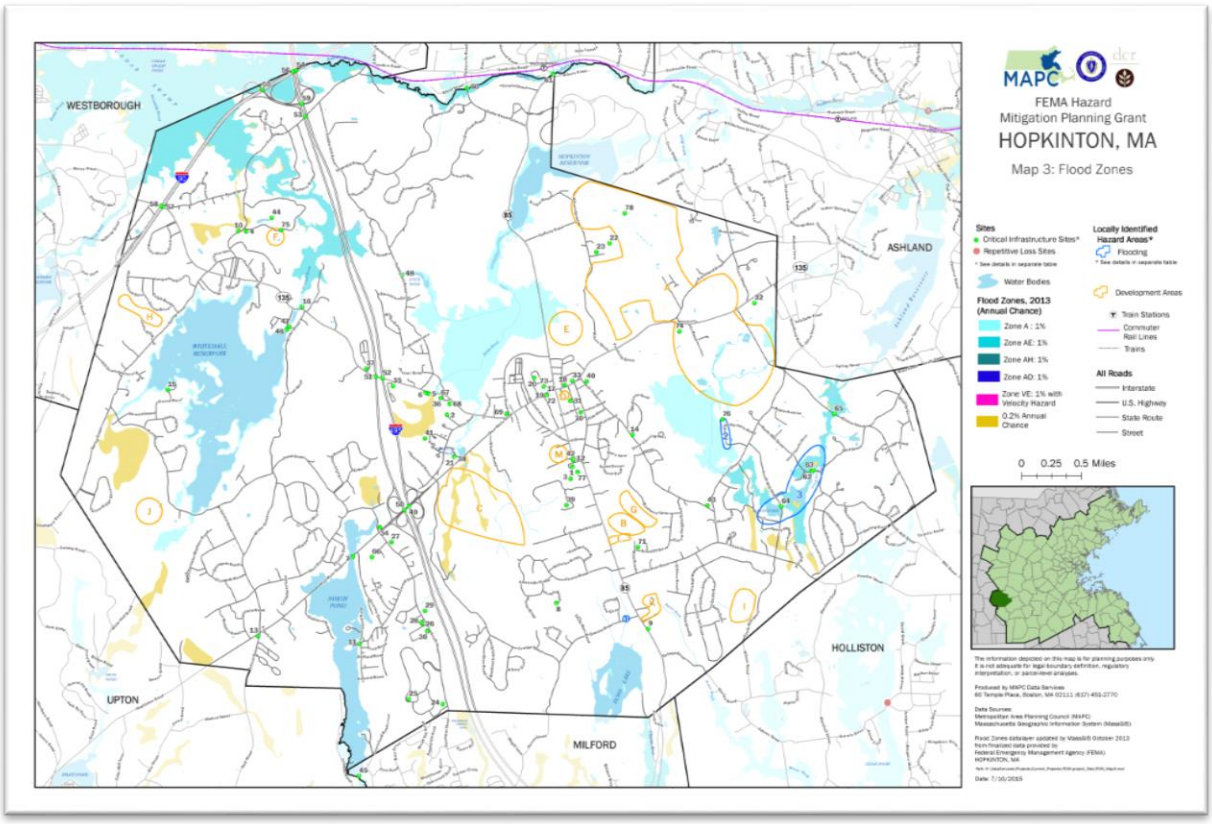
TOWN OF HOPKINTON

HAZARD MITIGATION PLAN
2015 UPDATE



MAPC
METROPOLITAN AREA PLANNING COUNCIL

Final Plan
Adopted by the Town
January 10, 2017

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TOWN OF HOPKINTON HAZARD MITIGATION PLAN
2015 UPDATE

ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the Town of Hopkinton by the Metropolitan Area Planning Council (MAPC) under the direction of the Massachusetts Emergency Management Agency (MEMA) and the Massachusetts Department of Conservation and Recreation (DCR). The plan was funded by the Federal Emergency Management Agency's (FEMA) Pre-Disaster Mitigation (PDM) Grant Program.

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Ken Clark	Fire Department Chief/Emergency Management (Retired)
John Westerling	DPW Director
Elaine Lazarus	Director of Land Use, Planning and Permitting
David Daltorio	Facilities and Building Department
Norman Khumalo	Town Manager

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TOWN OF HOPKINTON HAZARD MITIGATION PLAN
2015 UPDATE

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I. EXECUTIVE SUMMARY

Hazard Mitigation planning is a proactive effort to identify actions that can be taken to reduce the dangers to life and property from natural hazard events. In the communities of the Boston region of Massachusetts, hazard mitigation planning tends to focus most on flooding, the most likely natural hazard to impact these communities. The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to be eligible to receive FEMA funding for hazard mitigation grants, to adopt a local multi-hazard mitigation plan and update this plan in five year intervals.

Planning Process

Planning for the Hazard Mitigation Plan update was led by the Hopkinton Local Hazard Mitigation Planning Committee, composed of staff from a number of different Town Departments. This committee discussed where the impacts of natural hazards most affect the Town, goals for addressing these impacts, and hazard mitigation measures that would benefit the Town.

Public participation in this planning process is important for improving awareness of the potential impacts of natural hazards and to build support for the actions the Town takes to mitigate them. The Town hosted two public meetings, the first on December 16, 2014 and the second on August 11, 2015. The draft plan was posted on the Town's website for public review and neighboring municipalities were contacted for comment.

Risk Assessment

The Hopkinton Hazard Mitigation Plan assesses the potential impacts to the Town from flooding, high winds, winter storms, brush fires, geologic hazards, extreme temperatures and drought. Flooding, driven by northeasters, hurricanes and other storms, clearly presents the greatest hazard to the Town.

The Hopkinton Local Committee identified those areas where flooding most frequently occurs, comprising 0.64% of the Town's land area, and an estimated 33 buildings worth approximately $13,912,008.

Hazard Mitigation Goals

1. Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all identified natural hazards.

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of

emergency services.

3. Increase cooperation and coordination among private entities, Town officials and Boards, neighboring communities, State agencies and Federal agencies.

4. Increase awareness of the benefits of hazard mitigation through outreach and education.

Hazard Mitigation Strategy

The Hopkinton Local Committee identified a number of mitigation measures that would serve to reduce the Town's vulnerability to natural hazard events. The most important of these are projects that entail investigating areas of flooding, understanding the causes of flooding as part of the stormwater management system and developing structural and non-structural solutions. The hazard mitigation strategy also includes policy and educational measures which will position the Town to integrate natural hazard mitigation considerations and activities into the vision for the Town, and to provide public education relating to flooding and other natural hazards potentially impacting Hopkinton.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Hopkinton will be an ongoing process as understanding of natural hazards and the steps that can be taken to mitigate their damages changes over time. In particular, global climate change has the potential to impact the Town's vulnerability in ways that past experiences have not. Changing rainfall patterns and heavier storms is something that Town plans to monitor as part of the hazard mitigation process.

Due to the regional nature of many hazards, local officials will need to work together across municipal lines and with state and federal agencies in order to understand and address these changes. Similarly, at the local level, the Hazard Mitigation Strategy will be incorporated into other related plans and policies to inform other proposed and programmed changes in the Town.

Plan Review and Update Process

Table 1. Plan Review and Update

Chapter	Reviews and Updates
III – Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan, discussing strategies to enhance participation opportunities at the first local committee meeting. During plan development, the plan was discussed at two public meetings hosted by the Emergency Management Team. The plan was also available on the Town's website for public comment.
IV – Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. Town staff reviewed critical infrastructure with MAPC staff in order to create an up-to-date list. MAPC also used the most recently available version of HAZUS and assessed the potential impacts of flooding using the latest data.
V - Goals	The Hazard Mitigation Goals were reviewed and endorsed by the Hopkinton Local Hazard Mitigation Planning Team.
VI – Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the Town.
VII & VIII – Hazard Mitigation Strategy	Mitigation measures from the 2008 plan were reviewed and assessed as to whether they were completed, in-progress, or deferred. The Local Hazard Mitigation Planning Team determined whether to carry forward measures into the 2015 Plan Update or modify or delete them. The Plan Update's hazard mitigation strategy reflects both new measures and measures carried forward from the 2008 plan. The Local Hazard Mitigation Team prioritized all of these measures based on current conditions.
IX – Plan Adoption & Maintenance	This section of the plan was updated with a new on-going plan implementation review and five year update process that will assist the Town in incorporating hazard mitigation issues into other Town planning and regulatory review processes and better prepare the Town for the next comprehensive plan update.

As indicated on Table 25, Hopkinton has made significant progress on implementing mitigation measures identified in the 2008 Hazard Mitigation Plan with many upgrades to drainage and town infrastructure, including a new waste water treatment facility completed in 2012. The Town completed drainage upgrades at Lake Shore Drive, Spring Street, Granite Street, and West Main Street. It added brush fire fighting capacity, implemented full GIS mapping capability, oversaw the restoration of the Lake Whitehall

Dam by DCR, added an impressive amount of new open space, updated its flood plain ordinance and added emergency electrical generation capacity. It continues with it plan to rebuild Lake Maspenock Dam and build a new municipal DPW facility as two of the projects carried forward in this plan update.

Moving forward into the next five year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town's decision making processes.

Though not formally done in the 2008 Plan, the Town will document any actions taken within this iteration of the Hazard Mitigation Plan on challenges met and actions successfully adopted as part of the ongoing plan maintenance to be conducted by the Hopkinton Hazard Mitigation Implementation Team, as described in Section IX, Plan Adoption and Maintenance.

II. INTRODUCTION

Planning Requirements under the Federal Disaster Mitigation Act

The Federal Disaster Mitigation Act, passed in 2000, requires that after November 1 2004, all municipalities that wish to continue to be eligible to receive FEMA funding for hazard mitigation grants, must adopt a local multi-hazard mitigation plan and update this plan in five year intervals. This planning requirement does not affect disaster assistance funding.

Massachusetts has taken a regional approach and has encouraged the regional planning agencies to apply for grants to prepare plans for groups of their member communities. The Metropolitan Area Planning Council (MAPC) received a grant from the Federal Emergency Management Agency (FEMA) under the Pre-Disaster Mitigation (PDM) Program, to assist the Town of Hopkinton to update its 2008 Hazard Mitigation Plan. The local Hazard Mitigation Plan update produced under this grant is designed to individually meet the requirements of the Disaster Mitigation Act for each community.

In order to address multijurisdictional and regional issues, the participating municipalities were afforded the opportunity to review the draft Hopkinton plan. Neighboring communities and local organizations were invited to both public meetings and notified when the draft plan was posted online for review for a ten day period.

What is a Hazard Mitigation Plan?

Natural hazard mitigation planning is the process of determining how to systematically reduce or eliminate the loss of life and property damage resulting from natural hazards such as floods, earthquakes, and hurricanes. Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, projects, and other activities.

Previous Federal/State Disasters

The Town of Hopkinton has experienced 16 natural hazards that triggered federal or state disaster declarations since 1991. These are listed in Table 2 below. The vast majority of these events involved flooding.

Table 2 Previous Federal/State Disaster Declarations

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
Hurricane Bob (August 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)
No-Name Storm (October 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	FEMA Individual Household Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	All 14 Counties
October Flood (October 1996)	FEMA Public Assistance Project Grants	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	FEMA Individual Household Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk (36 projects)
1997	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
June Flood (June 1998)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (19 projects)
(1998)`	Community Development Block Grant-HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
March Flood (March 2001)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)
February Snowstorm (Feb 17-18, 2003)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 22-23, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
Hurricane Katrina (August 29, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
May Rainstorm/Flood (May 12-23, 2006)	Hazard Mitigation Grant Program	Statewide
	Hazard Mitigation Grant Program	Statewide
Flooding (March, 2010)	FEMA Public Assistance FEMA Individuals and Households Program SBA Loan	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Statewide
Hurricane Earl (September 2010)	FEMA Public Assistance Project Grants	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
Tropical Storm Irene (August 27-28, 011)	FEMA Public Assistance	Statewide
Severe snowstorm and Flooding (February 8-09, 2013	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide
Severe Winter Storm, Snowstorm, and Flooding (January 26-28, 2015)	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide

(Source: database provided by MEMA)

FEMA Funded Mitigation Projects

In the last 20 years, the Town of Hopkinton has received no funding from FEMA for mitigation projects under the Hazard Mitigation Grant Program.

