated State Mitigation Plans after November 1, 2004 with an update cycle of every three years. These regulations also provide specific requirements for the content of a State Hazard Mitigation Plan.

Additional information on the Robert T. Stafford Disaster Relief and Emergency Assistance Act and the Disaster Mitigation Act may be found in Appendix 2, Federal Legislation, Authorities & Executive Orders.

2.3 Adoption by the State

This State Hazard Mitigation plan has been reviewed and endorsed by the State Interagency Hazard Mitigation Committee. This is a standing committee of various state and federal agencies as well as private organizations involved in hazard mitigation (see committee member list in Appendix 1). After this review and approval process as described in Section 3 of this plan, the two primary state agencies responsible for hazard mitigation in Massachusetts – the Massachusetts Emergency Management Agency (MEMA) and the Department of Conservation and Recreation (DCR) – have reviewed and adopted this plan. The letter of adoption and assurance, signed by the Director of MEMA and the Commissioner of DCR, is presented in the front of this plan.

2.4 Profile of Massachusetts[2]

The Commonwealth of Massachusetts is one of the six New England states which makes up FEMA Region 1. To understand the structure of state and local government in this "commonwealth" – a structure which is intrinsic to New England but very different from the rest of the United States, this profile of Massachusetts is provided with the following information:

Demographics
Overview of geography
State government structure

The name Massachusetts comes from Algonquian Indian words that mean the great mountain, an apparent reference to the tallest of the Blue Hills, a recreation area south of the Town of Milton. Massachusetts is one of the original 13 states (6th) of the Union (February 6, 1788).

Official Name: Commonwealth of Massachusetts
Nickname: Bay State
Capital: Boston
Motto: Ense Petit Placidam Sub Libertate Quietem
(Translation: By the Sword We Seek Peace, But Peace Only Under Liberty)

Demographics

Massachusetts has a gross area of 8,257 square miles and a net land area of 7,838, ranks 13th in population with 6,349,097 residents and 45th in area among the states of the nation. It is divided into 14 county areas, varying in size and population from Nantucket (area 50.34 sq. mi., pop. 9,520) to Worcester (area 1,575.95 sq. mi., pop. 750,963) and Middlesex (area 844.21 sq. mi., pop. 1,465,396).

The counties are made up of 49 cities and 302 towns. The largest city is Boston which has a population of 589,141. The smallest is town is Gosnold with a population of 86. More than half of Massachusetts' total population lives in the Greater Boston area. The ten largest cities in Massachusetts are (2000 U.S. Census):

Boston:	589,141
Worcester:	172,648

[2] Information from this section has been complied from the Mass.gov, the official website of the Commonwealth of Massachusetts, April, 2009. All demographic information in this plan is for the 2000 US Census and the Massachusetts Secretary of State, March 2009.

Springfield:	152,082
Lowell:	105,167
Cambridge:	101,355
Brockton:	94,304
New Bedford:	93,768
Fall River:	91,938
Lynn:	89,050
Quincy:	88,025

A third of the state's population was not born in the United States. Of the total 2000 population, 55.2% identified with a single ancestry group, 33% with the multi-ancestry group, and 11.7% were not specified. Of the single ancestry groups, the six leading groups were: Irish (21%), English (14.5%), Italian (13.6%), French (9.9%), Portuguese (6%) and Polish (5.1%). In 2000, Hispanics comprised 6.8%, African-Americans 5.4%, Asians 3.8% and Native Americans 0.2% of the state's population.

According to U.S. Census data from 1970 to 2000, Massachusetts' population grew by 11.6% or by 659,927 people. There was minimal growth of only 0.8% from 1970 to 1980, but over the next two decades, the population increased 4.9% and 5.5%, respectively.

2010 US CENSUS

All demographic information in this plan is from the 2000 US Census and the Massachusetts Secretary of State. The 2010 US Census information will not be available for this plan update. P.L. 94-171 also requires that these data be delivered to each state no later than April 1, 2011.

General Overview of Massachusetts Geography

Area: 8,257 square miles (land and water)
Largest body of water: Quabbin Reservoir (39 sq. miles)
Longest river: Charles River (80 miles)
Highest elevation: Mt. Greylock (3,491 feet)
Lowest elevation: Atlantic Ocean (sea level)
Number of state parks: 107
Largest state park: October Mountain State Forest, Lee (15,710 acres)
Number of national historical parks, seashores, and historic sites: 20
Largest national area: Cape Cod National Seashore (43,500 acres)

RIVERS

There are 4,230 miles of rivers within the Commonwealth of Massachusetts. The longest instate river is the Charles, flowing 80 miles. The longest river in New England is the Connecticut, which flows from north to south for 67.5 miles in Massachusetts. Its

tributaries are the Deerfield, Westfield, Chicopee, and Miller's rivers. Other major rivers in western Massachusetts are the Housatonic River, which flows south and the Hoosic River, which flows north between the Hoosic and Taconic mountain ranges.

The Merrimack River, in the northeast, originates in New Hampshire and empties into the Atlantic Ocean. The Nashua and Concord rivers are major tributaries of the Merrimack. The Blackstone River flows south from the center of Massachusetts. The Mystic and Charles rivers flow into Boston Harbor, and the Taunton River enters Mount Hope Bay at Fall River.

LAKES

Massachusetts has more than 3,000 lakes and ponds. The largest of these are the Quabbin Reservoir (24,704 acres) and Wachusett Reservoir (4,160 acres), which are manmade. These two reservoirs provide Metropolitan Boston with most of its public water supply.

The largest lakes of natural origin are Assawompsett Pond (2,656 acres) in Lakeville and Middleborough, drained by the Taunton River; North Watuppa Pond (1,805 acres) and South Watuppa Pond (1,551 acres) in Fall River and Westport, drained by the Quequechan River; Long Pond (1,361 acres) in Lakeville and Freetown, drained by the Taunton River; Lake Chargoggagogmanchaugagogchaubunagungamaug (1,188 acres) – usually, and mercifully, called Lake Webster - in Webster, drained by the French River; Herring Pond (1,157 acres) in Edgartown on the island of Martha's Vineyard; Great Quittacas Pond (1,128 acres) in Lakeville, Rochester, and Middleborough, drained by the Taunton River; Lake Quinsigamond (1,051 acres) in Worcester, Shrewsbury, and Grafton drained by the Blackstone River; and Monponsett Pond (756 acres) in Halifax and Hanson, drained by the Taunton River.

ISLANDS

Lying off Cape Cod are Martha's Vineyard, Nantucket, and the Elizabeth Islands. Martha's Vineyard, triangular in shape, is about 19 miles long and less than 10 miles in width. It contains the towns of Edgartown, Chilmark, Tisbury, West Tisbury, Aquinnah, and Oak Bluffs.

Nantucket, also roughly triangular, about 15 miles long and from three to four miles wide, was once famed for its whaling industry. Both Martha's Vineyard and Nantucket are now popular summer resorts. The Elizabeth Islands are a group of about 22 small islands lying between Vineyard Sound and Buzzards Bay.

The Boston Harbor Island group includes the Four Brewsters, Bumpkin, Calf, Deer, Gallop's, George's (used for thousands of Confederate prisoners of war during the Civil

War), Grape, The Graves, Green, Hangman, Langley, Long, Lovell's, Moon, Nixes Mate, Peddock's, Raccoon, Ragged, Rainsford, Sara, Sheep, Slate, Spectacle, and Thompson's. Some islands have been made part of the mainland by the great amount of landfill that has gone on over the years. Governor's Island, where the first apple and pear trees in America were planted, is now a part of Boston's Logan International Airport. Most of the islands have been used for farming, resort-recreation areas, public facilities, or fortifications.

TOPOGRAPHY

Massachusetts' topography varies greatly; from the rocky shores, sandy beaches and salt marshes of the east coast; through rolling hills, and fertile valley to lofty wooded hills in the western part of the state.

Massachusetts landscape was extensively re-formed during the last Ice Age; substantial ranges are the Berkshire Hills, Blue Hills, Holyoke Range, and Wapack. Mount Greylock, altitude 3,491 feet, in Berkshire County, is the highest mountain in Massachusetts. Other noteworthy mountains are Mount Williams (2,951 feet) in North Adams; East Mountain (2,660 feet) in Hancock; Mount Everett (2,602 feet) in Mt. Washington; Spruce Hill (2,588 feet) in Adams; Mount Frissel (2,453 feet) in Mt. Washington; Potter Mountain (2,391 feet) in Lanesboro; French Hill (2,214 feet) in Peru; and Mount Wachusett (2,006 feet) in Princeton.

Government Structure in Massachusetts

The state and local governmental structure in the Commonwealth of Massachusetts has an influence on statewide hazard mitigation planning. It is important to understand the Commonwealth's history, state and local government structure, current and future demographics, and geography before one can understand the Statewide Hazard Mitigation Planning Strategy.

HISTORY OF STATE GOVERNMENT

The Massachusetts Constitution was ratified in 1780 during the Revolutionary War, nine years before the United States Constitution was adopted. It is the oldest written Constitution still in use in the world. It specifies three branches of Government: Executive, Legislative, and Judicial.

Massachusetts, like Pennsylvania, Virginia, and Kentucky, is called a "Commonwealth". Legally, Massachusetts is a commonwealth because the term is contained in the Constitution. In the era leading to 1780, when the state Constitution was ratified, a popular term for a whole body of people constituting a nation or state was the word "Commonwealth." This term was the preferred usage of some political writers. There also may have been some anti-monarchic sentiment in using the word "Commonwealth." The name, which in the eighteenth century was used to mean "republic", can be traced to the

second draft of the state Constitution, written by John Adams and accepted by the people in 1780. In this second draft, Part Two of the Constitution, under the heading "Frame of Government", states, "that the people...form themselves into a free, sovereign, and independent body politic, or state by the name of The Commonwealth of Massachusetts." The people had overwhelmingly rejected the first draft of the Constitution in 1778, and in that draft and all acts and resolves up to the time between 1776 and 1780, the name "State of Massachusetts Bay" had been used.

ORGANIZATION OF STATE GOVERNMENT

EXECUTIVE OFFICE

Six constitutional officers elected for four years: Governor, Lieutenant Governor, Secretary of the Commonwealth, Attorney General, Treasurer and Receiver General, Auditor.
The Constitutional Officers as of January 2010, are:
Governor: Deval Patrick
Lieutenant Governor: Timothy P. Murray
Secretary of the Commonwealth: William Francis Galvin
Treasurer and Receiver General: Timothy Cahill
Attorney General: Martha Coakley
Auditor: A. Joseph DeNucci

LEGISLATURE

Official Name: General Court
Senate: 40 members elected every two years.
House of Representatives: 160 members elected every two years.

HIGHEST COURT

Supreme Judicial Court: Chief Justice Margaret H. Marshall and five Associate Justices. The Governor, with the advice and consent of the Executive Council, appoints all justices.

COUNTIES

County government in Massachusetts, as in all of New England, is not a strong entity. The county level of government is not mentioned in the state Constitution, and was later established by legislative action. The fourteen counties, moving roughly from west to east, are Berkshire, Franklin, Hampshire, Hampden, Worcester, Middlesex, Essex, Suffolk, Norfolk, Bristol, Plymouth, Barnstable, Dukes, and Nantucket.

Massachusetts's counties were regional administrative districts before the Revolutionary War. Throughout Massachusetts's history the counties administered jails, health facilities,

agricultural schools, registries of deeds and probate, county courthouses, county roads and extension services.

For many years, there was criticism of county government as wasteful and inefficient. There were recommendations to abolish all county governments and transfer most of their functions to state agencies and their assets (land and buildings) to the Commonwealth.

Registers of Deeds and probate, sheriffs, and district attorneys, even where county government has been abolished, are still elected in county political districts. In counties, which have not been abolished or restructured, county commissioners and treasurers are still elected. It is important to understand that counties as geographical and/or political regions are not abolished or restructured; it is the government which is abolished or restructured.

Home rule legislation allows officials or voters in a county to establish a regional charter commission to study its government. The commission can submit one of three model charters for approval of voters in that county at a statewide election or it can submit a special charter, which must first be approved by the state legislature.

Cities and towns may choose a Regional Council of Government charter, which will be binding on those communities where a majority of voters in a city or town approve it. The regional council of governments can provide a variety of services to cities and towns, such as planning, public safety, engineering, water and waste disposal, and many other services. The participating communities pay assessments based on local property evaluation. The legislature approved special charters to allow several counties to become regional councils of government.

MUNICIPALITIES

There are a total of 351 cities and towns in Massachusetts, each with its own governing body. Typically elected Mayors govern Massachusetts's cities and elected officials called Selectmen usually govern the towns, however there are some exceptions to this. A Board of Selectmen is usually elected for a one-or-two-year term, and citizens participate in an annual town meeting, a tradition from Colonial times. The open town meeting is the active legislature in a town. Some communities have a representative open town meeting, while others; have a true "open" town meeting. A current listing of state, county and municipal government agencies and contacts may be found at the Commonwealth of Massachusetts website at www.mass.gov.

Section 3 Statewide Hazard Mitigation Planning Process

The following section provides documentation of the planning process, including a chronological overview of the Commonwealth's hazard mitigation program since the late 1970's, encompassing:

- History of Hazard Mitigation Planning
- Statewide planning strategy
- Overview of the statewide planning process
- Coordination with state agencies
- Program integration

Specific details of how this plan update addresses changes, updates, and revisions to each section see appendix 1.

3.1 History of Mitigation Planning in Massachusetts

This section reviews the progress and accomplishments of Hazard Mitigation.

Prior to the establishment of the Pre-Disaster Mitigation (PDM) Program, the state actively pursued available hazard mitigation planning funds through the Flood Mitigation Assistance (FMA) Program and the Hazard Mitigation Grant Program (HMGP). With annual FMA Program planning funds since 1997 and HMGP planning funds, Massachusetts has funded several mitigation plans.

Massachusetts Holds New England's First Mitigation Planning Workshop

In August 1998, the state developed and hosted New England's first hazard mitigation planning workshop with funding from FEMA Region I. Titled, *Community-Based Hazard Mitigation Planning: Lowering the Risks and Costs of Disaster,* this training clinic attracted over 100 planners and emergency managers from federal, state and local governments as well as non-profit and private organizations. Part of this meeting included the distribution of a state-developed planning guide, created by the Flood Hazard Management Program of the Department of Conservation and Recreation. The guidebook, entitled, *Flood Hazard Mitigation Planning: A Communitu Guide 1997*.

In 2002, the Commonwealth retained the services of Dewberry, a consultant with a background in natural hazards mitigation, with a PDM planning grant, to provide assistance with updating the statewide natural hazards risk assessment and GIS hazard maps project. This extensive risk analysis became the basis for the current risk assessment, which is continually being updated by the state.

The State Hazard Mitigation Team developed a community guidebook, *Natural Hazard Mitigation Planning: A Community Guide 2003,* to assist in developing local and regional plans. This handbook was the first guidance for Massachusetts's communities with an all hazards approach.

The State Hazard Mitigation Plan Update 2007 was developed in accordance with the requirements of the Code of Federal Regulations 44. 201.4 (c)(5)(ii). The State Hazard Mitigation Team (SHMT), as described in section 3.3, led the year long update process, submitted drafts for FEMA review. The 2007 plan was approved in October 2007.

Hazard Mitigation Planning Process 2007- 2010.

The SHMT held a series of planning workshops to incorporate any new hazards identified, information and data from local and regional mitigation plans, and an evaluation of the state's mitigation goals and objectives. In addition to the planning workshops, members of the SHMT worked with Geographic Information Systems (GIS) staff at MEMA to develop an updated hazard analysis to include any new or improved data available. Every section of the document was reviewed by the SHMT and updated as appropriate. For detail on the meetings, tasks, and coordination see Appendix 1.

WORKGROUPS

For this plan update, the State Hazard Mitigation Interagency Committee and the State Hazard Mitigation Team (SHMT) established a goal to facilitate a comprehensive review and update for the State Plan with increased collaboration of the State Hazard Mitigation Interagency Committee. To achieve increased coordination, the SHMT developed seven workgroups to revise specific data and make recommendations on updates for sections of the hazard identification, profile, state capabilities and mitigation strategy. The concept behind the Workgroup is to provide perspective as the subject matter expert on that hazard/issue. There were six hazard specific workgroups and a strategy workgroups. The charge of the hazard specific workgroups was to provide information on what, why, and (if available) how information/data can be included into the New State Hazard Mitigation Plan. Working groups coordinated among members, supplied relevant information on new data and occurrences, which was incorporated into this plan. In addition to the recommendations each workgroup also had the opportunity to review and comment on the entire updated draft State Hazard Mitigation Plan as an additional layer of editing and evaluation. The initial meeting of to kick off the workgroups was in January 2009.

WORKGROUPS

Flood Related Hazards,

The major charge of this work group was to review all pertinent information to flood related hazards specifically; riverine flooding, heavy rain, dam failure, and ice jams.

Coastal Related Hazards

The major charge of this work group was to review all pertinent information to coastal flood related hazards specifically; coastal storms, coastal erosion, and shoreline change.

Atmospheric and Winter Related Hazards

The major charge of this work group was to review all pertinent information to atmospheric and winter related hazards specifically; high winds, hurricanes, tornados, Nor'easters, severe thunderstorms, heavy snow, ice storms, and blizzard.

Geologic Hazards

The major charge of this work group was to review all pertinent information to geologic related hazards specifically; earthquakes, landslides, major erosion, and tsunami.

Other Natural Hazards

The major charge of this work group was to review all pertinent information to other natural hazards related hazards specifically; wildfire, conflagrations (major urban fires), drought, and extreme temperatures

Non-natural Hazards

The major charge of this work group was to review of all pertinent information to non-natural related hazards specifically; hazardous materials, nuclear events, transportation accidents, terrorism, and health related.

Mitigation Strategy and State Capabilities

The major charge of this workgroup was to review and recommend revisions on the plan's goals and objectives; the state capabilities section which provides information state and local laws and regulations that impact the overall hazard mitigation strategy, and review submission of the Hazard workgroups to identify overarching issues with data limitations or secondary hazard effects.

Members of the SHMT convened to organize a timeline for the 2010 state plan update. This is a unique update since it blends the aspects of three presidential declared disasters as well as a required three-year update.

2010 State Hazard Mitigation Plan Update Schedule

Regulation	Massachusetts Planning Step	Timeframe
	Planning Process	
CFR 201.4(a)(1)-(b)	State interagency Team meeting	Monthly
CFR 201.4(a)(1)-(b)	Create specific working groups to focus on certain parts of the plan	Jan 2009- Sept 2009
CFR201.4(c)(7)(d)	FEMA Region 1 Review Period	Jul 2010-Aug 2010
CFR201.4(c)(7)(d)	FEMA Region 1 Approval Letter generated	Oct 2010
CFR 201.4(c)(5)(ii)-(iii)	Post Final Version to MEMA Mitigation Website and make copies available.	Oct 2010
	Risk Assessment and Information Update	
CFR 201.4(c)(2)(i)	Hazard Identification and Profiling	Jan 2009- Sept 2009
CFR 201.4(c)(2)(ii)	Assessing Vulnerability by Jurisdiction and State Facilities	Sept 2009-Nov 2009
CFR 201.4(c)(2)(iii)	Estimating Potential Losses of Jurisdiction and State Facilities	Sept 2009-Nov 2009
	Mitigation Strategy	
CFR 201.4(c)(3)(i)	Review Massachusetts's current Mitigation Goal and determine if it continues to provide adequate language for reducing potential losses.	Oct 2009-Nov 2009
CFR 201.4(c)(3)(ii)	Review and update existing mitigation measures and state capability	Oct 2009-Nov 2009
CFR 201.4(c)(3)(iii)	Review, Update, and Evaluate current and new objectives and strategies	Oct 2009-Nov 2009
CFR 201.4(c)(3)(iii)	Update or add new objectives and strategies	Oct 2009-Nov 2009
	Local Mitigation Planning and Coordination	
CFR201.4(c)(2)(i)-(iii)	Review and Integrate identified Hazards/Risk Analysis data from FEMA approved regional and local mitigation plans.	Sept 2009- Apr 2010

Note: More details on the Plan Update schedule can be found in appendix 1.

GIS ANALYSIS

The map revision process took place between September and December 2009. A small team of MEMA staff, worked to revise data, run analyses, and develop the map products. The team developed a map template so that all maps for this plan are consistent with maps developed by MEMA for operational and other purposes. For this plan update all maps were reviewed in detail and updated where new data with available.

2010 US CENSUS

All demographic information in this plan is from the 2000 US Census and the Massachusetts Secretary of State. The 2010 US Census information will not be available for this plan update. Public Law 94-171 requires that these data be delivered to each state no later than April 1, 2011.

EVALUATION OF CURRENT MITIGATION MEASURES

The SHMT and Interagency Committee held the Evaluation of Current Mitigation Measures workshop on October 5, 2009. This planning workshop included an extensive review of current mitigation measures and a review of the effectiveness of previously identified mitigation measures.

EVALUATION OF MITIGATION GOALS, STRATEGIES, AND ACTIONS

The SHMT held the Evaluation of Mitigation Goals, Strategies, and Actions workshop on October 5, 2009 in conjunction with the current mitigation measures evaluation. This planning workshop included an extensive review of current mitigation strategies and actions, including an analysis of the status and effectiveness of the actions. The exercise also was a brainstorming session to set forth the strategies and action for the 2010 plan update. For this plan update very few new actions were identified. However the STAPLEE Planning Criteria was applied to all of the strategies and actions to ensure consistency and priory is sound and justifiable. The actions and strategies of local and multi-jurisdictional plans were also considered at this meeting and during subsequent SHMT meetings. See Appendix 1 for a copy of the STAPLEE Criteria used in this plan update and see appendix 9 for local mitigation actions.

AMENDMENTS

Following the receipt of the Severe Repetitive Loss (SRL) Grant Program Guidance in December 2007 the Commonwealth revised the original submission of this plan to include pertinent information regarding the state's strategy regarding the program and details on the implementation and monitoring of the grant. The original SRL Amendment package is in Appendix 10. The State's SRL amendment was approved in 2008 allow Massachusetts to have a 90/10 SRL split.

3.3 Coordination Among Agencies

STATE HAZARD MITIGATION TEAM (SHMT)

The Commonwealth of Massachusetts has a unique, interagency cooperation in the administration and management of its Statewide Hazard Mitigation Program. This program is a joint effort between the Massachusetts Department of Conservation and Recreation (DCR) and the Massachusetts Emergency Management Agency (MEMA). The State Hazard Mitigation Team is co-chaired by the State Hazard Mitigation Officer at DCR and the Disaster Recovery Manager at MEMA. The SHMT consists of the staff in DCR and MEMA working full-time on hazard mitigation programs, projects, and planning, such as the National Flood Insurance Program (NFIP), the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance (FMA) Program, Pre-Disaster Mitigation (PDM) Program, and Severe Repetitive Loss (SRL). The SHMT meets on a monthly basis to coordinate team members' individual work assignments. The SHMT also coordinates the activities of the larger State Hazard Mitigation Interagency Committee, which is described below

STATE HAZARD MITIGATION INTERAGENCY COMMITTEE

Coordination with State and Federal Agencies and Partnering with the Private Sector is a priority for the SHMT. Massachusetts has had an active State Hazard Mitigation Interagency Committee since its creation in 1991, following two Presidential Disaster Declarations, Hurricane Bob in August and the Halloween Storm in October of that year. This committee, which consists of state, federal, and private sector organizations, is responsible for reviewing and approving the State Hazard Mitigation Plan, as well as other duties described later in this section.

Members of the State Hazard Mitigation Interagency Committee[3] include representatives from the State Hazard Mitigation Team and representatives from the following government agencies and private organizations:

STATE AGENCIES

Executive Office of Energy and Environmental Affairs
Department of Transportation
Department of Conservation and Recreation
Department of Environmental Protection
Office of Coastal Zone Management
Department of Agricultural Resources
Department of Fish and Game

[3] For more information on the members of the interagency committee see appendix 1.

Massachusetts Emergency Management Agency
Department of Public Safety
Department of Public Health
Division of Capital Asset Management
Massachusetts Historical Commission
Board of Building Regulation & Standards
Massachusetts Board of Library Commissioners

FEDERAL AGENCIES

US Geologic Survey
US Army Corp of Engineers, New England District
Federal Emergency Management Agency
National Weather Service
Natural Resource Conservation Service

OTHER AGENCIES

New England Disaster Recovery Exchange
Massachusetts Fire Chiefs Association
Massachusetts Association of Regional Planning Agencies
Weston Observatory at Boston College
American Red Cross
Franklin Regional Council of Governments
Salvation Army
Woods Hole Oceanographic Institute
Northeast States Emergency Consortium
University of Massachusetts

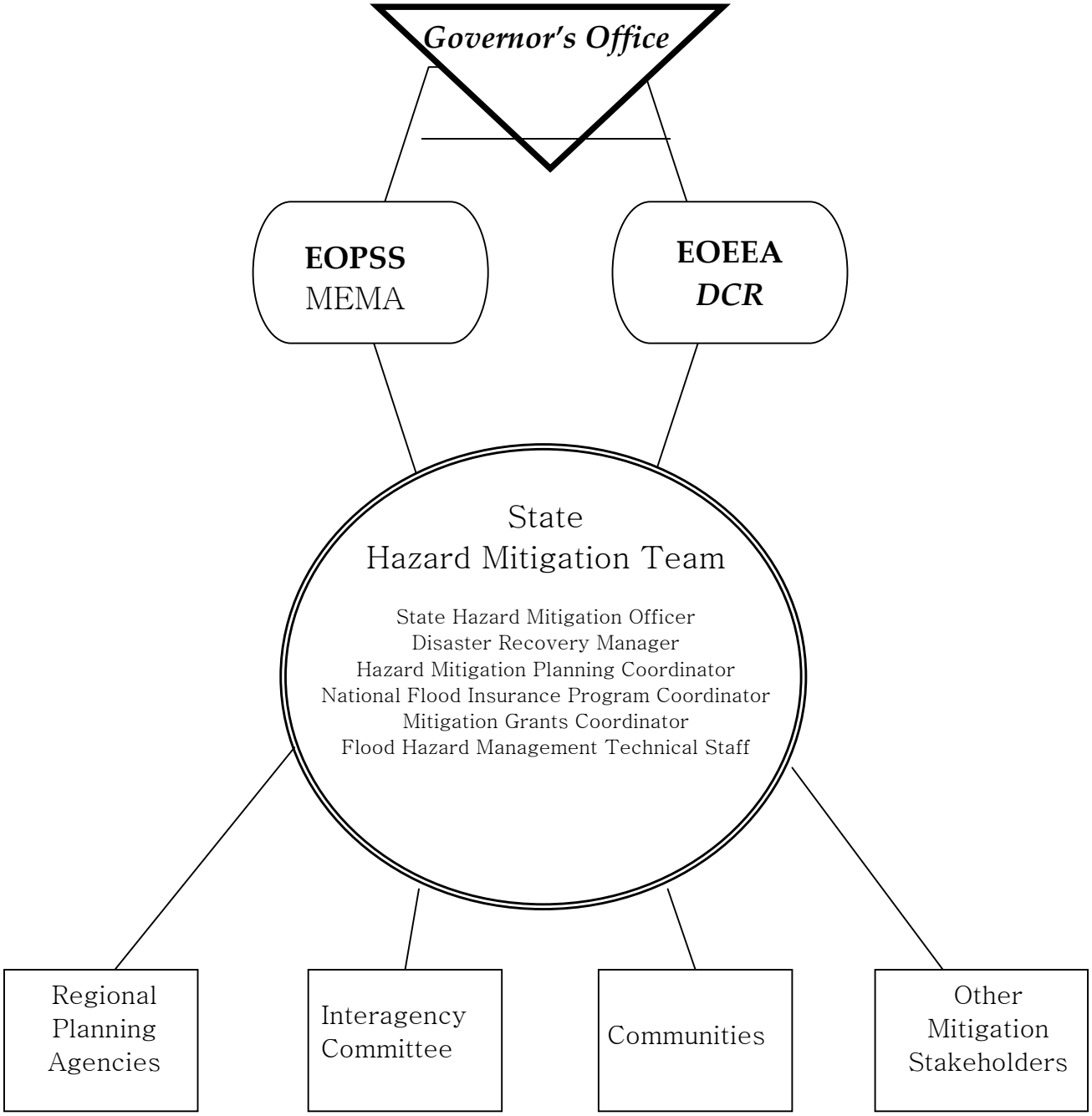
STATE HAZARD MITIGATION INTERAGENCY COMMITTEE RESPONSIBILITIES

Review and update the State Hazard Mitigation Plan as required by the Disaster Mitigation Act of 2000 and 44 CFR, Subpart M. These activities include:

- Review, update, and prioritize recommendations in the State Hazard Mitigation Plan.
- Develop a comprehensive strategy for the development and implementation of the State's mitigation program.
- Establish policies consistent with the statewide mitigation goals in the State Hazard Mitigation Plan.
- Review recommended project applications for the Hazard Mitigation Grant Program (HMGP) and provide recommendations as needed for the Flood Mitigation Assistance (FMA) program and the Pre-Disaster Mitigation Program (PDM).

- Identify additional federal, state and local funding sources for mitigation projects.
- Act as "subject matter experts" for ongoing hazard mitigation projects from initiation to close-out.
- Meet a minimum of once a year during non-disaster years and meet on an as-needed basis following a Presidential disaster declaration.

STATE'S HAZARD MITIGATION PARTNERSHIPS AND STAKEHOLDERS



Coordination and Outreach

The State Hazard Mitigation Interagency Committee is active in the update of the State Hazard Mitigation Plan. Since the 2007 plan update, there have been changes in membership to the committee. We have also welcome several new agencies to participate in the committee. The committee met on January 13, 2009 for an introduction to the update process, including assigning members in to the newly developed workgroups. For this update, members of more than twelve agencies met regularly with MEMA and DCR staff to provide key information and updates to each section of the plan.

The coordination among agencies has also improved since 2007. Several agencies have hosted or submitted requests to host mitigation planning and project training workshops for state agency staff. In 2008 MEMA conducted four trainings and three informational briefings related to planning and several other specific to grants and projects. In addition to direct training, coordination has improved by other agencies posting and distributing mitigation opportunities and dates on their websites and newsletters. This increase coordination has allowed our state to become even more resilient against natural hazards.

The State Hazard Mitigation Plan was provided to a variety of interest groups at all levels of government for an opportunity to review and contribute during the public out reach period. This began in January 2010 and continued through March 2010. Comments were solicited on several state agency webpages, at conferences and meetings, and through direct email announcements. It is estimated that the draft plan reached the largest audience of any previous mitigation plan. In addition to the Interagency Committee, all fourteen regional planning agencies received a copy to display and distribute to all interest groups at the regional level. In June 2010, the Interagency Committee also reviewed the draft plan and provided comments during the public outreach period. The Interagency Committee met to endorse the State Hazard Mitigation Plan on June 9, 2010.

3.4 Program Integration

NATIONAL FLOOD INSURANCE PROGRAM

The National Flood Insurance Program (NFIP) is a federal program, administered by FEMA, which makes subsidized flood insurance available in communities that agree to adopt corrective and preventative floodplain management regulations that will reduce future flood damages. Congress created the NFIP in 1968 with the passing of the National Flood Insurance Act. The Act was passed to address the fact that homeowners insurance does not cover flood damage, which left much of the burden of flood recovery to the general taxpayer through federal disaster relief programs. In general, flood insurance from private companies is either not available or extremely expensive. NFIP flood insurance is available anywhere in a participating community, regardless of the flood zone. Federal law requires that flood insurance be purchased as a condition of federally

insured financing used for the purchase of buildings in the Special Flood Hazard Area (SFHA).

Flood Insurance Rate Maps

FEMA produces Flood Insurance Rate Maps, commonly known as FIRMS, to support the National Flood Insurance Program. The FIRMs depict Special Flood Hazard Areas, the areas subject to inundation from the 1% annual chance flood (also known as the Base Flood or the 100-Year Flood). The SFHA determines where flood insurance is required as a condition of a federally insured loan through the NFIP mandatory purchase requirement. This requirement is intended to shift flood damage and recovery costs away from the general taxpayer and on to those who live in floodplains. The risk zones and flood elevations shown on the FIRMs within the SFHA are used to determine flood insurance rates. The SFHA also determines where NFIP floodplain management requirements must be enforced by communities that participate in the program. These include land use and building code standards. In addition to the NFIP, the FIRMs have also taken on additional uses. They are used within FEMAs Individual and Public disaster assistance programs, FEMAs Mitigation Grant Programs, emergency management, and in Massachusetts they identify areas where certain State Building Code and Wetlands Protection Act regulations must be enforced.

The Massachusetts Department of Environmental Protection relies of the FEMA FIRM Maps in its Wetlands Protection regulations, 310 CMR 10.00, to assist in delineating the extent of coastal flood areas. Also the Flood Insurance Study flood profiles are used to delineate riparian flood prone areas, for fold control and storm damage prevention purposes. These uses are in addition to the use of FIRMs by local building officials in enforcing State Building code provisions in 780 CMR 120.G.701 and 120.G.801 consistent with NFIP criteria.

Current effective FIRMs can often be viewed at local community offices. They are also available to view and purchase online at FEMAs Map Service Center website. These maps can be amended or revised to reflect existing topography or changes in flood characteristics. The Letter of Map Amendment (LOMA) process is often used to challenge a lender's determination that a building is in the floodplain.

FEMA FIRM Map Revision

FEMA is currently involved in an effort to "modernize" and update their Flood Insurance Rate Map (FIRM) inventory. FIRMs need to be updated for a number of reasons, including outdated base maps, development in watersheds, advancements in flood modeling, etc. Modernized FIRMs include an updated orthophoto base map. These FIRMs will be known as Digital FIRMs because they will be produced as a digital GIS based product. The State Hazard Mitigation Team has partnered with FEMA and the

DCR Flood Hazard Management Program to assist in the management and coordination of flood map modernization in Massachusetts.

Activities for developing a new Flood Insurance Rate Map (FIRM) and or updating an existing FIRM are completed in four phases:

- Mapping Needs Assessment
- Project Scoping
- Topographic and Flood Hazard Data Development/Report and Map Production
- Preliminary Map/Post-Preliminary Processing

The Mapping Needs Assessment forms the basis for selecting and prioritizing Flood Map Projects. Each community that has an existing FIRM, evaluates whether flood hazard and other data is accurate. For communities that do not have FIRMs, the Mapping needs Assessment determines whether a FIRM should be produced.

The Project Scoping phase begins after a community's mapping needs have been identified and a Flood Map Project has been initiated. There are several aspects to the scoping process including, but not limited to:

- Conducting background research and outreach;
- Determining what flood hazard data can be used in the revised analyses;
- Identifying other data needed to complete the Flood Map Project (base map, topography, cross sections, transects…);
- Establishing priority levels for flooding sources to be analyzed and mapped;
- Developing schedules and cost estimates.

In the third phase, topographic and flood hazard data are obtained or developed. New engineering analyses may be performed, or existing information is used to delineate floodplain boundaries and calculate the height of the base flood. A Flood Insurance Study (FIS) report is produced including text, Flood Profiles and data tables.

Finally, communities are issued a Preliminary FIRM and FIS for review and comment. If there have been changes to, or newly developed Base Flood Elevations (BFE's), a formal 90-day appeal period is provided. After all appeals are resolved and comments are evaluated, a compliance period is initiated (usually lasting 6 months) during which the affected communities make necessary changes to their local ordinances and by-laws. Also, final quality assurance and quality control are completed to ensure FIRM and FIS accuracy before printing and distribution.

	2008								2009												2010												2011					
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Middlesex	P																			L						F											
Bristol	P								L						F																						
Plymouth							P													L										F							
Dukes			P																		L						F										
Suffolk						P					L						F																				
Barnstable												P																			L						F
Norfolk												P																			L						F
Essex														P																	L						F
Salisbury (town)			P					L						F																							
Worcester (part)												P																			L						F
Hampden														P																	L						F
Nantucket														P																	L						F

Table 1 FEMA Map Mod Program Map Timelines; Table Key, P – Preliminary Maps, L – Letter of Determination, and F – Final . The shaded counties have final effective maps.

OTHER PROGRAMS

The State continues to make efforts to integrate mitigation to the greatest extent possible with other statewide planning and regulatory initiatives. For this plan update the SHMT consulted with several ongoing planning initiatives, in an attempt to integrate hazard mitigation. Some of those programs and/or departments include:

- Massachusetts Climate Protection Plan
- Massachusetts Smart Growth
- EOEEA Low-impact Development
- Coastal Hazards Commission Recommendations
- State Building Code Revisions

The State Hazard Mitigation Team (SHMT) has reviewed existing plans and programs and identified opportunities to integrate mitigation actions. For a complete list please refer to Section 5. Members of the SHMT participate in numerous programs across the state related to hazard mitigation:

Association of State Floodplain Managers

Climate Change Adaptation Advisory Committee

Community Assistance Program-State Support Services Element National Policy Group

Council of State Archivists Emergency Planning Committee

International Emergency Management Working Group

Map Modernization State and Local Workgroup

Massachusetts Coastal Hazards Commission

Massachusetts Emergency Management Team

Massachusetts Emergency Management Directors Advisor Committee

Massachusetts GIS Advisory Council

Massachusetts Public Private Workgroup

Muddy River Technical Advisory Committee

New England Floodplain and Stormwater Managers Association

National Emergency Management Association

Technical Advisory Committee for Coastal Construction and Environmental Issues (TACCCEI)

Unified Hazard Mitigation Assistance National Peer Review Panel

Unified Hazard Mitigation Assistance Summit

Section 4 State Risk Assessment

The Commonwealth of Massachusetts state risk assessment characterizes and analyzes natural hazards, risks, and vulnerabilities. This statewide overview compares potential losses by jurisdiction as well as potential losses of state facilities. This analysis allows the state to determine its priorities for implementing mitigation measures.

The state risk assessment includes

- An overview of the type and location of all natural hazards, including historical occurrences and probability of future occurrence
- An overview and analysis of the state's vulnerability to the hazards identified by jurisdiction
- An overview and analysis of the vulnerability of state facilities to the hazards identified
- An estimate of potential losses by jurisdiction and to state-owned facilities

4.1 Identifying and Profiling Natural Hazards

A hazard is an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing[4]. Natural hazards can exist with or without the presence of people and land development. However, hazards can be exacerbated by societal behavior and practice, such as building in a floodplain, along a sea cliff, or on an earthquake fault. Natural disasters are inevitable, but the impacts of natural hazards can, at a minimum, be mitigated or, in some instances, prevented entirely.

The purpose of the following section is to describe each hazard, which affects the state, the likely location of natural hazard impact, the severity of the impact, previous occurrences, and the probability of future hazard events are also included. For this update, extensive GIS data derived from state, regional, and local sources were utilized. Data sets from all FEMA approved local and multi-jurisdictional multi-hazard mitigation plans were incorporated with existing statewide data sets, when available. In addition to geographic data, information for this update was compiled by the SHMT from several federal sources on the most up to date and accurate information available. Additional information is available in the appendices of this plan.

[4] FEMA www.fema.gov

To fulfill the planning guidelines outlined in the Disaster Mitigation Act of 2000, this State Hazard Mitigation Plan focuses on the risk assessment, analysis, and recommendations for natural hazards mitigation however non-natural (man-made) hazards are identified and profiled to remain consistent and to allow for coordination with all other emergency plans and agencies in the Commonwealth.

Hazard identification is the process of identifying hazards that threaten a given area. New to the 2010 update of the Massachusetts State Hazard Mitigation Plan's risk assessment, natural hazards have been grouped in the following categories:

Flood Related Hazards – heavy rain, snow melt, dam failure, ice jams

Coastal Related Hazards - storms, erosion, sea level rise, sediments

Atmospheric Related and Winter Related Hazards – high winds, hurricanes, tornados, nor'easters, severe thunderstorms, heavy snow, ice storms, and blizzard

Other Natural Hazards – major urban fires, wildland fire, drought, and extreme temperatures

Geologic Hazards – earthquakes, landslides, and tsunami

Non-natural Hazards[5] – Pandemics, Chemical/Hazardous Materials, Transportation accidents, Nuclear, Invasive Species, Infrastructure Failure, Terrorism, and Commodity Shortages

This grouping is based on data collected for previous versions of the Massachusetts State Hazard Mitigation Plan, statewide risk assessment in 2004 and 2007, and the collaboration of existing MEMA and DCR Plans. The SHMT used the best available data for the risk assessment of this plan. Data limitations included, Digital Flood Insurance Rate Maps, DCAM facility database, hazard data, and local critical facilities. The data collection for this plan was from 2009 through January 2010.

[5] Please note this Plan does not intend to analyze the Commonwealth of Massachusetts' vulnerability or estimate losses from non-natural hazards. Non-natural hazards are presented in the identification and profile sections of this plan to provide consistency among plans and integrate terms, ideas, and process to improve the overall risk reduction in Massachusetts.

Flood Related Hazards

Flooding can be defined as a rising and overflowing of a body of water onto normally dry land. Floods can be slow or fast rising but generally develop over a period of days. Flooding often coincides with spring snow melt and can be a direct result of other frequent weather events in Massachusetts such as nor'easters, heavy rainstorms, tropical storms, and hurricanes. Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss – 75% of federal disaster declarations are related to flooding. Property damage from flooding totals over $5 billion in the United States each year. The following section includes brief descriptions of the various types of flood-related hazards most likely to affect Massachusetts.

INLAND OR RIVERINE FLOODING

Riverine or inland flooding often occurs after heavy rain and snowmelt. Riverine areas can endure overflow from river channels, flash floods, ice-jams, and dam-breaks.

In certain times of year or under specific conditions, high percentage of impervious surfaces and high groundwater levels does not allow heavy rain to be absorbed back into the ground. Basement, roadway, and infrastructure flooding can result in significant damages due to poor or insufficient storm water drainage. This not only causes flooding but also prevents groundwater recharge and can threaten water quality, which can affect public drinking water supplies.

FLOODPLAIN

By their very nature, floodplains are the low, flat, periodically flooded lands adjacent to rivers, lakes, and oceans and subject to geomorphic (land-shaping) and hydrologic (water flow) processes. It is only during and after major flood events that the connections between a river and its floodplain become more apparent. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood storage and erosion control. In addition, the floodplain represents a natural filtering system, with water percolating back into the ground and replenishing groundwater. When a river is separated from its floodplain with levees and other flood control facilities, then natural, built-in benefits are either lost, altered, or significantly reduced.

THE 100 YEAR FLOOD

The term "100-year flood" is misleading. It is not the flood that will occur once every 100 years. Rather, it is the flood that has a one percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood, which is the standard used by most federal and state agencies, is

used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance. A structure located within a Special Flood Hazard Area (SFHA) shown on an NFIP map has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage.

FEMA produces *Flood Insurance Rate Map*s, commonly known as FIRMS, to support the National Flood Insurance Program. The FIRMs depict *Special Flood Hazard Area*s, the areas subject to inundation from the 1% annual chance flood (also known as the Base Flood or the 100-Year Flood). Due to a lack of funding and resources in recent years, the average effective FIRM in Massachusetts has increased to over 20 years old. Updates to the FIRMs are needed for a number of reasons, including outdated base mapping, development in watersheds, advancements in flood modeling, and improvements to mapping procedures and methodologies, among other factors. FEMA is currently involved in an effort to "modernize" and update their FIRM inventory nationwide. The modernized FIRMs will be known as Digital FIRMs, or DFIRMS. They will include an updated orthophoto base map and a digital database for use in a GIS. The Commonwealth has partnered with FEMA to assist in the management and coordination of the flood map modernization effort in Massachusetts. As part of this partnership, the Commonwealth maintains a RiskMAPBusiness Plan, that outlines mapping needs and proposes sequencing for future mapping projects.

Zones A1-30 and AE: Special Flood Hazard Areas that are subject to inundation by the base flood, determined using detailed hydraulic analysis. Base Flood Elevations are shown within these zones.

Zone A (Also known as Unnumbered A Zones): Special Flood Hazard Areas where, because detailed hydraulic analyses have not been performed, no Base Flood Elevations or depths are shown.

Zone AO: Special Flood Hazard Areas that are subject to inundation by types of shallow flooding where average depths are between 1 and 3 feet. These are normally areas prone to shallow sheet flow flooding on sloping terrain.

Zone VE, V1-30: Special Flood Hazard Areas along coasts that are subject to inundation by the base flood with additional hazards due to waves with heights of 3 feet or greater. Base Flood Elevations derived from detailed hydraulic analysis are shown within these zones.

Zone B and X (shaded): Zones where the land elevation as been determined to be above the Base Flood Elevation, but below the 500 year flood elevation. These zones are not Special Flood Hazard Areas.

Zones C and X (unshaded): Zones where the land elevation has been determined to be above both the Base Flood Elevation and the 500 year flood elevation. These zones are not Special Flood Hazard Areas.

Location of the Hazards

Flooding in Massachusetts is often the direct result of frequent weather events such as coastal storms, nor'easters, heavy rains, tropical storms, and hurricanes.

Riverine, or inland flooding, affects the majority of communities in the Commonwealth. Massachusetts encompasses 27 watershed areas; the largest watershed completely contained with in the state is the Chicopee River Watershed, which covers more than 720 square miles including the largest public water supply reservoir in the Commonwealth.

Massachusetts is exposed to coastal flooding along its 1,500 miles of coastline. For the past thirty years, the population of the Massachusetts coastal zone has continued to grow proportional to the Commonwealth's population with about one third of the state's population living on the coast, about 2.1 million people.

Stormwater flooding can occur in every community, and unfortunately, since many of the urban areas have aging infrastructure, poor or insufficient storm water drainage is a common occurrence subsequent to rain events. The annual rainfall average from 1970 – 2005, was approximately 48 inches. This problem is exacerbated by increasing development which results in a loss of pervious surfaces. (www.noaa.gov,2006)

Previous Occurrences

In the past 50 years there have been more than ten major flood events in Massachusetts, see table #. Middlesex and Essex Counties have had the highest number of declared flood events.

Hurricane Diane and Flood	August 1955
Hurricane Gloria	September 1985
Hurricane Bob	August 1991
Nor'easter	October 1991
Nor'easter	December 1992
Floods	October 1996
Floods	June 1998
Winter Storm & Floods	March 2001
Floods	April 2004
Floods	October 2005
Mother's Day Floods	May 2006
Nor'easter	April 2007

Table 2: Flood events.

Some areas of the state are more flood prone and experience nearly annual minor flooding. The last major flood event was the Patriot's Day Nor'easter, April 2007. This storm system

caused inland and coastal flooding severe enough to trigger a presidential disaster declaration FEMA-1701-DR-MA.

National Flood Insurance Claims

There are currently 335 communities participating in the National Flood Insurance Program in Massachusetts. Homeowners and businesses have made about 26,800 claims totaling more than to $281 million dollars over the past three decades for flood related damages. The average claim paid from 1978-2008 is about $6,800. The year with the highest claim amounts was 2006, when that years average claim amount was in excess of $24,000. Coastal communities tend to have much higher individual claim amounts, numbers of claims, and repetitive claims.

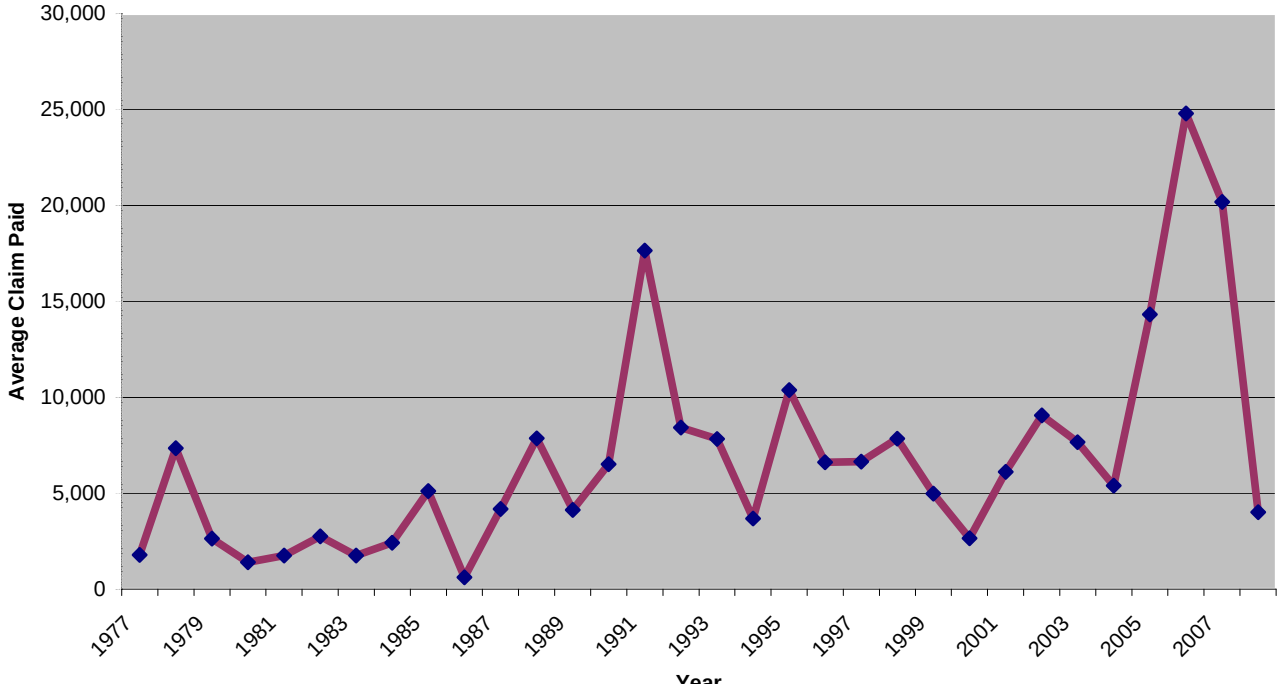


Figure 1. NFIP Average insurance claim amount paid to insured between 1977-2008.

DAM FAILURE

A "dam" is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water.

Dam failure can be defined as a catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water or the likelihood of such an uncontrolled release. Dams can fail for one or a combination of the following reasons:

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

- ❖ Inadequate maintenance and upkeep.

There are more than 2,800 public and privately-owned dams across Massachusetts. As infrastructure ages and maintenance and inspection costs increase, there is good reason to believe that there may be an increased risk for dam breaches or partial breaches.

Location of Hazard

The Massachusetts Office of Dam Safety, located within the Department of Conservation and Recreation (DCR), maintains a database of all the publicly and privately owned dams in the Commonwealth. This information includes all the high hazards dams currently listed the National Dam Inventory which is has been developed as part of the National Dam Safety Program under the U.S. Army Corps of Engineers (per Public Law 92-367). According to the Office of Dam Safety there are 2888 dams located throughout the Commonwealth of Massachusetts. There are lesser numbers in Barnstable, Dukes and Nantucket Counties. A 1999 study of USACE and FEMA data, of the counties 3043 counties, Worcester County, has the greatest number of dams, 425 in the United States[6].

The following represents the break down of dam hazard class by ownership type.

	Hazard Potential Classification		
Ownership	**High**	**Significant**	**Low**
Private	56	317	288
Non-Profit	7	18	14
Municipal	185	306	156
State	56	118	89
Federal Energy Regulatory Commission	15	26	16
US Government	12	2	0

Table 3 Massachusetts Dams by classification and ownership.

High Hazard Potential dam refers to dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).

Significant Hazard Potential dam refers to dams located where failure 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.

[6] Graf, William L. *Dam nation: A geographic census of American dams and their large-scale hydrologic impacts*. Water Resources Research, Vol. 35, No. 4, Pages 1305–1311, April 1999

Low Hazard Potential dam refers to dams located where failure may cause minimal property damage to others. Loss of life is not expected.
A map of dam locations of high and significant hazard dams is located in appendix 4 & 5. This map depicts shaded points to represent each dam location. The location of low hazard dams is not included.

Previous Occurrence

There is not reliable or consistent information collected on complete dam failures that would be pertinent to this analysis at this time, however, several noteworthy events have influenced the analysis for this section.

Whittenton Pond Dam, Taunton, an aged timber crib structure, was excessively stressed. Around 11.5 inches of rain fell across the Mill River watershed during October 2005. Most of this rain fell within a 6 hour time period. This resulted in the threat of an imminent catastrophic failure of the dam. A dam expert team decided construction of a rock dam/spillway downstream of the aged dam should occur, with a subsequent disassembly of Whittenton Pond Dam. Days later the new spillway was completed, just prior to another significant rainfall episode. The dam did not breach and no one in Taunton was harmed during this incident.

Forge Pond Dam, Freetown, is an earth filled dam more than 200 years old. In February 2010, heavy rains caused the dam to overtop and become unsafe. The DCR Office of Dam Safety determined that the dam posed a serious threat to public safety. Emergency actions were taken to stabilize the privately owned dam and no major damage occurred.

ICE JAMS

Ice jams occur in the winter or early spring when normally flowing water begins to freeze. There are two types of ice jams; a freeze up and a breakup jam. A freeze up jam forms in the winter as ice formation begins. This type of jam can act as a dam and begin to back up the flowing water behind it. The second type, a break up jam forms as a result of the breakup of ice cover, causing large pieces of ice to move downstream potentially acting as a dam, blocking water flow in culverts and around bridge abutments.

Location of Hazard

Ice jams can occur across the entire northern United States on rivers and lakes of all sizes. Historically, Farmington River-West Branch, Marsh Brook, Millers River, Quaboag River, and Westfield River-Middle Branch have had the greatest risk of ice jamming. Very little information was available for the older jams. Most of the rivers where the jams occurred are in the western half of the state. A map of all of the Ice Jams in Massachusetts between 1934 and 2009 is in appendix 4.

Previous Occurrence

There have been 219 reported ice jams in Massachusetts over the last 100 years[7]. According to CRREL's database, North Central Massachusetts averages at least one ice jam per year for almost the last decade. Only Buck River, Millers River, Nashua River, Westfield River, and Westfield River-Middle Branch have seen jams since 1990. The two most recent occurrences were on the Miller's River in February of 2008. One was about 1500 feet long, with the downstream edge 1-2 feet thick. The second, was a freeze up jam with accumulation located upstream of the Athol Wastewater Treatment Plant, continuing to about 1000 ft upstream of Main Street bridge. The water was flowing freely, carrying small chunks of ice down to the jam.

Coastal Hazards

Erosion and flooding are the primary coastal hazards that lead to the loss of lives or damage to property and infrastructure in developed coastal areas. Coastal storms are an intricate combination of events that impact a coastal area. A coastal storm can occur any time of the year and at varying levels of severity. One of the greatest threats from a coastal storm is coastal flooding due to storm surge. This is the inundation of land areas along the oceanic coast and estuarine shoreline by seawaters over and above normal tidal action. High winds, erosion, heavy surf, unsafe tidal conditions, and fog are ordinary coastal hazard phenomena. Some or all of these processes can occur during a coastal storm, resulting in an often detrimental impact on the surrounding coastline. Storms including northeasters and hurricanes, decreased sediment supplies, and sea-level rise contribute to these coastal hazards.

HURRICANES AND NOR'EASTERS

Hurricanes and Nor'easters are two storm types that impacts the coast and coastal resources. For this report Hurricanes and Nor'easters are identified and analyzed as an atmospheric and winter related hazard.

A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain. Frequently, Nor'easters are a coastal event for Massachusetts.

Hurricanes are relatively fast moving, rarely impacting the coast over multiple tidal cycles. When landfall is made, these concentrated, strong low-pressure systems usually pound

[7] The information on past ice jam locations in Massachusetts can be found at the U.S. Army Corp of Engineers Cold Region Research and Engineering Laboratory (CRREL) database. The Ice Jam Database can be found at CRREL's website at: http://www.crrel.usace.army.mil/

south facing shores with high winds, precipitation, and storm surge. A Category 2 storm can cause millions of dollars in damage.

Characteristics or impacts of coastal storms

	Nor'easters	Hurricanes
Similarities		
	Economic Impacts Winds Surge and Wave Action Inland Flooding potentials	
Differences		
Duration	Lasting days on average	Lasting only hours
Season	October-May	August-October
Evacuations	Fewer coastal area evacuations, off season	Very populated coastal areas
Debris impacts	Less foliage	Full foliage

Table 4: This table outline some of the similarities and differences in Nor'easters and Hurricanes

DECREASED SEDIMENT SUPPLIES

Coastal landforms such as coastal banks are essential to maintaining a supply of sediment to beaches and dunes. Where engineered structures are used to stabilize shorelines, the natural process of erosion is interrupted, decreasing the amount of sediment available and causing erosion to adjacent areas. Under conditions of reduced sediment, the ability of coastal resource areas such as dunes and beaches to provide storm damage prevention and flood control benefits is continually reduced. A major challenge is to ensure that regional sediment supplies are managed effectively and in ways that allow the beneficial storm damage prevention and flood control functions of natural coastal processes to continue—both for future projects and, where possible, existing coastal development.

SEA-LEVEL RISE

Climate change and sea-level rise are persistent contributors to coastal land loss in the Northeast. Increased volumes of water in the oceans due to thermal expansion of water as it warms and the addition of fresh water from melting ice sheets and glaciers result in the rise of sea surface levels. Records of tide gauges around Boston, Woods Hole, and Nantucket indicate that our relative sea level (the combination of a rising water surface with land subsidence) has risen approximately 10 inches over the past 100 years. The Intergovernmental Panel on Climate Change (IPCC) predicts that sea-level rise and its risk to coastal resources will accelerate over the next 100 years (IPCC, 2007). Conservative projections of sea-level rise by the end of the century range from 4 to 21 inches, while

projections given a higher emissions scenario range from 8 to 33 inches.[8] Also, important to note, there is a strong consensus among coastal experts that the IPCC projections for sea-level rise are even too conservative. As new research emerges projects of 20 to 55 inches of sea level rise are estimated by 2100.[9] With an accelerated rate of sea-level rise, low-lying coastal areas will be particularly vulnerable to increased erosion, flooding, and inundation. In addition, these impacts will extend further inland, resulting in greater loss of land and damage to development along the coast of Massachusetts. Localized land subsidence is also a contributor of sea level rise. The combination of rising sea levels, more frequent and intense storms, and increased coastal development will result in greater erosion and flooding impacts over time

COASTAL EROSION & SHORELINE CHANGE

Coastal shorelines change constantly in response to wind, waves, tides, sea level fluctuation, seasonal and climatic variations, human alteration, and other factors that influence the movement of sand and material within a shoreline system. The loss (erosion) and gain (accretion) of coastal land is a visible result of the way shorelines are reshaped in the face of these dynamic conditions. Shorelines tend to change seasonally, accreting slowly during the summer months when sediments are deposited by relatively low energy waves and eroding dramatically during the winter when sediments are moved offshore by high-energy storm waves, such as those generated by nor'easters. Regardless of the season, coastal storms typically cause erosion. With the anticipated change in climate an increase in intensity and frequency of storms is expected. This will, in turn, increase the likelihood of severe erosion episodes along the coast of Massachusetts.

Coastal erosion and shoreline change can result in significant economic loss through the destruction of buildings, roads, infrastructure, natural resources, and wildlife habitats. Damage often results from the combination of an episodic event with severe storm waves and dune or bluff erosion

Some of the methods used by property owners to stop, or slow down, coastal erosion or shoreline change can actually exacerbate the problem. Attempting to halt the natural process of erosion with seawalls and other hard structures typically worsens the erosion in front of the structure, prevents any sediment behind the structure from supplying down drift properties with sediment and subjects down drift beaches to increased erosion. Without the sediment transport associated with erosion, some of the Commonwealth's greatest assets and attractions – beaches, dunes, barrier beaches, salt marshes, and estuaries – are threatened and will slowly disappear as the sediment sources that feed and sustain them are eliminated.

[8] Union of Concerned Scientists, 2006.

[9] Rahmstrof, S. 2007.

The Massachusetts Office Coastal Zone Management (CZM) has been collecting new data and studying and monitoring shoreline change. Additional information on shoreline change may be found in CZM's Fact Sheet on New Data on Shoreline Change in Appendix 10 or online at http://www.mass.gov/czm/hazards/index.htm or http://www.mass.gov/czm/coastguide/online/index.htm

Location of the Hazard

Massachusetts and its 78 coastal communities are vulnerable to the damaging impacts of major storms, such as nor'easters and hurricanes, along more than 1,500 miles of varied coastline. As development and re-development increases, less-intense storms that occur more regularly and sea-level rise will also lead to costly storm damage. The Massachusetts coastal zone extends from the three-mile limit of the state territorial sea to 100 feet beyond the first major land transportation route encountered (a road, highway, rail line, etc.). For planning and technical assistance coordination the coastal communities are split among 5 Coastal Regions; North Shore, Boston Harbor, South Shore, South Coastal, and Cape Cod and Islands. Each area of the coast is impacted differently by each type of coastal hazard and has varying vulnerability.

North Shore

Following the coastline from Salisbury to Revere, industrial activity is moderate in comparison to other portions of the coast. The Merrimack River carries industrial effluent, including treated sewage and industrial process water, to the ocean waters of this region. Merrimack River, Cape Ann, and Salem Sound areas are homeport to significant fleets of fishing and tourism vessels, and the Annisquam River is also heavily used for tourism and recreational fishing purposes. The waters between Nahant and Manchester and between Gloucester and Rockport are the two most productively fished areas in the region, making up a large percentage of the total state lobster catch. Great Marsh is a major recreational destination. North of Cape Ann is characterized by public beaches of regional and national significance.

Boston Harbor/Massachusetts Bay

Covering the coastal communities from Winthrop to Weymouth, inclusive of the City of Boston. The Massachusetts Water Resources Authority (MWRA) treatment plant treats sewage from metropolitan Boston communities and releases treated effluent nine miles offshore. The Stellwagen Bank National Marine Sanctuary, which is eastward of the state ocean waters of this region, is a highly productive area of nutrient upwelling that provides abundant food for a variety of species of fish, marine mammals, and sea birds, including the endangered humpback and northern right whales.

Industrial Activity and Shipping is heavy in this region. The Port of Boston is a maritime industrial hub for New England, and has direct calls by large container vessels from Europe and the Far East, and 14 million tons of bulk cargo enters its waters each year. In 2002, 250,000 cruise passengers and more than 100,000 automobiles came across its docks. The Port of Boston is estimated to have an $8 billion impact on the economy, producing more than 9,000 direct jobs. The Conley container terminal, the complex of uses on the Mystic River, Logan Airport, and Chelsea Creek are major industrial features. The Weymouth Back River with its gas pipeline and ships carrying petroleum products are areas of localized industrial activity and a natural gas pipeline (the Hubline) extends from Weymouth to Salem, and two offshore liquefied natural gas ports have pipelines that connect to the Hubline east of Marblehead. Recreational boating is significant throughout Massachusetts Bay. Major destinations include Stellwagen Bank for fishing and whale watching and the Boston Harbor Islands for boating, hiking, fishing, and diving.

South Shore

Extending from Hingham to Plymouth. The South Shore coastline is predominantly sand and cobble. Erosion is an issue, particularly on these beaches and coastal banks. A large portion of Cape Cod Bay is designated critical habitat for northern right whales, which typically inhabit the waters during winter and early spring, although individual whales may periodically stay on later in the year. There are relatively few industrial uses on the South Shore and in Cape Cod Bay. The water-cooled Pilgrim Nuclear Power Station in Plymouth is the only major industrial facility in the region. Small commercial boating, including fishing operations, whale watching, sightseeing, and commuter ferry service out of Hingham, are major uses in this region.

Cape Cod and Islands

This region covers Cape Cod Bay from Bourne to Provincetown, Martha's Vineyard, and Nantucket. Cape Cod and the Islands are characterized by sandy barrier beaches backed by coastal dunes and banks along much of the coast. There are thousands of acres of salt marsh, and the area is significant to several endangered species of birds and vegetation. Cape Cod Bay is critical habitat for the endangered northern right whale. Other species of whales, marine mammals, and turtles also inhabit the Bay. The water quality is generally good and locally excellent (e.g., Wellfleet Harbor is designated as a body of outstanding Resource Water.) The industrial uses of the area are primarily related to fuel transport and storage. There are tank facilities located in Vineyard Haven, Gosnold, and Nantucket. Fuel is transported by barge to these facilities in significant quantities. There are also industrial transport activities associated with the year-round ferry service to the islands from Hyannis and Woods Hole. Woods Hole also supports a fleet of deep sea research vessels and fisheries vessels operated by the National Oceanic and Atmospheric Administration and National Marine Fisheries Service. Commercial fishing takes place with various fleet sizes

in many of the harbors across the Cape and the Islands. The entire region is largely dependent on tourism.

South Coast

Covering the coastal communities westward of Cape Cod includes all of Buzzards Bay. Buzzards Bay is a relatively shallow estuary and it receives relatively warm waters from the south through the Gulf Stream. It is home to some of the richest shellfish resources in the Commonwealth. Buzzards Bay provides vital habitat for endangered and rare species, including piping plovers, leatherback turtles, diamondback terrapins, and more than half of the North American population of the endangered roseate tern. The industrial ports of New Bedford and Fall River are significant economic engines for the region. Focusing on New Bedford, the port is predominated by approximately 400 large fishing vessels, but also receives cargo ships and, increasingly, cruise vessels. New Bedford is also home to a large and vibrant fish processing center that not only processes catch landed locally, but also large quantities of fish from around the globe brought in by freighter and airplane. In addition, there are significant large boat repair operations within the harbor.

Buzzards Bay is the center of extensive shipping activity, serving as the southern funnel to the Cape Cod Canal, through which pass vast quantities of petroleum and cargo bound for Boston and other ports farther north. It is estimated that approximately 2 billion gallons of petroleum products pass through Buzzards Bay each year. Since 2000, New Bedford has been ranked the highest dollar-value fishing port in the nation, with the annual fish landings valued at more than $268 million in 2007.

Pervious Occurrence

Additional information of hurricane and nor'easters can be found in the Atmospheric and Winter Related Hazards Section of this plan.

Coastal Storms

In 1991, two of the most significant coastal storms hit Massachusetts, Hurricane Bob and the October nor'easter. Damages caused by these events are a combined total of $49 million in damage to uninsured property and infrastructure in addition to the nearly $125 million paid out by the National Flood Insurance Program (NFIP) in flood insurance claims. The December 1992 coastal storm caused more than $12.6 million in damages to the public infrastructure (roads, bridges, public facilities, public utilities, etc), which resulted in 1,874 NFIP claims in Massachusetts at a cost of nearly $12.7 million.

Hurricanes and Nor'easters have varied impact on the coast dependant on a number of variables. There are three gauge stations, Boston, Woods Hole, and Nantucket, measuring tide and surge in Massachusetts. Each gauge has a varied recording history, Boston dates back to 1922, Woods Hole 1933, and Nantucket only to 1965, however the information

provides relevant comparisons. An analysis was conducted to rank the top, or highest, tides for each gauge.

High Tides at Massachusetts Gauges

Boston			Woods Hole			Nantucket		
Year	Month	Highest Tides	Year	Month	Highest Tides	Year	Month	Highest Tides
1978	2	15.1	1938	9	10.79	1991	10	7.87
1987	1	14.2	1954	8	10.19	1992	12	6.67
1991	10	14.14	1944	9	7.09	1987	1	6.34
1979	1	14.04	1991	8	6.86	2005	1	6.2
1992	12	14.02	1960	9	5.69	1978	2	6.13
1959	12	13.98	1972	2	5.39	2001	3	6.11
1972	2	13.89	1963	11	5.29	2007	11	6.11
2007	4	13.79	1974	12	5.27	2005	5	5.88
2005	5	13.78	1978	2	5.24	1995	12	5.81
1967	5	13.68	1987	1	5.22	1979	1	5.79
1940	4	13.58	1978	1	5.2	2002	11	5.75
2006	1	13.57	1997	1	5.06	2003	1	5.71
1961	1	13.56	1991	10	5.02	1993	12	5.68
1931	3	13.48	1979	1	4.99	1973	3	5.63
1944	11	13.48	1992	12	4.95	1967	4	5.6
2002	11	13.45	2007	4	4.83	1972	2	5.6
1976	3	13.41	1972	11	4.79	2006	1	5.59
1978	1	13.4	2005	12	4.79	1997	1	5.58
2003	1	13.4	2006	10	4.7	1998	1	5.58
1995	12	13.34	1944	11	4.69	2002	1	5.51
1956	3	13.28	1953	11	4.69	1968	11	5.5
1997	1	13.27	1968	11	4.69	1998	2	5.47
1979	2	13.2	1966	12	4.59	1993	3	5.45
1958	4	13.17	1985	9	4.57	1972	12	5.44
1962	3	13.16	1986	12	4.51	1997	4	5.43
1974	12	13.14	1983	11	4.5	2007	4	5.43
2005	2	13.13	2001	3	4.5	1996	1	5.38
1972	12	13.09	1954	9	4.49	2003	12	5.37
1973	4	13.09	1960	2	4.49	2006	2	5.34
2009	1	13.03	1976	2	4.48	1986	12	5.31

Table 5 Shows the top thirty highest tides for each gauge.

This data reveals eight of the highest tides occurred at all three gauges; February 1978, January 1987, October 1991, January 1979, December 1992, February 1972, April 2007, and January 1997. These storms are all highlighted in red on the table. In addition to these, the Boston and Woods Hole gauges share November 1944, January 1978, and December 1974, which are highlighted in blue. The Boston and Nantucket gauges share May 2005, January 2006, November 2002, March 1976, January 2003, December 1995, and April 1972, highlighted in orange. The Woods Hole gauge and the Nantucket gauge share one additional monthly high tide, March 2001 this is highlighted in grey.

The top tides shared by all three gauges, occurred during wintertime (October-May) northeast storms. The Woods Hole gauge's top five storms are hurricanes occurring in August and September and did not typically generate top tides in Boston or Nantucket.

Erosion

Approximately 75 percent of the U.S. ocean shoreline is eroding. Massachusetts' ocean-facing shore is no exception. A study of shoreline change in Massachusetts by the U.S. Geological Survey, Woods Hole Oceanographic Institution Sea Grant Program, and Cape Cod Cooperative Extension reveals that approximately 68 percent, or 513 miles, of Massachusetts' ocean-facing shore exhibits a long-term erosion trend, 30 percent, or 226 miles, shows long-term accretion, and two percent, or 15 miles, shows no net change.

For the entire ocean-facing Massachusetts shore, for the mid-1800's to 1994 the long-term average annual shoreline change rate ranges between -0.58 and 0.75 feet per year. Approximately 46 percent of the Massachusetts shore is eroding at one foot or less per year, while 22 percent of the shore is accreting at one foot or less per year. Eighty-one percent of the shore fluctuates +/-2 feet per year. Based on other studies (Pilkey & Thieler, 1992), 75 percent of the U.S. ocean shore is eroding, with the U.S. East Coast eroding at an average rate of 2-3 feet per year (Leatherman, 1993). Thus, Massachusetts' average annual shoreline change rate is lower than the East Coast average. That statistic is of little comfort for shorefront property owners in the Commonwealth, where rates of shoreline change vary considerably along the shore with some areas eroding between 7-10 feet per year, and higher.

Long-term rates of shoreline change calculated for each of the 15 Cape Cod communities and the islands of Martha's Vineyard and Nantucket reflect this shoreline change variability. It is important to note that rates also vary considerably within communities.

The highest rates of erosion and the longer expanses of eroding shoreline within a community are generally located along high-wave energy, open-ocean shores. For example, the Eastham shore exhibits the highest number of eroding shore perpendicular transects at 98 percent (2 percent accreting), followed by Truro at 83 percent eroding, (16 percent accreting), and Wellfleet at 81 percent eroding, (18 percent accreting). These communities are exposed to both predominant wind and waves from the northeast and prevailing winds and waves from the west. Other communities have less severe erosion problems, such as Falmouth at 67 percent eroding (29 percent accreting) and Mashpee at 69 percent eroding (30 percent accreting), due to the sheltering effects from ocean storm waves by the islands of Martha's Vineyard and Nantucket.

Only three Cape Cod communities have a greater number of accreting transect locations than eroding transects, including Harwich at 63 percent accreting (36 percent eroding),

which is protected from ocean storm waves by Monomoy Island. Also Provincetown at 62 percent accreting (37 percent eroding), which receives a large volume of sand from the eroding Cape Cod National Seashore bluffs.

A number of factors determine whether a community exhibits greater long-term erosion or accretion:

- exposure to high-energy storm waves,
- sediment size and composition of eroding coastal landforms feeding adjacent beaches,
- near-shore bathymetric variations which direct wave approach,
- alongshore variations in wave energy and sediment transport rates,
- relative sea level rise, and
- human interference with sediment supply (e.g. revetments, seawalls, jetties).

Challenges in Interpreting Shoreline Change Data

When reading long-term shoreline change rates; always analyze the short-term data that were used to calculate the long-term shoreline change rate. If short-term trend reversals in shoreline change have occurred (accretion to erosion or vice versa), it may be more appropriate to use the most recent short-term shoreline change rate than the long-term rate for siting a structure or for planning purposes.

For example, transects along the Codfish Park area of Nantucket's eastern shore show a long-term accretion rate of approximately +1.5 feet per year. However, the shoreline has been eroding since the 1950s, and erosion has accelerated since 1978 to 7-10 feet per year (Figure 1, above). The long period of accretion that took place from the mid-1800s to the 1950s biases the long-term rate, making the data suggest that the area is stable or accreting. The trend reversal and continuing erosion since the 1950s, however, illustrates the importance of analyzing short-term data and its potential utility in determining present-day construction setbacks and for planning purposes.

The widespread construction of coastal engineering structures, such as revetments, seawalls, jetties and groins -- particularly since the 1940s and 1950s -- has also affected shoreline change rates. In many areas, these coastal engineering structures have contributed to a trend reversal or accelerated down drift erosion rates, and therefore their effects must be factored into analyzing long-term shoreline rates. The northern area of Humarock Beach in Scituate is a case in point, where erosion rates have accelerated in recent years due to both natural and human effects. The shoreline area east of Sandwich Harbor in Sandwich shows erosion has accelerated due, in part, to the effects of jetties.

Human activity, however, is not the sole reason for trend reversals and shoreline changes. In some areas, such as the southeastern shore of Nantucket, natural processes are

responsible for large trend reversals (accretion to erosion back to accretion to erosion) over the 150-year study period. In this area, the data reveal that the shoreline has fluctuated between 50 to 100 feet of both erosion and accretion resulting in a long-term average suggesting stability. The shoreline is, however, exceptionally variable.

Coastal storm frequency caveats

Storms are often categorized by return frequencies (e.g. this was a 100 year storm, etc.). There are several shortcomings related to trying to categorize storms by return frequencies. First, the historical record of storms is relatively short to accurately assess the true long-term frequency of long period events. Most records only go back about 100 years. It is a little like sampling 20 ocean waves and making a conclusion of the full range of wave amplitudes in that part of the ocean. Second, when it comes to coastal flood impacts, it's not a level playing field. Sea level rise changes the vulnerability such that storms of say an average 100-year frequency will occur considerably more often. And how well that can be quantified is dependent upon the accuracy of sea level rise predictions. Third, coastal flood impacts can vary significantly from one locality to another depending upon such factors as onshore wind component and incidence of wave activity to the coastline. For example, the February 1978 storm wrought greater destruction than any storm hence so far for the Massachusetts east coastal region as a whole, but one can find pockets where the October 1991 storm was worse. Fourth, a storm may have been a once in a hundred year storm for coastal flooding but a once in 10-year storm for wind or snowfall or rainfall, etc. Also, the impact of a storm can be compounded if it has multiple severe dimensions (e.g. major coastal flooding in addition to very heavy snow and extreme winds) or if it impacts such a large area that mutual aid cannot be exercised. Fifth, development along the coastline or in other vulnerable areas can significantly increase the impact of a storm. Thus, the same storm in 1950 might not have garnered as much attention then as it would now with the increased coastal development.

There is a lot of misunderstanding as to what is meant by the statement, a "100 year storm" or a return frequency of 100 years. This does not mean that one should expect such a storm or greater once every 100 years, although one might get an average of such over a 1,000 years or so if the climate regime was static, now known not to be a good assumption. A 100-year storm, to use that frequency as an example, perhaps should best be described as a 1% chance of occurring in any given year. There might be 2 or 3 such storms in one hundred year period and then no more for the next 200 or 300 years.

Atmospheric and Winter Related Hazards

Atmospheric hazards include events such as high winds, hurricanes and tropical storms, Tornados, nor'easters, and thunderstorms.

HIGH WINDS

Wind is air in motion relative to the surface of the earth. Winds sustained at 31 to 39 mph for at least 1 hour or any gusts 46 to 57 mph cause the NWS to issue a Wind Advisory. Winds 58 mph or higher would lead to the issuance of a High Wind Warning. [There is also a "Tropical Storm Wind Warning" and "Hurricane Wind Warning" issued for inland areas, but only when associated with a tropical cyclone.]

Effects from high winds can include downed trees and/or power lines and damage to roofs, windows, etc. High winds can cause scattered power outages. High winds are also a hazard for the boating, shipping, and aviation industry sectors.

Massachusetts is susceptible to high wind from several types of weather events: before and after frontal systems, hurricanes and tropical storms, severe thunderstorms (see Thunderstorms section below for information about downbursts) and Tornados, and Nor'easters.

Sometimes, wind gusts of only 40 to 45 mph can cause scattered power outages from trees and wires being downed. This is especially true after periods of prolonged drought… or excessive rainfall, since both are situations which can weaken the root systems and make them more susceptible to the winds' effects. Winds measuring less than 30 mph are not considered to be hazardous under most circumstances.

Location of the Hazard

The entire commonwealth is vulnerable to high winds that can cause a wide range of damage. However, the coast is most frequently impacted by damage due to high wind events. The rest of this section provides more information on wind hazards, as wind is associated with other hazard events. The State Building Code has incorporated engineering standards for wind loads. Wind loads are for buildings and their components are to be designed to withstand the code-specified wind loads. Calculating wind loads is important in design of the wind force-resisting system, including structural members, components, and cladding, against shear, sliding, overturning, and uplift actions. The wind load zones for Massachusetts are shown on the Hurricane Tracks Map in Appendix 4.

HURRICANES AND TROPICAL STORMS

Hurricanes begin as tropical storms over the warm moist waters of the Atlantic, off the coast of West Africa, and Pacific Oceans near the equator. As the moisture evaporates, it rises until enormous amounts of heated, moist air are twisted high in the atmosphere. The winds begin to circle counterclockwise north of the equator or clockwise south of the equator. The center of the hurricane is called the eye.

Tropical cyclones (Tropical Depressions, Tropical Storms, and Hurricanes) form over the warm, moist waters of the Atlantic, Caribbean, and Gulf of Mexico. When water

temperatures are at least 80° F, hurricanes can grow and thrive, generating enormous amounts of energy, which is released in the form of numerous thunderstorms, flooding rainfall, and, very damaging winds. The damaging winds help create a dangerous storm surge (rise in the water above the normal astronomical tide).

A Tropical Depression is declared when there is a low pressure center in the tropics with sustained winds of 25-33 mph. A Tropical Storm, which is given a name, is defined as having sustained winds from 34-73 mph. If sustained winds reach 74 mph or greater, it becomes a Hurricane. The Saffir-Simpson Scale ranks hurricanes based on sustained wind speeds…from Category 1 (74-95 mph) to Category 5 (156 mph or more). Category 3, 4, and 5 hurricanes are considered "Major" hurricanes. Hurricanes are categorized based on sustained winds; wind gusts associated with hurricanes may exceed the sustained winds and cause more severe localized damages.

Hurricanes can range from compact storms only 50 miles across, to huge storms, as much as 500 miles wide -- Hurricane Allen in 1980 took up the entire Gulf of Mexico. There generally are two source regions for the storms that have the potential to strike New England: 1) off the Cape Verde Islands near the west coast of Africa and 2) in the Bahamas. The Cape Verde storms tend to be very large in diameter, since they have a week or more to traverse the Atlantic Ocean and grow. Bahama storms tend to be smaller, but they can also be just as powerful…and their effects can reach New England in only a day or two.

The eye of a hurricane is a relatively calm center, where extremely low barometric pressure exists. The location of the eye is not that important for New Englanders because the average forward speed of the entire storm averages 33 mph at our latitude. So an eye that is 15 miles wide will only last for less than 30 minutes at any one location.

Because our tropical systems almost always come from a southerly direction and accelerate up the east coast of the U.S., most take on a distinct appearance that is different from the classic hurricanes. Instead of having a perfectly concentric storm with heavy rain blowing from one direction, then the calm eye, then the heavy rain blowing from the opposite direction, our storms (as viewed from satellite and radar) take on an almost winter storm-like appearance. To the south and east of the track of the storm, there often are only a few showers and in fact, the sky may be sunny. But, that's where the worst winds and storm surge are located. To the north and west of the track of the storm is where dangerous flooding rains most often occur. Another threat from a landfalling tropical system is isolated Tornados. These generally would occur in the outer bands to the north and east of the storm, a few hours to as much as 15 hours prior to landfall or near land events.

The official hurricane season runs from June 1 to November 30. However, from 1900-2009, there are no records of a landfalling hurricane in New England during the months of June

or July. August, September, and the first half of October are the most frequent occurrence for New England. That is because it takes a while for the waters south of Long Island to warm up enough to sustain the storms this far north. Also, as we head toward Fall, the upper level jet stream has more dips, which means that the steering winds might flow from the Great Lakes southward to the Gulf states and then back northward up the eastern seaboard. This pattern would be conducive for capturing a tropical system over the Bahamas and accelerating it northward.

A Hurricane Warning is issued by the National Weather Service when sustained winds 74 mph or higher associated with a hurricane are expected in a specified area in 24 hours or less. A Hurricane Watch is announced for specific areas where hurricane conditions are possible within 36 hours. One should always prepare for a storm that is one category higher than expected because the fast forward speed of the storm means that wind gusts will be much higher, especially to the east of the track. Preparations should be complete by the time the storm is at the latitude of North Carolina. Outer bands containing squalls with heavy showers and wind gusts to tropical storm force can occur as much as 12-14 hours in advance of the eye, which can cause coastal flooding and may cut off exposed coastal roadways. The 1938 hurricane raced from Cape Hatteras to the Connecticut coast in 8 hours.