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Community Profile

Hopkinton is a town in Middlesex County, Massachusetts, less than 30 miles (48 km) west of Boston. The town is best known as the starting point of the Boston Marathon, held annually on Patriots' Day in April, and as the home of computer storage firm EMC Corporation. At the 2010 census, the town had a population of 14,925. (US Census) Hopkinton's 27.88 square-mile area lies within three major watersheds, with about 75% of the Town in the Concord River watershed, which includes the Sudbury River sub-watershed, a tributary that flows along the northern border of Hopkinton. The rest of Hopkinton is divided in roughly equal proportions by the Charles River and Blackstone River watersheds. The Charles River watershed encompasses 35 cities and towns from the river's headwaters in Hopkinton to Boston and Cambridge, where it discharges into Massachusetts Bay. (2007 Hopkinton Master Plan)

Hopkinton is served by two interstate highways and two state highways. Interstates 90 (the Massachusetts Turnpike) and 495, form an interchange on the northern border of Hopkinton and neighboring Westborough. Its proximity to Route 9 (the Boston/Worcester Turnpike) and Route 30 in Westborough, gives the Town additional access to east/west destinations.

Hopkinton is bordered by the communities of Upton to the southwest, Westborough to the northwest, Southborough on the north, Ashland to the northeast, Holliston on the

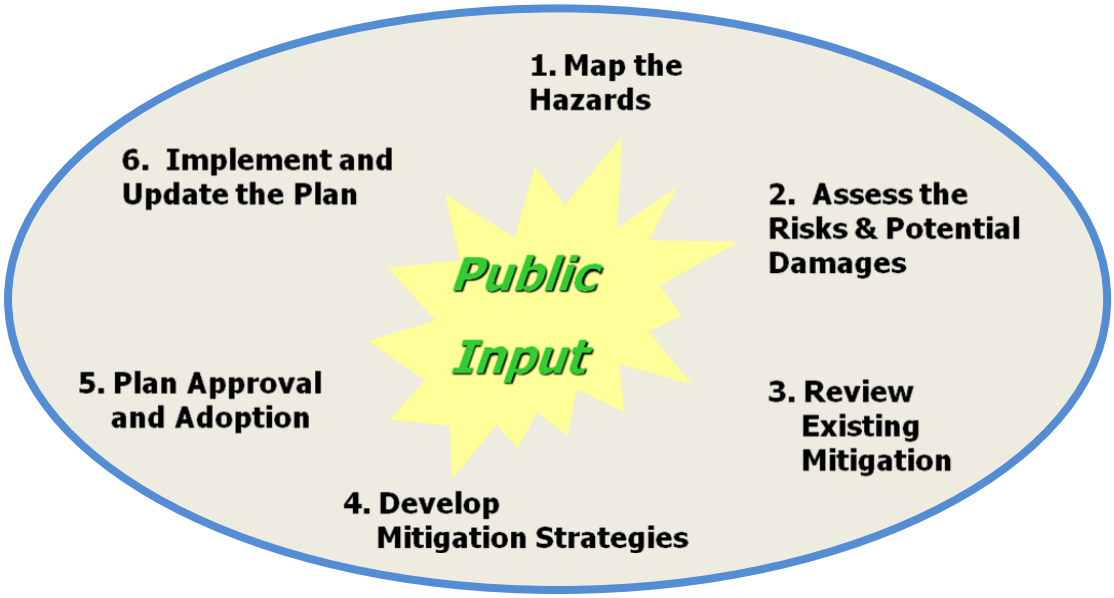
southeast and Milford to the south. The Town maintains a website at http://www.hopkintonma.gov/

III. PLANNING PROCESS AND PUBLIC PARTICIPATION

MAPC employs a six step planning process based on FEMA's hazard mitigation planning guidance focusing on local needs and priorities but maintaining a regional perspective matched to the scale and nature of natural hazard events. Public participation is a central component of this process, providing critical information about the local occurrence of hazards while also serving as a means to build a base of support for hazard mitigation activities. MAPC supports participation by the general public and other plan stakeholders through Local Hazard Mitigation Planning Committees, two public meetings hosted by the Local Hazard Mitigation Planning Committee, posting of the plan to the Town's website, and invitations sent to neighboring communities, Town boards and commissions, and other local or regional entities to review the plan and provide comment.

Planning Process Summary

The six-step planning process outlined below is based on the guidance provided by FEMA in the Local Multi-Hazard Mitigation Planning Guidance, July 1, 2008. Public participation is a central element of this process, which attempts to focus on local problem areas and identify needed mitigation measures based on where gaps occur in the existing mitigation efforts of the municipality. By working on municipal hazard mitigation plans in groups of neighboring cities and Towns, MAPC is able to identify regional opportunities for collaboration and facilitate communication between communities. In plan updates, the process described below allows staff to bring the most recent hazard information into the plan, including new hazard occurrence data, changes to a municipality's existing mitigation measures, and progress made on actions identified in previous plans.



1. Map the Hazards – MAPC relies on data from a number of different federal, state, and local sources in order to map the areas with the potential to experience natural hazards. This mapping represents a multi-hazard assessment of the municipality and is used as a set of base maps for the remainder of the planning process. A particularly important source of information is the knowledge drawn from local municipal staff on where natural hazard impacts have occurred, which is collected. These maps can be found in Appendix B.

2. Assess the Risks & Potential Damages – Working with local staff, critical facilities, infrastructure, vulnerable populations, and other features are mapped and contrasted with the hazard data from the first step to identify those that might represent particular vulnerabilities to these hazards. Land use data and development trends are also incorporated into this analysis. In addition, MAPC develops estimates of the potential impacts of certain hazard events on the community.

3. Review Existing Mitigation – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as many have adopted flood plain zoning districts, wetlands protection programs, and other measures as well as enforcing the State building code, which has strong provisions related to hazard resistant building requirements. All current municipal mitigation measures must be documented.

4. Develop Mitigation Strategies – MAPC works with the local municipal staff to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessments, and the community's existing mitigation efforts to determine where additional work is necessary to reduce the potential damages from hazard events. Additional information on the development of hazard mitigation strategies can be found in Chapter VII.

5. Plan Approval & Adoption – Once a final draft of the plan is complete it is sent to MEMA for the state level review and, following that, to FEMA for approval. Typically, once FEMA has approved the plan the agency issues a conditional approval with the condition being adoption of the plan by the municipality. More information on plan adoption can be found in Chapter IX and documentation of plan adoption can be found in Appendix D.

6. Implement & Update the Plan – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a five year basis making preparation for the next plan update an important on-going activity. Chapter IX includes more detailed information on plan implementation.

Local Plan Update Representatives

On February 28, 2014 a letter was sent notifying Hopkinton of the first meeting regarding the plan update and requesting that the Chief Elected Official designate a minimum of two municipal employees and/or officials to represent the community. The following individuals were appointed to represent Hopkinton:

Ken Clark	Chief, Fire Department, Emergency Management
Elaine Lazarus	Director of Land Use, Planning and Permitting

The Local Multiple Hazard Community Planning Team

MAPC worked with the local community representatives to organize a local Multiple Hazard Community Planning Team for Hopkinton (Local Committee). MAPC briefed the local representatives as to the desired composition of that team as well as the need for representation from the business community, civic organizations and citizens at large.

The Local Multiple Hazard Community Planning Team Meetings

On June 11, 2014, MAPC and MEMA staff held a meeting with the Local Committee to outline the hazard mitigation planning and updating process at Hopkinton Town Hall.

On October 9, 2014, MAPC conducted a meeting of the Hopkinton Local Committee. The meeting was organized by Fire and Emergency Management Chief Ken Clark and Elaine Lazarus, Director of Land Use, Planning and Permitting. The purpose of the meeting was to review and develop hazard mitigation goals, review the status of mitigation measures identified in the 2008 hazard mitigation plan, identify new potential mitigation measures and to gather information on local hazard mitigation issues and sites or areas related to these. The first meeting also covered measures to be carried forward from the previous plan and their prioritization.

Table 3 lists the attendees at each meeting of the team. The agendas for these meetings are included in Appendix A.

Table 3
Attendance at the Hopkinton Local Committee Meetings

Name	**Representing**
October 9,2014	
Elaine Lazarus	Land Use, Planning and Permitting
David Daltorio	Facilities and Engineering
John K. Westerling	Department of Public Works
Ken Clark	Fire Department and Emergency Management
Jamie Hellen	Town Manager

Table 3 **Attendance at the Hopkinton Local Committee Meetings**	
June 11, 2014	
Elaine Lazarus	Land Use, Planning and Permitting
David Daltorio	Facilities and Engineering
John K. Westerling	Department of Public Works
Ken Clark	Fire Department and Emergency Management
Don McAdams	Conservation Agent
Marybeth Groff	MEMA
Martin Pillsbury	MAPC
Sam Cleaves	MAPC

Public Meetings

Public participation in the hazard mitigation planning process is important, both for plan development and for later implementation of the plan. Residents, business owners, and other community members are an excellent source for information on the historic and potential impacts of natural hazard events and particular vulnerabilities the community may face from these hazards. Their participation in this planning process also builds understanding of the concept of hazard mitigation, potentially creating support for mitigation actions taken in the future to implement the plan. To gather this information and educate residents on hazard mitigation, the Town hosted two public meetings: one during the planning process and one just prior to a complete draft plan was ready for review.

The public had an opportunity to provide input to the planning process during an advertised and posted public meeting of the Local Committee on December 16, 2014 held in the Hopkinton Town Hall, which was also televised locally by Hopkinton public access television. The final draft of the plan was presented for public comment at an advertised public meeting of the Local Committee on August 11, 2015. This meeting was held in the Hopkinton Town Hall. The August 11 meeting was televised and re-broadcast on local cable.

Both meetings were publicized as public meetings of the Local Committee with the public invited to comment and ask questions regarding the plan. The presentation of the final draft was publicized at a public meeting, again with the invitation for public comment. An attendance list for each meeting can be found in Table 4. In addition, the plan was made available on the Town's website for public review.

Table 4
Attendance at Public Meetings

Name	Representing
First Public Meeting	
Ken Clark	Fire and EM Chief
John K. Westerling	DPW Director
David Daltorio	Town Engineer
Ed Lee	Hopkinton Police
Jamie Hellen	Town Manager
Mavis O'Leary	Hopkinton Resident
Second Public Meeting	
Jamie Hellen	Town Manager
Jennifer Burke	Principal Planner
Don McAdams	Conservation Agent
Joe Regan	Resident
Ken Clark	Fire and EM Chief

Other Opportunities for Public Involvement

Review by Community Organizations

In addition to communications with local committees and departments about the plan, notice was sent to the following organizations and neighboring municipalities inviting them to review the Hopkinton Hazard Mitigation Plan, and submit their comments to the Town.

Town of Upton
Town of Westborough
Town of Southborough
Town of Ashland
Town of Holliston
Town of Milford

Upper Charles Conservation, Inc.

Sudbury Valley Trustees

Hopkinton Area Land Trust

Website

A draft copy of the Hopkinton Hazard Mitigation Plan was posted on the Town's website. Members of the public could access the draft document and submit comments or questions. In addition, communication was sent to neighboring municipalities to share the draft plan and to provide opportunity for comment.

No comments were received on the draft plan.

Planning Timeline

February 28, 2014	Letter to the municipalities initiating the project.
June 11, 2014	Natural Hazard Overview and Process Meeting with Local Committee, MEMA and MAPC
October 9, 2014	Meeting of the Local Committee
December 16, 2014	First Public Meeting hosted by Local Committee
August 11, 2015	Second Public Meeting hosted by Local Committee
October 1, 2015	Draft plan submitted to MEMA
February 8, 2016	Revised draft plan submitted to MEMA
June 6, 2016	Approval Pending Adoption issued by FEMA

IV. RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town of Hopkinton as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. This section also includes a vulnerability assessment that estimates the potential damages that could result from certain large scale natural hazard events.

Update Process

In order to update Hopkinton's risk assessment, MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. MAPC also used the most recently available version of HAZUS (described below).

Overview of Hazards and Impacts

The Commonwealth of Massachusetts Hazard Mitigation Plan 2013 (state plan) provides an in-depth overview of natural hazards in Massachusetts. The state plan indicates that Massachusetts is most vulnerable to the following natural hazards: flooding, severe storms, and winter events, and is also vulnerable to other natural hazards such as drought, brush fires, earthquakes, landslides, tsunamis, and extreme temperatures. Previous state and federal disaster declarations since 1991 are summarized in Table 1.

Table 6 summarizes the hazard risks for Hopkinton. This evaluation takes into account the frequency of the hazard, historical records, and variations in land use. This analysis is based on the vulnerability assessment in the Commonwealth of Massachusetts State Hazard Mitigation Plan, 2013. The statewide assessment was modified to reflect local conditions and natural hazards in Hopkinton using the definitions for hazard frequency and severity listed below Table 5.