Massachusetts is susceptible to hurricanes and tropical storms. Between 1851 and 2004, approximately 32 tropical storms; five Category 1 hurricanes, two Category 2 hurricanes and three Category 3 hurricanes have made landfall. To date, the Commonwealth has not experienced a Category 4 or 5 hurricane[10]. Aside from direct hits from hurricanes and tropical storms, the Commonwealth is often affected by their extra tropical remnants as these storms move up the coast and out into the Atlantic Ocean. A complete map of these hurricane tracks may be found in Appendix 4.

[10] www.nhc.noaa.gov

SAFFIR/SIMPSON HURRICANE SCALE

The Saffir/Simpson scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential, which are combined to estimate potential damage. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf in the landfall region. All winds are using the U.S. 1-minute average, meaning the highest wind that is sustained for 1-minute. The following Saffir/Simpson Scale gives an overview of the wind speeds and range of damage caused by different hurricane categories:

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

Table 6: Saffir/Simpson Scale. NOAA

SLOSH

The U.S. Army Corps of Engineers (USACE), New England Division in cooperation with the Federal Emergency Management Agency (FEMA), initially prepared Sea, Lake, and Overland Surge from Hurricanes (SLOSH) inundation maps. SLOSH maps represent potential flooding from "worst case" combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. It does not include riverine flooding caused by hurricane surge or inland freshwater flooding. The mapping was developed for the coastal communities in New England using the computer model (developed by the National Weather Service to forecast surges that occur from wind and pressure forces of hurricanes), Long Island Sound Bathymetry and New England coastline topography. In Massachusetts, hurricane category is the predominant factor in "worst case" hurricane surges. The resulting inundation areas are grouped into Category 1 and 2, Category 3, and Category 4 classifications. The hurricane category refers to the Saffir/Simpson Hurricane Intensity Scale.

USACE considered the highest wind speed for each category, the highest surge level, combined with worst case forward motion and developed a model to depict areas that would be inundated under those combined conditions for each category of storm, for New England only categories 1-3 were used. It should be noted that the model considers only storm surge height and does not consider the effects of waves.

For the purpose of the State Hazard Mitigation Plan, the updated SLOSH maps split eastern Massachusetts into several sections and overlays the SLOSH inundation zones over base layers provided by MassGIS. These maps have been developed for all Massachusetts' Coastal Counties. Maps may be found in Appendix 4.

Location of the Hazard

The entire state is vulnerable to hurricanes and tropical storms, dependent on the storm's track. The coastal areas are more susceptible to damage due to the combination of both high winds and tidal surge, as depicted on the SLOSH maps. See Appendix 4. Inland areas, especially those in floodplains, are also at risk for flooding, due to heavy rain, and wind damage. The majority of damage following hurricanes and tropical storms often results from residual wind damage and inland flooding, as was demonstrated during recent tropical storms.

Previous Occurrence

Since the destructive hurricane of 1938, five other major hurricanes have struck the Massachusetts coast in 1954, 1955, 1960, 1985, and 1991. The last hurricane to make landfall in New England was Hurricane Bob, a weak category 2 hurricane, in August 1991. A hurricane or Tropical Storm does not need to make landfall to necessarily cause major damage.

Based on past hurricane and tropical storm landfalls, the frequency of tropical systems to hit the Massachusetts coastline is an average of once out of every six years. Therefore, it is forecasted that, Massachusetts, and the rest of New England, is long overdue for a major hurricane.

Great New England Hurricane

The New England Hurricane of 1938 (or Great New England Hurricane or Long Island Express or simply The Great Hurricane of 1938) was the first major hurricane to strike New England since 1869. The storm formed near the coast of Africa in September of the 1938 Atlantic hurricane season, becoming a Category 5 hurricane on the Saffir-Simpson Hurricane Scale before making landfall as a Category 3 hurricane on Long Island on September 21. To date it remains the most powerful, costliest and deadliest hurricane in New England history.

Initially, the hurricane was forecast by the U.S. National Weather Service to curve out into the Atlantic Ocean. Because the official forecasts expected mere overcast conditions, residents were unaware of the impending storm. The cyclone made landfall on Long Island, New York on September 21, 1938 as a strong Category 3 hurricane on the present-day Saffir-Simpson Hurricane Scale with a central pressure of 946 mb. It then traveled

across Long Island Sound into Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and finally into Canada while moving at an unusually high speed.

The majority of the storm damage was from storm surge and wind. Damage is estimated at $6 billion (2004 USD), making it among the most costly hurricanes to strike the U.S. mainland. It is estimated that if an identical hurricane struck today it would cause $39.2 billion (2005 USD) in damage. Approximately 600 people died in the storm in New England, most in Rhode Island, and up to 100 people elsewhere in the path of the storm. An additional 708 people were reported injured. The hurricane also devastated the forests of the Northeast, knocking down an estimated 2 billion trees in New York and New England. The hurricane produced 18- to 25-foot tides from New London, CT east to Cape Cod in Massachusetts.

The eye of the storm followed the Connecticut River north into Massachusetts, where the winds and flooding killed 99 people. In Springfield, the river rose to 6 to 10 feet above flood stage, causing significant damage. Up to six inches of rain fell across western Massachusetts, which combined with over four inches that had fallen a few days earlier produced widespread flooding. Residents of Ware were stranded for days and relied on air-dropped food and medicine. After the flood receded, the town's Main Street was a chasm in which sewer pipes could be seen.

To the east, the surge left Falmouth and New Bedford under eight feet of water. Two-thirds of all the boats in New Bedford harbor sank. The Blue Hills Observatory registered sustained winds of 121 mph and a peak gust of 186 mph.

Tropical Storms

There have been no significant tropical storms to affect Massachusetts in several years. Tropical Storm Beryl passed over Nantucket, Massachusetts on July 21, 2006 with sustained winds estimated to be 45 knots or 51.8 MPH. Thereafter, the cyclone continued to accelerate northeastward. Beryl lost tropical characteristics shortly after reaching land and moved off the coast. In 2009 Tropical Storm Bill impacted the south-facing coast with very minor impacts.

For the locations of wind zones for hurricanes and tropical storms refer to Appendix 4.

THUNDERSTORMS

A thunderstorm is a storm with lightning and thunder, produced by a cumulonimbus cloud, usually producing gusty winds, heavy rain and sometimes hail. A thunderstorm is

classified as "severe" when it produces damaging wind gusts in excess of 58 mph (50 knots), a tornado, or hail that is ¾" in diameter or larger (penny size)[11].

Cumulonimbus clouds produce lightning, which locally heats the air to 50,000 degrees Celsius, which in turn produces an audible shock wave, known as thunder. Thunderstorms frequently produce heavy rain and gusty winds. Less frequently, they can produce hail, which can become very large…and can also spawn a tornado.

Three basic ingredients are required for a thunderstorm to form: moisture, rising unstable air (air that keeps rising when given a nudge), and a lifting mechanism to provide the "nudge."

The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise -- hills or mountains, or areas where warm/cold or wet/dry air bump together can cause rising motion -- it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool, releasing the heat; and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice, and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder.

An average thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. *Severe* thunderstorms can be much larger and last much longer. Southern New England typically experiences about 10-15 days per year in which there are *severe* thunderstorms.

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

[11] Beginning Jan. 1, 2010, the National Weather Service plans to change this long-standing definition to be 1" diameter hail or larger (quarter size).

Location of the Hazard

The entire state of Massachusetts is susceptible to thunderstorms and severe storms. There are so many frequent rainstorms and thunderstorms that a GIS analysis showed the entire state was completely covered with rainstorm events. Every community appeared to be equally susceptible to rainstorm events.

Previous Occurrence

There have been several damaging thunderstorms in Massachusetts. In June of 1998 a very slow moving and complex storm system moved through southeast New England. The combination of its slow movement and presence of tropical moisture across the region produced rainfall of 6 to 12 inches over much of eastern Massachusetts. This led to widespread urban, small stream, and river flooding. As a result, the counties of Suffolk, Essex, Middlesex, Norfolk and Bristol received a Presidential Disaster Declaration for the Individual Household Program (Individual Assistance) on June 23, 1998. The counties of Plymouth and Worcester were added to the initial declaration on July 3, 1998. This 1998 storm caused more than $7 million in personal property damage (FEMA-1224-DR-MA). On May 24, 2009 Bristol, Plymouth, Norfolk, and Worcester Counties experienced an intense thunderstorm causing minor flooding, winds exceeding 70MPH, and quarter sized to golf-ball sized hail.

TORNADOS

A tornado is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground. Because wind is invisible, you can't always see a tornado. A visible sign of the tornado is the dust and debris which can get caught in the rotating column made up of water droplets. Tornados are the most violent of all atmospheric storms.

Some ingredients for tornado formation include:

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

Tornados can form from individual cells within severe thunderstorm squall lines. They can form from an isolated 'supercell' thunderstorm. They can be spawned by tropical cyclones or even their remnants that are passing through. And, weak Tornados can even sometimes occur from air that is converging and spinning upward, with little more than a rain shower occurring in the vicinity.

Typically, there are 1 to 3 tornados somewhere in southern New England per year. Most occur in the late afternoon and evening hours, when the heating is the greatest. The most common months are June, July, and August, but the Great Barrington, MA tornado (1995) occurred in May and the Windsor Locks, CT tornado (1979) occurred in October.

Waterspout

A waterspout is a rapidly rotating column of air extending from the cloud base (typically a cumulonimbus thunderstorm) to a water surface, such as a bay or the ocean. There are two methods of formation.

First, unlike a tornado, waterspouts can form on a clear, sunny day if the right amount of instability and wind shear exists. These storms can have wind speeds ranging from 60 to 100 mph, but since they do not move very far, they can often be navigated around. These can become a threat to land if they do drift onshore.

A tornadic waterspout, on the other hand, is a true tornado that happens to be moving over water at the time (tornado over water). These form from the same processes that cause Tornados (see section above).

The National Weather Service issues a Special Marine Warning (SMW) for waterspouts over the coastal waters. They also issue a Tornado Warning (TOR) if a waterspout shows signs of moving toward land.

The Enhanced Fujita Tornado Scale

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 01, 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale). It is considerably more complicated than the original F-scale, and it allows surveyors to create more precise assessments of tornado severity. Tables 2 and 3 illustrate the EF-scale and the damage indicators.

Location of the Hazard

A tornado may happen anywhere in Massachusetts given the right atmospheric conditions. The Reported Tornado Occurrences Map depicts the tornado risk based on probability of occurrence based past events. The density per 25 square miles indicates the probable number of tornado touchdowns for each 25 square mile cell within the contoured zone that can be expected over a similar period of record (approximately 50 years). It should be noted that the density number does NOT indicate the number of events that can be expected across the entire zone, but the percent probability of occurrence in the given area.

The analysis indicated that the area at greatest risk for a tornado touchdown runs from central to northeastern Massachusetts.

Massachusetts does not fall within Tornado Alley. However, tornados can occur at any time and in any area. Since Massachusetts experiences far fewer tornados than other parts of the country, residents may be less prepared to react to a tornado.

Previous Occurrence

The most destructive tornado in New England history was the Worcester tornado of June 9, 1953. The F4 tornado hit at about 3:30 p.m. The funnel quickly intensified, carving a 46-mile path of death and destruction as it moved through seven towns. The twister tore through Barre, Rutland, Holden, Worcester, Shrewsbury, Westborough, and Southborough. It killed 94 people and left approximately 1,300 people injured. The National Storm Prediction Center has ranked this as one of the deadliest tornados in the nation's history.

With wind speeds between 200 to 260 mph, the force of the tornado carried debris miles away and into the Atlantic Ocean. A music box and a 3-foot aluminum trap door were found about 35 miles away, according to the National Oceanic and Atmospheric Administration.

Based on the extent of destruction, it was believed that this tornado may have been an EF5 – the most severe on the Enhanced Fujita Tornado Scale. Two other deadly tornados occurred later – the May 29, 1995 Great Barrington tornado, an EF4, which claimed 3 lives and injured 24; and the August 28, 1973 West Stockbridge tornado, a EF4, which killed 4 and injured 36.

An E-F2 tornado moving north northeast from Rockingham County New Hampshire into Merrimack County New Hampshire on July 24, 2008. Although this event did not fall within the Massachusetts Boarder's the touchdown occurred about 35 miles north of the State line. Homes and buildings in the Tornados path sustained damage along the path, which was up to a half-mile wide and 50 miles long. The tornado traveled through 5 counties, resulting in 1 fatality and damage to over 100 structures some of which were completely destroyed.

A National Weather Service Damage Survey Team concluded that an EF-1 Tornado and/or Waterspout occurred in a portion of Eastern Rhode Island and Southeast Massachusetts on July 23, 2008 at 4:05 PM. What began as a waterspout just off of Rumstick Point in Barrington, Rhode Island quickly moved onto land over the southern portion of Warren, Rhode Island. It then continued eastward into southeastern Massachusetts. Most of the damage had a rating of EF0 on the Enhanced Fujita Scale with wind speeds of 65 to 75 mph. However, there was one small section of Warren, RI that demonstrated EF1 damage, where

wind speeds were estimated at 90 mph. The tornado path length was 4.2 miles and very narrow with a path width of only 40 yards. No injuries were reported. The majority of the damage was to trees, some of which fell onto power lines and houses.

The analysis depicts point locations of initial tornado touch down locations for the period of record using graduated symbols. These symbols depict tornado intensity based on the original Fujita Scale with thematically shaded tornado density zones derived through Arc View Spatial Analyst software and recorded tornado touchdown locations. These touchdown locations, obtained from NOAA, are based on a search radius of 50,000 square miles and the density of historical tornados translated to any given 20 square mile area. See appendix 4.

The density per 25 square miles in the map's legend indicates the probable number of tornados for each 20 square mile cell within the contoured zone that can be expected over a similar period of record (51 years). It should be noted that the density number does NOT indicate the number of events that can be expected across the entire zone on the map.

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

Table 7 . *The Enhanced F-scale still is a set of wind estimates (not measurements) based on damage.* Its uses three-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to the 28 indicators listed below. These estimates vary with height and exposure. Important: The 3 second gust is not the same wind as in standard surface observations. Standard measurements are taken by weather stations in open exposures, using a directly measured, "one minute mile" speed. ***(Source:*** **http://www.spc.noaa.gov/faq/tornado/ef-scale.html*, April, 2007)***

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

Table 8. Enhanced F Scale Damage Indicators. www.noaa.gov

NOR'EASTER

A nor'easter gets its name from its continuously strong northeasterly winds blowing in from the ocean ahead of the storm and over the coastal areas.

A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain. The storm radius is often as much as 1000 miles, reaching from the Carolinas to the Gulf of Maine. These storms occur most often in Late fall and early winter. Sustained

wind speeds of 20-40 mph are common during a nor'easter with short-term wind speeds gusting up to 50-60 mph. Nor'easters are among winter's most ferocious storms. These strong areas of low pressure often form either in the Gulf of Mexico or off the east coast in the Atlantic Ocean. The low will then either move up the east coast into New England and the Atlantic provinces of Canada or out to sea. These winter weather events are notorious for producing heavy snow, rain, and oversized waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. Wind gusts associated with these storms can exceed hurricane force in intensity. Nor'easters may also sit stationary for several days, affecting multiple tide cycles and extended heavy precipitation. The level of damage in a strong hurricane is often more severe than a nor'easter but historically, Massachusetts has suffered more damage from nor'easters because of the greater frequency of these coastal storms (1 or 2 per year).

Nor'easters are a common winter occurrence in New England and repeatedly result in flooding, various degrees of wave and erosion damage to structures, and erosion of natural resources, such as beaches, dunes and coastal bluffs. The erosion of coastal features commonly results in greater potential for damage to shoreline development from future storms.

Detailed studies of satellite images and other readings suggest that some low pressure systems associated with nor'easters may develop tropical storm characteristics such as an eye in the center of the low.

The Northeast Snowfall Impact Scale (NESIS)[12]

While the Fujita and Saffir-Simpson Scales characterize tornados and hurricanes respectively, there is no widely used scale to classify snowstorms. The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004) characterizes and ranks high-impact northeast snowstorms. These storms have large areas of 10 inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus NESIS gives an indication of a storm's societal impacts. This scale was developed because of the impact northeast snowstorms can have on the rest of the country in terms of transportation and economics.

NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The diagram below illustrates how NESIS values are calculated within a geographical information system (GIS). The aerial

[12] This section is an excerpt from the Northeast Snowfall Impact Scale website: http://www.ncdc.noaa.gov/oa/climate/research/snow-nesis/

distribution of snowfall and population information are combined in an equation that calculates a NESIS score which varies from around one for smaller storms to over ten for extreme storms. The raw score is then converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. For details on how NESIS scores are calculated at the National Climatic Data Center, see Squires and Lawrimore.

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

Table 9 NESIS categories, their corresponding NESIS values, and a descriptive adjective

Location of the Hazard

This type of storm is a major concern for Massachusetts' residents not only because of the damage potential in any given storm, but because there is a frequent rate of recurrence. Nor'easters have an average frequency of 1 or 2 per year with a storm surge equal to or greater than 2.0 feet. The comparison of hurricanes to nor'easters reveals that the duration of high surge and winds in a hurricane is 6 to 12 hours while a nor'easter's duration can be from 12 hours to 3 days.

Previous Occurrence

The most recent nor'easter began April 15, 2007. The storm resulted in a Presidential Disaster Declaration (DR-1701-MA). Damages from this event exceeded $12 million. This storm was primarily a rain event due to the warmer temperatures, however higher elevations received significant snow and ice accumulations. Another notable nor'easter in January 2005 significantly impacted the region. This storm was rated by the National Weather Service as a "top 5" in historic snowfall events in the US. The snow was very powdery and drifted, as it occurred with very low temperatures and high winds.
And last, the No Name Storm in October 1991, was an unusual event, the large nor'easter moved south to and gained strength when it joined up with the remains of Hurricane Grace, becoming named by some as the Perfect Storm. Winds from this event were measured over 80 MPH and waves were over 30 feet in some parts of the coastline. This storm caused flooding and wind damage in several counties.

Hurricanes				Nor'easter			
Date	**Name**	**Category**	**Landfall**	**Date**	**Name**	**Surge**	**Waves**
1635		3		1851	Portland Gale		
1815		3		1898			
1869		3		1978			
1938		3		1991			
1954	Carol	2-3		1992			
1991	Bob			2007	Patriot's Day		

Table 10 Table compiled by the Coastal Hazards Workgroup of history of hurricanes and nor'easters

The following table depicts the major winter storms in the Northeast and ranks them based on the NESIS scale.

Rank	Year	Date	NESIS	Category	Description
1	1993	Mar 12 - 14	13.20	5	Extreme
2	1996	Jan 06 - 08	11.78	5	Extreme
3	2003	Feb 15 - 18	8.91	4	Crippling
4	1960	Mar 02 - 05	8.77	4	Crippling
5	1961	Feb 02 - 05	7.06	4	Crippling
6	1964	Jan 11 - 14	6.91	4	Crippling
7	2005	Jan 21 - 24	6.80	4	Crippling
8	1978	Jan 19 - 21	6.53	4	Crippling
9	1969	Dec 25 - 28	6.29	4	Crippling
10	1958	Feb 14 - 17	6.25	4	Crippling
11	1983	Feb 10 - 12	6.25	4	Crippling
12	1966	Jan 29 - 31	5.93	3	Major
13	2007	Feb 12-15	5.63	3	Major
14	1978	Feb 05 - 07	5.78	3	Major
15	1987	Jan 21 - 23	5.40	3	Major
16	1994	Feb 08 - 12	5.39	3	Major
17	1972	Feb 18 - 20	4.77	3	Major
18	1979	Feb 17 - 19	4.77	3	Major
19	2007	Feb 12 - 15	4.63	3	Major
20	1960	Dec 11 - 13	4.53	3	Major
21	1969	Feb 22 - 28	4.29	3	Major
22	2006	Feb 12 - 13	4.10	3	Major
23	1961	Jan 18 - 21	4.04	3	Major
24	2009	Dec 18-21	4.03	3	Major
25	1966	Dec 23 - 25	3.81	2	Significant
26	1958	Mar 18 - 21	3.51	2	Significant
27	1969	Feb 08 - 10	3.51	2	Significant
28	1967	Feb 05 - 07	3.50	2	Significant
29	1982	Apr 06 - 07	3.35	2	Significant
30	2007	Mar 15-18	2.55	2	Significant
30	2000	Jan 24 - 26	2.52	2	Significant

Table 11 NESIS Storms data for Massachusetts. The highlighted storm is the only new event added since the last plan update. Data as of Jan 2010.

SNOW AND BLIZZARDS

Snow is frozen precipitation in the form of a six-sided ice crystal. Snow formation requires temperatures to be below freezing in all or most of the atmosphere from the surface up to cloud level.

Snow can fall when surface temperatures are above freezing in a relatively shallow layer. In situations like this, the snow will not have enough time to melt before reaching the ground - though it will be quite wet with large flakes, the result of wet snowflakes sticking to one another.

Generally, ten inches of snow will melt into one inch of water. Sometimes the snow-liquid ratio may be much higher - on the order of 20:1 or 30:1. This commonly happens when snow falls into a very cold air mass, with temperatures of 20 degrees or less at ground-level. Blowing snow is wind driven snow that reduces visibility to six miles or less causing significant drifting. Blowing snow may be snow that is falling and/or loose snow on the ground picked up by the wind.

A Blizzard is a winter snow storm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow reducing visibility to or below ¼ mile. These conditions must be the predominant condition over a 3 hour period. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of the definition. The hazard created by the combination of snow, wind and low visibility significantly increases, however, with temperatures below 20 degrees.

A severe blizzard is categorized as having temperatures near or below 10 °F, winds exceeding 45 mph, and visibility reduced by snow to near zero.

Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions due to the blowing snow.

Location of the Hazard

Although the entire state may be considered at risk (no community in Massachusetts escapes winter!), higher snow accumulations appear to be prevalent at higher elevations in Western and Central Massachusetts, and along the coast where snowfall can be enhanced by additional ocean moisture. The coastline is susceptible to the combination of both snow and coastal flooding during a nor'easter. See maps in Appendix 4.

Previous Occurrences

In the winter of 2008-2009 Massachusetts ranked much above normal in winter precipitation. Snow and other winter precipitation occur very frequently across the entire state.

Average annual Snowfall through 2007:
Blue Hills, MA 61.0 Inches
Boston, MA 43.3 Inches
Worcester, MA 69.1 Inches
(Source: NOAA, www.ncdc.noaa.gov. 2009)

There have been a number of severe winter storms, which caused enough damage to prompt a Presidential Emergency Declaration. In January 2005, a massive three-day winter storm system dropped more than three feet of snow in parts of southern New England. Logan Airport was shut down and roadways were complete impassable for more than 36-hours in parts of the state. The estimated costs of snow removal for this event statewide exceeded $40 Million.

ICE STORMS

Ice storm conditions are defined by liquid rain falling and freezing on contact with cold objects creating ice build-ups of 1/4th inch or more that can cause severe damage. An ice storm warning, now included in the criteria for a winter storm warning, is for severe icing. This is issued when 1/2 inch or more of accretion of freezing rain is expected. This may lead to dangerous walking or driving conditions and the pulling down of power lines and trees. A warning is used for winter weather conditions posing a threat to life and property.

Another form of freezing precipitation is ice pellets, which occur when snowflakes melt into raindrops as they pass through a thin layer of warmer air. The raindrops then refreeze into particles of ice when they fall into a layer of sub-freezing air near the surface of the earth.

Sleet occurs when raindrops fall into subfreezing air thick enough that the raindrops refreeze into ice before hitting the ground. Sleet is different from hail. Sleet is a wintertime phenomena; hail falls from convective clouds (usually thunderstorms) under completely different atmospheric conditions - and often during the warm spring and summer months.

Location of the Hazard

Ice storms can arise in any part of the state, however they most frequently occur in the higher elevations of Western and Central Massachusetts. The following table shows the number of ice storm events each county has experienced since 1971. See Maps appendix 4.

County	Number of Ice Events 1971-2009
Worcester	27
Middlesex	22
Essex	20
Hampshire	20
Hampden	19
Franklin	17
Berkshire	13
Norfolk	9
Bristol	8
Plymouth	8
Suffolk	7
Barnstable	3
Dukes	0
Nantucket	0

Table 12 Ice Storm Events in Massachusetts by County. NCDC Database

Previous Occurrences

From 1971 to 2009 there have been about 40 ice storm events which impacted at least one or more counties in the Commonwealth. All the storms within that period occurred between November to March, most frequently occurring in Late December and Early January. Ice storms of lesser magnitudes impact the state on at least an annual basis. However the state has been impacted by several noteworthy ice storms, the most recent of which resulted in a Presidential Disaster Declaration FEMA-1813-DR MA.

Other Natural Hazards

MAJOR URBAN FIRES

A major urban fire or conflagration is a large destructive, often uncontrollable, fire that spreads substantial destruction.

Location of the Hazard

Several urban areas in the Commonwealth of Massachusetts are at risk to major urban fires. Areas where there are larger concentrations of wood frame construction homes or businesses are more likely to experience large destructive fire. In addition, many former mill communities exist in Massachusetts, which have abandoned or vacant mills and warehouses. These structures are very susceptible to vandalism or accidental fires. Due to environmental impacts such as drought conditions, high winds or inadequate on-site fire

suppression equipments, as in vacant buildings, a fire in a densely developed area can quickly become a major hazard.

Previous Occurrences

The following is a list of notable fires that have occurred in Massachusetts:

- Fall River, 1834
- Great Boston Fire, 1872
- Great Lynn Fire, 1889
- Chelsea Fire, 1903
- Great Salem Fire, 1914
- Hull Conflagration, 1923
- Strand Theater, Brockton, 1941
- Coconut Grove nightclub, Boston, 1942
- Hotel Vendome Fire, Boston, 1972
- Chelsea Fire, 1972
- Lynn, 1981
- Worcester Fire, 1999
- Bernat Mills, Uxbridge, 2007

WILDLAND FIRE

A wildland fire can be defined as any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire (naturally occurring or human caused), and prescribed fire. Many of these are highly destructive and can be very uncontrollable. They occur in forested, semi-forested or less developed area. Wildland fires can be caused by lightning, human carelessness, and arson. Most frequently, wildland fires in Massachusetts are human caused.

The Wildland Urban Interface (WUI) is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. Urban and suburban development in or near wildland vegetation poses a major threat to habitat loss, wildlife populations, and wildfire damages. There are two reasons that the WUI has an increased risk to wildfire damages. The WUI is an area where protection of structures from wildfires is difficult, due to access and fire suppression issues. Regardless whether the fire is naturally occurring or otherwise, it is much more difficult to extinguish a fire in a rural area and the damage to homes may be much more severe. The second reason that the WUI is at most risk for wildfires is that human-caused fire ignitions are most common. In these areas homes are built in an among densely wooded areas, therefore humans are more likely to start a fire that will easily spread to the surrounding forested areas with plentiful vegetative fuels.

A significant portion of new development occurs at low and medium density and tends to be more dispersed. Therefore, housing growth is particularly high in areas such as forests or adjacent to protected areas, which are vulnerable to wildfire. [13]

Massachusetts had approximately 1,121 wildland fires on 1,143 acres in 2009 according to the Department of Conservation and Recreation Bureau of Forest Fire Prevention. When comparing the 2007 season to 2009, there were approximately 1551 fewer wildland fire incidents with 1762 fewer acres burned. In the last five years wildland fires reported to DCR are trending generally downward.

Location of the Hazard

The ecosystems that are most susceptible to the hazard are pitch pine, scrub oak, and oak forests. These are the vegetative fuels that are the most flammable.

The southeastern part of Massachusetts, Plymouth County to the Southern coast of Bristol County, Cape Cod and Martha's Vineyard, are more susceptible to wildland fires due to the availability of fuel, impact from off shore winds, and increasing development within the wildland areas. According to the 2000 U.S. Census data, the population of Cape Cod has increased by 19.1% between 1990 and 2000 while the population of Massachusetts grew only 5.5%. This growth rate does not account for additional visitors during the summer months. There are other WUI areas scattered in western and central counties on the Commonwealth, however the risk is noted to be slightly lesser than the southeast. See Wildland Fire Map in Appendix 4.

Previous Occurrence

The most recent large-scale wildfire occurred in the Town of Russell in Hampden County in September 1995. This wildfire, which initiated the federal Fire Suppression Agreement under a Presidential Declared Disaster (FEMA-2116-FSA), was finally controlled after two weeks. The fire's location on extremely steep terrain made access particularly difficult. The fire burned several days as a result of ready fuel and prolonged regional drought conditions. More than 500 acres were burned and several dwellings and farms were threatened in the Town of Russell.

One of the largest wildland fires on record was in Plymouth in May 1957. This catastrophic fire burned 15,000 acres and destroyed about 40 structures. Another large fire in the same area in 1964 burned 5,500 acres and destroyed cottages on Charge Pond.

[13] Text at whole and in part have been excerpted from the following article - Radeloff, V.C., R.B. Hammer, S.I. Stewart, J.S. Fried, S.S. Holcomb, and J.F. McKeefry. 2005. The wildland-urban interface in the United States. *Ecological Applications* 15(3): 799-805.

DROUGHT

Drought is a temporary irregularity and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plantlife.

The Commonwealth of Massachusetts is often considered a 'water-rich' state. Abundant precipitation results from frontal systems or storms that move across the continent and exit through the Northeast. Under normal conditions, regions across the state annually receive between 44 and 47 inches of precipitation.

State and federal agencies were called together in 1999 at the Massachusetts Emergency Management Agency Operations Center in Framingham as an ad-hoc Drought Management Task Force. The task force consisted of officials from state and federal agencies, professional organizations that have responsibility for areas likely to be affected by drought conditions, and agencies that provide data related to assessing the severity of drought conditions, such as the United States Geological Survey (USGS), National Weather Service (NWS), and other public health and safety professionals. From this group, a Massachusetts Drought Management Plan was developed (2001).

As part of this statewide drought management plan, data provided by the respective agencies is compiled into the "Current Water Conditions Report," a report summarizing current water resource conditions, in the Commonwealth that is prepared on a monthly basis by the Department of Conservation and Recreation (DCR) for the Water Resources Commission (WRC).

Unlike many other emergency situations, the severity of droughts develops over time allowing the opportunity to develop and implement appropriate measures as the situation worsens. Therefore, the Massachusetts Drought Management Plan defines action levels that trigger general levels of response given the severity of the situation. Please see appendix 5 for more information on the Drought Plan and Action Levels

Due to the wide range of regional weather conditions in the state, assessments of drought conditions by the Drought Management Task Force are undertaken on a regional basis, rather than using a single statewide assessment. The six regions are Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape Cod and the Islands.

Location of Hazard

Based on past events and current criteria outlined in the Massachusetts Drought Management Plan, it appears that western Massachusetts may be more vulnerable than eastern Massachusetts to severe drought conditions. However, many factors, such as water supply sources, population, economic factors (i.e., agriculture based economy), and infrastructure, may affect the severity and length of a drought event. The Massachusetts Drought Management Plan takes into account regional responses to such conditions. The drought risk map may be found in Appendix 4.

Previous Occurrences

Historically, most droughts in Massachusetts have started with dry winters, rather than a dry summer. During the summer of 2002, one-third of the country, including Massachusetts, experienced drought conditions. Massachusetts has experienced multi-year drought periods in 1879-83, 1908-12, 1929-32, 1939-44, 1961-69, and 1980- 83. The most severe drought on record in the northeastern United States was during 1961-69. Water supplies and agriculture were affected because of the severity and long duration of the drought. Precipitation was less than average beginning in 1960 in western Massachusetts and beginning in 1962 in eastern Massachusetts. March 2007 was the second driest March on record. March and April were months of high fire danger. A number of days had "red flag" wildfire warning due to hot and dry weather, high winds, and low fuel moisture. DCR placed an increased emphasis on wildfire detection and suppression during this period of time.

EXTREME TEMPERATURES

There is no universal definition for extreme temperatures. The term is relative to the usual weather in the region based on climatic averages. Extreme heat, for this climatic region, is usually defined as a period of 3 or more consecutive days above 90 °F, but more generally a prolonged period of excessively hot weather, which may be accompanied by high humidity. Extreme cold, again, is relative to the normal climatic lows in a region. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.

Massachusetts has four well-defined seasons. The seasons have several defining factors, with temperature one of the most significant. Extreme temperatures can be defined as those, which are far outside of the normal ranges for Massachusetts.

The average temperatures for Massachusetts are:
Winter (Dec-Feb) Average = 27.51°F
Summer (Jun-Aug) Average = 68.15°F

Extreme Cold

Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat.

Lowest recorded temperatures:

Blue Hills, MA	–21°F
Boston, MA	-12°F
Worcester, MA	-19°F

(Source: NOAA, www.ncdc.noaa.gov. 2007)

Extreme Heat

The temperature trend for the period of record is, 1895 to present.

Highest Temperatures recorded[14]:

Blue Hills, MA	101°F
Boston, MA	102°F
Worcester, MA	96°F

From 1979-2003, excessive heat exposure caused 8,015[15] deaths in the United States. During this period, more people in this country died from extreme heat than from hurricanes, lightning, tornados, floods, and earthquakes combined. Because most heat-related deaths occur during the summer, people should be aware of who is at greatest risk and what actions can be taken to prevent a heat-related illness or death. At greater risk are the elderly, children, and people with certain medical conditions, such as heart disease. However, even young and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. Some behaviors also put people at greater risk: drinking alcohol; taking part in strenuous outdoor physical activities in hot weather; and taking medications that impair the body's ability to regulate its temperature or that inhibit perspiration.

Location of the Hazard

Temperature extremes can occur throughout the entire state of Massachusetts. Colder temperatures and extremes are more common in the higher elevations. The coastal areas also have lower daily averages that the inlands parts of the state, but do not carry the same extreme temperature records. Areas that are more prone to heat include inland urban areas.

Previous Occurrence

In June 2008, temperatures across Massachusetts were recorded above 90 degrees for a period of four days, breaking records in some areas. The high of 94 degrees in Worcester

[14] NOAA, www.ncdc.noaa.gov. 2009

[15] CDC NCEH's Health Studies Branch. 2009

was three degrees hotter than a 1984 record and the high of 96 degrees in Providence, two degrees above a 1974 record. As a result of days of heat public schools in Taunton and Fall River were dismissed early. While in other towns children's attendance was optional.

Extreme Temperature Events

Notable Cold Weather Events

Date	Type
1/15/1994	Cold
1/18/1994	Cold
1/19/1994	Cold
1/27/1994	Cold
1/17/2000	Extreme Cold
5/20/2002	Freeze
5/22/2002	Freeze
10/15/2002	Freeze
1/15/2004	Extreme Cold/wind Chill
1/25/2007	Cold/wind Chill
2/3/2007	Extreme Cold/wind Chill
1/1/2009	Cold/wind Chill
1/16/2009	Cold/wind Chill

Notable Warm Weather Events

Date	Type
1/13/1995	Record Warmth
7/13/1995	Record Heat
2/22/1997	Record Warmth
1/3/1998	Record Warmth
3/27/1998	Record Warmth
3/28/1998	Record Warmth
3/31/1998	Record Warmth
9/27/1998	Record Heat
12/2/1998	Record Warmth
12/7/1998	Record Warmth
1/24/1999	Record Warmth
2/12/1999	Record Warmth
3/18/1999	Record Warmth
6/7/1999	Excessive Heat
6/7/1999	Record Heat
7/4/1999	Excessive Heat
7/5/1999	Record Heat
7/16/1999	Record Warmth
7/17/1999	Record Warmth
7/18/1999	Record Warmth
9/7/1999	Record Warmth
3/8/2000	Record Warmth
5/8/2000	Record Heat
5/9/2000	Record Heat
10/14/2000	Record Warmth
12/17/2000	Record Warmth
4/24/2001	Record Heat
5/2/2001	Record Heat
5/3/2001	Record Heat
5/4/2001	Record Heat
5/12/2001	Record Heat

Geologic Related Hazards

EARTHQUAKE

An earthquake is the vibration, sometimes violent, of the earth's surface that follows a release of energy in the earth's crust due to fault fracture and movement. A fault is a fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other. Faults are divided into three main groups, depending on how they move. Normal faults occur in response to pulling or tension: the overlying block moves down the inclined dip of the fault plane. Thrust (reverse) faults occur in response to squeezing or compression: the overlying block moves up the inclined dip of the fault plane. Strike-slip (lateral) faults occur in response to either type of stress; the blocks move horizontally along a vertical fault past one another. Most faulting along spreading zones is normal, along subduction zones is thrust, and along transform faults is strike-slip.

The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus). Earthquakes with focal depths from the surface to about 43.5 miles are classified as shallow. Earthquakes with focal depths from 43.5 to 186 miles are classified as intermediate. The focus of deep earthquakes may reach depths of more than 435 miles. The focuses of most earthquakes are concentrated in the crust and upper 20 miles of the Earth's crust. The depth to the center of the Earth's core is about 3,960 miles, so even the deepest earthquakes originate in relatively shallow parts of the Earth's interior.

The epicenter of an earthquake is the point on the Earth's surface directly above the focus, and the focus is the area of the fault where a sudden rupture initiates. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth. Earthquakes beneath the ocean floor sometimes generate immense sea waves or tsunamis if the earthquake causes upward or downward movement of the sea floor. The tsunami originates where this movement takes place.

The cause of earthquakes in eastern North America is the forces moving the tectonic plates over the surface of the Earth. New England is located in the middle of the North American Plate. One edge of the North American plate is along the west coast where the plate is pushing against the Pacific Ocean plate. The eastern edge of the North American plate is at the middle of the Atlantic Ocean, where the plate is spreading away from the European and African plates. New England's earthquakes appear to be the result of the cracking of the crustal rocks due to compression as the North American plate is being very slowly squeezed by the global plate movements.

Location of Hazard

The New England epicenters do not follow the major mapped faults of the region, nor are they confined to particular geologic structures or terrains. As opposed to plate boundary regions like California where many of the earthquakes align along known geologic faults, New England's earthquakes so far have not aligned along faults that have been mapped by geologists. Because earthquakes have been detected all over New England, seismologists suspect that a strong earthquake could be centered anywhere in the region. Furthermore, the mapped geologic faults of New England currently do not give any indications about locations where strong earthquakes are most likely to be centered. The GIS analysis included in this report shows the locations of earthquake epicenters between 1638-2008 with the magnitude of each event depicted by a graduated symbol, fault locations, and Peak Ground Acceleration (PGA) zones, expressed as percentages of gravity with a two percent probability of the depicted PGA being exceeded in a 50-year period

In an attempt to quantify the risk of damage due to an earthquake throughout the United States, the USGS through the Earthquake Hazard Program has developed national maps displaying likely levels of ground motion due to future earthquakes. When developing these maps, the USGS considered the potential magnitude and locations of future earthquakes based on historical data and geological information on the recurrence intervals of fault ruptures. Using these data, the extent of potential ground shaking with a 10 percent, 5 percent, and 2 percent chance of being exceeded in a 50-year period has been calculated, and color maps displaying these ground-motion values on a national scale have been prepared. Information about the nations seismic hazard maps is available from the USGS Earthquake Hazards Program website: http://eqhazmaps.usgs.gov/. The highest percentages of PGA areas in the state are located in Northern Middlesex and Essex Counties, however, the PGA percentage are very low compared to the national averages. See map in Appendix 4.

The most commonly used method to quantify potential ground motion is in terms of peak ground acceleration (PGA), which measures the strength of a potential earthquake in terms of the greatest acceleration value of ground movement. The potential damage due to earthquake ground shaking increases as the acceleration of ground movement increases. Peak ground acceleration is expressed as a percentage of a known acceleration, the acceleration of gravity ($9.8 m/s^2$), and is commonly referred to as "%g" in the national seismic hazard maps.

Major damage can occur in earthquakes due to secondary effects triggered by strong earthquake ground shaking. The Richter magnitude scale is a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. The Richter scale does not reflect damage caused by an earthquake.

One secondary effect that is often observed in low-lying areas near water bodies is ground liquefaction. Liquefaction is the conversion of water-saturated soil into a fluid-like mass. This can occur when loosely packed, waterlogged sediments lose their strength in response to strong shaking. Liquefaction effects may occur along the shorelines of the ocean, rivers and lakes, and they can also happen in low-lying areas away from water bodies but where the ground water is near the Earth's surface. Landslides and land slumps are other secondary effects that can be induced by earthquake shaking and that can be very damaging.

Although it is well documented that the zone of greatest seismic activity in the United States is along the Pacific Coast in Alaska and California, it may be surprising to most people that an average of six earthquakes are felt each year somewhere in New England, and that damaging earthquakes have taken place in historic time in New England.

New England has had a long history of earthquakes, starting with that recorded by the Plymouth Pilgrims and other early settlers in 1638. Of the over 5,000 earthquakes recorded in the Northeast Earthquake Catalog through 2008, 1,530 occurred within the boundaries of the six New England States, with 366 earthquakes recorded for Massachusetts between 1627 and 2008. Between 1924 and 2008, there have been 101 earthquakes in the Northeast with a magnitude of 4.5 or greater on the Richter scale. Out of these 101 earthquakes, 8 were within the six New England States and the other 93 within New York State or the Province of Quebec. Many of these earthquakes were so strong that they were felt throughout all of New England.

Based on the data provided by Weston Observatory[16] and on the national earthquake hazards map, it appears that northeastern Massachusetts, especially along the Massachusetts coastline from the northern portion of Plymouth County through the Boston Metropolitan area to the New Hampshire border, has greater vulnerability to potential earthquake activity than the rest of the state. There are very few earthquakes in western Massachusetts. However, the shaking from earthquakes in eastern New York State can affect western Massachusetts, and so all of the state has some measure of earthquake hazard.

Earthquakes above about magnitude 5.0 have the potential for causing damaging near their epicenters, and larger magnitude earthquakes have the potential for causing damage over larger wider areas. A 1994 report by the USGS, based on a meeting of experts at the

[16] Weston Observatory is a geophysical research laboratory of the Department of Geology and Geophysics at Boston College. The Observatory houses seismic instruments for the World-Wide Standardized Seismic Network (WWSSN) and for the New England Seismic Network (NESN). The staff monitors the Northeast United States for seismic activity and disseminates information pertinent to any events that are recorded.
http://www.bc.edu/research/westonobservatory

Massachusetts Institute of Technology, found that the probability of a magnitude 5.0 or greater earthquake centered somewhere in New England in a 10-year period is about 10%-15%. This probability rises to about 41% to 56% for a 50-year period. The last earthquake with a magnitude above 5.0 that was centered in New England took place in the Ossipee Mountains of New Hampshire in 1940.

In some places in New England, including Massachusetts, small earthquakes seem to occur with some regularity. For example, since 1985 there has been a small earthquake experienced approximately every 2 ½ years within a few miles of Littleton, Massachusetts. It is not clear why some localities experience such clustering of earthquakes, but one possibility suggested by Prof. John Ebel of Weston Observatory of Boston College is that these spatial clusters are sites where strong earthquakes were centered in the prehistoric past. These spatial clusters may indicate locations where there is an increased likelihood of future earthquake activity.

Previous Occurrences

Many earthquakes have affected Massachusetts over our recorded history. Almost all of these earthquakes have been of a small magnitude and have caused no damage. The last major earthquake to affect Massachusetts was more than 200 years ago in 1755 with an estimated magnitude of about 6.0 to 6.25. The epicenter was probably located off the coast of Cape Ann, north of Boston. The area of greatest damage in Massachusetts stretched along the northern coast of the state from Cape Ann to Boston, where chimneys were shattered and objects were flung from shelves. There have been other damaging earthquake centered in New England in the past. The 1727 earthquake at Newbury, Massachusetts caused local damage to masonry chimneys and buildings; its magnitude is estimated to have been about 5.6. In 1940 there was a pair of magnitude 5.5 earthquakes centered in the Ossipee Mountains of New Hampshire, and in 1904 there was a magnitude 5.7 earthquake at Eastport, Maine. Both of these earthquakes caused minor damage near their epicenters and were felt throughout Massachusetts.

LANDSLIDE

The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors, such as: erosion by rivers, glaciers, or ocean waves created over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquakes created stresses that make weak slopes fail.

According to the USGS, "The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors." Among the contributing factors are: erosion by rivers, glaciers, or

ocean waves create over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquakes create stresses that make weak slopes fail; and excess weight from accumulation of rain or snow, and stockpiling of rock or ore, from waste piles, or from man-made structures. USGS scientists also monitor streamflow, noting changes in sediment load carried by rivers and streams that may result from landslides. All of these types of landslides are considered aggregately in USGS mapping of landslides.

Location of Hazard

Landslides are common throughout the Appalachian region and New England. The greatest eastern hazard is from sliding of clay-rich soils. Based on the US data set for landslides, it appears that areas along the Connecticut River in western Massachusetts, and the greater Boston area have the highest risk to landslide. Refer to Appendix 4 for Landslide Map.

Previous Occurrences

Nationwide landslides constitute a major geologic hazard as they are widespread, occurring in all 50 states, and cause approximately $1-2 billion in damages and more than 25 fatalities on average each year. In Massachusetts, landslides tend to be more isolated in size and pose threats to highways and structures that support fisheries, tourism, timber harvesting, mining, energy production and general transportation. Landslides commonly occur with other major natural disasters such as earthquakes and floods that exacerbate relief and reconstruction efforts. Expanded development and other land use has increased the incidence of landslide disasters.

In September 2008 a small landslide occurred in Holyoke covering several cars and a large paved area under several feet of mud and debris. It is thought the cause of this slide was saturated soils due to days of rain and poor urban drainage.

TSUNAMIS

This phenomena can be defined as a string of waves created by an underwater disturbance such as an earthquake, landslide, volcanic eruption, or impact from a meteorite. An earthquake can give rise to a tsunami if the earthquake causes major vertical movements of the sea floor. An earthquake can also generate a tsunami if the earthquake causes a major landslide into a water body or if it causes a major slumping of submarine sediments. A tsunami is a series of water waves that can move hundreds of miles per hour in the open ocean and can come ashore with waves as high as 100 feet or more. The height of a tsunami wave that comes onshore is related to the strength of the source that generated the tsunami and to the configuration of the ocean bottom along the shore affected by the tsunami.

A tsunami is a devastating onshore surge of water that can be triggered from geologic activity. The National Tsunami Hazard Mitigation Program (NTHMP) was formed in 1995

by Congressional action which directed NOAA to form and lead a Federal/State working group. The NTHMP is a partnership between NOAA, the United States Geological Survey (USGS), the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF), and the 28 U.S. Coastal States Territories, and Commonwealths.

One of the actions outlined by the plan was the development of a tsunami monitoring system to monitor the ocean's activity and make citizens aware of a possible tsunami approaching land. In response, NOAA developed the DART™ tsunami monitoring buoys. To ensure early detection of tsunamis and to acquire data critical to real-time forecasts, NOAA has placed Deep-ocean Assessment and Reporting of Tsunami (DART™) stations at sites in regions with a history of generating destructive tsunamis. NOAA completed the original 6-buoy operational array in 2001 and expanded to a full network of 39 stations in March, 2008. The information collected by a network of DART™ buoys positioned at strategic locations throughout the ocean plays a critical role in tsunami forecasting.

When a tsunami event occurs, the first information available about the source of the tsunami is based only on the available seismic information for the earthquake event. As the tsunami wave propagates across the ocean and successively reaches the DART™ systems, these systems report sea level measurement information back to the Tsunami Warning Centers, where the information is processed to produce a new and more refined estimate of the tsunami source. The result is an increasingly accurate forecast of the tsunami that can be used to issue watches, warnings, or evacuations.

Location of Hazard

All of the coastal areas of Massachusetts are exposed to the threat of tsunamis. However, at the present time it is unknown what the probability is of a damaging tsunami along the Massachusetts coast.

Previous Occurrence

In 1929 a magnitude 7.3 earthquake and submarine slump along the Grand Banks of Newfoundland caused a significant tsunami that came ashore along the Newfoundland coast, inundating coastal villages and causing major damage and some deaths. In 1755 the major earthquake at Lisbon, Portugal caused a major tsunami along the Portuguese coast. Historic reports indicate that a small tsunami was observed across the Atlantic Ocean in the Caribbean from this Portuguese earthquake. Thus, history suggests that there is some tsunami hazard to Massachusetts, both from a strong, local offshore earthquake and from a major earthquake across the Atlantic Ocean. Some scientists have also suggested that a major tsunami could be generated if a major landslide were to take place on Canary Islands in the eastern Atlantic Ocean. There is no specific information on previous occurrences.

Non-natural Hazards

The Massachusetts Emergency Management Agency (MEMA) is the state agency responsible for coordinating federal, state, local, voluntary, and private resources during emergencies and disasters in the Commonwealth of Massachusetts. MEMA provides leadership to: develop plans for effective response to all hazards, disasters or threats; train emergency personnel to protect the public; provide information to the citizenry; and assist individuals, families, businesses, and communities to mitigate against, prepare for, respond to, and recover from emergencies, both natural and man made.

In an effort to take a holistic approach to mitigation and emergency management, this plan addresses several events that are non-natural that affect Massachusetts. This plan also references actions and strategies that relate to non-natural hazards. However, a complete hazards vulnerability analysis was not within the scope of this update. Some of the hazards include a description of the location of probable impact and history of occurrence when applicable. Due to sensitivity and data limitations some vulnerability information is left out of the plan as it pertains to these hazards. None of the non-natural Hazards will be analyzed in terms of strategies to reduce or eliminate the long-term risk to these hazards. MEMA also maintains the State Comprehensive Emergency Management Plan (CEMP) as well as other plans that deal with the specific response and mitigation aspects of and non-natural disasters, crime, and other emergencies. For information on how to obtain sections or information from the State CEMP, please refer to appendix 10.

PUBLIC HEALTH EMERGENCIES AND HAZARDS

A public health infectious disease emergency occurs when a community faces serious illness due to a communicable disease, which threatens to overwhelm the public health system. Infectious disease emergencies, which threaten to overwhelm the public health system, are rare. Of the more than 10,000 case reports of infectious disease received by MDPH annually, only a small fraction can be considered public health infectious disease emergencies. Health care providers, local boards of health, and the MDPH handle most infectious diseases routinely. They constitute an expected baseline rate of disease.

However, infectious disease spreading undetected or undeterred through a community—especially an easily communicable disease with high morbidity and mortality—is an emergency. The longer this type of disease goes unrecognized and untreated, the more severe the impact will be on human health.

How does a public health infectious disease emergency differ from bioterrorism? Bioterrorism represents one type of public health infectious disease emergency. Infectious disease emergencies may occur naturally, without any intent to harm people or create fear.

The ease of worldwide travel and the re-emergence of infectious diseases in more virulent forms may increase the rate of these kinds of public health infectious disease emergencies.

Bioterrorism is the intentional use of (or threat to use) biological agents like including but not limited to; anthrax, botulism, brucellosis, cholera, pandemic influenza, plague, ricin, smallpox, tularemia, and viral hemorrhagic fevers.

The Massachusetts Department of Public Health is the primary agency responsible for the study, planning, isolation/quarantine and actions, surveillance, and reporting for all public health emergencies.

Location of Hazard

Public health emergencies can occur in any community in the Commonwealth. Depending on the level of contagiousness or method or infectivity, urban environments may be more susceptible for faster spread of certain disease.

Previous Occurrences

The H1N1 flu (also referred to as the swine flu) caused by a new virus, first recognized in April of 2009, and is the most recent public health emergency. The H1N1 flu quickly spread to many parts of the world and was identified as a pandemic, or global outbreak impacting Massachusetts. H1N1 flu is not the same as swine flu, which is a virus that pigs can get and is not the same as "seasonal" flu, which occurs every year, during the winter and early spring. H1N1 flu causes symptoms that are similar to seasonal flu, is spread like seasonal flu, and can be prevented like seasonal flu.

Confirmed H1N1 cases in Massachusetts, April 26, 2009 - December 17, 2009

	Age group (N)	Pregnant (N)	Hospitalized (N)	Hospitalized (%)	Deaths (N)
0-4 years	293	0	88	30.03	2
5-12 years	499	0	85	17.03	0
13-18 years	368	6	44	11.96	1
19-25 years	222	21	27	12.16	2
26-44 years	275	33	45	16.36	5
45-64 years	203	0	67	33.00	10
65+ years	38	0	23	60.53	6
Unknown	2	0	0	0	0
TOTAL	1900	60	379	19.95	26

Table 13. Table and H1N1 information provided by the Mass Department of Public Health. December 20009. www.mass.gov/DPH

TRANSPORTATION ACCIDENTS

Transportation systems which exist in the Commonwealth include road, rail, air and maritime. All of these forms of transportation are prone to accidents that could lead to an emergency or disaster. The accidents may have either a natural or human cause.

Location of Hazard

Transportation system accidents and incidents have the potential to occur in every area of the Commonwealth. Larger communities such as Boston, Springfield, and Worcester are most at risk for transportation accidents and incidents due to their population density and multi-modal methods of transportation. Several communities host Air Force flight lines that contribute to the immediate areas inclusive risk for flight related incidents.

Previous Occurrences

Automobile accidents occur with great frequency across the Commonwealth. Rail accidents occur less frequently and are isolated to areas where active lines exist. Aircraft and marine accidents occur with the least frequency but have the potential of affecting most of the state due to standing flight lines and patterns.

NUCLEAR

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

Human exposure to ionizing radiation is measured in millirem and rem, which are units of dose equivalent. Dose depends upon the amount and type of radiation being emitted, the distance from the source of radiation, the length of exposure time, and the size of body area exposed. The greater the dose, the greater the potential for biological effect. However, it is impossible to predict precisely how an individual will respond to a particular dose, as effects will vary from one person to another.

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

Radiation effects can be classified in two categories, early or delayed, but these categories are not mutually exclusive.

Early (acute) effects of radiation exposure are expected to occur within 90 days from exposure, and may include fatalities, symptoms of acute radiation syndrome, or clinically detectable changes in blood and chromosomes. However, emergency protective actions can be taken to prevent or minimize these effects. The basis for protective action decisions for avoiding early health effects is justified in preventing such effects. However, they must be made rapidly and with balanced consideration of other existing constraints, such as severe weather, that could impact protective action measures such as evacuation.

Delayed effects of radiation exposure (i.e., biological effects that can only be observed on a statistical basis) could occur in some members of a population that has been exposed to radioactive materials. The effects may be fatalities or disabilities of somatic or genetic origin. In the long run, these effects may cause the greatest impact on the general population.

Location of the Hazard

The Nuclear Regulatory Commission (NRC) and the Environment Protection Agency (EPA) endorsed the emergency planning zone (EPZ) concept.

The EPZs are designated as areas for which plans are prepared to ensure that prompt and effective actions can be taken to protect the public in the event of an incident at a nuclear power plant. There are three EPZ's that impact Massachusetts.

One fixed nuclear facility operates within the borders of Massachusetts: Pilgrim Nuclear Power Station located in Plymouth and operated by Entergy Nuclear Northeast. Two other licensed facilities are located just over the border from Massachusetts: Vermont Yankee Nuclear Power Station (Vermont Yankee) located in Vernon, Vermont, and operated by Entergy Nuclear Northeast; and Seabrook Nuclear Power Station, located in Seabrook, New Hampshire, and operated by NextEra Energy.

Supporting Documents information my be found the State Comprehensive Emergency Management Plan Annex.

Previous Occurrences

The Three Mile Island accident of 1979 was a partial core meltdown in Unit 2 (a pressurized water reactor manufactured by Babcock & Wilcox) of the Three Mile Island Nuclear Generating Station in Dauphin County, Pennsylvania near Harrisburg. It was the most significant accident in the history of the American commercial nuclear power generating

industry. The TMI cleanup started in August 1979 and officially ended in December 1993, having cost around US$975 million.

Scientific follow-up studies showed that no member of the public was injured by the accident except for stresses caused by emotion-charged news coverage.
Due to the incident at Three Mile Island, there have been improvements to operating training, quality assurance, operational surveillance and emergency planning. Each nuclear site needed to have an approved emergency plan to direct the evacuation of the public within a ten mile EPZ. These plans are periodically rehearsed with federal and local authorities to ensure that all groups work together quickly and efficiently. Plans were developed for all cities, towns and counties for any incident at these nuclear facilities.

INVASIVE SPECIES

This evaluation includes risk from insects and plants that are non native to Massachusetts. The information for this summary was compiled from the Massachusetts Department of Agriculture Resources "Introduced Pests outreach Project", The Massachusetts Invasive Plant Advisory Group (MIPAG), Massachusetts Department of Conservation and Recreation Lakes and Ponds Program and the Invasive Plant Atlas of New England.

Asian Longhorn Beetle (Anoplophora glabripennis, "ALB")
The Asian Longhorn Beetle is an invasive species native to China and Korea. It was first discovered in the U.S. in Brooklyn in 1996, and has also been found in Chicago and New Jersey. The beetles cause damage by tunneling within the trunks and branches of trees, disrupting the sap flow and weakening and eventually killing them. This pest attacks a wide variety of hardwood trees including: Maples, Horsechestnut, Birch, Plane-tree, Poplar, Willow and Elms. ALB is considered a serious threat to the nursery, lumber, wood products, maple syrup, and tourism industries in our state. If it became established over a large area, it could also significantly disrupt the forest ecosystem.

ALB was discovered in the Greendale section of Worcester in 2008 and an eradication program has been developed by the USDA in partnership with MA DCR, the City of Worcester, and surrounding communities, to work to contain this threat.

Downed trees from a major ice storm in December 2008 posed a significant concern for transportation of this pest to other areas. A debris removal program was developed within the identified infected area to contain potential spreading of ALB. Companies or individuals working in the infested area had to have a compliance agreement with the Massachusetts Asian Longhorn Beetle Cooperative Eradication Program Wood had to be chipped to a size no greater than one-inch in two dimensions. Homeowners were allowed to burn fallen woody debris.

As of this time, tree removal still is underway in Worcester and monitoring for the possible spread continues for portions of Worcester and Middlesex counties.

Giant Hogweed

Giant Hogweed (Heracleum mantegazzianum) is a weed. It is a native of Caucasus and was transplanted from China to England, for use in ornamental gardens. It was first detected in North America in the early 1900's. The clear, watery sap of giant hogweed contains toxins that cause phytophotodermatitis. The sap from hogweed sensitizes skin to ultraviolet radiation, so exposure to sunlight within 48 hours of contact can cause severe burns. It prefers rich, moist soil, in semi-shade conditions. It crowds out native species and is a "water-demanding" plant because of its size.

Giant hogweed was first discovered at several sites in Massachusetts in 2002. At the time of this report, there were 13 active sites where eradication efforts are underway through the Massachusetts Department of Agricultural Resources. The areas include locations in Hampden, Hampshire, Franklin, Middlesex, and Worcester Counties.

Hydrilla

Hydrilla (Hydrilla verticillata) is a submerged aquatic perennial plant. The origin of hydrilla is unclear with several scientists believing it a native to India, Austrailia and Korea. Today it is found on every continent except Antartica and South America. One strain was imported to the United States for use in the aquarium trade during the 1950's. Another strain was not detected in the United States until the 1970's. In the Northeast this weed has been found in one pond on Cape Cod (Barnstable), and one pond in Stonington, Connecticut.

Hydrilla grows most often in freshwater lakes, ponds, rivers, impoundments, canals and ditches, under a wide range of environmental conditions. It usually grows in shallow waters, but can grow at depths greater than 30 feet. Hydrilla is adapted to grow under very low light conditions, and therefore can quickly dominate native vegetation. Hydrilla can also tolerate a range of temperatures and is winter-hardy. Hydrilla can be transported great distances by fragments that can root and grow. It becomes locally abundant by fragmentation and tubers, but also reproduces through seeds and turions.

In the great majority of cases, hydrilla enters lakes with flow, boats and birds, and the logical places to look first are the mouths of tributaries, boat ramps and areas of higher bird concentrations. While mature hydrilla growths will usually "top out", reaching the surface and forming a canopy, new infestations may be less obvious and often require underwater examination for early detection.

The ability to spread quickly and grow in a variety of environmental conditions allows hydrilla to out-compete native vegetation and quickly dominate a waterbody. Hydrilla often forms dense mats at the surface of the water. These large mats displace native vegetation, reduce biodiversity, and may alter ecosystem balances, including food chains and trophic interactions. Dense mats choke channels, clog water intakes, and restrict aquatic activities such as fishing, swimming and boating.

The DCR has taken the lead in Massachusetts with regard to encouraging control of invasive species, and supports control efforts as its budget allows. However, outside of the state parks and reservations, control is largely a function of local desire to protect and maintain the resource.

Eradication of hydrilla detected early in an invasion can be accomplished with hand harvesting, suction harvesting, benthic barriers, drawdown, or the herbicide fluridone. Hand harvesting and benthic barriers are often allowable without an Order of Conditions under the Wetlands Protection Act, and can therefore be implemented most rapidly. Each method has benefits and drawbacks, and the specific circumstances will affect which option(s) can be applied.

The most commonly recommended early actions are hand harvesting and bottom barriers, each of which has a high potential for success, low cost on a localized basis, and limited permitting needs. Where growths are too dense for effective hand harvesting and too extensive for cost-effective bottom barrier placement, suction harvesting could be considered. However, as expanded growths indicate that tubers and turions have probably been deposited, treatment with fluridone is more commonly recommended, with repeat treatment in a second year and careful follow-up monitoring.

Zebra Mussels

Zebra Mussel (Dreissena polymorpha) Discovery: Zebra Mussels had never been documented in Massachusetts' waters prior to July 2009, but are now confirmed to be present in Laurel Lake in Lee. Zebra Mussels have been considered the most "important" invasive species to ever exist in the United States and cost the country billions of dollars per year in control. They were identified by Lee resident Dimitri Consolati, who participated in DCR's Lakes and Ponds Program's zebra mussel education, monitoring, and outreach program. The Lakes and Pond Program's aquatic ecologist went to the site and confirmed their presence in the water body.

Once these invasive mussels invade a lake, there is no known way to eradicate them, but we can help prevent the spread to other water bodies. Lakes most at risk are in Berkshire County, where calcium concentrations are high enough to support breeding populations.

In keeping with the agency's invasive species protocol, DCR notified the Department of Fish and Game's (DFG) Office of Fishing and Boating Access (OFBA), which closed the lake's public access boat ramp temporarily on July 8th on an emergency basis. Under Massachusetts regulations, the OFBA has authority to close state boat ramps for not more than 45 days if it finds that the immediate establishment of management measures is necessary for the public health, safety or general welfare.

In addition, on July 9th DFG authorized municipalities to enforce limited restrictions on the use of boat ramps at other Berkshire County water bodies deemed at-risk to infestation by the highly destructive species. The purpose of the action was to reduce the risk that boats that have recently been on Laurel Lake will transport zebra mussels to other Berkshire County lakes, ponds and rivers.

INFRASTRUCTURE FAILURE

Infrastructure Failure, for the purposes of this plan includes multiple systems. Technological emergencies include any interruption or loss of a utility service, power source, life support system, information system or equipment needed to keep the business in operation. Examples include:

- Utilities including electric power, gas, water, hydraulics, compressed air, municipal and internal sewer systems, wastewater treatment services
- Security and alarm systems, elevators, lighting, life support systems, heating, ventilation and air conditioning systems, electrical distribution system.
- Manufacturing equipment, pollution control equipment
- Communication systems, both data and voice computer networks
- Transportation systems including air, highway, railroad and waterway

Location of Hazard

Technological emergencies have the potential to occur in every corner of the Commonwealth. Communities with limited technological infrastructure are more vulnerable to experiencing an incident because of the lack of redundant systems. Communities should consider mitigation measures such as emergency generators, buried cable, and preventative pruning to help reduce the risk of this type of emergency.

Previous Occurrences:

Previous occurrences of Technological Emergencies include the December 2008 Ice Storm and the New York blackout in 2003.

COMMODITY SHORTAGES.

Commodities are goods with have a certain level of demand in an emergency, such as food, fuel and medicine. The following section outlines common and critical commodities for Massachusetts.

PETROLEUM PRODUCTS SHORTAGE

Petroleum shortages in Massachusetts may be caused by natural disasters in the Commonwealth itself or in those parts of the world which supply petroleum to Massachusetts, by geopolitical events such as revolutions, embargoes, or wars, or by economic factors either driving up the price or reducing the available supply of petroleum.

Location of Hazard

All areas of Massachusetts are vulnerable to petroleum shortages. Massachusetts is particularly vulnerable to shortages during the winter months due to a combination of high demand for home heating and severe weather impacting regional distribution mechanisms – Massachusetts and New England in general are logistically isolated from major U.S. refineries and pipelines and depend on imports, chiefly by water, from domestic and foreign sources.

Massachusetts Petroleum Consumption (2007):

- 7.6 million gallons of gasoline per day, 42.6% of total gasoline demand in New England.
- 1.125 million gallons of diesel fuel per day, 31% of New England demand.
- 819,000 gallons per day of jet fuel, 64% of New England demand. Logan Airport drives Massachusetts' jet fuel demand.
- 1.69 million gallons per day of heating oil, mostly for residential heating. Massachusetts was the 4th highest user of residential heating oil in the country.
- 461,000 gallons of residual fuel oil per day, mostly for electricity generation.
- Approximately 36% of homes in Massachusetts are heated with #2 heating oil, 2.8% with propane, and a miniscule number with kerosene.

Previous Occurrence

The 1973 OPEC oil embargo led to increased fuel prices and rationing in the United States.

The 1979 Iranian Revolution caused a steep decline in that country's oil exports, which in turn caused a spike in fuel prices in the United States.

Severe weather in January and February of 2000 not only increased demand in Massachusetts but limited supply as weather conditions slowed the docking and unloading of barges and tankers.

In 2005, Hurricane Katrina shut down refineries and oil rigs in the Gulf of Mexico, leading to price spikes in Massachusetts due to limited supplies.

In the summer of 2008, oil prices skyrocketed to almost $150 per barrel. Combined with an ongoing recession, this created concerns in Massachusetts that residents would be unable to afford sufficient oil to heat their homes in winter.

NATURAL GAS SHORTAGE

Natural gas shortages in Massachusetts may be caused by natural disasters in the Commonwealth itself or in those parts of the world which supply natural gas to Massachusetts, disruptions to pipelines and other facilities which transport natural gas into Massachusetts, by geopolitical events such as revolutions, embargoes, or wars, or by economic factors either driving up the price or reducing the available supply of natural gas.

Location of Hazard

All areas of Massachusetts are vulnerable to natural gas shortages. New England receives about 80% of its natural gas supply from the Gulf Coast, western Canada, and eastern Canada via interstate pipelines. Liquefied natural gas (LNG) is also imported into the region through the Distrigas facility in Everett. LNG presently meets 20 to 25% of New England's demand, spiking to 30% in winter months.

Concern for natural gas supply reliability is almost exclusively confined to the winter months when demand for natural gas for space heating increases. During the three winter months, interstate pipelines feeding Massachusetts operate at over 90% of capacity. During the summer, when demand for natural gas for power generation increases, there is generally enough excess capacity to meet this need.

Severe winter weather can cause increased demand for natural gas for heating and electric power generation, along with delays of over-the road transportation of LNG to satellite facilities. Hurricanes in the Gulf of Mexico may shut down or damage natural gas infrastructure in that area. The supply of natural gas to New England via interstate pipelines may be disrupted by natural disaster, mechanical failure, or deliberate action. The supply of LNG to the Everett Distrigas facility may be disrupted by severe weather, geopolitical events, or accidental/deliberate damage to the facility itself.

Massachusetts Natural Gas Consumption (2006):

Massachusetts consumes about 405 billion cubic feet of Natural Gas per year, about 55% of New England's total consumption. Winter is the peak season for demand, however, due to the increase of gas power generation plants, is resulting in a steady increase in consumption over all months. Approximately 47% of Massachusetts's homes are heated using natural gas.

Gas consumption by sector:

- Residential: 28.4%
- Commercial: 14.5%

- Industrial: 11.4%
- Power generation: 45.7%

Previous Occurrences

Intensely cold weather in January 1981, combined with disruptions in the supply of liquefied natural gas to New England due to a storm off the coast of Algeria disrupting tanker shipments, caused then-Governor Edward King to declare an energy emergency in Massachusetts. Schools heated by natural gas were closed, non-residential buildings were ordered to lower thermostats to 55 degrees, and residential customers were urged to lower their thermostats by 10 degrees.

ELECTRICITY SHORTAGE

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

Location of Hazard

All areas of Massachusetts are vulnerable to electricity shortages. Shorter-duration heat waves (2-3 days) may cause demand surges, generator stresses/outages, and transmission problems. A prolonged heat wave may lead to electricity supply problems, rolling blackouts, and health and safety risks if priority users cannot be supplied with power. Electricity problems in neighboring power pools to New England may deplete available electricity reserves, leading to supply problems if conditions in New England deteriorate. Disruptions in the supply of natural gas or petroleum to New England may impact generating capacity in the region. Disruptions to generation plants or key transmission lines due to natural disasters, mechanical failure, or deliberate action may reduce the supply of electricity to the region.

Massachusetts Electricity Consumption:

Most electricity in Massachusetts is produced by gas- or oil-fired power plants. Coal-fired plants account for about 25% of net electricity production. Other electricity producers in Massachusetts include the Pilgrim nuclear power plant in Plymouth, several small hydroelectric facilities, and some facilities which recycle landfill gas and municipal solid waste. Local distribution companies (LDCs) such as National Grid or NSTAR distribute about 86% of Massachusetts' electricity demand. The remaining 14% is delivered by municipal utilities.

Previous Occurrence

In 1974, industrial action by coal miners in the United Kingdom forced the government to implement the "Three Day Week" from January to March of that year in order to conserve electricity and prolong the life of existing fuel stocks.

In the early 2000s, California experienced a shortage of electricity due to lack of generating capacity, price caps discouraging conservation, a drought in the Pacific Northwest reducing the available supply of hydroelectric power from that region, and market manipulation by speculators. This led to rolling blackouts through 2000 and 2001.

FOOD CONTAMINATION/FOODBORNE ILLNESS

Foodborne illnesses are caused by more than 200 different pathogens, including viruses, bacteria, parasites, toxins, chemical contaminants, and metals. Symptoms of foodborne illness range from mild stomach upset, to life-threatening neurological conditions, liver, and kidney syndromes, or even death.

Location of Hazard

All areas of Massachusetts are vulnerable to foodborne illness. According to the CDC, there are approximately 76 million cases per year of illness from foodborne agents, including about 325,000 hospitalizations and 5,000 deaths. Most cases of foodborne illness are natural or accidental in nature, but deliberate contamination of food for financial gain or as an act of terrorism is not unknown. In addition to illnesses and deaths that food contamination can cause, there is a significant economic impact to the food industry through the effects of recalls and decreased consumer confidence in the commercial food supply. Changes in demographics and consumption patterns have increased susceptibility to food-borne pathogens and contamination. In 2007, as much as 25% of the population was in a high-risk category from foodborne illness (e.g. young, elderly, pregnant, immune compromised). Additionally, more people are consuming ready-to-eat and prepared foods – these "convenience foods" are at higher risk of cross-contamination from other foods and/or from food workers. Consumers are also eating a greater variety of foods year-round, particularly those consumed raw or with minimal processing, which are often associated with foodborne illness. A greater proportion of foods are imported than in the past, some of which come from countries with less well-developed food safety systems.

Previous Occurrence

Hundred of people throughout the United States became ill from salmonellosis in the spring of 2008 as a result of eating contaminated peppers from Mexico.

In 2007, four people became ill from drinking milk contaminated with listeria bacteria from a dairy in Shrewsbury. Two of these later died.

Also in 2007, a wide variety of cat and dog foods made with vegetable protein products imported from China were found to be contaminated by melamine, which had been added by an unscrupulous supplier to artificially increase the measured protein content of the product. This resulted in the deaths of thousands of pets in the United States and Canada. A similar incident in the same year involving baby formula adulterated with melamine sickened hundreds of thousands in China.

In 1984, the Rajneeshee religious sect deliberately contaminated salad bars in The Dalles, Oregon with salmonella as part of a larger attempt to rig county elections in their favor. Over 750 people contracted salmonella poisoning as a result.

WATER CONTAMINATION/WATERBORNE ILLNESS

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

Location of Hazard

Drinking water comes from either groundwater sources (such as wells), or from bodies of water on the surface (such as rivers, lakes, or streams). In general, smaller and rural areas rely on groundwater, while larger urban areas rely on surface water. According to the USGS, an estimated 9.6% of Massachusetts households use private wells as their primary source of drinking water.[17] Urban areas with aging infrastructure may have leaky sewage collection systems or systems which discharge untreated sewage during storms or floods.

Previous Occurrences

In April 2007, malfunction of a feed mechanism resulted in system-wide water contamination in the town of Spencer when excessive amounts of sodium hydroxide were accidentally pumped into water mains. 145 people suffered chemical burns as a result of the incident and use of town water was prohibited for two days.

Officials in the town of Pembroke declared a state of emergency in August 2008 after *E. coli* bacteria were found in the municipal water supply. A boil order was issued and supplies of bottled water were delivered to the town for use by residents.

On August 8, 2009, the town of Milford issued a boil order for the entire town after E. coli bacteria were identified during routine testing of the municipal water supply. Supplies of

[17] USGS

bottled water were delivered to the town for use by residents during the first ten days that the boil order was in effect. On August 18, the boil order was lifted for most of the town, with the exception of about 475 customers, and completely lifted on August 28.

MEDICINE SHORTAGE

A shortage of medicine may be caused by either an inability of producers to keep up with consumer demand or by a sudden upsurge in demand outstripping current production capabilities. Existing pandemic operations plans provide for prioritizing limited supplies of medicine to especially vulnerable groups. Those groups with a lower priority would be disproportionately affected by a shortage.

Location of Hazard

All areas of Massachusetts are vulnerable to medicine shortage.

Previous Occurrences

The 2001 anthrax attacks led to a run on the antibiotic ciprofloxacin and a potential shortage of the drug in the United States. This led the Secretary of HHS to investigate breaking the patent so that generic ciprofloxacin could be produced to meet demand if necessary.

Approximately 80% of the United States' supply of H1N1 vaccine will be coming from abroad. In the event of a global H1N1 pandemic, vaccine producing countries may seize vaccine supplies and focus on protecting their own populations before exporting vaccine abroad.

CHEMICAL/HAZARDOUS MATERIALS

Chemical agents are poisonous vapors, aerosols, liquids, and solids that have toxic effects on people, animals, or plants. They can be released by bombs or sprayed from aircraft, boats, and vehicles. They can be used as a liquid to create a hazard to people and the environment. Some chemical agents may be odorless and tasteless. They can have an immediate effect (a few seconds to a few minutes) or a delayed effect (2 to 48 hours). While potentially lethal, chemical agents are difficult to deliver in lethal concentrations. Outdoors, the agents often dissipate rapidly. Chemical agents also are difficult to produce.

A chemical attack could come without warning. Signs of a chemical release include people having difficulty breathing; experiencing eye irritation; losing coordination; becoming nauseated; or having a burning sensation in the nose, throat, and lungs. Also, the presence of many dead insects or birds may indicate a chemical agent release.

Chemicals are found everywhere. They purify drinking water, increase crop production, and simplify household chores. But chemicals also can be hazardous to humans or the

environment if used or released improperly. Hazards can occur during production, storage, transportation, use, or disposal. Risks result from chemicals being used unsafely or released in harmful amounts into the environment.

Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are used and stored in homes routinely. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Chemical manufacturers are one source of hazardous materials, but there are many others, including service stations, hospitals, and hazardous materials waste sites.

Varying quantities of hazardous materials are manufactured, used, or stored at an estimated 4.5 million facilities in the United States--from major industrial plants to local dry cleaning establishments or gardening supply stores.

Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in plants.

HAZARDOUS MATERIALS EVENTS

Hazardous materials are substances that are either flammable or combustible, explosive, toxic, noxious, corrosive, oxidizable, an irritant or radioactive. A hazardous material spill or release can pose a risk to life, health or property. An incident can result in the evacuation of a few people, a section of a facility or an entire neighborhood.

There are a number of Federal laws that regulate hazardous materials, including: the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Resource Conservation and Recovery Act of 1976 (RCRA), the Hazardous Materials Transportation Act (HMTA), the Occupational Safety and Health Act (OSHA), the Toxic Substances Control Act (TSCA) and the Clean Air Act.

Title III of SARA regulates the packaging, labeling, handling, storage and transportation of hazardous materials. The law requires facilities to furnish information about the quantities and health effects of materials used at the facility, and to promptly notify local and State officials whenever a significant release of hazardous materials occurs.

Location of the Hazard

Hazardous Materials incidents have the potential to occur in every corner of the Commonwealth. A release may occur at a fixed facility or in transit. Communities with a large industrial base may be more inclined to experience a hazardous materials release due

to the number of facilities such materials in their manufacturing process. Communities with several major roadways may be at a greater risk due to the number and frequency of trucks transporting hazardous materials passing through.

Previous Occurrences

Major hazardous materials incidents have occurred throughout the Commonwealth. Specifically the communities of Danvers, MA and South Hadley, MA experienced incidents that required the highest level of response from the State Hazardous Materials Response Teams.

TERRORISM

As defined in the Homeland Security Act of 2002, activity that involves an act that is dangerous to human life of potentially destructive of critical infrastructure or key resources; is a violation of the criminal laws of the United States or of any State or the other subdivisions of the United States's and appears to be intended to intimidate or coercion, or to affect the conduct of a government by mass destruction, assassination, or kidnapping.

Terrorists often use threats to:

- Create fear among the public.
- Try to convince citizens that their government is powerless to prevent terrorism.
- Get immediate publicity for their causes.

Acts of terrorism include threats of terrorism, assassinations, kidnappings, hijackings, bomb scares and bombings, cyber attacks (computer-based), and the use of chemical, biological, nuclear, and radiological weapons.

High-risk targets for acts of terrorism include military and civilian government facilities, international airports, large cities, and high-profile landmarks. Terrorists might also target large public gatherings, water and food supplies, utilities, and corporate centers. Further, terrorists are capable of spreading fear by sending explosives or chemical and biological agents through the mail.

Protecting the citizens of the Commonwealth from the threat of terrorist activity has been a long-standing objective of the Massachusetts Emergency Management Agency. Since 1995, MEMA has conducted multiple anti-terrorism programs, training thousands of local, state, and federal public safety officials; hospital emergency room; and EMA personnel with classes in Anti-Terrorism, Incident Command, and Hazmat Awareness, including Chemical-Biological Threats. To ensure their preparedness, MEMA has conducted hundreds of exercises in conjunction with local communities and other state and federal agencies. Our Planning Department has worked closely with all 351 cities and towns to make certain that their local all hazards Comprehensive Emergency Management (CEM)

Plans are up to date. These local plans include a Terrorism Annex, which helps local officials focus on specific potential Terrorist Threats to their particular community.

Additionally, MEMA is expediting a State Strategic Plan to address issues raised in the on-going Department of Justice assessment of local vulnerabilities. Once completed, the Department of Justice will evaluate local and state needs and make additional equipment, planning and training available through MEMA. We continue to work closely with all federal, state, and local authorities to plan and prepare for any and all types of Terrorist Incidents and to ensure the safety of all of the citizens of Massachusetts.

Overview of Past Federal Emergency and Disaster Declarations

Between 1953 and 2009, FEMA Region 1 (New England States) endured more than 150 federal emergency and disaster declarations. The most significant events within Massachusetts include the following events:

Worcester Tornado	June 1953
Hurricane Diane and Flood	August 1955
Chelsea Conflagration	October 1973
The Blizzard of 1978	February 1978
Lynn Conflagration	December 1981
Hurricane Gloria	September 1985
Hurricane Bob	August 1991
Nor'easter	October 1991
Nor'easter	December 1992
Floods	October 1996
Floods	June 1998
Winter Storm & Floods	March 2001
Winter Storms	Dec. 2003 & Feb 2003
Floods	April 2004
Floods	October 2005
Mother's Day Floods	May 2006
Nor'easter	April 2007
Ice Storm	December 2008

HISTORY OF DISASTER DECLARATIONS

The following information gives an overview of the most recent type of disasters that have led to Presidential and State Disaster Declarations in Massachusetts.