Table 5
Hazard Risks Summary

Hazard	Frequency	Severity
Flood Related		
Inland/Riverine	High	Minor
Dam Failure	Very Low	Serious
Ice Jam	Low	Minor
Wind		
Hurricanes	Medium	Serious
Tornadoes	Low	Serious
Nor'easter	High	Serious
Severe Thunderstorm	High	Low

Table 5
Hazard Risks Summary

Winter Storms		
Ice Storm	Medium	Minor
Blizzard	High	Minor
Geologic		
Earthquakes	Low	Extensive
Landslide	Low	Minor
Other Natural Hazards		
Brush Fire	Medium	Minor
Extreme temperatures	Medium	Minor
Drought	Low	Minor

Definitions used in the Commonwealth of Massachusetts State Hazard Mitigation Plan

Definitions Used in the Commonwealth of Massachusetts State Hazard Mitigation Plan 2013

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

Flood Related Hazards

Flooding was the most prevalent natural hazard identified by local officials in Hopkinton. Flooding is generally caused by hurricanes, nor'easters, severe rainstorms and thunderstorms. Global climate change has the potential to exacerbate these issues over time with the potential for changing rainfall patterns and heavier storms.

Previous Occurrences and Extent of Flooding

There have been a number of major floods that have affected the Middlesex County region over the last fifty years. Significant historic flood events in Hopkinton have included:

- March 1968
- January 1979
- April 1987
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- December 2010

Town-specific data for previous flooding occurrences are not collected by the Town of Hopkinton. The best available local data is from the National Climatic Data Center (see Table 6). Middlesex County, which includes the Town of Hopkinton, experienced 76 flood events from 1996 –2015. No deaths or injuries were reported and the total reported property damage in the county was $40.83 million dollars.

Table 6 Middlesex County Flood Events, 1996-2015

Location	Date	Type	Deaths	Injuries	Property Damage
Totals:			0	0	40.830M
WESTERN MIDDLESEX (ZONE)	01/29/1996	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/17/1996	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/17/1996	Flood	0	0	0.00K
SOUTHEAST PORTIONS	09/18/1996	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	10/21/1996	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	10/22/1996	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/10/1998	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/11/1998	Flood	0	0	0.00K

Location	Date	Type	Deaths	Injuries	Property Damage
WESTERN MIDDLESEX (ZONE)	05/12/1998	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	06/14/1998	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	06/15/1998	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	06/17/1998	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/22/2000	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/23/2000	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/23/2000	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/23/2000	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/22/2001	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/22/2001	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/22/2001	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/23/2001	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/23/2001	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/31/2001	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/01/2001	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/01/2004	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/01/2004	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/02/2004	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/02/2004	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/02/2004	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/02/2004	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	04/15/2004	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	03/29/2005	Flood	0	0	0.00K
WESTERN MIDDLESEX (ZONE)	10/15/2005	Flood	0	0	100.00K
WESTERN MIDDLESEX (ZONE)	10/15/2005	Flood	0	0	100.00K
SOUTHEAST MIDDLESEX (ZONE)	10/15/2005	Flood	0	0	125.00K
COUNTYWIDE	05/13/2006	Flood	0	0	5.000M
COUNTYWIDE	05/13/2006	Flood	0	0	0.00K
WAKEFIELD	07/11/2006	Flood	0	0	2.00K
CAMBRIDGE	10/28/2006	Flood	0	0	5.00K
SAXONVILLE	04/16/2007	Flood	0	0	25.00K
FRAMINGHAM	02/13/2008	Flood	0	0	0.00K
MEDFORD	05/27/2008	Flood	0	0	3.00K
STONEHAM	06/24/2008	Flood	0	0	10.00K

Location	Date	Type	Deaths	Injuries	Property Damage
WESTLANDS	06/29/2008	Flood	0	0	5.00K
EVERETT	08/10/2008	Flood	0	0	15.00K
SUDBURY	08/10/2008	Flood	0	0	40.00K
NORTH WOBURN	09/06/2008	Flood	0	0	15.00K
BILLERICA	12/12/2008	Flood	0	0	20.00K
HOLLISTON	03/14/2010	Flood	0	0	26.430M
FARM HILL	03/29/2010	Flood	0	0	8.810M
FARM HILL	04/01/2010	Flood	0	0	0.00K
WEST NEWTON	08/28/2011	Flood	0	0	5.00K
RIVER PINES	10/14/2011	Flood	0	0	0.00K
NORTH SOMMERVILLE	06/08/2012	Flood	0	0	0.00K
BEAVER BROOK	06/23/2012	Flood	0	0	0.00K
MELROSE	06/23/2012	Flood	0	0	0.00K
TUFTS COLLEGE	06/23/2012	Flood	0	0	0.00K
MALDEN	06/23/2012	Flood	0	0	0.00K
TUFTS COLLEGE	06/23/2012	Flood	0	0	15.00K
NEWTON	07/18/2012	Flood	0	0	5.00K
NORTH WALTHAM	10/29/2012	Flood	0	0	0.00K
RIVER PINES	06/07/2013	Flood	0	0	0.00K
LOWELL	07/01/2013	Flood	0	0	0.00K
RIVER PINES	07/01/2013	Flood	0	0	0.00K
HARWOOD	07/23/2013	Flood	0	0	0.00K
FRAMINGHAM	09/01/2013	Flood	0	0	10.00K
CHELMSFORD CENTER	03/30/2014	Flood	0	0	35.00K
NORTH WALTHAM	03/30/2014	Flood	0	0	0.00K
GRANITEVILLE	03/30/2014	Flood	0	0	0.00K
CONCORD	07/27/2014	Flood	0	0	0.00K
NORTH LEXINGTON	08/31/2014	Flood	0	0	0.00K
FELCHVILLE	10/22/2014	Flood	0	0	20.00K
NEWTON LOWER FALLS	10/23/2014	Flood	0	0	0.00K
BOXBOROUGH	12/09/2014	Flood	0	0	0.00K
CLEMATIS BROOK	12/09/2014	Flood	0	0	5.00K
SOMERVILLE	12/09/2014	Flood	0	0	30.00K
NONANTUM	12/09/2014	Flood	0	0	0.00K

Location	Date	Type	Deaths	Injuries	Property Damage
Totals:			0	0	40.830M

Source: NOAA, National Climatic Data Center

Overview of Town-Wide Flooding

Many of the flood plain areas in the town are in close proximity to the major waterways, but these waterways are not the sole source for water-related hazard areas in the town. Major waterways located in Hopkinton include the Charles River, Sudbury River, Lake Maspenock, Echo Lake, Whitehall Lake, Hopkinton Reservoir, North Pond, Blood's Pond, Indian Brook, Cold Spring Brook, and Whitehall Brook, as well as several smaller brooks, creeks and streams that can also pose annual flood threats to the town. Virtually all of the 100-year and 500-year flood zones in town are located near major bodies of water, including those named above.
However, in many of those zones the flood frequency is greater than the 100-year flood event. Town officials indicated that they believe that many of the town's more frequent flooding problems are related to insufficient or inoperable flood management structures, such as culverts, dams and drain pipes that are not large enough to quickly transport flood waters away from town streets and neighborhoods and toward the nearby wetlands. Also, the headwaters of the Charles River are located at Echo Lake. The Town constructed a new waste water treatment plant in 2012.

As with most of eastern Massachusetts the natural hazard threat that is most prevalent in the town of Hopkinton, and therefore the focus of most of the town's hazard mitigation efforts is flooding. According to the Local Committee, most of the town's flood-related hazards are related to high rain events, such as heavy rainstorms, tropical storms or winter rain and snow storms. Flooding in the Town of Hopkinton is primarily a result of precipitation and storm water run-off overwhelming the capacity of natural and structured drainage systems to convey water, causing it to overflow the system.
In addition, the spring rainy season is a particularly hazardous time, as runoff from winter snowfalls, saturates much of the town's wetlands and fills the town's streams and brooks. A heavy or severe rain event at this time of year can often overwhelm the natural flood storage areas of the town and create flood hazards on streets and around residential and business areas in town.

Whitehall Lake, in Hopkinton, and its surrounding watersheds are considered the head waters of the Charles River. The Charles River is 80 miles in length - the longest river with its entire length in Massachusetts. The Charles River Watershed has a drainage area of approximately 308 square miles and encompasses all or part of 35 municipalities. The watershed drains northward and is divided into three distinct regions, which include the rural, forested upper watershed, the suburban lakes or middle watershed, and the urban lower watershed, which drains through the Boston metropolitan area. In general, the

upper and middle watersheds are characterized by forest cover and residential land use, while the lower watershed is characterized by commercial land use. Since 1995, the water quality of the Charles River has improved dramatically, and is now clean enough for boating and swimming for the greater part of each year, according to the Environmental Protection Agency (EPA). The greatest source of pollution to the river is non- point source pollution, especially from stormwater runoff and Combined Sewer Overflows (CSOs). The quantity of water available for residential and commercial use is also threatened by overuse, which has lowered groundwater levels and decreased stream flow.

In the 1960's studies by the Corps of Engineers revealed that the communities above Newton had a history of only minimal flooding. Extensive marshes, swamps and wet meadows scattered around the upper watershed were holding floodwaters and then only slowly letting them go. In 1974 Congress authorized the "Charles River Natural Valley Storage Area," allowing for the acquisition and permanent protection of 17 scattered wetlands in the middle and upper watershed. Final acquisition totaled 8,103 acres, with 3,221 acres of land acquired in fee and 4,882 acres in flood easement, at total project cost of $8,300,000. Hopkinton therefore, has the responsibility of preserving floodplains and other water storage areas in efforts reduce downstream flooding. It must be noted that within the Charles River Watershed, flooding within the lower watershed (Boston metro area) is controlled with dams and channelization, while the upper and middle watersheds, wetlands and other natural storage areas are relied upon to protect the area from flooding.

Inland/Riverine Flooding

Inland/Riverine flooding is associated with the rivers and streams in the town of Hopkinton, which can overtop their banks and inundate adjacent areas during storm events. In many cases, those areas where flooding occurs are floodplain and wetland areas where flood events are part of the natural system, only creating a problem where these areas have been previously developed. Development also increases the amount of impervious area, which serves to exacerbate flooding as storm water is prevented from absorbing into the ground and flows overland directly into the waterway, increasing the potential volume of water.

Areas vulnerable to inland/riverine flooding are shown on Map 3 in Appendix B, and specific sites identified by the Town subject to flooding are listed in section below on Potential Flood Hazard Areas. The vulnerability analysis below provides estimates of flood damages for these sites ranging from $1,391,201 - $6,956,004.

The inventory of Critical Facilities shows three sites located within flood hazard areas. These include two dams and a bridge. While there have not been previous occurrences of significant flood damage to these sites, the town is potentially vulnerable to loss or interruption of key services such as water supply, wastewater treatment, emergency response, and communications due to potential flooding at these sites.

Dams and Dam Failure

Dam failure can occur as a result of structural failure, independent of a hazard event, or as the result of the impacts of a hazard event such as flooding associated with storms or an earthquake. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters.

Dam failure is a highly infrequent occurrence but a severe incident could result in loss of lives and significant property damage. Since 1984, three dams have failed in or very near to Massachusetts, one of which resulted in a death. There have been no recorded dam breaches in Hopkinton.

According to data provided by the Massachusetts Department of Conservation and Recreation and the town, there are nine dams located in Hopkinton. Four of the dams are rated as either Significant or High hazard dams.

DCR defines dam hazard classifications as follows:

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

Table 7. Hopkinton Dams

Name	Impounds	Ownership Type	Owner	Hazard
Whitehall Reservoir Dam	Whitehall Brook	Public	MA/DCR	Significant
Echo Lake Dam	Charles River	Private	Milford Water Co.	High
Bloods Pond Dam	Cold Spring Brook	Public	Hopkinton	Significant
Grist Mill Dam	Cold Spring Brook	Public	Hopkinton	Low
Ice House Pond Dam	Indian Brook	Public	Hopkinton	Small, unregulated
Whitehall Lower Pond Dam	Whitehall Brook	Public	MA/DCR	Small, unregulated
Whitehall Upper Pond Dam	Whitehall Brook	Public	MA/DCR	Significant
Whitehall Reservoir Dike	Whitehall Brook	Public	MA/DCR	Small, unregulated
Whitehall Reservoir Distribution Dam	Whitehall Brook	Public	MA/DCR	Significant

The probability of future dam failure events is classified in the Massachusetts State Hazard Mitigation Plan 2013 as very low frequency, or an event that occurs less frequently than once in 100 years (less than 1% per year).

Ice Jams

Ice jams occur in cold weather when normally flowing water begins to freeze effectively damming the waterway and causing localized flooding in the area. There is no history of ice jams leading to flooding in Hopkinton and Town staff did not identify this hazard as an issue for the Town

Potential Flood Hazard Areas

The frequency and locations of flood hazard events in Hopkinton can be estimated based on a number of sources of information. The first was the National Flood Insurance Rate Maps (FIRMs). The FIRM flood zones are shown on Map 3 in Appendix B and their definitions are listed below.

Flood Insurance Rate Map Zone Definitions

Zone A (1% annual chance) - Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.

Zone AE and A1-A30 (1% annual chance) - Zones AE and A1-A30 are the flood insurance rate zones that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

Zones X500 (.2% annual chance) - Zone X500 is the flood insurance rate zone that correspond to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone.

Zone VE (1% annual chance) - Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply

The second was discussions with local officials and the public. The Locally Identified Areas of Flooding included below were identified by the Hopkinton Hazard Mitigation Planning Team as areas where flooding is known to occur. These areas do not necessarily coincide with the flood zones from the FIRMs. They may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone. The numbers correspond to the numbers on Map 8, "Hazard Areas". The numbers do not reflect priority order.

Locally Identified Areas of Flooding

Flood Sites carried over from 2008

#1- 32 Granite Street- Culvert upgrade in progress, project not carried forward.
2- Alprilla Farm Road- Blood's Pond Dam Operational Plan carried forward.

2014 Flood Site

#3- Cranberry Lane/North Hill Neighborhood: low lying area of 30- 40 home impacted by flooding caused by beaver activity.

Repetitive Loss Structures
As defined by the Community Rating System (CRS) of the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. For more information on repetitive losses see http://www.fema.gov/business/nfip/replps.shtm. There are no repetitive loss structures in Hopkinton, the same as the 2008 plan.

Wind Related Hazards

Wind-related hazards include hurricanes and tornadoes as well as high winds during severe rainstorms and thunderstorms. As with many communities, falling trees and tree limbs that result in downed power lines and power outages are an issue in Hopkinton. Information on wind related hazards can be found on Map 5 in Appendix B.

Hurricanes

A hurricane is a violent wind and rainstorm with wind speeds of 74-200 miles per hour. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits the land. Given its location on the coast, the town's entire area is vulnerable to hurricanes. Hurricanes occur between June and November.

Since 1900, 39 tropical storms have impacted New England (NESEC). Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane. This equates to a frequency of once every six years. A hurricane or storm track is the line that delineates the path of the eye of a hurricane or tropical storm.

There has been one major storm track through Hopkinton, a tropical depression tracked through the northwestern portion of Hopkinton in 1897. The Town experiences the impacts of the wind and rain of hurricanes and tropical storms regardless of whether the storm track passed through the Town. The hazard mapping indicates that the 100 year wind speed is 110 miles per hour.

Some of the hurricanes that have passed through the region are shown in Table 8:

Table 8. Hurricane Records for Massachusetts

Hurricane Event	Date
Great New England Hurricane*	September 21, 1938
Great Atlantic Hurricane*	September 14-15, 1944
Hurricane Doug	September 11-12, 1950
Hurricane Carol*	August 31, 1954
Hurricane Edna*	September 11, 1954
Hurricane Diane	August 17-19, 1955
Hurricane Donna	September 12, 1960
Hurricane Gloria	September 27, 1985
Hurricane Bob	August 19, 1991
Hurricane Earl	September 4, 2010
Tropical Storm Irene	August 28, 2011
Hurricane Sandy	October 29-30, 2012

*Category 3. Source: National Oceanic and Atmospheric Administration (NOAA)

Hurricane intensity is measured according to the Saffir/Simpson scale, which categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. These are combined to estimate potential damage. The following gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

Category	Winds (mph)	Surge (ft)	Potential Damage
1	74 – 95	4 - 5	Minimal
2	96 – 110	6 - 8	Moderate
3	111 – 130	9 - 12	Extensive
4	131 – 155	13 - 18	Extreme
5	> 155	>18	Catastrophic

Source: NOAA

Hurricanes typically have regional impacts beyond their immediate tracks. Falling trees and branches are a significant problem because they can result in power outages when they fall on power lines or block traffic and emergency routes. Hurricanes are a town-wide hazard in Hopkinton. Potential hurricane damages to Hopkinton have been estimated using HAZUS-MH. Total damages are estimated at $15,755,550 million for a Category 2 hurricane and $52,746,350 Million for a Category 4 hurricane. Other potential impacts are detailed in Table 21.

Based on the record of previous occurrences, Hurricanes in Hopkinton are a Medium frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Tornadoes

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. These events are spawned by thunderstorms and occasionally by hurricanes, and may occur singularly or in multiples. They develop when cool air overrides a layer of warm air, causing the warm air to rise rapidly. Most vortices remain suspended in the atmosphere. Should they touch down, they become a force of destruction. Buildings constructed prior to current building codes may be more vulnerable to damages caused by tornadoes. Evacuation of high-risk areas may be required on short notice. Sheltering and mass feeding efforts may be required along with debris clearance, search and rescue, and emergency fire and medical services. Tornadoes are most common in the summer, June through August, and most form in the afternoon or evening.

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 tornadoes using the Enhanced Fujita-scale (EF-scale), which allows surveyors to create more precise assessments of tornado severity. The EF-scale is summarized below:

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

Source: Massachusetts State Hazard Mitigation Plan, 2013

The frequency of tornadoes in eastern Massachusetts is low; on average, there are six tornadoes that touchdown somewhere in the Northeast region every year. The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC). The most recent tornado events in Massachusetts were in Springfield in 2011 and in Revere in 2014. The Springfield tornado caused significant damage and resulted in 4 deaths in June of 2011. The Revere tornado touched down at in Chelsea just south of Route 16 (Revere Beach Parkway) and moved north into Revere's business district along Broadway, past Revere City Hall, and ended near the intersection of Routes 1 and 60. The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour. According to Revere Fire Chief Gene Doherty, 65 homes had "substantial damages" and 13 homes and businesses were uninhabitable.

Although there have been no recorded tornadoes within the Hopkinton Town limits, the town's entire area is potentially subject to tornadoes. Since 1955 there have been 17 tornadoes in surrounding Middlesex County recorded by the National Climate Data Center. Two of these were F3 tornadoes and four were F2. These 17 tornadoes resulted in a total of one fatality and six injuries and up to $ 3.881million in damages, as summarized in Table 9.

Table 9. Tornado Records for Middlesex County

Date	Fujita	Fatalities	Injuries	Damage
10/24/1955	F1	0	0	2.50K
06/19/1957	F1	0	0	25.00K
06/19/1957	F1	0	0	0.25K
07/11/1958	F2	0	0	250.00K
08/25/1958	F2	0	0	2.50K
07/03/1961	F0	0	0	25.00K
07/18/1963	F1	0	0	25.00K
08/28/1965	F2	0	0	250.00K
07/11/1970	F1	0	0	25.00K
10/03/1970	F3	1	0	250.00K
07/01/1971	F1	0	1	25.00K
11/07/1971	F1	0	0	0.25K
07/21/1972	F2	0	4	2.500M
09/29/1974	F3	0	1	250.00K
07/18/1983	F0	0	0	0.25K
09/27/1985	F1	0	0	0.25K
08/07/1986	F1	0	0	250.00K

Source: NCDC

Buildings constructed prior to current building codes may be more vulnerable to damages caused by tornadoes. Evacuation of impacted areas may be required on short notice. Sheltering and mass feeding efforts may be required along with debris clearance, search and rescue, and emergency fire and medical services. Key routes may be blocked by downed trees and other debris, and widespread power outages are also typically associated with tornadoes.

Although tornadoes are a potential town-wide hazard in Hopkinton, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Hopkinton would greatly depend on the track of the tornado, with the more densely developed downtown area more liable to damage.

Based on the record of previous occurrences since 1950, Tornado events in Hopkinton are a Medium frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Nor'easters

Featuring strong northeasterly winds blowing in from the ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year and frequently lead to coastal flooding and erosion. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 10 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rains or snows, depending on temperatures. The entire town is potentially subject to Nor'easters.

Previous occurrences of Nor'easters include the following:

February 1978	Blizzard of 1978
October 1991	Severe Coastal Storm ("Perfect Storm")
December 1992	Great Nor'easter of 1992
January 2005	Blizzard/ Noreaster
October 2005	Coastal Storm/Nor'easter
April 2007	Severe Storms, Inland & Coastal Flooding/Nor'easter
January 2011	Winter Storm/Nor'easter
October 2011	Severe Storm/Nor'easter
Severe Snow Storm	January 2011
Blizzard of 2013	February 2013
Blizzard of 2015	January 2015

Many of the historic flood events identified in the previous section were precipitated by nor'easters, including the "Perfect Storm" event in 1991. More recently, blizzards in December 2010 and October 2011 were both large nor'easters that caused significant snowfall amounts.

The high winds of Nor'easters can cause falling trees, which can result in downed power lines and power outages, as well as obstruction of key routes and emergency access. In some cases structures may also be damaged by Nor'easters' heavy winds. Heavy precipitation associated with some Nor'easters may also cause localized flooding, both riverine and urban drainage related. The entire town of Hopkinton could be at risk from the wind, rain or snow impacts and coastal damages from a nor'easter, depending on the track and radius of the storm

Based on the record of previous occurrences, nor'easters in Hopkinton are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Severe Thunderstorms

While less severe than the other types of storms discussed, thunderstorms can lead to localized damage and represent a hazard risk for communities. Generally defined as a storm that includes thunder, which always accompanies lightning, a thunderstorm is a storm event featuring lightning, strong winds, and rain and/or hail. Thunderstorms sometime give rise to tornadoes. On average, these storms are only around 15 miles in diameter and last for about 30 minutes. A severe thunderstorm can include winds of close to 60 mph and rain sufficient to produce flooding. The town's entire area is potentially subject to severe thunderstorms. The town does not keep records of thunderstorms, but estimates that at least 8 to ten occur each year. In 2010, the committee noted that the Lake Shore Drive and Sandy Beach area experienced high winds and a microburst event that downed trees and knocked out four power line poles, resulting in power being out for 1-2 days in this area.

The Town does not track thunderstorm events. The best available data on previous occurrences of thunderstorms in Hopkinton is the National Climatic Data Center (NCDC). Between the years 1995 and 2015 NCDC records show 6 thunderstorm events in Hopkinton (Table 10). These storms resulted in a total of $25,000 in property damages. There were no injuries and no deaths reported. Middlesex County experienced 251 events with 10 injuries and $2.719 million in property damage for the same period

Table 10 Middlesex County Thunderstorm Events, 1995-2015

LOCATION	DATE	TYPE	MAGNITUDE	DEATHS	INJURIES	DAMAGE
HOPKINTON	7/15/1995	Thunderstorm	0			
HOPKINTON	5/31/1998	Thunderstorm	70			
HOPKINTON	7/23/1998	Thunderstorm	50			
HOPKINTON	8/10/2001	Thunderstorm	50			
HOPKINTON	8/27/20087	Thunderstorm	50			5,,000
HOPKINTON	7/8/2009	Thunderstorm	50			20,000
TOTAL				**0**		**5,000**

Source: NOAA, National Climatic Data Center- Magnitude refers to maximum wind speed in knots

Severe thunderstorms are a town-wide hazard for Hopkinton. The town's vulnerability to severe thunderstorms is similar to that of Nor'easters. High winds can cause falling trees and power outages, as well as obstruction of key routes and emergency access. Heavy precipitation may also cause localized flooding, both riverine and urban drainage related.

Based on the record of previous occurrences, severe thunderstorms in Hopkinton are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Winter Storms

Winter storms are the most common and most familiar of the region's hazards that affect large geographic areas. The majority of blizzards and ice storms in the region cause more inconvenience than they do serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response. .

Heavy Snow and Blizzards

Severe snow accumulation can have a number of different impacts on a community. Hazardous driving conditions can impact emergency response and vulnerable citizens in need of services, heavy snow on tree branches can cause them to fall and damage electric lines, and, in extreme situations, heavy snow can collapse cave in building roofs. The average annual snowfall for most Hopkinton is 48-72inches; the eastern edge of the Town averages 36 – 48 inches (see Map 6 in Appendix B).

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. 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 largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The NESIS categories are summarized below:

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

Blizzards include all of the hazards associated with heavy snows but also accompanied by 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 when temperatures are below 20 degrees. Historical occurrences of blizzards are included in the winter storm listing below.