Public Assistance (PA) Project grants. Supplemental disaster assistance to states, local governments, certain private non-profit organizations resulting from declared major disasters or emergencies.
Hazard Mitigation Grant Program (HMGP) - Project grants. To prevent future losses of lives and property due to disasters. Presidential declaration of a major disaster or emergency designated for hazard mitigation assistance.
Individual Household Program (IHP), formerly named IFG - Grants to individuals. To provide funds for the serious needs and necessary expenses of disaster victims NOTE: Individual assistance funding includes loans and grants under the FEMA Disaster Housing, State IFG Program and/or SBA Home and Business Loan Programs.
Community Development Block Grant (CDBG) - Project grants. Community development-type activities for long-term recovery needs (residential/commercial buildings)

Disaster Name	Date of Event	Declared Areas	Disaster #/Type of Assistance	Federal Share Disbursed	Non-Federal Share Disbursed	Total Disbursement
Hurricane Bob	August 1991	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk	FEMA-914-DR-MA (PA)	$28,166,029	$3,924,237	$32,090,266
			FEMA-914-DR-MA (HMGP)	$651,881		$651,881
Severe Coastal Storm	October 1991	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk	FEMA –920-DR-MA (PA)	$7,737,086	$983,661	$8,720,747
			FEMA –920-DR-MA (IHP)	$36,225,970	$581,924	$36,807,894
			FEMA –920-DR-MA (HMGP)	$626,406		$626,406

Disaster Name	Date of Event	Declared Areas	Disaster #/Type of Assistance	Federal Share Disbursed	Non-Federal Share Disbursed	Total Disbursement
Winter Coastal Storm	December 1992	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk	FEMA-975-DR-MA (PA)	$11,929,598	$1,620,619	$13,550,217
			FEMA-975-DR-MA (HMGP)	$400,943		$400,943
Blizzard	March 1993	All 14 Counties	FEMA-3103-EM (PA)	$1,284,873	$183,649	$1,468,522
Microburst Storm	July 1994	Town of Greenfield	STATE (PA)		$59,701	$59,701
Berkshire Tornado	May 1995	Towns of Egermont, Great Barrington, and Monterey; DEM and National Guard	STATE (PA)		$871,633	$871,633
Russell Fire	September 1995	DEM and National Guard	FEMA-2116-EM (PA)	$79,665		$79,665
Russell Fire	September 1995	Towns of Russell, Blandford, Cummington, Huntington, Montgomery, and Southampton	STATE (PA)		$100,000	$100,000
Blizzard	January 1996	All 14 Counties	FEMA-1090-EM (PA)	$16,177,860		$16,177,860
Windstorm	May 1996	Counties of Plymouth, Norfolk, and Bristol (inclusive of 27 communities)	STATE (PA)		$774,388	$774,388
Franklin Co. Rainstorm	June 1996	Towns of Montague, Leverett, Shutesbury, Conway, Wendell, DEM, and National Guard			$2,267,236	$2,267,236
Severe Storms /Flood	October 1996	Counties of Essex, Middlesex, Plymouth, Norfolk, and Suffolk	FEMA-1142-DR-MA (PA)	$21.547.026	$3,430,009	$24,977,035
			FEMA-1142-DR-MA (IFG)	$37,065,539	$478,072	$37,543,611
			FEMA-1142-DR-	$12,262,500		$12,262,500

Disaster Name	Date of Event	Declared Areas	Disaster #/Type of Assistance	Federal Share Disbursed	Non-Federal Share Disbursed	Total Disbursement
			MA (HMGP)			
			CDBG (FY97)	$4,259,911		$4,259,911
Heavy Rain/Flood	June 1998	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, and Worcester	FEMA-1224-DR-MA (IFG)	$20,034,025	$237.243	$20,034,025
			FEMA-1224-DR-MA (HMGP)	$1,769,145		$1,769,145
			CDBG (FY98)	$1,500,000		$1,500,000
Worcester Fire	December 1999	City of Worcester, State Fire Mobilization Communities, and Various State Agencies	FEMA-3153-EM (PA)	$2,733,435		
Tropical Storm Floyd	September 1999	Counties of Hampden, Hampshire, Franklin, Worcester (23 Communities)	State (PA)		$1,690,539.91	$1,690,539.91
Rainstorm	June 25, 2000	Towns of Adams, Cheshire, New Ashford, North Adams, and Williamstown	State (PA)		$316,210.61	$316,210.61
Rainstorm	July 2000	Town of Heath	State (PA)		$180,000.00	$180,000.00
Severe Storms and Flooding	March 2001	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester	FEMA-1364-DR-MA (IFG)	$18,000,000	$213,039.00	$18,213,039.00
			FEMA-1364-DR-MA (HMGP)	$1,562,356.00		$1,562,356.00
Snowstorm	March 2001	Counties of Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, and Worcester. The cost share is 75% federal and 25% local.	FEMA-3165-EM (PA)	$21,065,441.93		$21,065,441.93
Tropical	June 2001	Towns of Hampden, Leominster,	State (PA)		$635,534.00	$635,534.00

Disaster Name	Date of Event	Declared Areas	Disaster #/Type of Assistance	Federal Share Disbursed	Non-Federal Share Disbursed	Total Disbursement
Storm Allison		Monson, Princeton, and Wilbraham				
Rainstorm	June/July 2001	Towns of Bellingham, Millis, and Walpole	State (PA)		$254,968.02	$254,968.02
Terrorist Attack	September 11, 2001	Massachusetts residents who requested crisis counseling services following September 11.	FEMA-1391 (IFG)	$1,500,000.00		$1,500,000.00
Snowstorm	February 2003	All 14 Counties. The cost share is 75% federal and 25% local	FEMA-3175-EM (PA)	$28,868,815.75		$28,868,815.75
Snowstorm	December 2003	Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester	FEMA-3191-EM (PA)	$35,683,865.83		$35,683,865.83
Flooding	April 2004	Counties of Essex, Middlesex, Norfolk, Suffolk, and Worcester	FEMA-1512-DR (IFG)	$2,249,944.41	$62,457.61	$2,566,783.49
			FEMA-1512-DR (HMGP)	$243,225.00		$243,225.00
Snow	January 2005	All 14 Counties	FEMA-3201-EM (PA)	$49,945,087.29		$49,945,087.29
Hurricane Katrina	August 2005	All 14 Counties- 100% federally funded	FEMA-3252-EM (PA)	$5,855,580.73		$5,855,580.73
Severe Storms and Flooding	October 2005	Bristol County (Taunton Dam)	FEMA-3264-EM (PA)	$595,026.34	$56,819.60	$651,845.94
Severe Storms and Flooding	October 2005	Counties of Berkshire, Franklin, Hampden, Hampshire, Worcester	FEMA-1614-DR-MA (PA)	$6,731,194.23	$712, 674.43	$7,443,868.66
		Counties of Berkshire, Franklin, Hampden, Hampshire, Worcester, Middlesex, Plymouth,	FEMA-1614-DR-MA (IHP)	$3,452,361.47	$146,281.79	$3,598,643.26

Disaster Name	Date of Event	Declared Areas	Disaster #/Type of Assistance	Federal Share Disbursed	Non-Federal Share Disbursed	Total Disbursement
		Bristol, Norfolk				
		All 14 Counties. ($710,875.00 = Total Obligated as of 5/1/2009)	FEMA-1614-DR-MA (HMGP)	$67,175.63		$67,175.63
Severe Storms and Flooding	May 2006	Essex and Middlesex Counties	FEMA-1642-DR-MA (PA)	$17,285,547.98	$5,530,431.10	$22,815,979.08
		Essex, Middlesex, and Suffolk Counties	FEMA-1642-DR-MA (IHP)	$18,355,115.63	$452,777.98	$18,807,893.61
		All 14 Counties ($2,321,506.00= total obligated as of 5/1/2009)	FEMA-1642-DR-MA (HMGP)	$240,510.00		$240,510.00
Severe Storms & Inland/Coastal Flooding	April 2007		FEMA-1701-DR-MA (PA)	$8,769,388.54	$2,805,305.76	$11,574,694.30
		All 14 Counties ($491,440.00 total obligated as of 5/1/2009)	FEMA-1701-DR-MA (HMGP)	TBD		TBD
Severe Winter Storm	December 2008	Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, and Worcester.	FEMA-3296-EM-MA			
Severe Storms and Flooding	December 2008	Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, and Worcester. ****Figure as of 9/8/2009	FEMA-1813-DR-MA (PA)	$66,509,713.79	TBD	TBD
		All 14 Counties (6 month lock-in $7,200,000)	FEMA-1813-DR-MA (HMGP)			

RECENT PRESIDENTIAL DISASTER DECLARATIONS

Since 2007, there have been two major disaster declarations in Massachusetts. In April 2007 a nor'easter hit Massachusetts causing flooding and coastal erosion and in December 2008 a severe ice storm caused tree and infrastructure damage resulting in widespread power and utility outages.

PATRIOT'S DAY NOR'EASTER

FEMA-1701-DR-MA

"Flooding from the weekend nor'easter caused varying degrees of problems in Townsend causing us to declare a state of emergency yesterday."

Townsend Board of Selectmen

Quote from Worcester Telegram & Gazette

During the 111th Boston Marathon on Patriot's Day, Monday, April 16, 2007 forecasts included watches for rain showers and low temperatures, alerting emergency management of the possible health concerns for runners. The storms forecast elevated to a much more intense storm very quickly. Heavy rains and high wind warnings continued throughout Marathon day. High wind warnings and flood watches issued by the NWS combined with extraordinary high tide cycles caused the State Emergency Operations Center (SEOC) in Framingham, and Regional Offices in Tewksbury and Bridgewater to activate at a Level III or full activation. MEMT liaisons were at the SEOC and 24-7 Operations were underway.

This relatively brief storm triggered the Massachusetts Emergency Management Agency to request a Preliminary Damage Assessment in 12 counties for Public Assistance and Small Business Administration Loan Program. These assessments indicated the most severe impacts were to public infrastructures including access roadways, bridges, seawalls, sand barriers and revetments impacting hundreds of residents.

Coastal flood and high winds caused severe erosion to much the coastline. Additionally, several coastal homes were washed into the ocean due to damaging erosion and hundreds more homes remain at risk. Many rivers and streams rose to levels far above flood stage forcing hundreds of road closures, power outages, numerous evacuations and sheltering of residents. During the peak of the storm, approximately 90,000 customers were without power statewide. Fortunately, the storm struck during most of the state's public school spring vacation week, therefore few schools had to closed due to this event. This storm did bring severe financial hardship to those communities that experienced flood events of May 2006 and October 2005 who were still recovering from the damaged caused during those events.

DECEMBER ICE STORM

FEMA-1813-DR-MA

"I have never seen anything like this in 30 years where the entire town is without power."

Deputy Chief Peter Bergstrom, Town of Holden Fire Department
Quote from Fox News

A cold frontal boundary dropped south of New England on the evening of December 10, 2008. Low pressure developed along the frontal boundary across the southeastern states late on the night of the 10th into the 11th. The low then tracked rapidly to the northeast, spreading a significant amount of precipitation into New England. A deep layer of warm air aloft and sub-freezing air at the surface resulted in a major ice storm across interior Massachusetts and southern New Hampshire as well as much of northern New England.

Up to an inch of ice accumulated on exposed surfaces, which resulted in the downing of thousands trees, branches, power and phone poles, and wires across eight counties including; Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, and Worcester Counties. The hardest hit areas in southern New England were the Monadnock region of southwest New Hampshire, the Worcester Hills in central Massachusetts, and the east slopes of the Berkshires in western Massachusetts. Damages to the impacted areas in Massachusetts totaled more than $60 million in federal reimbursements and insurance claims.

Many trees fell on cars and houses as well as blocked roads, which resulted in the closure of many major roads including several sections of Interstate Highway. In addition to the weight of the accreted ice, this storm carried especially breezy conditions, which exacerbated the number of downed trees, branches, and power lines and resulted in widespread power outages. More than 300,000 customers were reportedly without power in Massachusetts. Because of the breadth of this storm (from Pennsylvania to Maine), light and power crews from states as far away as Tennessee and South Carolina were called in to help with power restoration and clean up. While most people had their power restored within a week, others were still without power at Christmas (nearly 2 weeks later). During this period, temperatures were mostly below normal and at least one major snowstorm affected the same area. At the time of the December 19th snowstorm, over 100,000 customers were still without power in the two states combined. Most communities in the impacted region had opened shelters to provide a warm, safe place for residents and hundreds of schools were closed. The extent of the damage and number of people affected prompted the governors of both Massachusetts and New Hampshire to request federal disaster assistance. FEMA approved both requests. President Bush issued a Major Disaster Declaration for Public Assistance for seven Massachusetts counties and all of New Hampshire.

Future Natural Hazards

CLIMATE CHANGE IMPACTS ON MASSACHUSETTS [18]

According to the National Academy of Sciences, the Earth's surface temperature has risen by about 1° Fahrenheit in the past century, with accelerated warming during the past two decades.

More detailed information may be found on the Massachusetts Environmental Protection Agency's website at http://www.mass.gov/dep/air/climate/

Climate change is a shift in long-term weather patterns: temperature, precipitation, wind, and more. There is scientific consensus that our climate is changing, largely as a result of human activities. These include the combustion of fossil fuels, which increases atmospheric concentrations of:

Carbon dioxide (CO_2),
Methane (CH_4),
Nitrous oxide (N_2O), and
Other heat-trapping gases

These greenhouse gases form a "blanket" of pollution that traps heat in the atmosphere and causes climate instability characterized by severe weather events such as storms, droughts, floods, heat waves, and rising sea levels.

Climate change is a worldwide concern because, if it continues, there will be significant impact on people, natural resources, and economic conditions around the globe. While the magnitude of these potential changes is difficult to predict, there is broad agreement that they are coming and will dramatically affect many aspects of our daily lives.

If local climate trends continue as projected, weather patterns in Boston may, within the next 50 to 100 years, more closely resemble those now found in Richmond, Virginia, or Atlanta, Georgia.[19] Climate change on this scale would have wide-ranging consequences for everyone in Massachusetts. Predicted impacts of climate change in the New England area are:

- Warmer annual temperatures - up 2ºF since 1970

[18] Global Warming Fact Sheet for Massachusetts from the EPA, found in Appendix H and the Massachusetts Climate Protection Plan, Spring 2004

[19] For more information see MassDEP www.mass.gov/dep

- Warmer winters – up 1.3ºF per decade since 1970
- Decreasing winter snowpack
- Earlier flowering plants
- More frequent extreme summer heat

Increased Temperature and Precipitation:

- By 2100, temperatures in Massachusetts could increase by about 4◦ F (with a range of 1-8◦ F) in winter and spring and about 5° F (with a range of 2-10◦ F) in summer and fall.
- By 2100, precipitation in Massachusetts is estimated to increase by about 10% in spring and summer, 15% in fall, and 20-60% in winter.

Increased Risks to Public Health

- A temperature increase of 4◦ F, with no other change in weather or emissions, could increase concentrations of ground-level ozone, a major component of smog, by 4%. Currently in Massachusetts, ground-level ozone concentrations already exceed national ozone health standards. Ground-level ozone aggravates respiratory illnesses such as asthma, reduces existing lung function, and induces respiratory inflammation.
- An increase could occur in Massachusetts in the transmission and/or incidence of diseases including malaria, Eastern equine encephalitis, dengue fever and Lyme disease because ticks, their rodent hosts, and mosquito populations will likely increase due to the warmer temperatures and increased vegetation.
- Warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms (so-called red tides), which are toxic to humans, and will damage Massachusetts shellfish habitat and nurseries and spread bacteria like those causing cholera.
- Warmer summer temperatures could increase water quality problems because of increased evaporation, which concentrates pollutant levels, and more favorable conditions for algae and other water organisms.

Harm from Sea Level Rise

- At Boston, sea level already is rising by 11 inches per century, and it is likely to rise another 22 inches by 2100.
- Sea level rise could cause flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges in Massachusetts.

Global Warming Solutions Act

In August 2008, Governor Deval Patrick signed into law the Global Warming Solutions Act (GWSA), making Massachusetts one of the first states in the nation to move forward with a comprehensive regulatory program to address Climate Change.

The GWSA requires the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA), in consultation with other state agencies and the public, to set economy-wide greenhouse gas (GHG) emission reduction goals for Massachusetts that will achieve:

- A reduction of between 10 percent and 25 percent below statewide 1990 GHG emission levels by 2020; and
- A reduction of 80 percent below statewide 1990 GHG emission levels by 2050.

To ensure that these goals will be met, the Global Warming Solutions Act requires the Commonwealth to:

1. Establish regulations requiring reporting of greenhouse gas emissions by the Commonwealth's largest sources by January 1, 2009. These reports will provide important data about the actual types and levels of GHG emissions in the Commonwealth.
2. Establish a baseline assessment of statewide GHG emissions in 1990, which will be used to measure progress toward meeting the emission reduction goals of the Act. The Legislature chose 1990 as the base year for these measurements because it is the base year used by many local, state and international climate agreements (including the Kyoto Protocol).
3. Develop a projection of the likely statewide GHG emissions for 2020 under a "business as usual" scenario that assumes that no targeted efforts to reduce emissions are implemented. This projection estimates the levels of greenhouse gas emissions that will come from Massachusetts sources if no government action is implemented to require reductions, and will be used to analyze the extent of emission reductions that will be required to achieve the 2020 target established in the Act.
4. Establish target emission reductions that must be achieved by 2020, and a plan for achieving them. The GWSA requires that these must be established by January 1, 2011.
5. Through an advisory committee, analyze strategies and make recommendations for adapting to climate change. The GWSA requires that the committee reports to the Legislature by December 31, 2009.

Energy and Environmental Affairs Secretary Ian Bowles has established two advisory committees to provide input on the implementation of the GWSA. The Climate Protection and Green Economy Advisory Committee (created under the GWSA), which is charged

with advising the Executive Office of Energy and Environmental Affairs on measures to reduce greenhouse gas emissions in accordance with the GWSA, and the Climate Change Adaptation Advisory Committee (also created under the GWSA), which is charged with studying and making recommendations regarding strategies for adapting to climate change. This adaptation subcommittee has active members from emergency management and the Floodplain Management Programs. For more information on any of these above initiatives or Massachusetts work on climate change adoption see the MassDEP Website: http://www.mass.gov/dep/air/climate/

Secondary Effects of Hazard Events

Some hazards can be a resulting effect due to the occurrence of another hazard. For example, an earthquake could trigger fires, landslides, floods, ground liquefaction or a tsunami. In another example, if an area is experiencing drought conditions, it is at risk to the secondary effect of wildfire in the region. Each hazard identification description in Section 4.1 identifies the most important risks associated with that individual natural hazard. As a part of the ongoing maintenance and enhancements of this plan, a matrix has been developed to better understand the nexuses among different hazards and the mutual effects that arise when one hazard triggers another. This type of analysis shows that most hazards do not just have a singular risk factor. In fact, all hazards identified below have at least one or more risks associated.

SECONDARY HAZARD EFFECTS MATRIX

Primary Hazards	Structural Damage	Utility Outage	Chemical Release/ Spill	Commodity Shortages	Emergency Comm. Failure	Erosion	Structural Fire	Mold	Carbon Monoxide Poisoning	Disease	Flooding	Landslide	Dam Failure	Storm Surge	Tornado	Wildfire	Hail	Tsunami
Coastal Erosion	X										X	X						
Coastal Flooding	X		X			X		X		X		X						
Inland Flooding	X	X	X			X		X		X		X	X					
Hurricane/ T.S.	X	X	X	X	X	X		X	X	X	X			X	X			
Tornado/ Downburst	X	X	X					X										
Major Thunderstorm/ lightning		X					X								X	X	X	
Earthquake	X	X	X	X	X		X		X			X	X					X
Winter Storms/nor'easters	X	X		X		X	X		X		X			X				
Ice Storms	X	X		X	X		X		X									
Ice Jam	X										X		X					
Landslide	X					X												
Wildfires	X						X											
Tsunami	X	X	X	X		X		X		X	X							
Major Urban Fire	X	X	X															
Drought				X												X		
Epidemic / Pandemic Disease				X														

Table 14: This matrix is designed to illustrate the identified hazards or primary hazards and possible secondary impacts or effects of those hazards.

4.2 Overview of Massachusetts Potential Vulnerability

The vulnerability analysis considers all natural hazards that have occurred or may potentially occur in Massachusetts. To depict the results of the Risk & Vulnerability Assessment a Natural Hazards Vulnerability Matrix has been developed based on the best available scientific and historical data on past hazard event damage, subject matter expertise of the committee members, and a comprehensive review of existing documentation and reports.

The 2010 Update included a complete review of the criteria used to analyze the vulnerability for hazards. The assessment was conducted by Interagency Committee and State Hazard Mitigation Team Members , based on the hazard identification and hazard profile of the natural hazards identified. For this update the team incorporated changes from local and regional mitigation plans as well as the Inter State Planning Analysis completed by the Northeast States Emergency Management Consortium (NESEC) in 2009. There were no substantial changes in the actual risk or vulnerability of natural hazards in the last three years. The SHMT was however able to refine the analysis with better data and input from local plans, NESEC, and the Workgroups.

The most significant alteration in this analysis is the fourth criteria of vulnerability, Area of Occurrence, detailing the areas that are likely to experience this type of event in the future. This is an improvement provides a distinction between the location in the Commonwealth where this hazard is likely to occur and the size , extent, or impact a particular event is likely to have. An example would be a flood even could occur in any part of the state (area of occurrence) but any one even is likely to be regionalized (area of impact).

In the matrix the shaded areas with "X", indicate the likely level of frequency, severity, extent, and likely hood of occurrence of each hazard. The "P" designates the potential for the hazard to reach a higher level as indicated. In this assessment public infrastructure is defined as roads, bridges, trains, airports, public parks, etc and essential services are utilities, hospitals, schools, etc. The following is a description of the criteria and categories used to create this assessment.

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

Severity Categorization
Minor: Limited and scattered property damage; limited damage to public infrastructure and essential services not interrupted; limited injuries or fatalities.
Serious: Scattered major property damage; some minor infrastructure damage; essential services are briefly interrupted; some injuries and/or fatalities.

Extensive: Widespread major property damage; major public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and/or fatalities.
Catastrophic: Property and public infrastructure destroyed; essential services stopped; numerous injuries and fatalities.

Area of Impact (extent of impact on any locality for a particular event)
Isolated: a single whole or partial community impacted
Local: One community to several communities impacted
Regional: many communities to a county impacted
Widespread: multiple counties impacted

Area of Occurrence (the areas and the size of the areas that are likely to experience this type of hazard in the future)
Isolated: Scattered areas around the state can experience this hazard
Regional: Multiple communities and counties can experience this hazard
Statewide: The entire state can experience this hazard

Massachusetts Potential Vulnerability to Future Natural Hazards

	Frequency				Severity				Area of Impact				Area of Occurrence		
	Very Low	Low	Medium	High	Minor	Serious	Extensive	Catastrophic	Isolated	Local	Regional	Widespread	Isolated	Regional	Statewide
Flood				☒		☒		P			☒				☒
Dam Failure	☒						☒	P		☒				☒	
Coastal Hazards				☒		☒	P				☒			☒	
High Wind				☒	☒		P				☒				☒
Hurricane/ Tropical storm			☒			☒		P				☒			☒
Thunderstorm				☒	☒		P				☒				☒
Tornado			☒			☒	P			☒					☒
Nor'easter				☒	☒		P					☒			☒
Snow and Blizzard				☒	☒		P					☒			☒
Ice Storm			☒		☒		P				☒				☒
Major Urban Fires		☒			☒	P			☒						☒
Wildland Fire			☒		☒		P			☒				☒	
Drought		☒			☒	P						☒			☒
Extreme Temperature			☒		☒	P						☒			☒
Earthquake	☒					☒		P			☒				☒
Landslide		☒			☒		P			☒					☒
Tsunami	☒						☒	P				☒		☒	

Table 15 . Potential Vulnerability to Natural Hazards. This symbol ☒ represents the vulnerability ranking established for this hazard mitigation plan update. This symbol P denotes the *worst case scenario potential* for a given hazard.

4.3 Assessing Vulnerability by Jurisdiction

In the previous section, the natural hazards that have occurred and are most likely to occur in Massachusetts have been described and reviewed. This section will provide additional information on where natural hazards may impact a particular jurisdiction.

For this plan update, extensive GIS analysis was performed integrating information from more than seventy federal, state, and local sources. Maps have been produced to illustrate areas at risk to natural hazards, see appendix 4 for copies of the hazard maps.

It is important for the state to understand the vulnerabilities that each hazard presents in addition to the areas in the state most vulnerable to these hazards. In addition to the GIS analysis and other statewide information, the following data was derived and supplements some of the statewide analysis. This table represents jurisdictions with a unique or varied risk compared to that of the overall statewide level analysis.

Middlesex and Essex Counties have had the highest number of declared flood events.
According to a 1999 study of USACE and FEMA data, of the country's 3043 counties, Worcester County, has the greatest number of dams, 425[20].
Historically, Farmington River-West Branch, Marsh Brook, Millers River, Quaboag River, and Westfield River-Middle Branch have had the greatest risk of ice jams. Most of the rivers where the jams occurred are in the western half of the state.
Each area of the coast is impacted differently by each type of coastal hazard and has varying vulnerability. The coastal zones are North Shore, Boston Harbor/Massachusetts Bay, South Shore, Cape Cod and Islands, and South Coast.
The coast is most frequently impacted by damage due to high wind events.
The entire state is vulnerable to hurricanes and tropical storms, dependent on the storm's track. The coastal areas are more susceptible to damage from these storms.
The area at greatest risk for a tornado touchdown runs from central to northeastern Massachusetts.
Higher snow accumulations are more prevalent at higher elevations in Western and Central Massachusetts, and along the coast where snowfall can be enhanced by additional ocean moisture.
Ice storms more frequently occur in the higher elevations of Western and Central Massachusetts.
The southeastern part of Massachusetts, Plymouth County to the Southern coast of Bristol County, Cape Cod and Martha's Vineyard, are more susceptible to wildland fires due to the availability of fuel, impact from off shore winds, and past events.
Colder temperatures and extremes are more common in the higher elevations.

[20] Graf, William L. *Dam nation: A geographic census of American dams and their large-scale hydrologic impacts*. Water Resources Research, Vol. 35, No. 4, Pages 1305–1311, April 1999

Western Massachusetts may be more vulnerable than eastern Massachusetts to severe drought conditions.
Northeastern Massachusetts, especially along the Massachusetts coastline from the northern portion of Plymouth County through the Boston Metropolitan area to the New Hampshire border, has greater vulnerability to potential earthquake activity than the rest of the state
The Connecticut River Valley in western Massachusetts, and the greater Boston area have the highest risk to landslide.
All of the coastal areas of Massachusetts are equally exposed to the threat of tsunamis.

Table 16 Is a representation of the jurisdictions with a unique or varied risk compared to that of the overall statewide level analysis

Development and Growth by Jurisdiction

Massachusetts has a population of approximately 6 million people sharing a geographic space of approximately 5 million acres. Over two-thirds of the population inhabits communities east of the City of Worcester.

To understand exposure to natural hazards it is important to consider population trends and projections. Statewide population trends indicate a slow increase in population growth and development, 6% slower than the national average[21]. Massachusetts is expected to have an increase of only 3% population by the year 2020[22]. From 2000 to 2009, Massachusetts' population grew by about 250,000 people, or 3.8%.[23] Table 16 shows the population growth by jurisdiction from 2000 to 2009. Highest growth took place in Suffolk and Worcester County. By 2020, the population is only anticipated to reach 6,767,732, only about 172,000 more people than presently reside in Massachusetts. The growth projection for the next decade is actually less than the last decade.

Jurisdictions (Counties)	2009 Population	2009 Housing Units	2000-2009 Population change	2020 Estimated Population	Percent change 2009-2020
Barnstable	221,151	155,686	-1,083	299,035	35%
Berkshire	129,288	68,539	-5,665	118,452	-8%
Bristol	547,433	225,670	12,480	576,868	5%
Dukes	15,974	16,381	987	21,822	37%
Essex	742,582	299,508	19,161	787,032	6%
Franklin	74,778	33,362	3,243	73,806	-1%
Hampden	471,081	191,380	14,855	453,115	-4%
Hampshire	156,044	61,949	3,789	163,233	5%

[21] US Census, 2009.

[22] Mass Benchmark. Donahue Institute. University of Massachusetts www.massbenchmarks.org, 2009.

[23] Mass Benchmark. Donahue Institute

Jurisdictions (Counties)	2009 Population	2009 Housing Units	2000-2009 Population change	2020 Estimated Population	Percent change 2009-2020
Middlesex	1,505,006	598,481	38,610	1,469,494	-2%
Nantucket	11,322	10,657	1,802	14,426	27%
Norfolk	666,303	266,793	15,997	652,440	-2%
Plymouth	498,344	194,237	25,522	517,664	4%
Suffolk	753,580	305,127	63,771	776,811	3%
Worcester	803,701	320,551	53,728	843,534	5%
Statewide Total	**6,596,587**	**2,748,321**	**247,197**	**6,767,732**	**3%**

Table 17. Population Growth Projections by County

Some jurisdictions are experiencing growth and development at a slightly faster rate than the state average due to numerous factors, however, statewide there is no increase in development that is significant. New residential and commercial development has not experienced significant change at the statewide level; therefore, local hazard mitigation plans are required to reflect changes in development in hazard prone areas.

To analyze the vulnerability of jurisdictions by current and future development the SHMT consults the analysis completed in local and regional Multi-hazard Mitigation Plans. As part of the plan update process, the state looked at changes in growth and development. Also reviewed were notable and important trends identified in the review of the regional hazard mitigation plans. The results of the review of the local mitigation plans are in Table 18. It is helpful for the State Hazard Mitigation Team to review these trends in consideration of where to prioritize outreach and planning initiatives. Based on these estimates it is not likely that the natural hazard risks statewide will increase rapidly. However in the jurisdictions experiencing growth, the hazards may be locally exacerbated.

Jurisdictions	*Local Assessments of Development and Growth*
Berkshire	This region consists of 30 towns and 2 cities and has a total population of 134,953, which is a decrease of 3.2% since 1990. Only 8% of the county is developed mostly due to its topography. The population density is 140 persons per square mile. Growth is defined as being on a declining trend overall due to major industry and jobs relocating out of the county. Pittsfield is the largest community in the county.

Jurisdictions	*Local Assessments of Development and Growth*
Cape Cod	This region consists of 15 towns, has a total population of 223,000 and has a density of about 540 persons per square mile. There is a large summer populations on the Cape with estimates reaching over 500,000. About 44% of the land is developed; leaving about 17% as developable. However this does not account for areas with current conservation/wetlands restrictions or other restrictions. Considering only current zoning and land use regulations the region could reach it's maximum build out by 2040. One unique feature of this region is that it is only accessible through the two four-lane bridges at the Cape Cod Canal.
Central Mass Regional	Plan not available at time of this analysis
Franklin County	This region consists of 26 communities, has a total population of 71,535 and has a population density of 98.6 people per square mile; making it the most rural county in MA. In addition, 16 of 26 communities have a per capita income lower than the national average, and 20 of 26 have a per capita income less that the state average. The largest community is Greenfield, in the center of the county with a population of about 18,000. 18 of the 26 towns have a population fewer than 2,000. The county's population growth has slowed significantly since 1980. For some communities the population decline is considerable. Only 5.2% of the county is developed residential and .4% is commercial.
MAPC Urban Core	This region consists of 1 town and 8 cities, has a total population of 1,037,437, and has a density of 11,463 persons per square mile. This region includes the City of Boston, which is the largest city in the state and it's capital. There are about 441,300 housing units. Of those, 51% were built before 1940 indicating that many are pre-NFIP and other regulatory tools. The total residential land use is about 25,000 acres (43%) in these 10 communities.
MAPC South Shore	This region consists of 9 towns and 1 city, has a total population of 304,373, and has a density of 2,005 persons per square mile. There are about 129,500 housing units. The total percentage of residential land use ranges from 32% to 59% in these 10 communities. This region has 21.7 Square miles on non-contagious land which is considered developable (13,910 acres) but is 86% built out.
MAPC North Shore	This region consists of 5 towns and 5 cities, has a total population of 347,947, and has a density of 4,334 persons per square mile. There are about 142,500 housing units. The total percentage of residential land use ranges from 37% to 72% in these 10 communities. This region has 10.8 Square miles on non-contagious land, which is considered developable (6,948 acres).
MAPC Metro North West	Plan not available at time of this analysis
MAPC Upper North Shore	Plan not available at time of this analysis
MAPC Metro South West	Plan not available at time of this analysis

Jurisdictions	*Local Assessments of Development and Growth*
Merrimack Valley	This region consists of 15 towns and cities, has a total population of 318,556, and has a density of 1,193 persons per square mile. Based on a regional build out analysis there is the potential to add 27% more persons to this region. Single family residential units are the principle form of growth in this region with an average of about 1000 new homes per year since 1980. 40% of the region's population is in two communities, Lawrence and Haverhill.
Nantucket	This island community has a population of 9,520. There is a stable increase in population over the past 5 years. There are 212 people per square mile. Unlike most coastal communities in the US, residential development is not concentrated on the coastline, mainly due to conservation and current zoning. Large developments are low; most of the increases are seen in individual residential developments. There is approximately 100 new residential developments per year, including single and multi-unit development.
Northern Middlesex	The 9 communities of this region have a population of 281,000, and an average density of 1,400 people per square miles. The City of Lowell accounts for 37% of the region's population and is the largest community. In 2010, there were 296,000 households in the region. During the 1990s, new subdivisions occupied 7,241 acres of land incorporating 5.8 % of the region's total land area. The trend toward urbanization/suburbanization of the region has implications for natural hazard planning. As more land is developed, additional impervious surface is created, potentially increasing the flood risk and decreasing the area available for flood storage.
Old Colony	This region consists of 15 towns and cities, has a total population of 321,515 and has a density of 929 persons per square mile. The largest community in the region is Brockton with a population of 94,304. The region grew about 8% between 1990-2000, less than the national average of 13.2%. Residential growth is estimated to occur at a fast rate in the less populated communities in the region. There has been recent growth in commercial and retail development in the region. Though most is not in or near the floodplain there are some developments in or near the scrub oak and pitch pine forest, which could increases wildland fire risk.
Martha's Vineyard	This island region is comprised of 7 towns on several islands with a population of 15,000 off-season and a summer population of 75,000. In the next 50 years, development could increase more than 53% in currently developable areas. However this estimate is unlikely because it does not account for areas with current conservation restrictions or agricultural restrictions.
PVPC Hampden/Hampshire County	This region consists of 43 towns and cities, has a total population of 608,000, and has a density of 506 persons per square mile. Growth is defined as being fairly stable with minor urban sprawl around Springfield, Northampton, and Westfield in the form of residential development. The Pioneer Valley is experiencing a unique form of growth called "sprawl with out population growth," due to a variety of factors. Undeveloped farmland conversion rose at a rate of 48%, but this rate of development is not sustainable due to the nearly stable population in the region.

Jurisdictions	*Local Assessments of Development and Growth*
Montachusett Region	This region consists of 22 towns and cities, has a total population of 228,005, and has a density of 337 persons per square mile. The largest communities are Fitchburg, Leominster and Gardner. Growth is defined as slowly increasing at about 6% between 1990-2000, less than the national average of 13.2%. New residential development is important and "Approval Not Required" is a major trend in residential development. Only 50 square miles of 100-year flood zone are in the region.
SRPEDD	This region includes 27 communities, 23 are towns and 4 are cities. The regional population is 600,000 with the population being dispersed from the smallest community Rochester 4,581 persons to New Bedford with 93,768. There are 765.5 people per square mile in this region. The 6 coastal communities have an increased summer population due to tourism. From 1990-2000 the population's growth percentage was 6.1%, less than the national average of 13.2%. In a 1999, 42.7% of the region is considered urbanized or built out, 20.6% is considered developable, 37% is not developable or protected.

Table 18. Local Assessments of Development and Growth from regional and multi-jurisdictional plans.

There are several state and regional agencies that monitor and assist communities as needed with changes or modifications to existing codes and regulations. The Executive Office of Energy and Environmental Affairs (EOEEA) is the agency responsible for analysis statewide growth and its impacts. Representatives from EOEEA sit on the State Hazard Mitigation Interagency Committee, which provides input to this plan. For more information on the statewide build-out analysis, see appendix 10.

Flood Vulnerability

National Flood Insurance Claim and Repetitive Losses

The National Flood Insurance Program Repetitive Loss and Severe Repetitive Loss (SRL) Property Data is a useful tool to determine the location of areas vulnerable to flood and severe storm hazards. The majority of the Repetitive Loss and SRL properties are located in eastern Massachusetts in the Counties of Barnstable, Essex, Middlesex, Norfolk, Plymouth, and Suffolk.

NATIONAL FLOOD INSURANCE PROGRAM REPETITIVE LOSS AND SEVERE REPETITIVE LOSS PROPERTY DATA

	2006			2009			2006-2009Changes		
Community	SRL Properties	RL Properties	RL Claims	SRL Properties	RL Properties	RL Claims	SRL Properties	RL Properties	RL Claims
Scituate	50	502	1504	52	503	1551	+2	+1	+47
Revere	16	274	873	16	288	935	0	+14	+62
Hull	6	230	680	7	235	713	+1	+5	+33
Marshfield	3	155	419	3	156	442	0	+1	+23
Quincy	1	131	364	1	144	408	0	+13	+44
Winthrop	1	139	386	5	136	396	+4	-3	+10
Nantucket	1	45	106	1	47	113	0	+2	+7
Nahant	1	45	123	1	46	133	0	+1	+10
Duxbury	1	39	107	1	42	121	0	+3	+14
Billerica	1	38	104	1	41	110	0	+3	+6
Peabody	0	30	105	1	37	131	+1	+7	+26
Swampscott	1	37	107	1	37	108	0	0	+1
Plymouth	2	33	86	2	34	91	0	+1	+4
Falmouth	0	32	72	0	34	76	0	+2	+4
Newton	2	29	77	2	30	81	0	+1	+4

Table 19. Top fifteen repetitive loss communities, ordered by number of RL claims. Data as of December 2009.

During this plan update the State Hazard Mitigation Team examined vulnerability by analyzing the statewide hazard analysis maps as well as regional and local data assessments. The process in place for data to be integrated, includes GIS data and data tables created from the local plans. All communities that have approved plans send their GIS database to the Massachusetts Emergency Management Agency, which integrates that into the statewide data layers. Section 6 provides a full summary of the Regional and Local Plan Integration.

Hurricane and High Wind Vulnerability

An analysis was compiled of all police stations and Emergency Operations Centers (EOC's) that are located within a SLOSH Zone. The following facilities are either within the SLOSH zone or within less than 1 mile of a SLOSH zone. Please see appendix 4 for maps.

Barnstable County Sheriff	Dartmouth Police Dept	Salem Police Dept
Boston Police Frontage Rd	Manchester Police Dept	Salisbury Police Dept
Boston Police Harbor Patrol	Marion Police Dept	Sandwich Police Dept
Boston Police Harrison St	Medford Police Dept	State Police Revere
Boston Police Gibson St	Nantucket Police Dept	State Police Logan
Boston Police Paris St.	New Bedford Police Dept.	State Police Medford
Bourne Police Dept	Oak Bluffs Police Dept	State Police Ted Williams Tunnel
Buzzards Bay Police Dept	Provincetown Police Dept	State Police Sumner Tunnel
Chilmark Police Dept	Quincy Police Dept	Suffolk County Sheriff

Note: The State Police Stations are also included the DCAM data sets under State Facilities in the next section.

In addition to the state programs, Massachusetts' partners with the Rhode Island Department of Environmental Management and the John H. Chaffee Blackstone Valley National Heritage Corridor Commission in a watershed build-out analysis for the Blackstone River Watershed. This project is on going. For more information, visit the EOEEA website at www.mass.gov/envir.

4.4 Assessing Vulnerability & Estimating Potential Losses of State Facilities

The Commonwealth of Massachusetts owns and operates more than 6,000 properties and facilities across the state. The Massachusetts Department of Capital Asset Management (DCAM) is the department responsible for comprehensive services to state agencies in the fields of public-building design, construction, maintenance, and real estate. DCAM manages a comprehensive electronic inventory of state owned property infrastructure and critical facilities. In addition to the DCAM facility database, locations are also maintained by some individual state and quasi-state agencies such as state college dormitories and parking facilities.

In 2002, the state retained a consultant to perform the first statewide hazard analysis for state owned property using a previous version of this database. For this update, the MEMA GIS Staff worked with DCAM to evaluate digitally enhanced and GPS corrected data for state facilities. This data was then analyzed with GIS software. This analysis was conducted using best available data. For some hazards, statewide GIS layers were not available or were not compatible to this type of analysis and are covered in a qualitative or descriptive manner.

Another indicator of vulnerability by jurisdiction to natural hazards is to assess the potential losses to state facilities. For this plan the potential losses are shown within this section. The DCAM facility database, was used to obtain the loss estimates for this plan in November 2009. More recent financial information is not available at this time and it has been determined that the 2007 figures are still applicable due to the recent real estate and financial recession.

Vulnerability of State Facilities by Flood Related Hazards

To assess the vulnerability of the state-owned facilities identified in the DCAM database an analysis was conducted with the FEMA DFIRM and Q3 flood data, where available. This data includes the locations and boundaries of the FEMA flood zones, including the 100-year flood zones or 1% annual chance (including both A zones and V zones.) Using ArcMap, GIS software, this data was overlaid with the state-owned facility data from DCAM; and the appropriate flood zone determination was assigned to each facility. When applicable the newest FEMA FIRM or DFIRMs are used in this analysis, include Preliminary DFIRMS. Franklin County does not have Q3 FIRMS but developed a digital floodplain layer based on the effective paper maps.

Structures located within the coastal high hazard area, or V-zone, were assigned a level of high risk to reflect the high levels of damage that can be sustained due to the forces of associated waves. Structures located outside of the V-zone but within the 100-year flood zone, or A-zone, were assigned a moderate risk. Structures located in the 500 year or .2% annual chance or occurrence are assigned a low risk due to the infrequent occurrence.