The most significant winter storm in recent history was the "Blizzard of 1978," which resulted in over 3 feet of snowfall and multiple day closures of roadways, businesses, and schools. More recently, the snow storm of October 29, 2011, while not large by traditional standards, knocked out power to most of the Town for several days due to snow and ice build up on trees that were still in foliage.

Historically, severe winter storms have occurred in the following years in Hopkinton:

Blizzard of 1978	February 1978
Blizzard	March 1993
Blizzard	January 1996
Severe Snow Storm	March 2001
Severe Snow Storm	December 2003
Severe Snow Storm	January 2005
Severe Snow Storm	December 2010
Severe Snow Storm	January 2011
Blizzard of 2013	February 2013
Blizzard of 2015	January 2015

Source: NOAA

The Town of Hopkinton does not keep local records of winter storms. Data for Middlesex County, which includes Hopkinton, is the best available data to help understand previous occurrences and impacts of heavy snow events. According to the National Climate Data Center (NCDC) records, from 1995 to 2015, Middlesex County experienced 151 heavy snowfall events, resulting in no deaths, no injuries, and $4.415 million dollars in property damage. See Table 11 for and heavy snow events and impacts in Middlesex County.

Table 11. Heavy Snow events and Impacts in Middlesex County 1995 –2015

Date	Type	Deaths	Injuries	Property Damage
01/02/1996	Heavy Snow	0	0	0.00K
01/02/1996	Heavy Snow	0	0	0.00K
01/07/1996	Heavy Snow	0	0	1.400M
01/07/1996	Heavy Snow	0	0	1.500M
01/10/1996	Heavy Snow	0	0	0.00K
01/12/1996	Heavy Snow	0	0	0.00K
02/02/1996	Heavy Snow	0	0	0.00K
02/16/1996	Heavy Snow	0	0	0.00K
02/16/1996	Heavy Snow	0	0	0.00K

Date	Type	Deaths	Injuries	Property Damage
03/02/1996	Heavy Snow	0	0	0.00K
03/02/1996	Heavy Snow	0	0	0.00K
03/07/1996	Heavy Snow	0	0	0.00K
03/07/1996	Heavy Snow	0	0	0.00K
04/07/1996	Heavy Snow	0	0	0.00K
04/07/1996	Heavy Snow	0	0	0.00K
04/09/1996	Heavy Snow	0	0	0.00K
04/09/1996	Heavy Snow	0	0	0.00K
12/06/1996	Heavy Snow	0	0	0.00K
12/06/1996	Heavy Snow	0	0	0.00K
12/07/1996	Heavy Snow	0	0	1.360M
03/31/1997	Heavy Snow	0	0	0.00K
03/31/1997	Heavy Snow	0	0	0.00K
04/01/1997	Heavy Snow	0	0	0.00K
04/01/1997	Heavy Snow	0	0	0.00K
11/14/1997	Heavy Snow	0	0	0.00K
12/23/1997	Heavy Snow	0	0	0.00K
12/23/1997	Heavy Snow	0	0	0.00K
01/15/1998	Heavy Snow	0	0	0.00K
01/15/1998	Heavy Snow	0	0	0.00K
01/23/1998	Heavy Snow	0	0	0.00K
01/14/1999	Heavy Snow	0	0	0.00K
01/14/1999	Heavy Snow	0	0	0.00K
02/25/1999	Heavy Snow	0	0	0.00K
02/25/1999	Heavy Snow	0	0	0.00K
03/06/1999	Heavy Snow	0	0	0.00K
03/06/1999	Heavy Snow	0	0	0.00K
03/15/1999	Heavy Snow	0	0	0.00K
03/15/1999	Heavy Snow	0	0	0.00K
01/13/2000	Heavy Snow	0	0	0.00K
01/13/2000	Heavy Snow	0	0	0.00K
01/25/2000	Heavy Snow	0	0	0.00K

Date	Type	Deaths	Injuries	Property Damage
01/25/2000	Heavy Snow	0	0	0.00K
02/18/2000	Heavy Snow	0	0	0.00K
02/18/2000	Heavy Snow	0	0	0.00K
12/30/2000	Heavy Snow	0	0	0.00K
01/20/2001	Heavy Snow	0	0	0.00K
01/20/2001	Heavy Snow	0	0	0.00K
02/05/2001	Heavy Snow	0	0	0.00K
02/05/2001	Heavy Snow	0	0	0.00K
03/05/2001	Heavy Snow	0	0	0.00K
03/05/2001	Heavy Snow	0	0	0.00K
03/09/2001	Heavy Snow	0	0	0.00K
03/09/2001	Heavy Snow	0	0	0.00K
03/30/2001	Heavy Snow	0	0	0.00K
12/08/2001	Heavy Snow	0	0	0.00K
12/08/2001	Heavy Snow	0	0	0.00K
03/20/2002	Heavy Snow	0	0	0.00K
03/16/2004	Heavy Snow	0	0	0.00K
03/16/2004	Heavy Snow	0	0	0.00K
02/24/2005	Heavy Snow	0	0	0.00K
12/13/2007	Heavy Snow	0	0	0.00K
12/13/2007	Heavy Snow	0	0	0.00K
12/16/2007	Heavy Snow	0	0	0.00K
12/16/2007	Heavy Snow	0	0	0.00K
12/19/2007	Heavy Snow	0	0	0.00K
12/19/2007	Heavy Snow	0	0	0.00K
01/14/2008	Heavy Snow	0	0	28.00K
01/14/2008	Heavy Snow	0	0	20.00K
01/14/2008	Heavy Snow	0	0	20.00K
02/22/2008	Heavy Snow	0	0	0.00K
02/22/2008	Heavy Snow	0	0	0.00K
02/22/2008	Heavy Snow	0	0	0.00K
03/01/2008	Heavy Snow	0	0	0.00K

Date	Type	Deaths	Injuries	Property Damage
12/19/2008	Heavy Snow	0	0	0.00K
12/19/2008	Heavy Snow	0	0	0.00K
12/19/2008	Heavy Snow	0	0	0.00K
12/20/2008	Heavy Snow	0	0	0.00K
12/20/2008	Heavy Snow	0	0	8.00K
12/21/2008	Heavy Snow	0	0	0.00K
12/31/2008	Heavy Snow	0	0	0.00K
12/31/2008	Heavy Snow	0	0	0.00K
01/10/2009	Heavy Snow	0	0	0.00K
01/11/2009	Heavy Snow	0	0	0.00K
01/18/2009	Heavy Snow	0	0	0.00K
01/18/2009	Heavy Snow	0	0	0.00K
01/18/2009	Heavy Snow	0	0	0.00K
03/01/2009	Heavy Snow	0	0	0.00K
03/01/2009	Heavy Snow	0	0	0.00K
03/02/2009	Heavy Snow	0	0	0.00K
12/09/2009	Heavy Snow	0	0	15.00K
12/09/2009	Heavy Snow	0	0	0.50K
12/19/2009	Heavy Snow	0	0	0.00K
12/20/2009	Heavy Snow	0	0	0.00K
01/18/2010	Heavy Snow	0	0	0.00K
02/16/2010	Heavy Snow	0	0	0.00K
02/16/2010	Heavy Snow	0	0	0.00K
02/16/2010	Heavy Snow	0	0	15.00K
02/23/2010	Heavy Snow	0	0	8.00K
01/12/2011	Heavy Snow	0	0	0.00K
01/12/2011	Heavy Snow	0	0	0.00K
01/26/2011	Heavy Snow	0	0	0.00K
01/26/2011	Heavy Snow	0	0	0.00K
01/26/2011	Heavy Snow	0	0	0.00K
10/29/2011	Heavy Snow	0	0	0.00K
10/29/2011	Heavy Snow	0	0	30.00K

Date	Type	Deaths	Injuries	Property Damage
12/29/2012	Heavy Snow	0	0	0.00K
12/29/2012	Heavy Snow	0	0	0.00K
12/29/2012	Heavy Snow	0	0	0.00K
02/08/2013	Heavy Snow	0	0	0.00K
02/08/2013	Heavy Snow	0	0	0.00K
02/08/2013	Heavy Snow	0	0	0.00K
02/23/2013	Heavy Snow	0	0	0.00K
03/07/2013	Heavy Snow	0	0	0.00K
03/07/2013	Heavy Snow	0	0	0.00K
03/07/2013	Heavy Snow	0	0	0.00K
03/18/2013	Heavy Snow	0	0	0.00K
03/18/2013	Heavy Snow	0	0	0.00K
03/18/2013	Heavy Snow	0	0	0.00K
12/14/2013	Heavy Snow	0	0	0.00K
12/14/2013	Heavy Snow	0	0	0.00K
12/14/2013	Heavy Snow	0	0	0.00K
12/17/2013	Heavy Snow	0	0	0.00K
12/17/2013	Heavy Snow	0	0	0.00K
12/17/2013	Heavy Snow	0	0	0.00K
01/02/2014	Heavy Snow	0	0	0.00K
01/02/2014	Heavy Snow	0	0	0.00K
01/02/2014	Heavy Snow	0	0	0.00K
01/18/2014	Heavy Snow	0	0	0.00K
02/05/2014	Heavy Snow	0	0	0.00K
02/05/2014	Heavy Snow	0	0	0.00K
02/05/2014	Heavy Snow	0	0	0.00K
02/13/2014	Heavy Snow	0	0	0.00K
02/13/2014	Heavy Snow	0	0	0.00K
02/13/2014	Heavy Snow	0	0	0.00K
02/18/2014	Heavy Snow	0	0	0.00K
02/18/2014	Heavy Snow	0	0	0.00K
11/26/2014	Heavy Snow	0	0	10.00K

Date	Type	Deaths	Injuries	Property Damage
01/24/2015	Heavy Snow	0	0	0.00K
01/24/2015	Heavy Snow	0	0	0.00K
01/24/2015	Heavy Snow	0	0	0.00K
01/26/2015	Heavy Snow	0	0	0.00K
01/26/2015	Heavy Snow	0	0	0.00K
02/02/2015	Heavy Snow	0	0	0.00K
02/02/2015	Heavy Snow	0	0	0.00K
02/02/2015	Heavy Snow	0	0	0.00K
02/08/2015	Heavy Snow	0	0	0.00K
02/08/2015	Heavy Snow	0	0	0.00K
02/08/2015	Heavy Snow	0	0	0.00K
02/14/2015	Heavy Snow	0	0	0.00K
02/14/2015	Heavy Snow	0	0	0.00K
02/14/2015	Heavy Snow	0	0	0.00K
Total		0	0	4.415M

Blizzards and heavy snow events are considered to be high frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs more than once in five years, with a greater than 20 percent chance of occurring each year.

Ice Storms

The ice storm category covers a range of different weather phenomena that collectively involve rain or snow being converted to ice in the lower atmosphere leading to potentially hazardous conditions on the ground. Hail size typically refers to the diameter of the hailstones. Warnings and reports may report hail size through comparisons with real-world objects that correspond to certain diameters:

Description	Diameter (inches)
Pea	0.25
Marble or Mothball	0.50
Penny or Dime	0.75
Nickel	0.88
Quarter	1.00
Half Dollar	1.25

Walnut or Ping Pong Ball	1.50
Golf ball	1.75
Hen's Egg	2.00
Tennis Ball	2.50
Baseball	2.75
Tea Cup	3.00
Grapefruit	4.00
Softball	4.50

While ice pellets and sleet are examples of these, the greatest hazard is created by freezing rain conditions, which is rain that freezes on contact with hard surfaces leading to a layer of ice on roads, walkways, trees, and other surfaces. The conditions created by freezing rain can make driving particularly dangerous and emergency response more difficult. The weight of ice on tree branches can also lead to falling branches damaging electric lines.

Town-specific data for previous ice storm occurrences are not collected by the Town of Hopkinton. The best available local data is for Middlesex County through the National Climatic Data Center (see Table 12). Middlesex County, which includes the Town of Hopkinton, experienced four events from 1995 –2015. No deaths or injuries were reported and the total reported property damage in the county was $6.155 million dollars

Table 12. Middlesex County Ice Storm Events, 1995-2015

Location	Date	Type	Deaths	Injuries	Damage
Totals:			0	0	6.155M
WESTERN MIDDLESEX (ZONE)	01/09/1998	Ice Storm	0	0	5.00K
WESTERN MIDDLESEX (ZONE)	11/16/2002	Ice Storm	0	0	150.00K
NORTHWEST MIDDLESEX COUNTY (ZO...	12/11/2008	Ice Storm	0	0	3.000M
WESTERN MIDDLESEX (ZONE)	12/11/2008	Ice Storm	0	0	3.000M
Totals:			0	0	6.155M

Ice storms are considered to be medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs once in 5 years to once in 50 years, with 2% to 20% chance of occurring each year. The impacts of winter storms are often related to the weight of snow and ice, which can cause roof collapses and also causes tree limbs to fall which can in turn cause property damage and potential injuries.