The study that was performed to analyze flood risk of state facilities shows that there are five counties with at least one or more state facilities in a V-zone. The V zone on the new DFIRMs increased the number of state-owned structures in Essex and Plymouth Counties. This is most likely due to the new DFIRMs improved level of accuracy. In the A-zone analysis all mainland counties have property in an A zone. The Islands have fewer A-zones and state owned facilities. All counties with a 500-year flood zone delineated have at least one structure in this low risk zone. Again this analysis is much more refined since the 2007 plan due to improved DFIRMS in a number of counties. Current replacement cost are not

available, this analysis uses 2007 building replacement values to estimate potential losses of state owned facilities.

County	Number of DCAM Buildings in V-Zone	Number of DCAM Buildings in A-Zone	Number of DCAM Buildings in 500 yr-Zone	Estimated Building Replacement Cost
	2009			April 2007
Barnstable	4	16	0	$64,915,500
Berkshire	0	18	3	$7,365,485
Bristol	15	22	4	$107,538,324
Dukes	1	0	1	0
Essex	1	22	19	$38,534,447
Franklin	0	1	-	$10,907,370
Hampden	0	12	13	$1,373,630
Hampshire	0	14	7	$72,890,168
Middlesex	0	40	17	$166,678,526
Nantucket	0	0	3	0
Norfolk	0	25	13	$17,583,618
Plymouth	11	12	11	$89,963,517
Suffolk	0	28	7	$127,815,569
Worcester	0	23	6	$58,515,403
Total	32	233	104	$764,081,557

An analysis was also undertaken to determine which state agencies had facilities in the flood zones. The following table shows the relevant state agency that manages, leases, or occupies the majority of the build or structure. Twenty-seven agencies have buildings or structures in a flood zone. The Department of Conservation and Recreation (DCR) operates numerous flood control and water recreation areas, which account for a large number of the structures in the flood zone.

Agency	500 year	A-Zone	V-Zone	Grand Total
Department of Conservation and Recreation	21	124	26	171
Department of Transportation Highway Division	11	31	3	45
Department of Corrections	12	11		23
MassWildlife	4	17		21
Massachusetts Maritime Academy		12	3	15
UMass Amherst	11	1		12
Department of Developmental Services	4	7		11

Agency	500 year	A-Zone	V-Zone	Grand Total
Salem State College	9	2		11
Military Division	8	2		10
Department of Environmental Protection	6			6
Essex County Sheriff's Department	6			6
UMass Lowell	2	4		6
Department of Mental Health		5		5
Trial Court		5		5
UMass Boston	3	1		4
Department of Public Health		3		3
Massachusetts Commission for the Deaf	2			2
Division of Capital Asset Management	2			2
UMass Medical Center Concord Campus		2		2
Westfield State College	2			2
Berkshire County Sheriff's Department		1		1
Fitchburg State College		1		1
Massachusetts College of Liberal Arts		1		1
Middlesex Community College		1		1
Northern Essex Community College	1			1
State Police		1		1
UMass Dartmouth		1		1
Grand Total	104	233	32	369

Table 20: It is IMPORTANT to note that this building data is always being updated, changed and corrected as agencies change or modify. This analysis may contain minor errors in the relevant state agency listed above or in the exact location of a structure. As GIS and spatial data improve this information will be corrected. The facility information is current as of December 9, 2009.

Vulnerability of State Facilities by Hurricanes

To assess the vulnerability of the state-owned facilities identified in the DCAM facility database,, the SLOSH data is the most appropriate. The SLOSH zone data for all areas along the Massachusetts coastline from the Cape Cod Canal north to the New Hampshire Border was obtained in a ArcMap shape file format with the surge categories being assigned corresponding to a category 1, category 2, category 3, and category 4 hurricane. For the structures within this region of the State, the digital SLOSH data was overlaid with the structure data and the appropriate SLOSH zone was determined.

A total of 277 structures or facilities, or about 5% of state-owned facilities, are located within the SLOSH inundation zones. Category 1 zone has 57 State owned structures located within. Category 1 storms occur more frequently than higher category storms, these structures are the most vulnerable because they tend to be in the low lying areas very close to the coastline. Category 2 zone has128 structures, Category 3 zone has 49 and Category 4 has 43. All other state owned structures or facilities are not located within a defined SLOSH zone. This is a change from the previous plan update due to the newer digital SLOSH maps for Buzzards Bay and more accurate DCAM facility database. Current replacement cost are not available, this analysis uses 2007 building replacement values to estimate potential losses of state owned facilities.

DCAM Structures in the SLOSH Zones

The data shows buildings, which would be impacted by a particular category hurricane.

	Cat 1 Area	Cat 2 Area	Cat 3 Area	Cat 4 Area	Total	Estimated Building Replacement Cost April 2007
Barnstable	10	7	9	2	**28**	$93,758,283.00
Berkshire	0	0	0	0	**0**	0
Bristol	3	8	13	9	**33**	$21,709,222.00
Dukes	0	2	0	0	**2**	$1,528,329.00
Essex	4	22	10	12	**48**	$162,042,865.00
Franklin	0	0	0	0	**0**	0
Hampden	0	0	0	0	**0**	0
Hampshire	0	0	0	0	**0**	0
Middlesex	7	12	0	5	**24**	$43,190,889.00
Nantucket	0	0	0	1	**1**	$492,212.00
Norfolk	2	5	0	2	**9**	$13,840,070.00
Plymouth	2	18	10	6	**36**	$20,833,937.00
Suffolk	29	54	7	6	**96**	$1,807,055,620.00
Worcester	0	0	0	0	**0**	0
Total	**57**	**128**	**49**	**43**	**277**	$2,164,451,427.00

Table 21 *Note that all lower categories would be included for example, for a cat 2 in Barnstable the total number of buildings would be 17 because you add cat 1 and cat 2.*

Vulnerability of State Facilities to Atmospheric and Winter Related Hazards

HIGH WINDS

The Commonwealth of Massachusetts is divided into four wind zones, the limits of which are defined by the Massachusetts State Building Code Seventh Edition. The basis of these wind zones, as defined by the State Building Code, is a set of national wind data prepared by the American Society of Civil Engineers. The data can be found in a document titled, ASCE-7 "Minimum Design Loads for Buildings and Other Structures."

Using ArcMap, GIS software, this data was overlaid with the DCAM facility database; and the appropriate wind load zone determination was assigned to each facility. It is not possible to estimate the potential losses of any one structure at this time, however, the estimated replacement cost for the nearly 6,000 state owned structures is estimated at greater than $20 billion. Wind load zones are delineated on a map in Appendix 4.

Wind Load Zone	State Structures in each Wind load Zone
Less than 90 MPH	346
90 MPH	2259
100 MPH	2722
110 MPH	636
Grand Total	5963

TORNADO

The Reported Tornado Occurrences Map depicts the tornado risk based on probability of occurrence based past events. The density per 25 square miles indicates the probable number of tornado touchdowns for each 25 square mile cell within the contoured zone that can be expected over a similar period of record (approximately 50 years). It should be noted that the density number does NOT indicate the number of events that can be expected across the entire zone, but the percent probability of occurrence in the given area. The analysis indicated that the area at greatest risk for a tornado touchdown runs from central to northeastern Massachusetts.

To analyze how tornados could impact state facilities, DCAM data was overlaid with the states area of highest probability of occurrence. There are over 3,000 state owned structures in this .011-.018 probability zone. That is nearly half of all state owned and operated facilities.

Tornado Probability	Number of DCAM Facilities
High (1 occurrence per 50 years)	3118
Low (< 1 occurrence per 50 years	2845

SNOW AND BLIZZARDS

New to this plan update, the vulnerability assessment to State structures utilized a map showing the frequency of areas in the state impacted with snow events with 5 inches or greater in one event. The State is separated in to four bands relative to the average number of days per year that area experience storms of 5 inches or more. Using ArcMap, GIS software, this data was overlaid with the DCAM facility database,; and the snow data. To locate the snow bands see map in Appendix 4. This data shows that 87% of state structures will receive storms of 5 inches or greater fewer than 2.4 days each year.

Number of days an area experiences snow storms totaling greater than 5 inches of snow	State Structures in each Snow Band
Less than a half day per year	2941
Half day to 2.4 days per year	2303
2.5 days to 4.4 days per year	653
4.5 days to 7.4 days per year	87
Grand Total	5984

Vulnerability of State Facilities to Other Related Hazards

EARTHQUAKES

According to USGS data, damages due to the effects of an earthquake will begin at a level of ground shaking of approximately .1g. The MMI intensity scale associates damages with levels of earthquakes. According to this scale, the damage that can be expected from this range of ground shaking will vary from plaster cracking and disruption of building contents, to moderate damage to poorly constructed buildings. It should be noted, however, that the expected probability of such a level of ground shaking is extremely low, and according to the USGS data can be expected to occur once every 2,476 years.

Because of this low frequency of occurrence and the relatively low levels of ground shaking that would be experienced, the entire state of Massachusetts can be expected to have a low to moderate risk to earthquake damage as compared to other areas of the country. The relatively small difference in the level of impact from one area of the state to another does not justify differentiating risk levels from one portion of the state to another.

WILDFIRE

The vulnerability of state facilities to fire-related hazards, especially wildfires, is currently difficult to determine based on the current, best available data. There is a lack of consistent data on previous wildfire and man-made fire occurrences.

4.5 Estimating Potential Losses by Jurisdiction

The loss estimate can be the foundation upon which the local and regional mitigation goals and objectives are developed. With it, the state can consider the jurisdictions where the highest losses would occur, how much a hazard may cost were it to occur, and how the disaster recovery might be affected. The loss estimates at the state or local levels might be able to inform the overall strategy of the mitigation plan.

All jurisdictions in the Commonwealth have hazard-prone areas identified from a particular natural hazards; the most common is flooding. Those jurisdictions that are experiencing growth and development will also have an increase in their vulnerability to and impact from associated hazards. This will be identified in their Local Hazard Mitigation Plans as well as in the County descriptions in this update of the State Plan in Section 4.3.

The local and Regional assessments are reflecting very minimal short-term changes in risk at a widespread level. In Section 4.3 the plan analyzes the development and growth patterns by jurisdictions. Based on particular land use or development patterns locally

there have been some areas of growth and very limited increases in risk or losses in new growth areas. The damages and losses that are occurring in most counties are not impacting new growth, but existing infrastructure and buildings. It is important to note that most of the state identified a historical change in risk from the 1960's to the 1990's when Massachusetts experienced the most development.

For this plan update the SHMT compiled data from FEMA approved Regional and Local Hazard Mitigation Plans as well as county level information from the census. Since each region or local community analyzed losses differently, it is not possible at this time to represent the information comparatively across the state. See Appendix 9 for information by jurisdiction on loss estimates that were considered for this plan update.

To estimate potential losses by jurisdiction an analysis was performed considering the total number of buildings, the estimated values and estimated growth from 2000-2009. This shows that Nantucket had the highest percentage of growth at 13%, which is close to the national average, adding an average of 155 structures per year. This statistic is notable because the estimated values of structures in this county are substantially higher than all the other counties. It is important to note that very little new development on Nantucket occurs near the coastal areas due to strong coastal protection by-laws and conservation restrictions. The counties with the lowest growth have some of the lowest property values.

County	Housing Units 2000	Housing Units 2009	Change 2000-2009	Average Annual Increase	Average Value
Barnstable County	147,463	155,686	8,223	914	$193,101
Berkshire County	66,354	68,539	2,185	243	$160,020
Bristol County	217,090	225,670	8,580	953	$127,761
Dukes County	14,886	16,381	1,495	166	$135,570
Essex County	287,423	299,508	12,085	1,343	$148,912
Franklin County	31,960	33,362	1,402	156	$123,156
Hampden County	185,982	191,380	5,398	600	$144,859
Hampshire County	58,732	61,949	3,217	357	$140,233
Middlesex County	577,269	598,481	21,212	2,357	$155,303
Nantucket County	9,258	10,657	1,399	155	$293,002
Norfolk County	255,449	266,793	11,344	1,260	$180,494
Plymouth County	181,843	194,237	12,394	1,377	$134,366
Suffolk County	292,633	305,127	12,494	1,388	$121,392
Worcester County	298,729	320,551	21,822	2,425	$136,488

Table 22. Housing Unit Statistics by Jurisdiction, US Census.

Depending on a particular event the damage and associated financial losses are assessed at the time of the disaster by state and local liaisons. This allows for the response and disaster

recovery operations to occur in a targeted and strategic manner. Section 6 discusses local plan integration in more detail.

Statewide data on estimating losses may be obtained based on the statewide vulnerability assessments and by reviewing previous natural disasters. More than $270 million in federal and disaster assistance has been obligated to Massachusetts in only the last 15 years[24]. The following chart gives an overview of the hazard risk index, which addresses vulnerability and potential losses by impact to disasters. This analysis show that there has been no change in hazard risk or any increased risk by jurisdiction, however has there have been additional events in the past three-year which have increased the index statewide. The assumption is that areas with a higher index would be vulnerable to higher potential losses.

County	Flood	Dam Failure	Coastal Hazards	High Wind	Hurricanes/ Tropical Storms	Thunderstorms	Tornado	Nor'easter	Snow and Blizzard	Ice Storm	Major Urban Fires	Wildland Fires	Drought	2010 Hazard Index Rating	2010 Hazard Index Rank	2007 Hazard Index Rating	2007Hazard Index Rank	Change in Rank From 2007-2010
Barnstable	1		2	2	1			2	5				2	15	7	15	7	0
Berkshire	4						1		6	1				12	12	11	12	0
Bristol	5	1	1	2	1			1	5			1	2	19	4	18	4	0
Dukes	1		2	2	1			2	4					12	11	12	11	0
Essex	7	1	2	2	1			2	6	1	1	1	1	25	1	23	1	0
Franklin	3			1	1	1			6	1				13	10	12	10	0
Hampden	3				3				6	1		1		14	9	13	9	0
Hampshire	1				1				6	1				9	14	8	14	0
Middlesex	8		1	2	1			1	6	1	1		1	22	2	20	2	0
Nantucket	1		1	2	1			1	4					10	13	10	13	0
Norfolk	6		1	2	1			2	5				3	20	3	19	3	0
Plymouth	6		1						5				2	14	8	13	8	0
Suffolk	5		2	2	1			2	5		1			18	6	17	5	0
Worcester	6				2				6	2	2			18	5	16	6	0

Table 23. Overview of the hazard risk index by county, 1991-2009.

The Massachusetts Emergency Management Agency maintains a funding archives listing all declared disaster events and the financial aid received. Over the past 15 years there have been 31 events and 33 emergency and disaster declarations.

- 11 were state disaster declarations
- 20 were federal, or Presidential, disaster declarations
- 17 events, or 59%, of these disaster declaration primarily involved major flood events

[24] Not including March 2010 FEMA-DR-1895-MA that is estimated to reach more that $125million in Federal disaster funds.

- 3 disasters, or 11%, primarily involved high wind events
- 8 disasters, or 40% were blizzards or major snowstorms
- 2 disasters, or 6%, were major fires.

The recent disaster loss by jurisdictions shows the category "other" has had the largest overall losses in the past few years. That category includes state agencies, private non-profits, and other eligible applicants whose physical damages are in more than one county or are not able to geographically identified. The county with the highest amount of losses is Worcester County. There are five counties, not listed below which have not suffered major losses from declared disaster events in 2006-2008.

Jurisdictions	Type of Hazard			
	Winter Storm/Ice Storm 2008	Nor'easter and Flooding 2006	Nor'easter and Flooding 2007	Total
Berkshire	$2,076,704	$0	$676,8930	$8,845,634
Dukes	$0	$0	$52,474	$52,474
Essex	$1,600,986	$8,580,588	$1,944,147	$12,125,721
Franklin	$2,047,235	$0	$1,006,443	$3,053,678
Hampden	$661,847	$0	$1,373,297	$2,035,144
Hampshire	$1,091,697	$0	$559,709	$1,651,406
Middlesex	$4,908,672	$2,357,355	$0	$7,266,027
Plymouth	$0	$35,196	$1,384,957	$1,455,349
Worcester	$22,769,578	$0	$0	$22,769,578
Other	$29,079,267	$0	$1,105,311	$30,184,578

Table 24 Funds obligated by FEMA's PA Program, for eligible disaster recovery costs associated with DR-1642, 1701, and 1813.

Section 5 Statewide Hazard Mitigation Strategy

The state must analyze what current programs, strategies, and public policies address the impacts of natural hazards to develop a comprehensive hazard mitigation strategy for the future. With this knowledge, the state can determine the gaps in protection and incorporate appropriate solutions into this statewide plan. This section provides an overview of Massachusetts' current programs, policies and agencies that address natural hazards through hazard mitigation, followed by a brief overview of commonly used hazard mitigation measures in Massachusetts. These programs form the basis for Massachusetts' recommended hazard mitigation goals, action steps, and potential resources to accomplish these identified tasks.

5.1 Statewide Strategy, Goals & Action Steps

This section of the plan provides a list of Massachusetts' goals and action steps necessary to implement a comprehensive hazard mitigation program over the next three years. These goals and action steps and the statewide strategy are based on the data provided in the previous sections of the plan, especially the risk and vulnerability assessment and the current hazard mitigation program matrix.

For this plan update, the SHMT held the Evaluation of Mitigation Goals, Strategies, and Actions Workshop on November 5, 2009. This planning workshop included an extensive review of the 2007 mitigation strategies and actions.

The SHMT and Interagency Committee Members reviewed and analyzed the statewide goals and each action for relevance, effectiveness, and validity. It was determined that the goals for the State Hazard Mitigation Plan are appropriate and applicable and therefore was no revision of the goals for this update. The SHMT reviewed and discussed the actions and revised them as needed. Also during this brainstorming session the team added several actions. These new actions are noted as '*new*' in the last column in the following chart. The STAPLEE Planning Criteria were applied to all of the new and ongoing actions developed. See Appendix 1.

Massachusetts Mitigation Strategy

Reduce the statewide loss of life, property, infrastructure, and cultural resources from natural disasters through a comprehensive hazard mitigation program, which involves planning, awareness, coordination, and project development.

Goals

1. Meet the planning requirements for hazard mitigation plans contained in the Disaster Mitigation Act of 2000.
2. Increase awareness of the cost-savings and public safety benefits of hazard mitigation projects.
3. Increase coordination and cooperation between state agencies in implementing sound hazard mitigation planning and project development.
4. Fund cost-effective hazard mitigation projects through available federal grants and local cost share, PDM, HMGP, FMA, SRL, and 406 Mitigation Programs.
5. Monitor, evaluate, and disseminate information on the effectiveness of completed hazard mitigation projects, especially after disaster events.

Commonwealth of Massachusetts - Hazard Mitigation Goals & Actions

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
1. Meet the planning requirements for hazard mitigation plans contained in the Disaster Mitigation Act of 2000.					
a. Complete a standard State Hazard Mitigation Plan and submit for FEMA review and approval prior to the September 2010 deadline per DMA 2000.	State Hazard Mitigation Team and Interagency Committee	Current	Current MEMA/DCR staff; state funds	Required by DMA 2000 planning regulations. A FEMA-approved State Mitigation Plan is needed to continue to implement the Statewide Mitigation Planning Strategy and to continue the availability of disaster assistance and hazard mitigation grants.	*Revised.* The Commonwealth of Massachusetts is committed to mitigation; this plan will continue to be updated.
b. Perform a statewide risk analysis for all hazards to include in future updates to this state hazard mitigation plan and other related plans	SHMT, Interagency Committee, MEMA	1-3 years	HMGP, PDM Planning Grant, State funds	An updated hazards analysis would enhance the validity, accuracy and practicality of the Statewide risk analysis.	*Revised*. The responsible agency has been expanded to the entire Interagency Committee as well as MEMA/DCR staff. For complete details see the change documentation in the Appendix
c. Evaluate the development of an Enhanced State Hazard Mitigation Plan.	SHMT	1-3 years	Current MEMA/DCR staff; HMPG funds	An enhanced plan will allow the state to be eligible for up to 20% in available HMGP funding. Additional HMGP funding will support implementation of more hazard mitigation projects as identified in the state, regional, and local hazard mitigation plans.	*Revised*. Due to new policy from FEMA allowing for states to be eligible for up to 20% in available funding, the SHMT revised this action to evaluate the feasibility and importance developing this plan.

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
d. Partner with regional planning agencies (RPA's) and other groups in Massachusetts to develop and implement regional and local multi-hazards mitigation plans by providing technical assistance.	SHMT	Ongoing	Current MEMA/DCR/CZM staff; state funds	FEMA-approved local mitigation plans are needed to implement the Statewide Mitigation Planning Strategy and the availability of hazard mitigation grants to communities. RPA's bring local and regional planning expertise, knowledge, and contacts, especially in transportation issues and land use planning, to the mitigation planning process.	*Unchanged.* The SHMT will continue to work with RPA's to prepare hazard mitigation plans.
e. Apply for available federal funding to implement and update the completed and approved multi-jurisdictional and local hazard mitigation plans.	SHMT	Ongoing	Future PDM-C, HMGP & FMA	Obtain maximum available funding to implement identified mitigation projects. Federal mitigation grant funding is a key component to support implementation of hazard mitigation projects as identified in the state, regional, and local hazard mitigation plans.	Unchanged. The state continues to see this as a priority.
f. Continue to incorporate new data and recommendations from the FEMA-approved regional and local mitigation plans into the State Mitigation Plan, especially locations of critical facilities and assessments of vulnerability and estimates of potential losses by jurisdiction.	SHMT	Ongoing	Current MEMA/DCR staff	Analyze regional and local data and recommendations to update the state plan. Will assist the state in compiling up-to-date lists of prioritized hazard mitigation projects and actions throughout the state.	Unchanged. The state continues to see this as a priority.

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
g. Track potential hazard mitigation projects and strategies statewide in a database, using new information provided by the multi-jurisdictional plans with local annexes and state agencies.	SHMT	3 years	Current MEMA/DCR staff	Develop a statewide database of potential hazard mitigation projects and strategies that support of the goals and objectives of the completed mitigation plans.	*Revised*. This action was not accomplished in the past cycle due to lack of funding and staff availability and has been revised to include state agency projects.
h. Coordinate data collection and sharing with other statewide planning initiatives, such as the Statewide Homeland Security Planning process.	SHMT, EOPSS Staff	Ongoing	Current MEMA, DCR, EOPSS staff	Combining resources will allow for more accurate information in several statewide plans. Coordination of data collection methodology and new information will allow for a more accurate statewide plans and maps.	*Unchanged*. The state continues to see this as a priority.
i. Continue to support existing statewide mitigation planning, especially the Community Assistance Program-State Support Element (CAP-SSSE) Floodplain Management Plan, including activities under the National Flood Insurance Program, and the RiskMAP Business Plan.	DCR's Flood Hazard Management Program (FHMP) staff	Ongoing	CAP-SSSE funding; RiskMAP, CTP funding; FHMP staff	Ongoing and improved compliance with the NFIP, in conjunction with the RiskMAP, will allow the state to focus its resources, such as technical assistance and mitigation grants, in the highest flood risk communities.	*Revised*. The Map Mod Program is transitioning to RiskMAP. This bring a few new elements which will continue to be a priority for the Commonwealth.
j. Address data deficiencies and improve analysis, when available, by partnering with Federal, State, local, and other subject matter experts.	SHMT	3 years	PMD Planning Funds and/or Current MEMA, DCR, EOPSS staff	In order to continue to improve the risk assessment for the Commonwealth and address data deficiencies. This action also encompasses the incorporation of all new or improved data that is made available to the State.	*New.*

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
2. Increase awareness of the cost-savings and public safety benefits of hazard mitigation projects.					
a. Develop and implement a statewide hazard mitigation training program, including educational materials for federal and state agencies	SHMT & State Hazard Mitigation Interagency Committee	Ongoing	Hazard Mitigation Grant Program (HMGP), state funds	Greater awareness among state and federal agencies will reduce the risks to natural hazards by allowing for more effective implementation of the strategy, especially the completion of mitigation projects & actions.	*Completed and ongoing.* A Mitigation in Massachusetts course was created in 2008 and delivered to more 100 participants over 6 sessions. The State will continue to improve and refine this training program.
b. Conduct hazard mitigation community outreach and educational programs for the general public, such as programs in schools and at home improvement stores and events.	SHMT & State Hazard Mitigation Interagency Committee	Ongoing	Hazard mitigation admin and technical assistance funds	Educated consumers will be better protected from natural disasters because they have reduced risks by implementing various hazard mitigation techniques, projects and actions.	*Revised.* The state worked with FEMA post disaster to educate homeowners. This revised strategy will include partnering with PNP's and other organizations as well others previously identified.
c. Continue to hold hazard mitigation grant workshops for state agencies and local governments after natural disasters, especially immediately following Presidential Disaster Declarations.	SHMT	Within 2-3 months of disaster declaration	Hazard mitigation admin and technical assistance funds	Informed public officials will apply for funding for hazard mitigation projects and well as motivate communities without plans to develop hazard mitigation strategies.	*Revised.* The state continues to see this as a priority.

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
d. Utilize the Internet to develop more consistent and timely tools for distributing information about current hazard mitigation programs and success stories in Massachusetts to other government agencies, the private sector, and the general public.	SHMT	Ongoing	HMGP and technical assistance funds	Informed public officials will apply for funding for hazard mitigation projects as well as motivate communities without plans to develop hazard mitigation strategies. Informed local officials will apply for funding for hazard mitigation projects and actions that will help to reduce future risks.	*Revised.* The SHMT has partnered with CZM to provide information on the www.Stormsmartcoasts.com website.
e. Provide improved outreach to all eligible applicants for mitigation projects and planning.	SHMT	1 year	State resources	More partners in Mitigation will increase the effectiveness of the overall mission of Mitigation in Massachusetts.	*New.*
3. Increase coordination and cooperation between state agencies in implementing sound hazard mitigation planning and project development.					
a. Investigate the possibility of creating a standardized format or model for local hazard mitigation plans to create consistency among all plans statewide.	SHMT, CZM Staff	1-5 years	Staff resources	Massachusetts has 351 communities with the potential to have 351 different plans and formats. Having a standardized format will facilitate incorporation of data to state or regional mitigation plans	*Unchanged.* The state continues to see this as a priority.
b. Develop a strategy to reduce the overlap between Comprehensive Emergency Management Plans (CEMP) and Hazard Mitigation Plans	SHMT & MEMA	Ongoing	Staff resources	Creating a comprehensive approach to all emergency and mitigation planning can eliminate local confusion and help to make planning funding more effective at the local level by not duplicating benefits of state and federal programs.	*Unchanged*. The state continues to see this as a priority and has faced administrative difficulties with the action.

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
c. Build 'non-traditional' partners in mitigation by encouraging colleges and universities, non-governmental organizations, private non-profits, and the private sector to use their resources to study hazard vulnerability and implement mitigation projects and by prioritizing project applications for traditional funding sources that leverage funding and contributions from these non-traditional sources.	SHMT Lead involves many agencies	Ongoing		Building partnership with all public and private partners to reach more citizens and increase awareness for mitigation and help to leverage funding for more diverse mitigation projects.	New
d. Educate all communities, state agencies, and the private sector specifically, building and insurance industries to the benefits of mitigating against natural hazards by participating in planning and projects.	SHMT	Ongoing	Staff resources	Greater awareness of mitigation at the local level will reduce the risks to natural hazards by allowing for more effective implementation of the strategy, especially the completion of mitigation projects & actions.	Revised. The state continues to see this as a priority and revised this to include state agencies.
e. Continue to make recommendations to the Board of Building Regulations and Standards (BBRS) as the MA State Building Code is updated to include updated NFIP Standards and other building standards related to natural hazards, such as wind, snow, seismic loads and others. hazards.	MEMA, DCR, Interagency Committee	Ongoing, as needed (dependent on Building Code update schedule)	MEMA, DCR staff	The inclusion of revised federal mitigation standards in the State Building Code will allow for consistent implementation of sound mitigation measures statewide, especially in new construction and in the repair/renovation of substantially damaged structures. Allows for uniform application of mitigation measures by local officials.	*Completed and ongoing.* The state continues to see this as a priority. In 2009 a recommendation was made to adjust the State building for add consistency to continue to comply with the NFIP.

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
f. Encourage project granting agencies in the state, such as the MA Department of Housing and Community Development's review of CDBG Grants, to include the analysis of hazard impacts when reviewing applications for funding	SHMT & State Hazard Mitigation Interagency Committee	Ongoing	MEMA, DCR, EOPSS	By avoiding the building of new structures within an area of potential natural hazard impacts, this coordinated action between agencies will reduce, or mitigate, future damages and costs following future hazard events.	*Unchanged.* The state continues to see this as a priority.
g. Recruit additional state agencies to become involved in the State Hazard Mitigation Interagency Committee.	SHMT	Ongoing	MEMA, DCR Staff	Active participation of state agencies in the interagency committee will facilitate the sharing of information between agencies, expedite implementation, and ensure more widespread and consistent implementation of sound hazard mitigation measures throughout the state.	*Completed and ongoing*. The state continues to see this as a priority. There have been 4 new committee members added in the last 3 years.
h. Continue working with other state agencies, especially those on the State Hazard Interagency Committee, to ensure that all the necessary permits and requirements are being met before the execution of all hazard mitigation projects through the PDM, HMGP, FMA and SRL programs.	SHMT & State Hazard Mitigation Interagency Committee	Ongoing, especially following a Presidential Disaster Declaration	MEMA, DCR Staff, and State Grants Admin. Plan	By coordinating all the necessary federal and state permits, the state will avoid future problems as projects are constructed. Coordination of the permits and other requirements ensures a timely completion of an effective mitigation project.	*Unchanged*. The state continues to see this as a priority.
4. Fund cost-effective hazard mitigation projects through available federal grants and local cost share, PDM, HMGP, FMA, SRL, and 406 Mitigation Programs.					

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
a. Research the potential for implementing a state hazard mitigation program that more effectively includes involvement with all state agencies and the possible source for a state investment in mitigation	SHMT & MEMA	Ongoing	Staff resources	Assessing our state assets and potential for partnering with existing programs and funding sources allows the state to maximize the potential local and state contribution to hazard mitigation projects.	Revised. The state continues to see this as a priority and has set the timeframe to ongoing
b. Enhance the effectiveness of 406 funding by working to further integrate mitigation into the FEMA Public Assistance Program.	SHMT & MEMA	Ongoing	Staff resources	By working with FEMA Public Assistance Program the state can maximize the cost effectiveness of federal grants by mitigating hazards during the recovery process.	*Completed and ongoing*. The state continues to see this as a priority. NOTE: At the time of this plan's publication FEMA is proposing new 406 policies in the PA Program.
c. Apply for available federal hazard mitigation project grants through pre-disaster and post-disaster mitigation programs and other federal mitigation programs as the funding becomes available and explore state or other funding options.	SHMT	Ongoing	MEMA, DCR staff, FEMA grants, State Grants Administrative Plan	Hazard mitigation projects are expensive and federal funding is needed by the state and communities to complete most projects. Funding cost effective hazard mitigation projects in high-risk areas, as identified in this plan as well as in regional and local hazard mitigation plans, will reduce future losses.	*Unchanged*. The state continues to see this as a priority.
d. Notify all eligible applicants of available hazard mitigation project grant programs for mitigation projects, including available funding through the FMA, PDM, HMGP and SRL programs and other mitigation opportunities	SHMT	Ongoing	MEMA, DCR staff, FEMA grants, State Grants Administrative Plan	Hazard mitigation projects are expensive and federal funding is needed by the state and communities to complete most projects. Funding cost effective hazard mitigation projects in high-risk areas, as identified in this plan as well as regional and local hazard mitigation plan, will reduce future losses.	*Completed and ongoing*. . The state continues to see this as a priority.

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
e. Work with state agencies that own state facilities believed to be at high or medium flood risk or Overland Tidal Surge (as identified in Section 4) to further evaluate the flood and surge risk and to identify and implement appropriate mitigation strategies.	SHMT & State Hazard Mitigation Interagency Committee	3 – 5 years	MEMA, DCR staff; individual agency capital funding; FEMA planning and project grant funding	Individual analysis will provide a better assessment of the flood and surge risks and identify specific flood mitigation measures for implementation by state agencies. By further identifying these risks and mitigation measures for individual structures and facilities, the state can make recommendations for funding appropriate projects that will reduce or eliminate these risks.	*Unchanged* This action was not accomplished in the past cycle due to lack of funding and staff availability. The state continues to see this as a priority.
f. Develop a methodology for collecting and assessing the natural hazard risks, especially flooding, erosion, and storm damage, for all current and future state owned facilities and properties, to be used by agencies to identify and implement appropriate mitigation strategies.	State Interagency Committee, MEMA, DCR, DCAM	Ongoing	MEMA, DCR staff, Interagency Committee, DEP & CZM	Collecting such data will assist in identifying high-risk facilities and properties and incorporating hazard mitigation measures into the planning processes. Improving the data on high-risk facilities will assist in implementing hazard mitigation measures for specific facilities and properties.	*Unchanged* The state continues to see this as a priority.
g. Work with state agencies to fully identify all potential hazards to facilities before major repairs, or the construction of new facilities, to minimize future impacts from natural hazards, particularly flooding, storm damage and erosion.	State Interagency Committee, MEMA, DCR	Ongoing	MEMA, DCR staff, Interagency Committee, DEP & CZM	Recognizing exposure to natural hazards prior to construction of all new state facilities and major renovations to such facilities will result in appropriate hazard mitigation measures being included in the master planning and design process. Inclusion of hazard mitigation measures during the planning of facilities will save future repair and disaster assistance costs.	*Unchanged* This action was not completely accomplished in the past cycle, however some progress was made. The state continues to see this as a priority.

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
h. Work with communities to implement cost-effective, environmentally sound, and feasible mitigation projects to severe repetitive loss properties.	SHMT	Ongoing	SRL, HMGP, & FMA	Mitigation of severe repetitive loss structures will reduce or eliminate claims under the NFIP through project activities that will result in the greatest savings to the NFIF in the shortest period of time.	*Completed and ongoing*. This action was completed and the state continues to see this as a priority. In FY08 the state successfully applied and received an SRL grant to assist one target community.
5. Monitor, evaluate, and disseminate information on the effectiveness completed hazard mitigation projects, especially after disaster events.					
a. Develop a process to track all completed mitigation projects in Massachusetts, including 406 mitigation and privately funded mitigation projects.	SHMT	3-5 year	Staff resources	Evaluating existing successes can act as a public relations tool to create awareness to the importance of natural hazard mitigation.	*Revised*. Some of the details of this action have been refined. The state continues to see this as a priority.
b. Evaluate the feasibility of maintaining a database of potential mitigation projects across the state, taken from local hazard mitigation plans, Project Worksheets from the Public Assistance Process, and other sources.	SHMT	1-3 years	Staff resources	Evaluating potential projects will allow the State to maximize the cost effectiveness of federal grants by mitigating hazards in a pre- and post disaster setting.	*Revised*. Some of the details and tasks regarding this action have been refined. The state continues to see this as a priority.
c. Prepare hazard mitigation best practices and case studies on a regular basis.	SHMT & FEMA	Ongoing and following future disasters	MEMA, DCR and FEMA Public Information staff.	Sharing information on completed hazard mitigation projects that prevent loss and damage, demonstrates the effectiveness of the hazard mitigation program, and motivates other communities to undertake similar hazard mitigation projects in the future. Mitigation project "success stories" help to publicize communities and effective projects, thereby raising awareness of	*Completed and ongoing*. This action was accomplished in the past cycle and the state continues to see this as a priority.

Action	Responsible Agency	Projected Timeline	Resources	Explanation	2010 Update Comments and Revisions
				effective hazard mitigation measures.	
d. Implement a standard information sharing procedure on disaster damage data collected by FEMA, PDA, Community Relations and Infrastructure Inspectors to use in local hazard mitigation planning efforts and identifying potential hazard mitigation projects.	SHMT & FEMA	Ongoing, following future disasters	MEMA, DCR and FEMA Infrastructure (Public Assistance) staff	In-the-field inspectors can provide useful information on opportunities for hazard mitigation projects. Timely, coordinated data can better identify areas that warrant mitigation actions and eliminate duplication of efforts by programs.	*Unchanged*. Completed duing the most recent disasters and this action continues to be a high priority for the state.

Explanation of Mitigation Actions Update

The statewide mitigation goals, action steps, and opportunities for improvement to existing mitigation programs are a multi-faceted comprehensive approach to addressing natural hazards in the Commonwealth.

The actions will be undertaken as resources and program improvement opportunities become available, the regional multi-jurisdictional plans and local annexes are completed, and the impacts of occurring disasters are analyzed. In most cases the goals and actions draw from different sets of resources so there is no competition for limited resources between alternative mitigation actions.

As described in Section 3, the SHMT held a strategy workshop to review and analyze the action plan developed in 2007. The participants reviewed each action and determined whether it was Revised, Unchanged, or Deleted. Revised actions are those, which are still a priority to the Commonwealth but needed to be modified to be implemental in this update. The Unchanged actions are carried forward directly from the plan in 2007, and the deleted actions are those that have been removed from the state strategy for this update. The participants then analyzed the actions based on the STAPLEE Planning Criteria. This criterion evaluates and prioritizes mitigation actions by considering the following elements.

S Community Acceptance

	Effects on Segment of Population
	Technical Feasibility
T	Long Term Solution
	Secondary Impacts
	Staffing
A	Funding Allocated
	Maintenance/ Operations
	Political Support
P	Local Support
	Public Support
	State Authority
L	Existing Local Authority
	Potential Legal Challenge
	Benefit of Action
E	Cost of Action
	Contributes to Economic Goals
	Outside Finding Required
	Effects on Land/Water
	Effects of HAZMAT/ Waste Sites
E	Consistent with Community Environmental Goals
	Consistent with Federal Laws

The results of the STAPLEE analysis for this plan update can be found in Appendix 1. The actions listed in the matrix are those, which were considered to be the highest priority as they contribute to the overall State Hazard Mitigation Strategy. The plan clearly does not include all mitigation strategies that the State Hazard Mitigation Team would consider and like to implement.

Local mitigation projects and plan applications are prioritized per criteria found in the Massachusetts Mitigation Grants Administrative Plan see Appendix 10 and in Section 5, Mitigation Measures and Projects

5.2 State Capability Assessment

The Massachusetts Capability Assessment is a summary of the state's hazard mitigation capability through a variety of state laws, regulations, authorities, and agencies. This section includes and an in-depth look at the personnel involved in mitigation; a matrix of current state laws; executive orders, regulations, and policies and programs; implementation procedures, and related funding sources at both the state and federal level.

State Agency Partnership-Lead State Agencies –

The Commonwealth of Massachusetts has a unique, statewide effort of interagency cooperation in the administration and management of its Hazard Mitigation Program. This program is a joint staffing effort between the Massachusetts Department of Conservation and Recreation (DCR) Flood Hazard Management Program, which oversees the National Flood Insurance Program, and the Massachusetts Emergency Management Agency (MEMA) Disaster Recovery and Mitigation Division.

STATE HAZARD MITIGATION TEAM

The team consists of the staff members employed by DCR and MEMA who work full-time on hazard mitigation planning, grants management, and project management. The team is co-chaired by the State Hazard Mitigation Officer at DCR and the Disaster Recovery Manager at MEMA. The team meets on a monthly basis to coordinate team members' individual hazard mitigation work assignments and to give progress reports on statewide mitigation plans, mitigation projects, and technical assistance.

STATE INTERAGENCY HAZARD MITIGATION COMMITTEE

This statewide committee consists of representatives of state and federal agencies, including the State Hazard Mitigation Team, that play key roles in implementing hazard mitigation programs, policies, and projects throughout Massachusetts. The committee reviews policies, coordinates mitigation efforts and recommends recipients of hazard mitigation grants, and assists in the development, implementation, and, maintenance of the State Hazard Mitigation Plan. For this plan update the interagency committee was encouraged to have great involvements by joining a plan update workgroup.

The chart in Section 3.3 gives an overview of the State Interagency Hazard Mitigation Committee and the State Hazard Mitigation Team.

APPROACHES TO ADDRESS COASTAL HAZARDS

Flood managers generally employ many different measures to reduce the risks posed by coastal hazards along developed coasts. Policies and regulatory tools, such as minimum setbacks and building codes, can be developed to prevent or limit new development in hazardous locations, relocate buildings at risk of severe damage, and prohibit

reconstruction of destroyed buildings. Regulations are also implemented to limit the use of new shoreline-stabilization structures and to ensure that adverse impacts of projects are minimized. These measures can result in a wide range of environmental and economic costs varying with the physical, economic, human, social, and natural character of coastal communities.

Non-structural measures such as beach nourishment (i.e., the active addition of sediment to a beach system) are also considered as viable alternatives to protect development with the added benefit of maintaining recreational beaches. Massachusetts successfully completed a beach nourishment project on Revere Beach State Reservation in 1992 using an upland source of approximately 768,000 cubic yards of sediment, financed by the state and federal governments. Smaller nourishment projects were also completed on Dead Neck Beach in Osterville (1998) and Long Beach in Plymouth (1999) using sediment from offshore sources and private and local funds respectively. Two major beach nourishment projects using offshore sources of sediment have been proposed for Winthrop Beach and Siasconset Beach using state and private funds respectively. Nourished beaches can be quite successful in restoring the vitality of communities, energizing local economies, and minimizing property and infrastructure damages. Maintaining an artificial beach width, however, does require continued placement of sediment and funding.