Winter storms are a potential town-wide hazard in Hopkinton. The Town's vulnerability is primarily related to restrictions to travel on roadways, temporary road closures, school closures, and potential restrictions on emergency vehicle access. The Town works to clear roads and carries out general snow removal operations, and bans on-street parking during snow removal to ensure that streets can be plowed and public safety vehicle access is maximized. Another winter storm vulnerability is power outages due to fallen trees and utility lines.

Geologic Hazards

Earthquakes

Geologic hazards include earthquakes and landslides. Although new construction under the most recent State building code generally will be built to seismic standards, there are still many structures that pre-date the current building code. Information on geologic hazards in Hopkinton can be found on Map 4 in Appendix B.

Damage in an earthquake stems from ground motion, surface faulting, and ground failure in which weak or unstable soils, such as those composed primarily of saturated sand or silts, liquefy. The effects of an earthquake are mitigated by distance and ground materials between the epicenter and a given location. An earthquake in New England affects a much wider area than a similar earthquake in California due to New England's solid bedrock geology (NESEC).
According to the State Hazard Mitigation Plan, 2013.New England experiences an average of five earthquakes per year. From 1627 to 2008, 366 earthquakes were recorded in Massachusetts (NESEC). The region has experienced larger earthquakes, including a magnitude 6.0 quake that struck in 1755 off the coast of Cape Anne. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940, and a 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historical records of significant earthquakes in the region are shown in Table 13. There have been no recorded earthquake epicenters within Hopkinton.

Table 13
Historical Earthquakes in Massachusetts or Surrounding Area,

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5

MA - Cape Ann	12/29/1727	NA
MA – Cape Ann	2/10/1728	NA
MA – Cape Ann	3/30/1729	NA
MA – Cape Ann	12/9/1729	NA
MA – Cape Ann	2/20/1730	NA
MA – Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA – Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA – Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA – Cape Ann	1/7/1925	4
MA – Nantucket	10/25/1965	NA
MA – Boston	12/27/74	2.3
VA –Mineral	8/23/11	5.8
MA - Nantucket	4/12/12	4.5
ME - Hollis	10/17/12	4.0

Source: Boston HIRA

The closest recorded earthquake epicenter to Hopkinton was 0.29 mi from Littleton, MA, occurring on 10/19/2007, with a 2.5 magnitude and 0.5mi depth. (Source: Homefacts) Given the regional scale of earthquakes, the entire town is potentially subject to earthquakes. On October 16, 2012 the Town felt tremors from an earthquake centered in Maine. No losses of power, damage or injuries were reported.

Seismologists use a Magnitude scale (Richter Scale) to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized below.

Richter Magnitudes	**Earthquake Effects**
Less than 3.5	Generally not felt, but recorded
3.5- 5.4	Often felt, but rarely causes damage
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small

Richter Magnitudes	Earthquake Effects
	regions.
6.1-6.9	Can be destructive in areas up to about 100 km. across where people live.
7.0- 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred meters across.

Source: Nevada Seismological Library (NSL), 2005

One measure of earthquake risk is ground motion, which is measured as maximum peak horizontal acceleration, expressed as a percentage of gravity (1 g). The range of peak ground acceleration in Massachusetts is from 10g to 20g, with a 2% probability of exceedance in 50 years. Earthquakes are a hazard with multiple impacts beyond the obvious building collapse. Buildings may suffer structural damage which may or may not be readily apparent. Earthquakes can cause major damage to roadways, making emergency response difficult. Water lines and gas lines can break, causing flooding and fires. Another potential vulnerability is equipment within structures. For example, a hospital may be structurally engineered to withstand an earthquake, but if the equipment inside the building is not properly secured, the operations at the hospital could be severely impacted during an earthquake.

Earthquakes are a potential town-wide hazard in Hopkinton although areas developed prior to current building codes are potentially more vulnerable to earthquake damage. In Hopkinton the older development is primarily in and around the town center area. Potential earthquake damages to Hopkinton have been estimated using HAZUS-MH. Total damages are estimated at $209.02 million for a 5.0 magnitude earthquake and $2,182.45 million for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 22.

According to the Boston College Weston Observatory, in most parts of New England, there is a one in ten chance that a potentially damaging earthquake will occur in a 50 year time period. The Massachusetts State Hazard Mitigation Plan classifies earthquakes as "very low" frequency events that occur less frequently than once in 100 years, or a less than 1% chance of occurring each year.

Landslides

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 or ocean waves 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.

Landslides can result from human activities that destabilize an area or can occur as a secondary impact from another natural hazard such as flooding. In addition to structural damage to buildings and the blockage of transportation corridors, landslides can lead to sedimentation of water bodies.

There is no universally accepted measure of landslide extent but it has been represented as a measure of the destructiveness of a landslide. The table below summarizes the estimated intensity for a range of landslides. For a given landslide volume, fast moving rock falls have the highest intensity while slow moving landslides have the lowest intensity.

Estimated Volume	**Expected Landslide Velocity**		
($m^{3)}$	Fast moving landslide (Rock fall)	Rapid moving landslide (Debris flow)	Slow moving landslide (Slide)
<0.001	Slight intensity		
<0.5	Medium intensity		
>0.5	High intensity		
<500	High intensity	Slight intensity	
500-10,000	High intensity	Medium intensity	Slight intensity
10,000 – 50,000	Very high intensity	High intensity	Medium intensity
>500,000		Very high intensity	High intensity
>>500,000			Very high intensity

Source: *A Geomorphological Approach to the Estimation of Landslide Hazards and Risks in Umbria, Central Italy*, M. Cardinali et al, 2002

The majority of the Town has been classified as having a moderate susceptibility for landslides with a low incidence of landslides.
There are no recorded instances of landslides having occurred in the Town of Hopkinton. Should a landslide occur in the future, the type and degree of impacts would be highly localized, and the town's vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures, Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Hopkinton.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan, landslides are of Low frequency, events that can occur less frequently than once in 50 to100 years (a 1% to 2% chance of occurring each year).

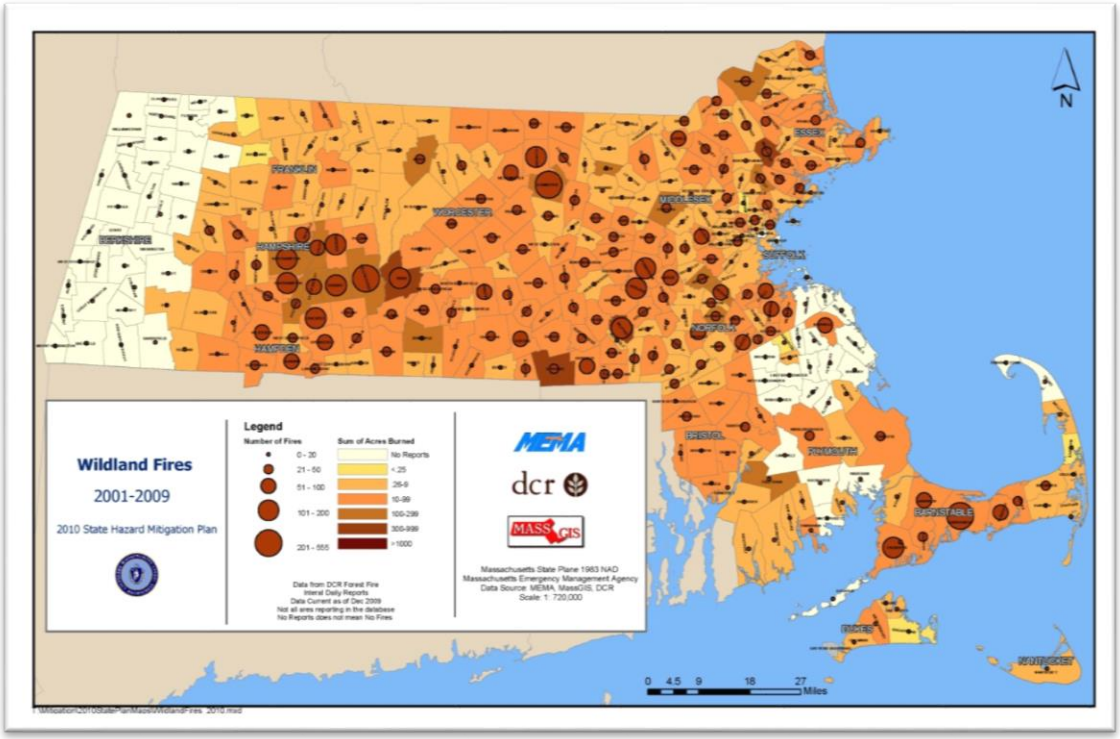
Brush Fires

A brush fire is an uncontrolled fire occurring in a forested or grassland area. In the Boston Metro region these fires rarely grow to the size of a wildfire as seen more typically in the western U.S. As their name implies, these fires typically burn no more than the underbrush of a forested area. These fires present a hazard where there is the potential for them to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire the spread into homes.

The Hopkinton Fire Department an average of 15-20 brush fires annually. These fires are generally small but some are larger and are the result of either human causes, such as improper disposal of smoking materials and improperly tended campfires, or an accumulation of dried vegetation on the forest floor, like branches and leaves.

Wildfires in Massachusetts are measured by the number of fires and the sum of acres burned. The most recent data available for wildfires in Massachusetts communities, shown in Figure 1 below, indicates that there were 21 to 50 recorded wildfires from 2001to 2009 in Hopkinton, with no 10 to 99 acres burned.

Figure 1. Massachusetts Wildfires 2001-2009



There have been no recorded wildfires in Hopkinton that resulted in significant property damage. The following areas, the same areas noted in the 2008 plan, of Town were identified as having the highest potential for brush fires based on past occurrences and their potential for the accumulation of dried vegetation growth. The numbers correspond to the numbers on Map 8, "Hazard Areas":

4. Interstate 495 Corridor- There are frequent brush fires along this corridor caused by discarded cigarettes from passing motorists. Most of these fires are small and cause little damage.
5. Hopkinton State Park- There are one or two pedestrian related brush fires every year at the State Park. Most of these fires are small, but some are larger. There is a potential for severe fires, especially during dry summers and fall months.
6. Peppercorn Hill-Peppercorn Hill is prone to infrequent large brush fires. There is a potential for severe fires, especially during dry summers and fall months.
7. Saddle Hill- There are infrequent brush fires in this area. These fires are caused by pedestrian use and usually small. However, there is a potential for severe fires, especially during dry summers and fall months.
8. Upton State Park- The Upton State Park sustains infrequent brush fires. These fires are caused by pedestrian use. The site poses a unique challenge to the town as the State Park resides on both Upton and Hopkinton land. In some instances, brush fires occur in the Upton, but are responded to by Hopkinton, or vice versus. Most of these fires are small, but some are larger. There is a potential for severe fires, especially during dry summers and fall months.

9. Massachusetts Turnpike- The Massachusetts Turnpike runs east to west through the northern portion of Hopkinton. There are frequent brush fires along this corridor caused by disregarded cigarette from passing motorist. However, most of these fires are small and cause little damage.