Work of the Coastal Hazards Commission

Coastal storms are an intricate combination of events that impact a coastal area. A coastal storm can occur any time of the year and at varying levels of severity. One of the greatest threats from a coastal storm is coastal flooding due to storm surge. This is the inundation of land areas along the oceanic coast and estuarine shoreline by seawaters over and above normal tidal action. Also common to coastal storms are high winds, erosion, heavy surf and unsafe tidal conditions, and fog. Some or all of these processes can occur during a coastal storm , resulting in an often detrimental impact on the surrounding coastline. For additional information see the Coastal Hazards Commision Report at: www.mass.gov/czm/chc/recommendations/final_recommendations.htm

Massachusetts Existing Hazard Mitigation Matrix

The most current information on all Massachusetts state agencies, including those listed throughout this matrix, may be found on the official Commonwealth of Massachusetts website at www.mass.gov.

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
Emergency Management			
Civil Defense Act of 1950	Authorizes the creation of the Massachusetts Civil Defense Agency (predecessor to the Massachusetts Emergency Management Agency) and the development of a statewide civil defense program.	The Massachusetts hazard mitigation program is administered jointly by the Massachusetts Emergency Management Agency (MEMA) in coordination with the Department of Conservation and Recreation (DCR).	Unchanged. Allows for statewide coordination of resources from numerous state agencies and the private sector allows for more effective program.
MA Executive Order 144 and MA Executive Order 242	Amends and updates the Civil Defense Act of 1950 by creating the position of Secretary of Public Safety, coordinating emergency preparedness activities and the promulgation of a Comprehensive Emergency Response Plan for the state.	The Massachusetts hazard mitigation program is administered jointly by the Massachusetts Emergency Management Agency (MEMA) in coordination with the Department of Conservation and Recreation (DCR).	Unchanged.. Hazard mitigation will continue to be a core mission of both MEMA and DCR..

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
MA Executive Order 149 and Chapter 21 of Massachusetts General Laws (MGL)	Executive order designates the Massachusetts Water Resources Commission (WRC) as the state coordinating office for the NFIP. Under MGL Chapter 21, the Department of Environmental Management (DEM) Division of Water Resources (DWR) serves as support staff for the WRC. In 1980, the Flood Hazard Management Program (FHMP) was created within DWR to be the NFIP coordinating office. DEM is now the Department of Conservation and Recreation (DCR).	Assists flood-prone communities in obtaining and maintaining participation in NFIP and assists property owners in making sound decisions related to flood insurance purchase and coverage. This encourages flood mitigation activities that will reduce the risk of flood damage to existing property.	Unchanged
Hazard Mitigation Grants for Plans & Projects			

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
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% non-Federal) for FEMA-approved hazard mitigation projects following a Presidential declared disaster. These grants are available to state, local and tribal governments as well as eligible non-profit organizations.	Allows for the completion of post-disaster mitigation projects that will reduce and/or eliminate losses due to natural hazards. Since 1991, following 6 Presidential disaster declarations, 101 hazard mitigation projects were constructed, using $17 million in federal funds and $7 million in non-federal funds. These projects could not have been completed without federal funding. The data collected from the regional plans with local annexes will help the state to identify potential hazard mitigation strategies and projects before disasters occur. Completion of a FEMA-approved enhanced State Hazard Mitigation Plan could more the double the available HMGP funding.	Unchanged
Pre-Disaster Mitigation Program (PDM) Grants for Mitigation Planning and Projects	This all hazards mitigation grant program provides funding for hazard mitigation planning and projects. Originally allocated to states under a formula based on risk estimates, these matching grants (75% Federal, 25% non-Federal) for FEMA-approved hazard mitigation projects are now awarded through an annual national competition.	Provides critical funding for multi-jurisdictional plans with local annexes to be developed to help identify potential hazard mitigation projects and for mitigation projects.	Massachusetts has funded all 13 regional planning agencies at least once to develop regional and local hazard mitigation plans. Continued funding allows for ongoing focus on repetitive loss properties and complements current funding under the PDM and HMGP programs.

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
Flood Mitigation Assistance (FMA) Planning & Project Grants	Since 1997, this program has provided annual pre-disaster funding for developing local flood mitigation plans and corresponding flood mitigation projects on a cost-shared basis (75% Federal, 25% non-Federal). Program focuses on mitigation to NFIP repetitive loss properties.	Program is often the sole source of funding for flood mitigation plans and projects, which have resulted in cost savings for communities and property owners. To date, Massachusetts has funded more than 15 plans and 7 projects.	Unchanged
Legislative Pre-Disaster Mitigation (L-PDM)	Non-Competitive Earmark, the National Legislative Pre-Disaster Mitigation Fund to assist States and local governments in implementing cost-effective hazard mitigation activities that complement comprehensive mitigation programs, reduce injuries, loss of life, and damage and destruction of property. L-PDM is a pre-disaster grant program.	This program is still in its early stages and no impact information is available	New
Severe Repetitive Loss (SRL)	This program targets severe repetitive loss residential structures insured under the National Flood Insurance Program (NFIP) with up to a 90% FEMA share for Mitigation projects.	To implement cost-effective measures that reduces or eliminates the continued claims to the NFIP for these severe repetitive loss residential structures.	New
Hazard Identification & Mapping			

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
Massachusetts Statewide Mitigation Planning Strategy – regional and local risk analysis	The Commonwealth plans to partner with and fund multi-jurisdictional hazard mitigation plans with local annexes for all 13 Massachusetts regional planning agencies. These plans will include hazard identification, risk assessment and maps.	This strategy will be continually evaluated and refined to develop the best risk assessment information. New data from the multi-jurisdictional plans will assist in better identification of critical facilities and other structures, which may be at risk to natural hazards. This data may be used by other state agencies as other plans are developed.	
MA Coastal Zone Management (MCZM): Historic Shoreline Change Project	Provides 1:10,000 scale shoreline change maps that show the relative positions of four or five historic shorelines and depict the long-term change rate at 40-meter (approximately 131-foot) intervals along the shore.	Measures and estimates the changes in the state's coastline as a result of natural erosion and accretion as well as relative sea rise. Assists in identifying potential areas and structures at high risk to coastal erosion and shoreline change.	Unchanged
MCZM & FEMA: Initiative to re-delineate Velocity (V) zone floodplain boundaries in four Massachusetts communities	This project is through FEMA's Cooperating Technical Partners (CTP) Initiative. Many coastal flood zones, as delineated on Flood Insurance Rate Maps (FIRMs), are outdated and need revision due to beach erosion/accretion and changes to the NFIP's regulatory V zone definition to include primary frontal dunes.	The completed delineation will be submitted to FEMA and their Flood Map Production Coordination Contractor for review, and, once accepted, will be used to produce new FIRMs for the study communities.	Completed

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
Massachusetts RiskMAPBusiness Plan	Developed by DCR as part of FEMA's nationwide program to update the maps of flood zones in most communities. Flood Insurance Rate Maps, or FIRMs, and the accompanying Flood Insurance Study (FIS) data are used in the administration of the minimum requirements of the NFIP.	Business plan includes a strategy and implementation schedule for the update of FIRMs throughout Massachusetts. Massachusetts cities and town rely heavily on the flood hazard information contained in the FIRMs and FIS for review of proposed development.	Unchanged. Business plan updated July 2007.
MA Coastal Zone Management (MCZM) Repetitive Flood Loss Structure Assessment	MCZM prepared maps of the Massachusetts Coastal Zone to delineate the location of repetitive loss structures. CZM identified correlations between high concentrations of repetitively damaged properties and a wide range of coastal processes parameters.	Identification of repetitive flood loss properties and correlations will assist in the development of better tools for coastal management and planning, such as purchasing flood insurance.	Unchanged``
Massachusetts Ocean Resource Information System (MORIS)	The Massachusetts Ocean Resource Information System, is an online mapping tool to search and display spatial data pertaining to the Massachusetts coastal zone; specifically, tide gauge stations, marine protected areas, access points, eelgrass beds, etc.	Identification of coastal infrastructure will assist in the in all emergency management planning processes.	New
Public Safety			
State Board of Building Regulations & Standards/State Building Code (780 CMR)	Massachusetts State Building Code covers the entire state, applies to both public and private construction, and is administered through the local building inspectors with state oversight. Section 3107 of the State Building Code contains most of the NFIP construction requirements related to	NFIP standards are an integral section of the state building code, ensuring that all new construction and substantial improvements meet national flood resistant standards. Many communities have enacted stricter standards under their local floodplain ordinances. Allows for the	Updated. In 2008 the code was updated to include several new components that are related to natural hazards, including, flooding and wind.

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
	buildings or structures.	application of NFIP standards on all new construction of buildings and structures throughout the state.	
USDA-NRCS Emergency Watershed Protection Program	Provides technical and financial assistance to localities to reduce vulnerability of life and property in small watersheds damaged by severe natural events.	Allows immediate action to stabilize storm damages in streams following a federal declared natural disaster.	Unchanged
Massachusetts Dam Safety Program, Ch. 330, Acts of 2002; 302 CMR 10	Inspects and registers the 2,900 dams in the state.	These structures require continual maintenance, which is a challenge to state and local governments. Dams need continual inspection and maintenance schedules. There may be future opportunities for the state and local governments to partner with NRCS to continue ongoing inspections and repairs. Helps ensure the structural integrity of dams thus preventing downstream flood loss.	Unchanged
U.S. Army Corps of Engineers (USACE) constructed flood control projects, under state and local control and maintenance	Built by the U.S. Army Corps of Engineers, these structures (dams, dikes, seawalls, and protection barriers) protect many cities in Massachusetts from riverine and tidal flooding. USACE assists the state and local governments in conducting annual inspections.	Since completion, these structures have prevented flood damages in major Massachusetts urban areas estimated at multi millions of dollars.	Unchanged

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
USDA-NRCS constructed PL 566 flood control dams, under state and local control and maintenance	32 small flood control dams that provide flood control to small watersheds in the central and western sections of the state.	The state continues to inspect state-owned PL 566 dams and provides flood protection to watersheds susceptible to high flood flow.	Unchanged
Massachusetts Wildfire Program, MGL Chapter 48: Sections 8 through 28C	Carries out a comprehensive program of wildfire prevention, suppression, and education through the state fire bureau and municipal forest wardens.	The primary vehicle to reduce losses from wildfire especially in developing areas known as the "wildfire urban interface" (WUI) where the new construction of buildings and structures in areas bordering, or in, forested areas prone to periodic wildfires.	Unchanged
State Fire Assistance; the Cooperative Forestry Assistance Act (PL 95-313), Volunteer fire Assistance and Federal Excess Property program	USDA Forest Service provides a wide range of grants to states for wildfire prevention, training, and education programs; federal excess fire fighting materials; technical assistance and grants to communities with fewer than 10,000 population for forest fire related purposes	Provides critical support to local wildfire prevention programs.	Unchanged
Northeastern Forest Fire Protection Commission	Massachusetts is a party to mutual aid agreements with other state and provincial forest fire control agencies.	Enables Massachusetts to be able to call upon additional out-of-state resources to combat extreme conflagrations that may occur in Massachusetts.	Unchanged
Massachusetts Fire Academy	The Massachusetts Fire Academy, operated by the Office of the State Fire Marshal, provides instruction on methods of fire suppression and specialized training to municipal fire fighters to qualify them for the U.S. Forest Service Red Card, which is	Well-trained and educated firefighters for both structural and wildfires will more effectively, and safely, extinguish such fires and prevent future fires.	Unchanged

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
	required for deployment to any out of state fire.		
Fire Management Assistance Grant Program	The state annually signs an agreement with FEMA for this program under Section 420 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.	The state must have a signed and up-to-date FEMA-State Agreement and a Wildfire Management Plan before receiving federal funding under approved requests for Fire Management Assistance declarations.	Unchanged
Planning & Environmental Protection			
Massachusetts Zoning Enabling Act MGL Ch. 40A	The Zoning Act was enacted in 1975 to facilitate, encourage and foster the adoption and modernization of zoning ordinances and by-laws by municipal governments; and establish standardized procedures for the administration and promulgation of municipal zoning laws.	The 1975 Act, commonly referred to as chapter 808, establishes the zoning regulations.	Added, but Unchanged.
EOEEA: Massachusetts Environmental Policy Act (MEPA) MGL Ch. 30, Sec. 61-62h; 301 CMR 11.00	The primary state environmental review process for state actions, projects with State funding, or projects requiring permits or licenses from state agencies.	Ensures that major development projects being contemplated have considered applicable flood protection laws and regulations.	Unchanged
DEP: Wetlands Protection Act MGL Ch. 131, Sec. 40; 310 CMR 10.00	Establishes state policy for protecting the state's wetland resource areas by limiting development in wetland resource areas and within a 100-foot buffer zone.	Limits new and expanded building in the state's coastal and wetland resource areas including lands subject to flooding. Wetland resource areas include the 100-	Unchanged. Additional "effects on loss" language was add to strengthen the plans

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
		year coastal and riparian flood hazard areas identified by FEMA.	description.
DEP: Rivers Protection Act; MGL Ch. 258-Acts of 1996; incorporated into 310 CMR 10.00	Establishes state policy for protecting the natural integrity of the Commonwealth's rivers and establishes open space along the rivers. The act regulates activities within the Riverfront Resource Area extending 200 feet from the edge of each bank.	Two of the eight interests promoted by this Act are providing flood control and preventing storm water damage. This Act expands the area along the state's rivers in which flood control aspects of a proposed project are considered.	Unchanged
DEP: Inlands and Coastal Wetlands Restriction Acts (MGL Ch. 130, Sec. 105) and inland areas (MGL Ch.131, Sec. 40A)	Records at the Registry of Deeds restrictions on individual property deeds against future development of coastal wetlands on Cape Cod, some towns on the south coast, and in the Charles River basin. The program now focuses on restoring wetlands.	Further protects critical coastal wetlands and barrier beaches from development. Reduces the amount of new development in high risk coastal areas that could be affected by coastal flooding, erosion and high winds.	Unchanged.
EOEEA: Community Preservation Act	Encourages cities and towns to undertake the purchase of open space to preserve natural resources.	Allows for the preservation of open space that also serves as flood storage areas. Also, allows for the potential purchase of floodplains and wetlands to prevent future building of potential flood prone structures.	Unchanged. The state continues to provide technical assistance to participating communities other communities and interested in passing a local preservation act.
Coastal Development and Use-Chapter 91 Program; (MGL Ch. 91)	Protects the coastal tidal area for public open space purposes and regulates new and expanded construction within this area.	Further restricts development along coastal shores.	Unchanged

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
DEP-Title 5/Septic System Management Title 5, (310 CMR 15):	Establishes minimum standards for the Subsurface Disposal of Sanitary Sewage. Enforced by DEP and local Boards of Health. Communities may adopt standards more restrictive than the state requirements.	Title 5 mitigates losses due to adverse effects of improper sewage treatment by strict requirements for placement and construction within high hazard flood areas. Helps to minimize property damage as well environmental and health risks that could occur from improperly built septic systems in high hazard flood areas.	Ongoing
U.S. EPA Stormwater Management Program	Provides for 255 of 351 Massachusetts municipalities to prepare Phase II Storm Water Management Plans.	These plans directly address the major cause of flood damage loss in non-coastal communities in the state.	Unchanged Additional "description" language was add to strengthen the plans description.
MCZM Massachusetts Coastal Zone Management; (P.L. 92-583, Section 306)	Undertakes comprehensive coastal education and protection programs.	MCZM ensures that projects located in, or that affect the coastal zone, are in compliance with CZM enforceable programs.	Unchanged
MCZM: Executive Order 181, Barrier Beach Protection (1980)	This Massachusetts Executive Order discourages further development on barrier beaches by limiting state and federal funding for new support facilities, gives priority status for relocation assistance to storm damaged barrier beach areas; and encourages public acquisition of barrier beaches for recreational purposes.	Recognizes that human-induced changes to barrier beaches decreases the storm damage prevention and flood control capacities of these dynamic coastal areas.	Assists in reducing and/or limiting development in high risk areas for coastal flooding, erosion, and high winds.

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
MCZM-State Rapid Response Storm Damage Assessment Team	The team consists of coastal planning and engineering experts who are "on call" to conduct damage assessment surveys of coastal areas immediately following storm events.	The team's damage assessments provide state and federal emergency managers with valuable information of coastal storm damages within several hours of a storm event thus allowing better targeted response and recovery assistance.	This team continues to be utilized several times a year as coastal storm events occur.
State Sustainability Program, Executive Order No. 438, July 2002	This program helps state agencies minimize the environmental impacts of their operations and activities, and to promote innovative sustainable practices in Massachusetts.	By sustaining the environment and by implementing long-range planning, more hazard mitigation measures may be implemented by state agencies.	With tens of thousands of employees, hundreds of facilities, thousands of buildings and vehicles, and a multi-billion dollar budget, state government can achieve significant savings in energy, water, and materials use through greater efficiency and effective long-range planning.
EOEEA –Land Acquisition/Open Space Program-	This effort allows the environmental agencies to acquire land for open space purposes to include outdoor recreation, promoting biodiversity and protecting the natural resources of the Commonwealth.	Directly promotes flood water retention and flood loss reduction by preserving many critical parcels along the coast and rivers of the Commonwealth as open space.	This program continues to receive funding from the state capital funding plans.
Massachusetts Climate Protection Plan – Office of Community Development	This plan is an initial step in a coordinated effort to reduce the affects of climate changes, such as reduction in the emission of greenhouse gases and improvements energy efficiency.	Many of the protection measures to alleviate climate impacts also bring with them significant other benefits. Such actions will help the economy, protect natural resources, and preserve the quality of life in Massachusetts.	Continued coordination and cooperation is needed between the more than 15 agencies involved in the plan.
Cultural & Historical Resources			

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
MHC: National Historic Preservation (NHPA) Act of 1966 (36 CFR Part 800 – Protection of Historic Properties)	Massachusetts Historic Commission administers the NHPA Section 106 review process for all proposed hazard mitigation projects submitted to the federal government under the HMGP, FMA, SRL, and PDM programs. Properties subject to Section 106 review include all properties listed on the National Register of Historic Places and all properties believed to be eligible for listing in the National Register.	Ensures that FEMA-funded mitigation projects achieve loss reduction while preserving the historic integrity of the listed properties. Administered through the Massachusetts Historic Commission (MHC). Close coordination is facilitated through the MHC director, being a member of the State Hazard Mitigation Interagency Committee.	By focusing on cultural resources, hazard mitigation will reduce future economic, cultural, and historical losses which are vital to many Massachusetts communities. Also, ensures that new hazard mitigation projects will not adversely affect cultural and historic sites.
MBLC: Emergency Assistance Program for Massachusetts Libraries	The Massachusetts Board of Library Commissioners administers a grant program for libraries to undertake flood loss prevention actions.	One staff person works full time on mitigation activities, and MBLC provides an important source of funds for mitigation actions.	This program continues to provide technical assistance on an as needed basis to many communities throughout the state.
MBLC: Emergency Assistance Program	A program of education and training regarding preparedness, mitigation, response, and recovery; caches of supplies; technical assistance; and freezing and drying capabilities for affected materials. The last component is limited to public libraries. In addition, a Weather Alert distribution list permits the Agency to provide a heads up to the cultural heritage community regarding weather events that could impact their facilities and collections.	One staff person spends a considerable amount of time dealing with disaster mitigation, preparedness, response, and recovery activities for these institutions. This role is an important one in educating the cultural heritage community about disaster mitigation	New

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
Coordinated Statewide Emergency Preparedness for Massachusetts (COSTEP-MA)	Cultural resources exist throughout Massachusetts and are located in a wide variety of buildings, geographical locations, and are threatened by flooding and other natural hazards. COSTEP-MA promotes pro-active steps to reduce losses from natural hazards, especially flooding or water damage following fires but also including all such hazards, through cooperative, team-building activities in communities and through educational activities within the cultural heritage and emergency management communities.	COSTEP-MA has worked to develop an Annex to the state's CEMP and to promote education and cooperation in communities to enhance the protection of cultural resources from natural disasters.	New
MBLC: Cultural Emergency Management Team	This committee of several government agencies and cultural institutions promotes education and technical assistance projects to enhance the protection of cultural resources from natural disasters.	Massachusetts's cultural resources are often stored in basements susceptible to flooding. This committee promotes pro-active steps to reduce losses from natural hazards, especially floods or water damage following fires.	This committee restarted in 2004 to focus on the Boston/Metro area after a five-year hiatus. Meets on a regular basis to further identify hazard mitigation needs and funding opportunities for cultural and historical institutions.
Technical Assistance			

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
Massachusetts State Mitigation Team at DCR & MEMA	A cooperative program between two state agencies, which has been in existence since 1993. Allows for the sharing of staff and agency resources in support of state and federal hazard mitigation programs.	Both agencies work cooperatively to provide hazard mitigation grants and project management, especially ongoing technical assistance, to communities, regional planning agencies and other state and federal agencies participating in mitigation programs statewide, especially the Pre-Disaster Mitigation Program (PDM), the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA) and Severe Repetitive Loss (SRL).	The state continues to provide technical assistance on hazard mitigation grants and projects on an as-needed basis with a recent focus on working with regional planning agencies throughout the state to complete the Statewide Hazard Mitigation Planning Strategy (See Section 2).
Massachusetts Office of Coastal Zone Management's StormSmart Coasts Program	This is a technical assistance program that was designed to help communities address the challenges arising from erosion, storms, floods, sea level rise, and other climate change impacts. The program operates on two levels – a website that provides a suite of tools for successful coastal floodplain management and direct technical assistance to communities through its pilot projects program	This program provides all 78 coastal communities with valuable information needed to improve their floodplain management strategies. It has helped communities enhance their regulatory language, planning, and outreach efforts to address coastal flooding. Additionally, it has helped a community incentivize elevating structures out of the flood zone.	New
DCR: Floodplain Management Services (FPMS) and Section 22 Planning Assistance to States Program.	US Army Corps of Engineers provides floodplain management and water resources technical assistance to states. This program is coordinated in Massachusetts by the Department of Conservation and Recreation and the Water Resources Commission.	Provides a continuing source of technical assistance for flood loss reduction plans and projects.	The state continues to provide information and technical assistance to communities to help identify potential projects that would qualify for funding.

Existing Protection Element	Description	Effect on loss and/or risk reduction	Update 2010 Notes/ amendments/ comments
Other Programs			
U.S. Department of Housing and Urban Development (HUD)	In 1997 and 1998, additional funding for hazard mitigation projects became available under HUD's Community Development Block Grant Disaster Recovery Initiative (DRI).	This grant, administered in a partnership between MEMA, DCR and Massachusetts DHCD, allowed for the completion of 13 hazard mitigation projects since 1997.	Unchanged
USGS Advanced National Seismic System	Monitor all earthquakes in the region that can affect Massachusetts. Deliver timely information on the locations, magnitudes and impacts of all regional earthquakes. Conduct studies to assess the potential occurrences and impacts of future earthquakes	Regional earthquake monitoring and delivery of earthquake information	Additional federal and state resources are needed to enhance the seismic monitoring capabilities and to increase the delivery speed of accurate earthquake information to state agencies.
U.S. Geological Survey (USGS)	USGS researches the processes that control or trigger natural hazards and manages real-time river flood stage monitoring and warning systems. USGS maintains 108 real-time stream-gauging stations in cooperation with state agencies.	Real time river flood stage monitoring is essential for the operation of flood response plans.	Updated: USGS has limited funding available to assist in the installation of stream gauges in smaller urban rivers throughout Massachusetts.

5.3 Implementing Hazard Mitigation in Massachusetts

The Commonwealth of Massachusetts has been committed to developing and implementing sound hazard mitigation measures to reduce the impact of natural disasters since 1978 when the state joined the National Flood Insurance Program (NFIP). As of 2009, 335 out of 351, or 95%, of Massachusetts's communities participate in this important program.

In addition to the NFIP, the Commonwealth has had a FEMA-approved State Hazard Mitigation Plan since 1986 and as of December 2009, 163 communities have approved Local Hazard Mitigation Plans.

MASSACHUSETTS STATE PLAN TIMELINE

1986	First State "409" Plan submitted to FEMA Region I for review and approval.
1989	State submits an update report on the state plan to FEMA for review and approval
1993	State updates and submits an updated of the State "409" Plan and the Hazard Mitigation Grant Program (HMGP) Administration to FEMA Region I.
1998	State updates and submits an updated of the State "409" Plan and the Hazard Mitigation Grant Program (HMGP) Administration to FEMA Region I for review and approval.
2000	State updates "409" Plan to include additional information from the June 1998 floods and submits plan to FEMA Region I for review and approval.
2004	State completes first All Hazard Mitigation Plan and submits to FEMA Region 1 for approval.
2007	State submits Update to the Multi-Hazard Mitigation Plan.
2008	State submits an amendment to the 2007 State hazard Mitigation Plan to include strategies for the new FEMA grant program; Severe Repetitive Loss.

Mitigation Measures and Projects

Implementing effective hazard mitigation in high-risk areas in the Commonwealth involves several approaches. These approaches may be categorized in two major areas: non-structural and structural hazard mitigation measures or projects. In support of the efforts by municipalities, organizations, businesses, and private citizens to reduce damages after natural disasters, the Commonwealth's Hazard Mitigation Program emphasizes the use of a non-structural hazard mitigation approach before undertaking a structural approach (see following definitions). Massachusetts places a higher priority on funding non-structural projects. Although some non-structural hazard mitigation measures may be lower in cost (i.e. adoption of a floodplain ordinance), such measures may be very time intensive in terms of staff time and take several years to implement.

Non-Structural Hazard Mitigation Measures & Projects

A non-structural hazard mitigation approach is a strategy that does not attempt to control or contain the natural hazard but involves preventative actions that improve infrastructure to reduce the damages or improve coordination of resources. Again, Massachusetts places a priority on funding non-structural projects.

Some examples of non-structural projects include:

Building & Construction Design (Massachusetts State Building Code)
Enforcement of Building Codes
Planning and Zoning
Open Space Preservation & Wetlands Protection
Floodplain Development Management (subdivision regulations, erosion control bylaws, floodplain ordinances)
Stormwater Management
Relocation
Acquisition
Building Elevation
Floodproofing (barriers, dry flood proofing, wet flood proofing, elevation of essential utilities)
Sewer Backup Protection Insurance
Erosion and Sediment Control
Beach Nourishment (through natural methods such as the placement of snow fencing and the planting of beach grass)
Best Management Practices
Weather Forecasting
Emergency Measures (Comprehensive Emergency Management Plans for each community)

Public Information (flood map information, outreach projects, real estate disclosure, technical assistance, education programs)

Structural Mitigation Measures & Projects

A structural approach involves measures used to prevent a natural hazard, such as floods, from reaching property. These measures are "structural" because they involve construction of man-made structures to control a hazard, such as construction of a dam or sea wall to control water flow. Most structural projects can be very expensive and have other shortcomings, such as: destruction of natural habitats by disturbing the land and natural water flow, increased erosion to adjacent unarmored shorelines or river banks, causing extensive damage when built to a certain flood protection level but then are exceeded by a larger flood and require continuous and high cost maintenance. Examples of structural measures include dikes, drainage modifications, dams, and seawalls.

Over the past decade as hazard mitigation project funding became available to Massachusetts, the Commonwealth realized the high cost and maintenance involved with building any new structural hazard mitigation projects. While the Commonwealth's Hazard Mitigation Program emphasizes the use of non-structural approaches over structural approaches, the density of at-risk development in some areas combined with the high value of existing mitigation infrastructure (e.g., seawalls, drainage systems) at times makes it more cost-effective to upgrade existing structures to provide added levels of protection. In such cases a limited structural approach (e.g., upgrading an existing seawall or culvert) may be preferable to a non-structural approach.

Local Hazard Mitigation Measures

As the local hazard mitigation plans are completed as annexes to the aforementioned regional hazard mitigation plans, these local mitigation measures and projects are incorporated into the State Hazard Mitigation Plan. These local measures and projects, like the regional hazard mitigation measures and projects, will be reviewed and analyzed by the SHMT. Depending upon future funding, the Commonwealth will provide the participating communities with technical assistance as needed for the implementation of cost-effective hazard mitigation measures.

Section 6 of this plan contains a summary of strategies and project from approved local and regional plans. Section 6 will be updated with input from participating communities after each grant funding cycle.

TRACKING HAZARD MITIGATION MEASURES & PROJECTS

Since 1991, Massachusetts has been able to support 217 hazard mitigation projects and plans with over $66 million in federal funding from both pre-disaster and post-disaster hazard mitigation grant programs.

Disaster Name/ Grant Type	Program Number	Date(s)	Federal Funding	#of Projects	Status
Hazard Mitigation Grant Program					
Hurricane Bob	914	8/1991	$651,881	17	Closed
Winter Storm	920	10/1991	$626,406	10	Closed
Winter Storm	975	12/1992	$400,943	7	Closed
Flooding	1142	10/1996	$12,262,500	37	Closed
Flooding	1224	6/1998	$1,769,145	22	Closed
Flooding	1364	4/2001	$1,562,356	17	Closed
Flooding	1512	4/2004	$243,225	1	Closed
Flooding	1614	10/2005	$763,899	4	Open
Flooding	1642	5/2006	$2,600,528	14	Open
Nor'easter	1701	4/2007	$1,364,794	5	Open
Ice Storm	1813	12/2008	$7,205,475*		Pending
Flood Mitigation Assistance					
FMA	FY97		$286,544	4	Closed
FMA	FY98		$238,428	3	Closed
FMA	FY99		$457,367	6	Closed
FMA	FY00		$240,713	5	Closed
FMA	FY01		$307,201	8	Closed
FMA	FY02		$173,081	3	Closed
FMA	FY03		$221,100	2	Closed
FMA	FY04		$291,601	3	Closed
FMA	FY05		$143,250	2	Open
FMA	FY06		$1,119,737	3	Open
FMA	FY07		$634,335	5	Open
FMA	FY08		$0	0	Closed
FMA	FY09		$240,889	1	Open
FMA	FY10				Pending
Pre-Disaster Mitigation					
PDM	FY02		$352,990	4	Closed
PDM	FY03		$222,497	4	Closed
PDM-C	FY03		$483,272	3	Closed
PDM-C DRU	FY04		$199,750	2	Closed

Disaster Name/ Grant Type	Program Number	Date(s)	Federal Funding	#of Projects	Status
PDM-C	FY05		$4,346,890	13	Open
PDM-C	FY06		$255,750	2	Open
PDM-C	FY07		$162,000	1	Open
PDM-C	FY08		$3,000,000	1	Pending
PDM-Earmark	FY08		$100,000	1	Open
PDM-C	FY09		$516,421	4	Open
PDM-Earmark	FY09		$100,000	1	Pending
PDM-C	FY10				Pending
PDM-Earmark	FY10				Pending
Severe Repetitive Loss Program (SRL)					
SRL	FY08		$653,166	1	Open
Community Development Block Grant (CDBG)					
CDBG	FY97		$3,977,888.72	12	Closed
CDBG	FY98		$1,494,878.76	2	Closed

Table 25 Summary of Mitigation Projects Funded in Massachusetts. At the time of this Plan the State has only been provided a 6-month lock-in for 1813. This figure may be subject to change.

MASSACHUSETTS MITIGATION TRACKING DATABASE

In 1999, the State Hazard Mitigation Team developed a comprehensive database to track and monitor all open and completed hazard mitigation project and planning grants funded under the HMGP, FMA, HUD and PDM programs. This program has allowed the Commonwealth to track and monitor project and plan timelines and completion dates. The database allows the state to track projects and plans by a specific grant program, by community, by project type, by project cost balances, and other related data. For instance, the database allows for tracking by project type, such as dam improvements, stormwater management, elevation etc. Information from this database is located in appendix 8.

HAZARD MITIGATION PROJECT SUCCESS STORIES IN MASSACHUSETTS

In addition to the project tracking database, the Commonwealth also places emphasis on highlighting successes in mitigation. As often as funding is available, the SHMT and FEMA intend to create pamphlets and brochures to highlight these successes. Many hazard mitigation projects were completed in the late 1990s; the true test of those projects came in March 2001 following a severe early spring snowstorm and coastal flooding event. A Presidential disaster declaration was issued in April 2001, and again in March 2004, for eastern Massachusetts. The SHMT, in coordination with FEMA's Hazard Mitigation Officer for the disaster relief operation, utilized available national disaster operations staff to make site visits to completed mitigation projects throughout eastern Massachusetts. During each event since 2005, the SHMT has worked in conjunction with FEMA to compile newsletters, which document successful hazard mitigation projects throughout the state. Copies of these newsletters and more success stories may be found in appendix 8.

The following section on hazard mitigation project success stories highlights several of the completed and test mitigation projects.

BANK STABILIZATION PROJECT

The Town of Becket, faced with a roadway in jeopardy of erosion, developed a plan to permanently stabilize this roadway through an environmentally sensitive bank stabilization structure. Brooker Hill Road was collapsing into adjoining Shaker Mill Brook and was in serious danger of additional failure. One lane of the road had collapsed, causing the road to be reduced to one lane, one-way. This put a hardship on residents, emergency response vehicles, and traffic to the elementary school. Tourism also had been hurt by the restrictions on this road, which connects one side of town to the other, putting a strain on the economic development and growth of North Becket Village. Becket applied for and received a grant from the Federal Emergency Management Agency (FEMA) to help fund the project costs, which totaled $259,383. FEMA provided a grant for $186,348 through the Pre-Disaster Mitigation Competitive (PDM-C) Grant Program. The success of the project was dependent on the intergovernmental coordination and cooperation among the various town departments, Massachusetts Emergency Management Agency (MEMA), Department of Conservation and Recreation (DCR), the National Park Service and FEMA. The project site involved a sensitive design because Shaker Hill Brook, a tributary of the Westfield River, is a Nationally Designated Wild and Scenic River. The National Wild and Scenic Rivers System was created by Congress in 1968 to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The project, completed in September 2008, provides permanent stabilization to the affected portion of Brooker Hill Road through the placement of a slope retention system made of an interlocking retention wall. Not only does this system provide a sound technique for solving road erosion, it also allows for native vegetation to grow which adds to the stability of the slope and its natural characteristics. Most significantly, the project has allowed the roadway to re-open as a two-lane, two-way road, which greatly enhances the safety of residents, and the elementary school children, and restore adequate emergency response time to at least pre-disaster conditions. It will also allow for continued tourism in the area, which will help in the economic growth of the town.

TOWN OF DRACUT COMPLETES A SEWER LIFT STATION PROJECT

The Town of Dracut, concerned over the ongoing potential for flooding of the sewer lift station at 150 Turtle Hill Road, developed a solution that would enable the town to mitigate a potential public health risk. During normal operations, sewage is pumped up from the neighborhood to the station. If the lift station were to be flooded, operations would cease. Houses in this neighborhood would become threatened by a risk of sewage back-up which ultimately could lead to a significant public health issue if the lift station was inoperable for an extended period of time. Dracut applied for and received a grant through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program to offset the majority of the project costs required to fund this risk mitigation project. The total cost of the project was $48,000. This sewer lift station currently services 311 residences. At full build-out, it would service 415 residences. The lift station was originally built to ½ foot above BFE (Base Flood Elevation) of 121 feet. The lift station was still threatened by flooding from nearby Beaver Brook, because the flood hazard appears to have increased since the original Flood Insurance Study was published; therefore the station required additional protection. If this pump were to sustain flooding in excess of the BFE, the pump and related electrical components could fail. That failure could cause sewage to back up into homes, causing a significant risk to public health. The project consisted of building a 12-inch thick concrete wall surrounding the station. The wall is centered on one-foot thick, two-foot wide footings. The wall is 10 feet total in height, with 6'6" below grade, and 3'6" above grade, to prevent floodwaters from damaging the electrical components. The floodwall is providing an additional 3 feet of protection above the existing BFE. There is a 4-foot wide service opening to allow access to the station. The opening will be closed with stop logs, already stored at the site, when the lift station is at risk of flooding. The project was completed in November of 2008. This neighborhood was vulnerable to the potential impact of a failed sewer lift station before this wall was installed. Now there is an increased level of protection to this pump station and related electrical components as well as the homes serviced by this sewage pump.

HARWICH COMMUNITY CENTER SHUTTER PROJECT

In times of emergency the Harwich Community Center, located at 100 Oak Street, serves as a Red Cross Shelter. Additionally, it houses Channel 18, the local access cable network. In order to ensure that the shelter workers and residents are as safe as possible during an emergency, the town of Harwich decided to invest in hurricane panels that could be installed to protect the building and its occupants. Harwich applied for and received a grant through FEMA's Hazard Mitigation Grant Program. The total project cost was $53,900. The project consists of the installation of corrugated polycarbonate resin hurricane shutter panels. By protecting the windows from high velocity wind damage and flying debris, it enhances the integrity of the building, and insures the safety of the local residents and workers utilizing it as a shelter. These shutters protect not only the windows and doors they cover, but also the people and equipment inside the building. Once a window or door has been breached by hurricane winds tremendous pressure is brought to bear on interior walls and upward pressure on the building's roof. This can lead to roof failure, which exposes the entire contents of the building to the storm. Shutters are a first line of defense against a hurricane. Studies show that engineered storm shutters are more effective and safer to use than plywood panels. The shutter panels are "see-through", therefore everyone can remain safely inside and still monitor the situation outside. Having hurricane panels at the Harwich Community Shelter provides a safe place for residents and workers to ride out the storm.

INSTALLATION OF BACK FLOW PREVENTERS

Town of Framingham was faced with recurring flooding on Auburn Street and the Auburn Street Extension causing repetitive damages to the town and private properties as a result of the Sudbury River backing up at these locations into the town's storm water drainage system. In order to mitigate this problem, the town decided to install two backflow preventers, a component of which is a "duckbill" style check valve. This valve allows liquids to flow in a single direction. These valves are used in situations where the direction of liquid flow must not be allowed to reverse itself. At the first installation, located at 18 Auburn Street, a 24" duckbill style backflow preventer was installed over and around a 24" reinforced concrete outfall pipe. The installation required the assistance of an excavator as the preventer weighed 220 pounds. At the second location, 18 Auburn Street Extension, a 12" duckbill style backflow preventer was installed around a 12" reinforced concrete outfall pipe. The preventer weighed 50 pounds and was installed by hand. However, due to continued high water conditions, the contractor first installed a cofferdam to remove water from the immediate site of installation. A cofferdam is an enclosure within a water environment constructed to allow water to be removed for the purpose of creating a dry work environment. The total cost of the project was $16, 387. Framingham was successful in receiving a Flood Mitigation Assistance grant from FEMA for $12, 290. The mitigation grant award included final design, permitting, and construction.

LEGAL FRAMEWORK FOR IMPLEMENTING HAZARD MITIGATION

A number of different Massachusetts state agencies and offices conduct hazard mitigation as part of their organizational missions. The legal foundation for such hazard mitigation work is part of each agency's enabling legislation. Descriptions of each agency's hazard mitigation functions, including their enabling legislation, and current hazard mitigation measures can be found on the chart in Section 5, State Capability Assessment.

Several important pieces of legislation, including Executive Orders, in support of federal and state agencies' incorporation of hazard mitigation methods should be noted. For example, Federal Executive Orders 11988 and 11990, Floodplain Management and Protection of Wetlands, require that federal agencies avoid direct or indirect support of development in the floodplain and work to minimize harm to floodplains and wetlands. State agencies reviewing federally funded projects or receiving federal grants for projects must take these Executive Orders into consideration.

On the state level, Executive Order 149, State Coordination and Participation with the Federal Administration under the National Flood Insurance Act, designates the Massachusetts Water Resources Commission as the state agency to implement floodplain management programs within Massachusetts. Executive Order 181, Barrier Beaches, prohibits licensing development in velocity zones of primary dunes, as well as permitting of coastal engineering structures within barrier beaches. It also constrains the use of state funds and federal grants for construction projects that could encourage growth and development in barrier beach areas. Enacted in 1996, the Massachusetts Rivers Protection Act amends the Wetland Protection Act (MGL Chapter 131 Section 40) to provide protection to rivers and implements hazard mitigation by regulating activities within a 200-foot wide resource area known as the Riverfront Area.

The State Board of Building Regulations and Standards (BBRS) administers the State Building Code which incorporates FEMA's National Flood Insurance Construction Program Standards. As of the most recent edition of the State Building Code, these standards may be found under 780 CMR 3107.0, Flood Resistant Construction.

5.4 Funding Resources

The availability of federal funding sources depends upon Congress' ongoing budget appropriations process. In 2003, the federal government established two comprehensive websites that track available funding from all the federal agencies at www.fedgrants.gov or www.grants.gov. In addition, it may also be helpful to check

current federal appropriations from Congress through the Federal Registers at thomas.loc.gov.

A Summary of Federal Funding Sources

The following is a summary of the programs, which are the primary source for federal funding of hazard mitigation projects and activities in Massachusetts.