Potential vulnerabilities to wildfires include damage to structures and other improvements, and impacts on natural resources. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases. However, given the low extent of wildfires in the town and the immediate response times to reported fires in Hopkinton, the likelihood of injuries and casualties is minimal. There are none that have been recorded in the past.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan 2013, brushfires are of High frequency. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Extreme Temperatures

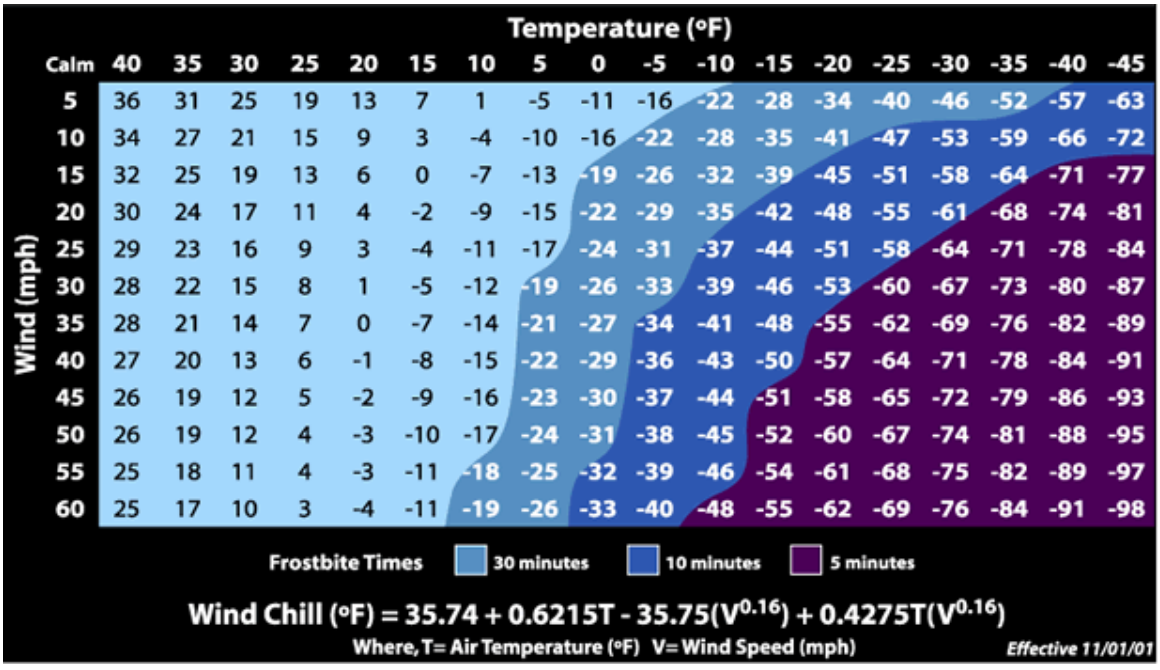
Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time where the there is prolonged period of excessively hot or cold weather.

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, which may be accompanied by high humidity.

Extreme cold is also 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.

For extreme cold, temperature is typically measured using Wind Chill Temperature Index, which is provided by the National Weather Service (NWS). The latest version of the index was implemented in 2001 and it meant to show how cold conditions feel on unexposed skin. The index is provided in Figure 2 below.

Figure 2. Wind Chill Temperature Index and Frostbite Risk



While a heat wave for Massachusetts is defined as three or more consecutive days above 90°F, another measure used for identifying extreme heat events is through a Heat Advisory from the NWS. These advisories are issued with the heat index (Figure 2 below) is forecast to exceed 100 degree Fahrenheit (F) for 2 or more hours; an excessive heat advisory is issued if forecast predicts the temperature to rise above 105 degree F.

Figure 3. Heat Index Chart

	Temperature (°F)																
Relative Humidity (%)		80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
	40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
	45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
	50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
	55	81	84	86	89	93	97	101	106	112	117	124	130	137			
	60	82	84	88	91	95	100	105	110	116	123	129	137				
	65	82	85	89	93	98	103	108	114	121	128	136					
	70	83	86	90	95	100	105	112	119	126	134						
	75	84	88	92	97	103	109	116	124	132							
	80	84	89	94	100	106	113	121	129								
	85	85	90	96	102	110	117	126	135								
	90	86	91	98	105	113	122	131									
	95	86	93	100	108	117	127										
	100	87	95	103	112	121	132										

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke or Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Hopkinton 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 seasonal ranges for Massachusetts. The average temperatures for Massachusetts are: Winter (Dec-Feb) Average = 31.8°F and summer (Jun-Aug) Average = 71°F. Extreme temperatures are a town-wide hazard.

Extreme Heat

Extreme heat poses a potentially greater risk to 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. Hot summer days can also worsen air pollution. With increased extreme

heat, urban areas of the Northeast are likely to experience more days that fail to meet air quality standards.

The Town of Hopkinton does not collect data on excessive heat occurrences. The Town designated the Library and Senior Center as cooling stations in 2012 but they have not been widely used yet. The best available local data are from the National Climatic Data Center, which collects data by county. From 1995- 2015, there have been one excessive heat event in Middlesex with no reported deaths, injuries or property damage resulting from excessive heat (see Table 14).

Table 14 – Middlesex County Extreme Heat Occurrences

DATE	EVENT_TYPE	DEATHS	INJURIES	DAMAGE
7/6/2010	Excessive Heat	0	0	0

Source: NOAA, National Climatic Data Center

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.

The Town of Hopkinton does not collect data for previous occurrences of extreme cold. The best available local data are from the National Climatic Data Center, which collects data by county. There are three extreme cold events on record, for Middlesex County from 1995- 2015. These events caused no deaths and no injuries or property damage (see Table 15)

Table 15 – Middlesex County Extreme Cold & Wind Chill Occurrences

Date	Location	Type	Deaths	Injuries	Property Damage
2/15/2015	Western Middlesex	Extreme Cold/wind Chill	0	0	0
2/16/2015	Northwest Middlesex	Extreme Cold/wind Chill	0	0	0
2/16/2015	Southeast Middlesex	Extreme Cold/wind Chill	0	0	0

Source: NOAA, National Climatic Data Center

Extreme temperature events are projected to be medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. Both

extreme cold and hot weather events occur between once in five years to once in 50 years, or a 2 percent to 20 percent chance of occurring each year.

Drought

Drought is a temporary irregularity in precipitation 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 plant life.

In Massachusetts, droughts are caused by the prevalence of dry northern continental air and a decrease in coastal- and tropical-cyclone activity. During the 1960's, a cool drought occurred because dry air from the north caused lower temperatures in the spring and summer of 1962-65. The northerly winds drove frontal systems to sea along the Southeast Coast and prevented the Northeastern States from receiving moisture (U.S. Geological Survey). This is considered the drought of record in Massachusetts.

Average annual precipitation in Massachusetts is 44 inches per year, with approximately 3 to 4 inch average amounts for each month of the year. Regional monthly precipitation ranges from zero to 17 inches. Statewide annual precipitation ranges from 30 to 61 inches. Thus, in the driest calendar year (1965), the statewide precipitation total of 30 inches was 68 percent of average.

Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. The DCR precipitation index divides the state into six regions: Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape and Islands. Hopkinton is located in the Northeast Region. In Hopkinton drought is a potential town-wide hazard.

Five levels of drought have been developed to characterize drought severity: Normal, Advisory, Watch, Warning, and Emergency. These drought levels are based on the conditions of natural resources and are intended to provide information on the current status of water resources. The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions. They begin with a normal situation where data are routinely collected and distributed, move to heightened vigilance with increased data collection during an advisory, to increased assessment and proactive education during a watch. Water restrictions might be appropriate at the watch or warning stage, depending on the capacity of each individual water supply system. A warning level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which mandatory water restrictions or

use of emergency supplies is necessary. Drought levels are used to coordinate both state agency and local response to drought situations.

As dry conditions can have a range of different impacts, a number of drought indices are available to assess these various impacts. Massachusetts uses a multi-index system that takes advantage of several of these indices to determine the severity of a given drought or extended period of dry conditions. Drought level is determined monthly based on the number of indices which have reached a given drought level. Drought levels are declared on a regional basis for each of six regions in Massachusetts. County by county or watershed-specific determinations may also be made.

A determination of drought level is based on seven indices:

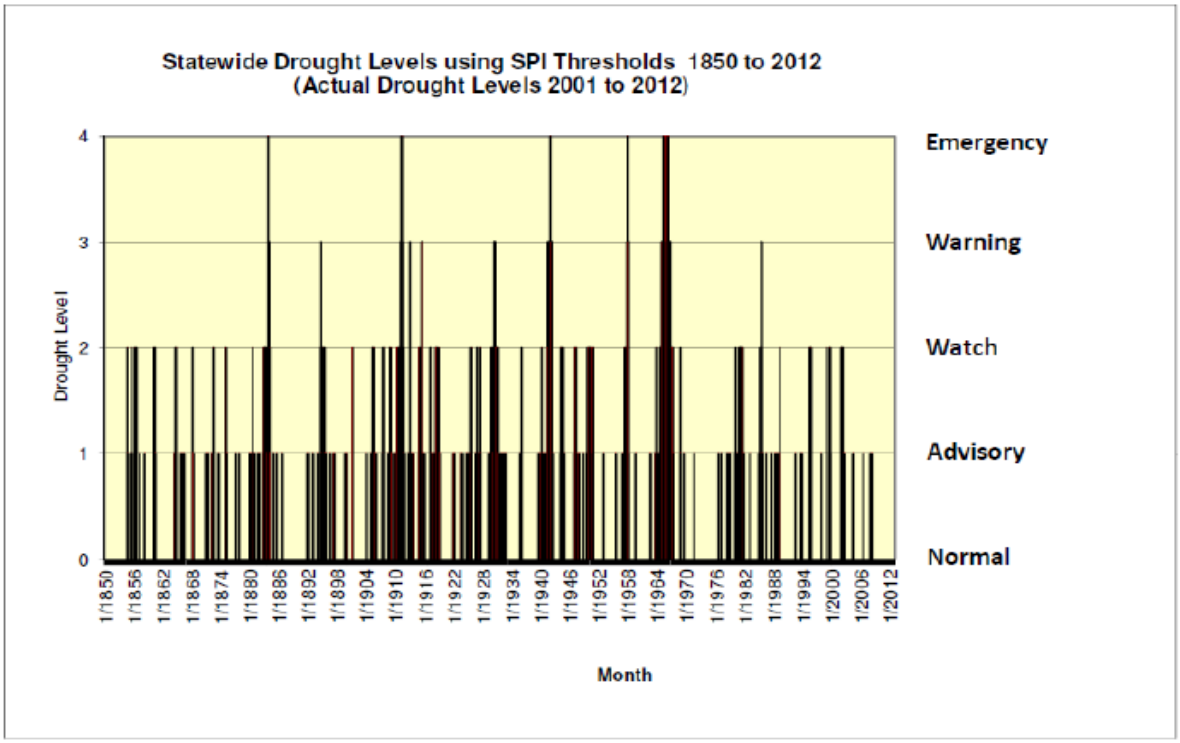
1. Standardized Precipitation Index (SPI) reflects soil moisture and precipitation.
2. Crop Moisture Index: (CMI) reflects soil moisture conditions for agriculture.
3. Keetch Byram Drought Index (KBDI) is designed for fire potential assessment.
4. Precipitation Index is a comparison of measured precipitation amounts to historic normal precipitation.
5. The Groundwater Level Index is based on the number of consecutive month's groundwater levels are below normal (lowest 25% of period of record).
6. The Stream flow Index is based on the number of consecutive months that stream flow levels are below normal (lowest 25% of period of record).
7. The Reservoir Index is based on the water levels of small, medium and large index reservoirs across the state, relative to normal conditions for each month.

Determinations regarding the end of a drought or reduction of the drought level focus on two key drought indicators: precipitation and groundwater levels. These two factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture and potential for forest fires.

Previous Occurrences

Hopkinton does not collect data relative to drought events. Because drought tends to be a regional natural hazard, this plan references state data as the best available data for drought. The statewide scale is a composite of six regions of the state, Regional composite precipitation values are based on monthly values from six stations, and three stations in the smaller regions (Cape Cod/Islands and West). Because the statewide analysis may result in a muting of more extensive local drought impacts, this drought history summary will likely underestimate the spatial frequency of droughts (i.e., droughts may occur more frequently in individual regions than depicted in the statewide analysis).

Figure 4 - Statewide Drought Levels using SPI Thresholds 1850 – 2012



(Source: Mass. State Drought Management Plan 2013)

Figure 3 depicts the incidents of drought levels' occurrence in Massachusetts from 1850 to 2012 using the Standardized Precipitation Index (SPI) parameter alone. On a monthly basis, the state would have been in a Drought Watch to Emergency condition 11 percent of the time between 1850 and 2012. Table 16 summarizes the chronology of major droughts since the 1920's.

Drought Emergency

Drought emergencies have been reached infrequently, with 5 events occurring in the period between 1850 and 2012: in 1883, 1911, 1941, 1957, and 1965-1966. The 1965-1966 drought period is viewed as the most severe drought to have occurred in modern times in Massachusetts because of its long duration. On a monthly basis over the 162-year period of record, there is a one percent chance of being in a drought Emergency.

Drought Warning

Drought Warning levels not associated with drought Emergencies have occurred four times, in 1894, 1915, 1930, and 1985. On a monthly basis over the 162-year period of record, there is a two percent chance of being in a drought Warning level.

Drought Watch

Drought Watches not associated with higher levels of drought generally have occurred in three to four years per decade between 1850 and 1950. In the 1980s, there was a lengthy drought Watch level of precipitation between 1980 and 1981, followed by a drought Warning in 1985. A frequency of drought Watches at a rate of three years per decade resumed in the 1990s (1995, 1998, 1999). In the 2000s, Drought Watches occurred in 2001 and 2002. The overall frequency of being in a drought Watch is 8 percent on a monthly basis over the 162-year period of record.