Program	Type of Assistance	Availability	Managing Agency	Funding Source
National Flood Insurance Program (NFIP)	Pre-Disaster Insurance	Any time (pre & post disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA
Community Rating System (CRS) (Part of the NFIP)	Flood Insurance Discounts	Any time (pre & post disaster)	DCR Flood Hazard Management Program	Property Owner
Flood Mitigation Assistance (FMA) Program	Cost share grants for pre-disaster planning & projects	Annual pre-disaster grant program	MEMA	75% FEMA/ 25% non-federal
Hazard Mitigation Grant Program (HMGP)	Post-disaster Cost-Share Grants	Post disaster program	MEMA	75% FEMA/ 25% non-federal
Pre-Disaster Mitigation Program	National, competitive grant program for projects & planning	Annual, pre-disaster mitigation program	MEMA	75% FEMA/ 25% non-federal
Severe Repetitive Loss	For SRL structures insured under the NFIP.	Annual	MEMA	Authorized up to $40 million for each fiscal year 2005 through 2009
Small Business Administration (SBA) Mitigation Loans	Pre- & Post-disaster loans to qualified applicants	Ongoing	MEMA	Small Business Administration
Public Assistance	Post-disaster aid to state &	Post Disaster	MEMA	FEMA/ plus a non-federal

Program	Type of Assistance	Availability	Managing Agency	Funding Source
	local governments			share

The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program, the Community Rating System, the Flood Mitigation Assistance Program (FMA), the Hazard Mitigation Grant Program (HMGP), Severe Repetitive Loss (SRL), and the Pre-Disaster Mitigation Program (PDM). All of these programs are administered in coordination with DCR and MEMA.

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 Public Assistance. In coordination with its Mitigation Division, Response and Recovery distributes information on hazard mitigation methods, acquisition/relocation initiatives and coordinating HMGP grants for mitigation projects to protect eligible damaged public and private nonprofit facilities through the Public Assistance Program. In addition to these programs, FEMA also provides disaster recovery and hazard mitigation training at its Emergency Management Institute in Emmitsburg, Maryland.

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

STATE FUNDING SOURCES

Matching FEMA assistance – following Presidential disaster declarations, the state may contribute a portion of the 25% non-federal share for federal Infrastructure Support funds. Since 1991, the state has contributed nearly $20 million to match FEMA's funding following declared Presidential disasters (see Section 4.5, Estimating Potential Losses).

SPECIAL APPROPRIATIONS FOLLOWING STATE DISASTERS

Although there is no separate state disaster relief fund in Massachusetts, the state legislature may 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 issued 10 state disaster declarations, providing $7,177,251 in funding to aid affected communities.

STATE REVOLVING FUND

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

STATE LAND ACQUISITION & CONSERVATION PROGRAM

Through the Massachusetts Executive Office of Energy and Environmental Affairs, this annual 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. Updated information may be found on the website of the Executive Office of Energy and Environmental Affairs Open Space Protection program at http://www.mass.gov/envir/openspace/default.htm.

MAJOR FLOOD CONTROL PROJECTS

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

FLOOD CONTROL DAMS

Natural Resource Conservation Service (NRCS), manages the Flood Control Dams Program, (PL566), which funds states in the operation and maintenance of the 25 PL566 flood control dams located on state property. This program also include technical assistance and other smaller services from the NRCS and partners.

FLOOD HAZARD MANAGEMENT PROGRAM STAFF FUNDING

The state provides the 25% non-federal share for FEMA's funding under the Community Assistance Program - State Support Services Element (CAP-SSSE). CAP-SSSE funding, and the state match supports the Flood Hazard Management Program (FHMP) within the Department of Conservation and Recreation. The FHMP works with FEMA to coordinate the National Flood Insurance Program throughout Massachusetts, providing technical assistance to participating communities, professionals, and individuals.

6.1 Local Funding and Technical Assistance

Since 1997, Massachusetts SHMT has been providing grant funding for local mitigation plans, formerly flood mitigation plans, and technical assistance. The State Hazard Mitigation Team started working closely with Massachusetts's communities in 1997 on local flood mitigation plans in accordance with the Flood Mitigation Assistance (FMA) program. This program provides annual funding, through the NFIP, for communities to develop local flood mitigation plans. In 1997, the state also hired a full-time mitigation planner to work on the State Mitigation Plan and to provide technical assistance, with other State Mitigation Team members, to communities working on FMA plans.

Massachusetts is one of only a few states that have a position solely dedicated to hazard mitigation planning. This planning position, State Hazard Mitigation Planning Coordinator, has been expanded to provide technical planning assistance to Regional Planning Agencies and communities that are developing all hazards plans. The planners also is responsible to coordinate the update of the State Hazard Mitigation Plan to meet new requirements under DMA 2000.

This technical planning assistance has involved meeting with local officials and the local planning teams to provide overviews of the hazard mitigation planning process and the mitigation plan's requirements, and descriptions of potential hazard mitigation measures.

Multi-Jurisdictional & Local Hazard Mitigation Plans

As part of the Commonwealth's statewide planning strategy *to meet the planning requirements for hazard mitigation plans contained in DMA 2000*, the SHMT has invested in the regional planning agencies (RPA's). The RPA's develop multi-jurisdictional or regional hazard mitigation plans and annexes for the participating communities.

The Commonwealth of Massachusetts provided the opportunity for every community to participate through one of the RPA's by providing funding through various federal planning grants since 2002. The first round of funding was allocated in 2002, to four regional planning agencies; Cape Cod Commission (CCC); Franklin County Council of Governments (FRCOG); Metropolitan Area Planning Council (MAPC); Southeastern Regional & Economic Development District (SRPEDD). In 2003, three more RPA's

received funding; Berkshire Regional Planning Commission (BRPC); Northern Middlesex Council of Governments (NMCOG); Old Colony Planning Council (OCPC). In 2005, seven planning grants were allocated to Nantucket Planning & Economic Development Commission, Merrimack Valley Regional Planning Commission (MVPC), Martha's Vineyard Commission, Central MA Regional Planning Commission (CMRPC), Pioneer Valley Planning Commission (PVPC), additional areas of the MAPC region, and two additional communities in the Franklin Regional Council of Governments (FRCOG). In 2006, two planning grants were allocated, Montachusett Regional Planning Council (MRPC) and additional areas of the MAPC region. In 2007, all remaining communities in the MAPC region applied for planning grants. To date, all communities in the Commonwealth of Massachusetts who have chosen to participate with their RPA have had the opportunity to begin and/or complete a multi-hazard mitigation plan.

LOCAL PLAN UPDATES

At the time of this plans publication several local mitigation plans have expired and have begun the update process. FY09 PDM Plan Update grants were awarded to MAPC, BRPC, and FRCOG. In addition, NMCOG, and OCPC have submitted FY10 Plan Update Grants to the PDM National Review. In addition to these FEMA funded plan updates, several individual communities around the state and the Cape Cod Commission are updating plan with non-federal funding sources. At this time it is anticipated that the majority of plans expiring in 2010 will be updated within 9 months of the expiration date or less. The State Hazard Mitigation Team is working to provide assistance to all communities and regions conducting a plan update. With these plan updates, the State Hazard Mitigation Team (SHMT) has several areas that we would like to be a focus to communities as they update their mitigation plans. Since these are updates; this is an opportunity to show what the community has done in the past 5 years.

The SHMT Focus Points for updates are…

o internal planning process in your community. Use this as an opportunity to get together with other departments in your community. Have a round table discussion about the hazards, what they mean to your town, and what do you really want to do about them? Use it as an opportunity to have the conversations of what really needs to happen. Regional meetings with only one representative will not be enough local planning process, this update has to document that there was local initiative and effort in the mitigation planning process.

o plan changes with this update. Reflect of what has happened since the last plan was approved. Were you successful in competing any of your actions? If no,

why not? Was it local constraints funding? Personnel? or was the plan useful? And if not, now is the time to really make your own and make it something of great value.

o getting other stakeholders involved. Major businesses, downtown development districts, property owners, colleges, large companies, environmental advocacy groups, etc. Try to branch out the process to be able to get buy-in and support for the project that are really important. The town may also learn about hazards or issues that are new or increasing from a broader audience.

o integrating the actions and lessons from this mitigation plan into other plans, procedures, meetings, groups, etc in your community. By imbedding mitigation actions into other existing processes, there may be a better chance of success that the actions in your plan can happen.

o analyzing overall risk to the town. For each hazard, are there neighborhoods, business, parks, streets, docks, seawalls, that are MORE at risk to certain hazards? Then really let those things shape what the town needs to do to get mitigation done. Again, now is the time to really make this process your own and make it something of great value.

DEVELOPING LOCAL MITIGATION PLANS

As of December 2009, 163 communities have approved hazard mitigation plans. This equates to 80 plans receiving approval in the past 3 years. Of the approved plans 139 are annexes under a multi-jurisdictional plan, 22 are single-jurisdictional, and 4 are unknown or other. There are 132 of communities currently involved in the process of completing a Hazard Mitigation Plan. This category include conditionally approved plans and those under review. 58 communities in Massachusetts do not have a plan, of those, 14 are Non-NFIP Participating.

The table below outlines the Multi-Hazard Mitigation Plan Status for municipalities. In addition to the information below, there are also 2 Universities and 6 Colleges involved in Mitigation Planning in Massachusetts. Massachusetts Institute of Technology, Emmanuel College, Massachusetts College of Art and Design, Massachusetts College of Pharmacy and Health Sciences, Simmons College, Wentworth Institute of Technology and Wheelock College have approved Disaster Resistant University Plans (DRU) and University of Massachusetts Amherst is currently developing a DRU plan.

Hazard Mitigation Plan Status December 2009		
	# of plans	% of communities
Approved	163	46.4%
Conditional Approval	12	3.4%
In Process	132	37.6%
Local Revisions	0	0%
Review	43	12.2%
05 PDM	58	16.5%
06 PDM	1	.2%
07 PDM	16	4.5%
No Plan	44	12.5%
Non-NFIP	14	3.9%
Total Communities	351	
DRU Plans	8	
Grand Total	359	

Table 26. Local Hazard Mitigation Plan Status as of December 2, 2009.

Most communities in Massachusetts do not have the existing staff capability to develop hazard mitigation plans without funding or technical assistance.

In recognition of this reality, the SHMT developed a strategy consistent with the DMA 2000, to fund RPA's through the Pre-Disaster Mitigation (PDM) and available post-disaster funding through HMGP for the development of hazard mitigation plans. The RPA's have professional planners on staff with extensive knowledge of the communities within their regions. A more detailed description of the Massachusetts State Mitigation Planning Strategy is found in Section 3.

Although the majority of communities in the Commonwealth have joined forces with their RPA's for this planning effort, a number have decided to apply directly to FEMA through the state for funding to conduct their own planning process. These plans are then to be integrated with any multi-jurisdictional or regional mitigation plan in place to remain consistent across the state. The SHMT works directly with those communities to assist them through the planning process.

LOCAL PLAN REVIEW PROCESS STANDARD OPERATING PROCEDURE

The majority of local and multi-jurisdictional hazard mitigation plans are submitted through an RPA. Plans are recorded in the MEMA Mitigation Plan Database on the date that they are received at MEMA.

1) Within a maximum of 45 days, the Planner uses the FEMA Crosswalk to review the plan submissions. The reviewer indicates the pages and records qualitative comments as it pertains to the 44 CFR 201.6 as well as to the mission of the SHMT and the State Hazard Mitigation Plan.
2) If the plan meets all requirements on the crosswalk – excluding 44 CFR 201.6 (c)(5) the Planner forwards the plan and Crosswalk to FEMA Region 1 for their review.
    a. The plans and crosswalks are emailed to FEMA Region 1
    b. MEMA Planner files a copy of plan and a print out of the "sent" email to FEMA.
    c. Then the submission gets recorded in the MEMA Mitigation Plan Status Database.
3) After their review of the submitted documents, if FEMA agrees the plan meets the crosswalk, FEMA will send a letter of Conditional Approval to the RPA/community. (Skip to Step 7)
4) If the plan needs revision (FEMA does not feel the plan meets the crosswalk), the SHMT/Mitigation Planner provides comments and provides technical assistance to the RPA/Community in order to ensure the plan revisions are clear and executable by the RPA/Community.

5) The RPA or the community revises and resubmits their revised draft plan to the planner. The planner reviews the 2nd submission – confirms it meets all the requirements and fills out a crosswalk. Then the planner forwards the final draft plan and crosswalk to FEMA Region 1 for Conditional Approval. (using steps 2.a, 2.b, and 2.c)

6) FEMA Region 1 sends a letter of Conditional Approval to the RPA or the community and CC's the Planner and SHMO. When the planner receives the letter of Conditional Approval the following procedure is followed:
   a. Records the conditional approval date in the MEMA Mitigation Database
   b. The letter gets filed in files for all communities listed on the letter
   c. Copies the letter for the binder
   d. updates the Mitigation Plan status map

7) Upon receipt of the Letter of Conditional Approval the community is to formally adopt the mitigation plan by vote of the Board of Selectmen, City Council, Mayor etc.

8) The RPA/community must forward the applicable documentation of local plan adoption to the planner. The planner then forwards the adoption documentation to FEMA by the following procedure.
   a. The local plan adoptions are emailed to FEMA Region 1
   b. MEMA Planner files an official copy of plan adoption and a print out of the "sent" email to FEMA.
   c. Then the submission date and date of local adoption gets recorded in the MEMA Mitigation Plan Status Database.

9) FEMA reviews the adoption documentation and issues a Formal Letter of Approval to the RPA/Community and sends a CC to SHMO and Mitigation Planner.

10) Upon receipt of the Formal Approval Letter the MEMA Planner:
   a. Records the official date in the MEMA Mitigation Database and the five year expiration date
   b. The letter gets filed in files for all communities listed on the letter
   c. Copies the letter for the binder
   d. updates the Mitigation Plan status map

11) Three and a half years after the approval date a letter is sent to the CEO, EMD, etc. to remind the community of the upcoming plan expiration

As local and multi-jurisdictional plans are approved, the hazard mitigation measures (and other elements) are entered into the Local/Regional Database[25], which is later incorporated in to this section of the plan. For this update, measures were reviewed and analyzed by the SHMT, to identify any trends and issues related to these proposed hazard mitigation measures. Depending upon future funding, the Commonwealth will provide the participating RPA's and communities with technical assistance, as needed for the implementation of cost-effective hazard mitigation measures. (*Provisions will be made under certain circumstances if the SHMT requires additional time to review local and regional plans)

6.2 Local Plan Integration

The Massachusetts SHMT reviews each multi-jurisdictional and/or local mitigation plan according to the guidelines set forth by the Stafford Act, applicable FEMA guidance, and completes a crosswalk. During this review the state also confirms that the plan is consistent with the State Hazard Mitigation Plan. The Massachusetts State Hazard Mitigation Planning Coordinator, who is a member of the SHMT, manages this review and analysis process. For this update data was compiled from the multi-jurisdictional and /or local mitigation plans into a database. A summary of that information is in this section. For the complete database please see appendix 9.

Regional Goals and Objectives

An analysis was conducted to compare and collate the common goals and objects of all the approved mitigation in the state. Below is a list of goals and/or objectives, which appeared in at least four or more plans reviewed.

Minimize and mitigate the impacts of flooding

Minimize and mitigate the impacts of any/all hazards

Reduce the risk of dam failure

Increase the capacity of local governments to plan and mitigate natural hazards

Increase public awareness of natural hazard mitigation

Minimize the cost (financial impacts) of natural hazards

Hazard Mitigation Planning-continuity and updates

Implement programs to promote mitigation-apply for grants

Work with surrounding communities to ensure regional cooperation and solutions for hazards affecting multiple communities.

[25] See appendix 10 for more information on the Local/Regional Database.

Encourage future development in areas that are not prone to natural hazards.

Educate the public about natural hazards and mitigation measures.

Make efficient use of public funds for hazard mitigation.

Action Items Identified	Berkshire Regional	Cape Cod Commission	Franklin County	MAPC SouthShore	MAPC Northshore	Merrimack Valley	Nantucket	Northern Middlesex	Old Colony	SRPEED	Martha's Vineyard	PVPC Hampden County	PVPC Hampshire County	Montachusett Region	MAPC NorthWest	MAPC SouthWest	MAPC Urban
												Plans approved since 2007 State Plan Update					
Minimize the impacts of flooding	x			x	x	x	x		x	x	x	x	x	x	x	x	x
Minimize the impacts of all/other hazards			x	x	x	x		x	x	x	x	x	x		x	x	x
Reduce the Risk of Dam failure	x				x				x					x	x	x	x
Mitigate Beaver Dams and Damages						x								x	x	x	
Increase the Capacity of local governments to plan and mitigate natural hazards	x	x	x			x				x			x				
Increase public awareness of natural hazard mitigation options	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Minimize the cost (financial impacts) of natural hazards	x	x	x					x	x		x		x				
Hazard Mitigation Planning Commitment and Updates		x	x	x			x					x	x	x			
Implement programs to promote mitigation-apply for grants		x	x			x		x	x	x	x	x					
Ensure that critical infrastructure sites are protected from natural hazards.		x		x	x	x		x	x	x	x	x	x	x	x	x	x
Protect existing residential and business areas from flooding.	x			x	x		x		x			x	x		x	x	x
Maintain existing mitigation infrastructure in good condition.	x		x	x	x	x	x	x	x	x	x		x		x	x	x
Continue to enforce existing zoning and building regulations.	x		x	x	x		x	x	x		x	x	x		x	x	x
Continue to comply with the NFIP						x	x	x			x	x	x	x	x	x	x
Educate the public about zoning and building regulations				x	x	x	x			x	x	x	x	x	x	x	x
Work with surrounding communities to ensure regional cooperation and solutions		x		x	x	x		x	x	x	x	x	x		x	x	x
Encourage future development in areas that are not prone to natural hazards.			x	x	x				x						x	x	x
Make efficient use of public funds for hazard mitigation.				x	x		x	x	x			x	x	x	x	x	x
Identify and prioritize mitigation projects for future updates			x	x		x		x	x	x	x	x	x	x			
Encourage integrations with local Capitol Improvements	x							x						x			
Implement regulatory changes as identified								x					x				
Incorporate mitigation into zoning reviews/subdivision reviews/site plan review		x			x		x	x									
Elevate High Risk Structures and Rep Losses				x	x				x		x				x	x	x

Figure 2. Local Mitigation Plan's Identified Actions/Objectives, by Jurisdiction

6.3 Local Capability Assessment

As mentioned in Section 3, local municipalities, rather than counties, have the primary authority over land use and development in Massachusetts. Local governments for Massachusetts' 351 communities have a vital role in natural hazards mitigation especially in floodplain management activities. The municipal department and managers have the legal frontline responsibility to implement local floodplain ordinances or by-laws. Some of these critical programs include; National Flood Insurance Program standards, Massachusetts State Building Code, Wetlands Protection Act, Title 5 of the State Environmental Code (wastewater disposal), and many other local mitigation policies.

There are several types of plans and programs within the land use and environmental sector that require communities to develop and maintain strategic or action plans to guide land use and development activities. These plans are the vehicle in which local mitigation strategies can be integrated into everyday planning, zoning, and future improvements. For example many communities have used their local mitigation plan actions to update local subdivision regulations or by-laws to include or clarify requirements relating to the NFIP or other flood reduction measures.

Generally, municipalities develop and enforce a variety of local codes, ordinances, and policies; manage municipal budgets; and implement hazard mitigation planning and projects. Towns and cities in Massachusetts are empowered based on their charter to enforce local laws and policies including disaster recovery and mitigation. The following matrix elaborates on the capability and effectiveness of local governments as well as opportunities for improving their abilities to mitigate against all-hazards. One major challenge in smaller communities is that there are few paid part-time staff wearing several "hats" and/or volunteers fulfill several functions.

The following is an overview of the departments found within the majority of Massachusetts's municipalities. This analysis was completed reformatted and updated in April 2010 after a comprehensive review of regional and local mitigation plans. Each plan identifies the existing or current mitigation measures and discusses the effectiviness and possible opportunities for improvement. This analysis helps the SHMT understand the strengths and challenges faced by the local governments

Local Level Capabilities (Updated April 2010)	
Building Departments and Local Building Inspectors	
Explanation and Rationale	The Building Inspector implements and enforces the Massachusetts State Building Code (specifically Section 3107, "Flood Resistant Construction"), **which incorporates the National Flood Insurance Program construction standards.** The building inspector also enforces locally adopted by-laws, especially to prevent floods. The state building code includes sections on wind, snow, structural loads, and seismic retrofitting. Ensures that the NFIP standards and other mitigation standards are uniformly applied statewide. For instance, the building inspector is responsible for administering municipal zoning ordinances, including those addressing floodplains.
Effectiveness	Insures that NFIP standards and other mitigation standards are uniformly applied across the communities of the Commonwealth. Building inspectors may often find potential problems and/or violations of the State Building Code related to other hazards in addition to flooding.
Opportunities	There may be more opportunities for the state to provide additional training to local building inspectors concerning new hazard mitigation measures or increasing the local enforcement and encouragement of sound building practices
Public works department and/or town engineer	
Explanation	The Department of Public Works and/or the Water and Sewer Departments, which are primarily responsible for municipal drainage and stormwater management systems, take the lead in ensuring the communities' compliance with the EPA's Phase II Storm Water Regulations (National Pollutant Discharge Elimination System).
Effectiveness	Because storm water flooding is one of the major flood hazards in Massachusetts, ongoing maintenance and upgrading of local stormwater systems by local public works departments is crucial to reducing flood risks. Public works staffs are integral in implementing local hazard mitigation plans, especially in identifying and implementing local hazard mitigation projects

Opportunities	A number of smaller communities do not have a significant engineering or public works capabilities. Communities with a very small population or highly rural may not be required to comply with the NEPDES Phase I or II standards and may not regulate storm water or surface water discharges as vigorously as the NEPDES regulated areas.
Conservation Commissions	
Explanation	The Conservation Commission has primary responsibility for implementing the MA Rivers Protection Act of 1996 (MGL Ch. 258, 310 CMR 10.58), MA Wetlands Protection Act (MGL Ch. 131, Section 40), (310 CMR 10.00). The Conservation Commission reviews, approves or denies applications for any project in the regulatory 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, where it is within 25 feet of a river or stream).
Effectiveness	These regulations contain performance standards, which address flood control and storm damage prevention. For instance, the Wetlands Protection Act restricts development in wetlands and within a 100-foot buffer zone. Since most wetlands are within the 100-year floodplain, this adds an extra layer of protection to promote flood loss protection.
Opportunities	Local Conservation Commission is required to review development with potential impacts on any type of river, stream, pond, or wetland. These commissions play an important role in enforcing regulations that minimize flood impacts. Continuing to enforce the requirements of the RPA, WPA, and other rules will continue to ensure proper development and lessen flood impacts.
Planning boards, planning department, and/or town planner	

Explanation	This board has the general planning authority under the MGL Ch. 41 Zoning Act and implements local subdivision regulations. The planning board's responsibilities include recommending land use regulations to protect the public health, safety, and welfare. The Planning Board is the primary vehicle at the local level that ensures that new development incorporates federal and state storm water management "best management practices." The Planning Board is responsible for maintaining floodplain bylaws and ordinances to address current floodplain issues and updating them to ensure compliance with state and federal regulations. Often coordinates the hazard mitigation planning process and the implementation of hazard mitigation plans. Provides professional expertise in plan development, bylaw drafting, and grant application preparation.
Effectiveness	Planning boards can often bring in regional planning perspectives as well as information concerning new developments. It should also be noted that the planning board is able to adopt their own subdivision rules and regulations without an action at the town meeting.
Opportunities	There may be more opportunities for the state to provide additional training to local planners concerning hazard mitigation planning opportunities. In many communities, the Planning Department coordinates the hazard mitigation planning process and the implementation of hazard mitigation plans.
Board of Health	
Explanation	This local board implements the State Environmental Code, Title 5, and 310 CMR 15: Minimum Requirements for the Subsurface Disposal of Sanitary Sewage. The community may adopt local board of health requirements that are more restrictive than the state requirements. Title 5 protects public health and mitigates losses due to adverse effects of improper sewage treatment in high hazard areas. Also, this board becomes involved in issues related to water quality and infectious diseases following disasters.
Effectiveness	Some communities opt to adopt local board of health requirements that are stricter than the state requirements.
Opportunities	By involvement of this board, additional public health issues may be included within the mitigation planning process. At this time the effectiveness of local Boards of Health is unknown. 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

Board of Selectmen or City Council	
Explanation	Massachusetts's communities with a city form of government are led by elected Mayors and City Councils, and an elected Board of Selectmen governs towns. In most towns, town meetings of all registered voters meet at least annually. This tradition from Colonial times approves town budgets and all land use and zoning ordinances and regulations.
Effectiveness	These bodies are the chief elected officials of each municipality and provide leadership and approval for hazard mitigation grant applications, plans, and potential projects. 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.
Opportunities	More education needed concerning the benefits of hazard mitigation planning and projects.
Emergency Management Director	
Explanation	Each Massachusetts community is required to appoint and emergency manager (Chapter 639 of the Acts of 1950 has an emergency manager who is primarily responsible for local preparedness, mitigation, response and recovery as well as mutual aid for natural and man made hazards. Emergency managers play a primary role in developing local comprehensive emergency management (CEM) plans required by MA state law, as well as other plans required by MEMA and FEMA.
Effectiveness	Each community has an emergency management director who is the key point of contact for all MEMA and FEMA related business. This is a key link for outreach and involvement in mitigation planning and grants.
Opportunities	EMD could have a more active role in the recovery and mitigation process in their communities. More education needed concerning the benefits of hazard mitigation planning and projects. Most EMD's are unpaid volunteers or have other full-time jobs. More resources for the local EMD's would allow for enhanced planning and over all local capabilities.

An analysis was conducted to compare and collate the common existing hazard mitigation measures of all the approved mitigation in the state. Below is a list of existing hazard mitigation measures appearing nearly all of the approved mitigation plans as of January 2009.

Capital improvement planning

Emergency operations equipment

EPA Phase II Stormwater Treatment

Floodplain bylaw

Structural mitigation projects

All hazards tree maintenance

Local regulations- local by-law cluster sub-divisions, soil conservation

State regulations- State Building Code, Wetlands Protection Act

6.4 Prioritizing Local Assistance

Hazard Mitigation Project Eligibility and Prioritization in Massachusetts

The state has had a FEMA-approved Hazard Mitigation Grant Program (HMGP) Administrative Plan since 1986, most recently updated in 2009, which details the process for prioritizing local assistance through post-disaster mitigation funding of local mitigation projects. Massachusetts has also used similar criteria to prioritize local pre-disaster mitigation grants applications.

The following criteria for prioritizing local assistance for hazard mitigation grants are found in the State Grants Administrative Plan (complete text of this plan is found in Appendix 10:

Eligible projects for pre-disaster and post-disaster hazard mitigation funding in Massachusetts must meet the following criteria:

Must be in conformance with a FEMA-approved local and/or multi-jurisdictional all-hazards mitigation plan that meets the mitigation planning requirements per the Disaster Mitigation Act of 2000 (this guideline became effective Nov. 1, 2004).

Must be in conformance with the Massachusetts State Hazard Mitigation Plan developed as a requirement of the Disaster Mitigation Act of 2000. Massachusetts places a priority on local mitigation projects that involve:

non-structural, or "low cost" solutions (i.e. updating and enforcing local flood ordinances); retrofitting high-risk structures (i.e. elevating residences in coastal flood zones) and the acquisition of repetitive loss storm-damaged structures.

Must be in compliance with all existing Massachusetts Laws and Regulations for construction, land alterations, and natural resource protection, such as the Massachusetts State Building Code, the Massachusetts Wetlands Protection Act and Regulations, the Massachusetts Wetlands Restriction Act, and the Massachusetts Coastal Zone Management Policies.

Must be in compliance with municipal ordinances and zoning regulations.

Must be in conformance with 44 CFR, Part 9, Floodplain Management and Protection of Wetlands, and 44 CFR, Part 10, Environmental Considerations.

Must provide a solution to a problem independently, or provide a significant functional portion of a solution being addressed in a combined project. If the project constitutes a significant functional portion of a solution being addressed, the status of any associated dependent or supporting projects must be given. There must be reasonable assurance that the total mitigation project will be completed. The identification or analysis of a problem does not automatically qualify for eligibility.

Must meet FEMA's cost effective criteria such as the need to substantially reduce the risk of future damage, hardship, or losses resulting from a major disaster. Documentation will be required that demonstrates:

> The problem is repetitive and/or poses a significant risk if left unsolved. Therefore, a brief history of previous occurrences of the problem at the project location, including dates and impact of each event, and/or an analysis of projected potential damages if the project is not completed must be given.
>
> Sufficient information to allow comparison of the cost of the project with the anticipated value of future direct damage reduction or negative impacts to the area.
>
> Documentation comparing the proposed project to alternatives considered, including non-structural approaches.
>
> The proposal has been determined to be the most practical, effective, and environmentally sound alternative found after consideration of all available options.

The project contributes to the long term solution of the problem it addresses. Therefore, an estimate of the effective life of the project and a listing of influence factors should be included.

Development of the project considers any long range alterations to the area and the entities that it protects and has future maintenance requirements that are financially feasible and can be modified, if necessary, without changing the impact on the area.

Hazard Mitigation Project Selection

Available federal funds for pre-disaster and post-disaster hazard mitigation assistance will most likely not be sufficient to support all eligible project applications. Recommendations for funding will be made to the regional FEMA office by the Director of MEMA and the Commissioner of DCR, under advisement by the State Interagency Hazard Mitigation Committee. FEMA will make the final selection of grants to be awarded. The mitigation measure proposed should not be intended to replace what was damaged but rather should provide more protection to life and property than what existed prior to the storm.

The proposals will be evaluated and prioritized by the Massachusetts State Interagency Hazard Mitigation Committee and the State Hazard Mitigation Team according to the following criteria:

- The project application clearly describes the hazard/problem the proposed mitigation project is intended to address.
- Hazard Mitigation measure that, if not taken, will have a detrimental impact on the applicant, such as potential loss of life, loss of essential services, damage to critical facilities/infrastructure, and/or economic hardship.
- The proposed project clearly describes the solution to the hazard/problem. This includes a detailed scope of work, budget, and alternative analysis. The proposed project appears to be the most practical, effective, and environmentally sound alternative.
- Application describes how the proposed project will provide long-term hazard mitigation benefits. The level of protection that will exist after the project is implemented is clearly defined.
- The project application clearly demonstrates that the project is cost-effective-anticipated benefits of the mitigation activity exceed the project costs .A well-defined 'Benefit-Cost Analysis' (BCA) is provided with relevant supporting documentation.

- The application demonstrates the capability of the applicant to implement and complete the project in a timely manner. This includes all environmental permitting, state and local, which are required.
- The application demonstrates the commitment of the applicant to get the project accomplished. This includes providing documentation of the availability of the non-federal cost match, description of relevant public/private partnerships.
- The application details how the proposed mitigation activity is consistent with State Hazard Mitigation Plan, the FEMA-approved hazard mitigation plan for the local jurisdiction as well as other plans (comp land use plans, capital improvement plans, etc.)
- The proposed project is consistent with NAI (No Adverse Impact) principles ("do no harm"). Proposed mitigation activity is sustainable (with a priority on non-structural solutions), and provides environmental benefits.
- Proposed project is in the federally declared disaster area and/or mitigates the type of hazard that caused the declared event.

Upon completion of local and/or multi-jurisdictional plans, local hazard mitigation assistance will be based in part on the risk assessments, project recommendations, and benefit cost analyses described in these plans. The Massachusetts Mitigation Grants Administrative Plan is found in Appendix 10.

Massachusetts will use its Mitigation Hazard Mitigation Grants Administrative Plan to guide review and prioritized local hazard mitigation assistance.

Section 7 Plan Maintenance Process

7.1 Monitoring, Evaluating, and Updating this Plan

The Massachusetts State Hazard Mitigation Plan is a living document which will be reviewed, updated, and adopted by state officials and submitted to FEMA for approval every three years. Per the Commonwealth of Massachusetts Hazard Mitigation Strategy outlined in this plan, the plan will be revised more frequently as multi-jurisdictional and local plans are completed and if conditions under which the plan was developed change, such as a major disaster or a new or revised state policy.

This section describes the process through which this plan will be updated. Federal hazard mitigation planning regulations (44 CFR 201.4) require the state plan to be reviewed, revised, and submitted for approval to the Regional Director of FEMA every three years. The regulations require a plan maintenance process that includes an established method and schedule for monitoring, evaluating, and updating the plan; a system for monitoring implementation of mitigation measures and project closeouts; and a system for reviewing progress on achieving goals as well as activities and projects identified in the Mitigation Strategy.

Plan Maintenance Process

The State Hazard Mitigation Team is responsible for developing and maintaining the Massachusetts State Hazard Mitigation Plan. The team's State Hazard Mitigation Planning Coordinator is the individual responsible for overseeing this work.

Additional Participants in the plan maintenance process include the following:

- The State Interagency Hazard Mitigation Interagency Committee (see Section 3 for a list of participants)
- MEMA Staff
- Representatives from the regional planning agencies
- Representatives of local jurisdictions whose hazard mitigation plans were used in the development of the multi-jurisdictional plans or who developed a "stand alone" local plan.

The state plan review will take place in three ways:

1. Annually for progress made on mitigation actions and projects identified in the Mitigation Strategy of the state plan in Section 5.

2. After each major disaster in Massachusetts declared by the president, to look for areas where the state plan should be refocused due to the impact of the disaster.

3. Every three years, before submission to FEMA for approval per federal regulations.

Review and Updates

The SHMT has organized this document in such as way that the future updates will be seamless. Any new information that is located in the plan is highlighted in the Executive Summary in Section 1. This plan has undergone a page-by-page review of its content to ensure that all relevant revisions or changes are made. This process will also take place in 3 years for the 2013 Update.

Annual Progress Review

The purpose of the annual review is to gauge the progress of mitigation activities and to evaluate any changed conditions that may affect hazard mitigation planning and implementation in Massachusetts. The state plan has been and will continue to be reviewed annually to reflect significant policy changes that took place during the preceding year and to report on the progress made on funded hazard mitigation projects statewide. Based on FEMA approving the Massachusetts State Hazard Mitigation Plan in October 2010, this annual review will take place at the end of each calendar year.

Review on the progress of implementing the actions and measures identified in the state plan will occur at this time. Once a year, the State Hazard Mitigation Interagency Committee and other participants will:

- Examine progress or changes in natural hazards and disaster occurrences.
- Examine progress on mitigation actions and projects in the State Mitigation Strategy, especially progress on the multi-jurisdictional and local plans.
- Identify any implementation problems (financial, technical, political, and legal).
- Recommend how to solve such problems and to increase involvement of state agencies, local jurisdictions, and the private sector in hazard mitigation planning.
- Review, revise, and update the State Capability Assessment and the Mitigation Strategy in Section 5 to reflect major changes in policies, priorities, programs, and funding.

Post Disaster Review

After each Presidential disaster declaration and in coordination with FEMA, the SHMT will assist in documenting the effects of the disaster and convene a meeting of all the state planning participants in this section, to share observations and data related to the disaster and to review specific hazard mitigation needs of the disaster-affected area. This will most often occur as a part of the After Action Reporting (AAR) which is conducted by MEMA after all events as is recommended under National Incident Management System. This will allow for the development of hazard mitigation recommendations to FEMA during the disaster recovery operation as well as to update the State Hazard Mitigation Strategy as needed.

This post-disaster review may replace an annual review in any year a major disaster occurs, depending on the disaster event's severity and time of year.

Three-Year Plan Review and Revision

The State Hazard Mitigation Team will facilitate the review and revision of the Massachusetts State Hazard Mitigation Plan every three years. The review and revision will begin approximately 18 months before FEMA approval is required. Review and revision will involve the State Interagency Hazard Mitigation Committee and the other planning participants, especially those RPA's that have completed multi-jurisdictional plans. This process will incorporate all the revisions made during the annual plan review, particularly new information on hazard identification and risk assessment from completed multi-jurisdictional plans will be incorporated into the three year update.

The State Interagency Hazard Mitigation Committee and other planning partners will:

> Examine and revise the Hazard Identification and Risk Assessment section, to remain current and accurate. New data from the completed multi-jurisdictional plans will be vital to updating these sections of the state plan.
>
> Examine the progress on, and determine the effectiveness of, the mitigation strategies and actions outlined in the State Mitigation Strategy and in the multi-jurisdictional plans and local annexes and determine how the performance of such recommendations will influence the State Mitigation Strategy. It is anticipated that local governments and regional planning agencies, pending available funding, will review and revise their plans and annexes using the processes that they have identified and described in their plans and annexes.

Examine the effectiveness of funded local mitigation projects (see following section on monitoring plans and projects) and determine how the performance of those projects should influence the State Mitigation Strategy.

Examine the overall implementation of the state plan, identify problems (financial, technical, political, and legal), and develop recommendations to overcome them.

Recommend ways to increase participation by state agencies and local jurisdictions in the hazard mitigation planning process.

Recommend any necessary revisions to the Risk Assessment and to the State Mitigation Strategy to reflect changes in federal and state policies, priorities, programs, and funding and incorporate new information following major disaster events.

Following review and revision of the state plan, participants will analyze the plan maintenance process and the project monitoring process, and make appropriate changes to improve these processes.

7.2 Monitoring Projects Implementation and Closeouts

In addition to the monitoring activities of the State Interagency Hazard Mitigation Committee, the State Hazard Mitigation Team (SHMT), will monitor the progress of hazard mitigation plans and projects. Mitigation projects are monitored at a minimum by the use of quarterly reports and regular site visits.

The sub-grantee/applicant will maintain documentation of expenses for review by the State Hazard Mitigation Team during periodic inspection visits or subsequent audit. All records must be maintained for a minimum of six years from the date of project close-out. Quarterly reports on project status will identify how the grant funds are being spent.

MEMA project files will be maintained in accordance with the requirements described in the FEMA grant award package. MEMA will create, maintain and organize a separate project file for each project approved for FEMA HMGP funding. The project file will include individual files for contract, application, payments, environmental review and general correspondence.

A final accounting and reporting will be submitted to MEMA by the sub-grantee/applicant upon the completion of the project, to include a thorough

assessment of project accomplishments and failures. MEMA will review all project costs and resolve any outstanding issues of non-compliance (if any) prior to final (100%) project payment. MEMA grant management will comply with all administrative and audit requirements as outlined in 44 CFR Parts 13, 14 and §206 subpart M & N. At this time there are no major changed to the system or procedures of internal project management. As regulations change, the SHMT will update administrative changes in the Mitigation Admin Plan, see appendix 10.

7.3 Monitoring Planning and the 2010 Update Review

In order to adequately track and modify the strategy of this plan, the implementation strategy is available at each SHMT meeting for discussion. As changes and notations are need an ongoing matrix has been developed. This matrix is regularly updated as an ongoing effort of the SHMT. An example of this matrix is in appendix 1. For this plan update the strategy has been modified to detail all changes and accomplishments. The action's matrix in section 5 has a column dedicated for the State to demonstrate all changes made since the last update. The table below show the progress of the actions laid out in the state's strategy.

Status for 2010 Update	Number of Actions
Completed & Ongoing	7
New	3
Revised	12
Unchanged	13
Deleted	3

The SHMT and Interagency Committee held the Evaluation of Current Mitigation Measures, Mitigation Goals, Strategies, and Actions workshop on October 5, 2009. This planning workshop included a review of current mitigation measures and a review of the effectiveness of previously identified mitigation measures. This planning workshop also included an extensive review of current mitigation strategies and actions, including an analysis of the status and effectiveness of the actions. The exercise also was a brainstorming session to set forth the strategies and action for the 2010 plan update. The SHMT is confident that the strategies are being addressed, as resources and time are made available.

The STAPLEE Planning Criteria, described in section 3, was applied to all of the strategies and actions to ensure consistency and priorities are sound and justifiable. This criteria is also used by the SHMT to evaluate the implementation of projects and actions that are in progress in the current mitigation strategy. This system is recognizable and uniform to provide team members with uniform criteria. For this

plan update very few new actions were identified and those will be analyzed in the next plan update.

Due to budget cuts and other staff concerns not all of the State's Hazard Mitigation Strategy was addressed in the past three years. The SHMT is committed to the goals and actions in this plan and will continue to implement actions as resources and time are made available.

7.4 Ongoing Public Participation and Coordination

This plan will be posted on the Massachusetts Emergency Management Agency Website at www.mass.gov/mema (link to Disaster Recovery & Mitigation) for comments from stakeholders throughout the next three years. Additionally, the SHMT will solicit comment on the final plan through the IC organizations, MEMT, and groups related to mitigation plans and projects. In section 5, actions are listed relating to the ongoing participation of the public and coordination of stakeholders. Any of those comments, questions, corrections or suggestion concerning any part of this plan should be addressed to:

Richard Zingarelli
Acting State Hazard Mitigation Officer
Department of Conservation & Recreation
Flood Hazard Management Program
251 Causeway St., 8th Floor
Boston, MA 02114
617-626-1406
Richard.Zingarelli@state.ma.us

-OR-

Sarah White
Hazard Mitigation Planner
Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, MA 01702
508-820-1435
sarah.white@state.ma.us