Table 16 - Chronology of major droughts in Massachusetts

Date	Area affected	Recurrence interval (years)	Remarks
1929-32	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.
	Statewide	15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.
1957-59	Statewide	5 to 25	Record low water levels in observation wells, northeastern Massachusetts.
1961-69	Statewide	35 to >50	Water-supply shortages common. Record drought. Multistate.
1980-83	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.
1985-88	Housatonic River basin	25	Duration and severity unknown. Streamflow showed mixed trends elsewhere.

Probability of Future Occurrences

The state has experienced Emergency Droughts five times between 1850 and 2012. Even given that regional drought conditions may occur at a different interval than state data indicates, droughts remain primarily regional and state phenomena in Massachusetts. Emergency Drought conditions over the 162 period of record in Massachusetts are a Low Frequency natural hazard event that can occur from once in 50 years to once in 100 years (1% to 2% chance per year), as defined by the Massachusetts State Hazard Mitigation Plan, 2013.

Land Use and Development Trends

Existing Land Use

The most recent land use statistics available from the state are from aerial photography done in 2005. Table 17 shows the acreage and percentage of land in 28 categories. If the three residential categories are aggregated, residential uses comprise approximately 16% of the area of the Town (~ 399 acres). The highest percentage is Forest, which comprises 52.30% of the land area or 9,322 acres.

Table 17
2005 Land Use

Land Use Type	Acres	Percent
Brushland/Successional	13.64	0.08
Cemetery	19.07	0.11
Commercial	131.85	0.74
Cropland	133.10	0.75
Forest	9322.32	52.30
Forested Wetland	1603.65	9.00
Golf Course	103.68	0.58
High Density Residential	190.45	1.07
Industrial	334.46	1.88
Junkyard	1.83	0.01
Low Density Residential	2399.22	13.46
Medium Density Residential	298.40	1.67
Mining	62.77	0.35
Multi-Family Residential	114.44	0.64
Non-Forested Wetland	307.42	1.72
Nursery	523.73	2.94
Open Land	106.39	0.60
Orchard	7.20	0.04
Participation Recreation	100.51	0.56
Pasture	35.63	0.20
Powerline/Utility	63.66	0.36
Transitional	57.82	0.32
Transportation	284.59	1.60
Urban Public/Institutional	80.73	0.45
Very Low Density Residential	399.07	2.24
Waste Disposal	41.23	0.23
Water	1087.96	6.10
Water-Based Recreation	0.62	0.00

Total	***17,825.43***	***100***

Economic Elements

Commercial uses occupy approximately 140 acres of land in Hopkinton. The commercial property inventory includes small retail establishments, a supermarket, pharmacy, restaurants, office space, a lumber yard, truck terminals, warehouse and distribution facilities, auto repair facilities, and membership-only outdoor recreation facilities. A majority of Hopkinton's commercial development exists in and adjacent to the downtown area and around the I-495 interchange.

Over time, the Industrial District on South Street has attracted a number of industries, notably EMC Corporation, Hopkinton's largest private-sectoremployer. Manufacturing, warehouses, research and development facilities and industrial-office space occupy about 693 acres of industrial land in Hopkinton, while a granite quarry, a gas production plant, natural gas storage and other utilities account for approximately 342 acres. (Source: 2007 Hopkinton Master Plan)

Historic, Cultural, and Natural Resource Areas

The buildings in Hopkinton express the stages of development that make up the Town's history. Existing one- and two-story dwellings from the 18th century reflect the moderate and utilitarian lifestyle of the early settlers. Many well-preserved examples from the Federal Period exhibit the Town's growing affluence in the early 19th century. Several are of brick construction, and on East Main Street there are at least two examples of the use of local granite to build an entire building. The predominant style of Hopkinton's historic homes dates to the mid-1800s, with gable ends oriented to the street, defining modest 1½-story dwellings as well as in large, elaborate, templar gable-end Greek Revival and Italianate structures Hopkinton has two local historic districts: the Hopkinton Center District and the Woodville Historic District. (Source: Hopkinton Master Plan)

The Town of Hopkinton, state agencies and non-profit land trusts own a considerable inventory of open land that is protected from future development, or very unlikely to be developed due to the public purposes for which the land was originally acquired. The Town holds 1,497 acres of open space and the Commonwealth of Massachusetts owns another 2,609 acres. Since 2008, the Town added 301.86 acres plus 203 acre of restricted land at Legacy Farms. Land Trusts have added 52.65 acres with 17 acres of conservation restrictions and the state acquired 63.5 acres of rare species habitat within Hopkinton. (Source: Hopkinton Open Space and Recreation Plan)

Development Trends

Development trends throughout the metropolitan region are tracked by MAPC's Development Database, which provides an inventory of new development over the last

decade. The database tracks both completed developments and those currently under construction. The database includes 28 developments in the Town of Hopkinton since 2008, of which 5 are completed and 23 were under construction as of May 2015.

The database also includes several attributes of the new development, including acres, housing units, and commercial space. The developments in Hopkinton are sited on a total of 729.39 acres and include a total 1,983 housing units, and 827,510 square feet of commercial space. (See Table 18)

In order to characterize any change in the town's vulnerability associated with new developments, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map. The analysis shows that none of the five developments completed since 2008, or twenty-three developments under construction are within a flood hazard zone.

Table 18 Summary of Hopkinton Developments 2005- 2015

DEVELOPMENTS COMPLETED 2005-2015	ACRES	HOUSING UNITS	COMMERCIAL (SQ FEET)	PROJECT TYPE
Deerfield Estates	28.56	47	0	Residential
Perkin Elmer Campus Expansion	20	0	85000	Campus
Legacy Farms	150	0	334000	Commercial component of Legacy Farms development
Hopkinton Square	8	0	70000	40,000 sf grocery store; 15,000 retail; 15,000 office
Hayden Woods	22.57	18	0	Multifamily development
SUBTOTAL Construction Complete	229.13	65	489000	
DEVELOPMENTS UNDER CONSTRUCTION				
Lumber St. - West Main St. & Hopkinton Mews	96	280	250000	Up to 250,000 sq. ft. of commercial space and 280 Multi-Family Units
Peloquin Estates	32.07	9	0	9 Single Family Units
Spring Hill Estates	8	5	0	5 Single family Units
Elmwood Farms III	25	25	0	25 Single Family Units
203 Pond Street	42	12	0	12 single family units
Bridle Path	13	6	0	3 Single Family Units remaining in 2014 (6 total)
Hopkinton Village Center	2.87	9	28000	1 Building. Mixed use retail, office and residential development at 25 and 35 Main Street.
Connelly Hill Estates	78	60	0	7 Single Family Units remaining in 2014
Hunters Ridge	37.4	19	0	Single family subdivision

DEVELOPMENTS COMPLETED 2005-2015	ACRES	HOUSING UNITS	COMMERCIAL (SQ FEET)	PROJECT TYPE
Christian Way	0.999	3	0	3 Single Family units remaining in 2014
Hopkinton Retirement Residence	5.89	129	0	127 suite units in 1 building; and 2 manager apartments.
Legacy Farms North	730	425	0	425 Residential Units
Legacy Farms (Pulte)	230.28	275	0	Pulte has 275 approved residential units of varying sizes and make up planned to be constructed in a village type setting along and off of Legacy Farm South
Cross Roads Redevelopment	57	375	0	Construct 375 apartment units and a 150-room hotel; possibly renovate old EMC building or completely rebuild it; and build new access roadway to site.
42 Main St.	1	0	14000	New commercial building
E. L. Harvey & Sons	40	0	125300	Materials Recovery & Recycling Facility
Maspenock Woods	15	31	0	Condominium project
Forest Ridge	3	12	0	12 unit multifamily townhouse development
Legacy Farms (Alta) - Wood partners	18	240	0	240 residential units in 7 buildings, a community clubhouse, 7 free-standing garage structures.
85 West Main St.	1	0	7430	Commercial Development
Weston Nurseries	50	0	11	Commercial Sales &

DEVELOPMENTS COMPLETED 2005-2015	ACRES	HOUSING UNITS	COMMERCIAL (SQ FEET)	PROJECT TYPE
				Maintenance buildings
78 West Main St.	1	0	3000	Dunkin Donuts
Highland Park III	0.999	3	0	3 single family units remaining in 2014.
SUBTOTAL Under Construction	1488.508	1918	413755	
TOTAL Complete/Under Construction	729.39	1983	827510	

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Potential Future Development

MAPC consulted with Town staff to determine areas that are likely to be developed in the future, defined for the purposes of this plan as a ten year time horizon. These areas are shown on Map 2, "Potential Development" and are described below. The letter for each site corresponds to the letters on Map 2.

A. Weston Nurseries-Residential and Commercial Development
B. Hayden Rowe- Residential Development
C. Terry Property- Residential and Commercial Development
D. Hopkinton Village Center- Residential and Commercial Development
E. Wilson Street-Residential Development
F. Fruit Street- Residential Development
G. Paper Street- Residential Development
H. Spring Street-Residential Development
I. Hunter's Ridge- Residential Development
J. 203 Pond Street- Residential Development
K. Hayden Woods-Residential Development
L. 149 Hayden Rowe (Forest Ridge)-Residential Development
M. Leonard Street-Residential Development

Vulnerability Assessment

The purpose of the vulnerability assessment is to estimate the extent of potential damages from natural hazards of varying types and intensities.

Future Development in Hazard Areas

Table 19 shows the relationship of these parcels to two of the mapped hazards. This information is provided so that planners can ensure that development proposals comply with flood plain zoning and that careful attention is paid to drainage issues.

Table 19: Relationship of Potential Development to Hazard Areas

Parcel	Landslide risk	Flood Zone
Weston Nurseries	Low incidence	3.63% in A: 1% Annual Chance of Flooding, no BFE
Hayden Rowe	Low incidence	-
Terry Property	Low incidence	13.63% in X: 0.2% Annual Chance of Flooding
Hopkinton Village Center	Low incidence	-
Wilson Street	Low incidence	6.19% in A: 1% Annual Chance of Flooding, no BFE

Fruit Street	Low incidence	-
Paper Street	Low incidence	-
Spring Street	Low incidence	-
Hunter's Ridge	Low incidence	-
203 Pond Street	Low incidence	-
Hayden Woods	Low incidence	-
149 Hayden Rowe (Forest Ridge)	Low incidence	-
Leonard Street	Low incidence	-

Critical Infrastructure in Hazard Areas

Critical infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, etc.) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). These facilities are listed in Table 20 and are shown on all of the maps in Appendix B.

The purpose of mapping the natural hazards and critical infrastructure is to present an overview of hazards in the community and how they relate to critical infrastructure, to better understand which facilities may be vulnerable to particular natural hazards. All critical infrastructure sites are located within areas designated as having an average annual snowfall of 36" or greater.

Explanation of Columns in Table 20

Column 1: ID #: The first column in Table 10 is an ID number which appears on the maps that are part of this plan. See Appendix B.

Column 2: Name: The second column is the name of the site. If no name appears in this column, this information was not provided to MAPC by the community.

Column 3: Type: The third column indicates what type of site it is.

Column 4: Landslide Risk: The fourth column indicates the degree of landslide risk for that site. This information came from NESEC. The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to http://pubs.usgs.gov/pp/p1183/pp1183.html**.**

Column 5: FEMA Flood Zone: The fifth column addresses the risk of flooding. A "No" entry in this column means that the site is not within any of the mapped risk zones on the Flood Insurance Rate Maps (FIRM maps). If there is an entry in this column, it indicates the type of flood zone as follows:

> **Zone A** (1% annual chance) - Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.
>
> **Zone AE and A1-A30** (1% annual chance) - Zones AE and A1-A30 are the flood insurance rate zones that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.
>
> **Zones X500** (.2% annual chance) - Zone X500 is the flood insurance rate zone that correspond to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone.
>
> **Zone VE** (1% annual chance) - Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply

Column 6: Locally-Identified Flood Area: The locally identified areas of flooding were identified by Town staff as areas where flooding occurs. These areas do not necessarily coincide with the flood zones from the FIRM maps. They may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone. The numbers correspond to the numbers on Map 8, "Hazard Areas".

Column 7: Hurricane Surge Category: The seventh column indicates whether or not the site is located within a hurricane surge area and the category of hurricane estimated to be necessary to cause inundation of the area. The following explanation of hurricane surge areas was taken from the US Army Corps of Engineers web site:

> "Hurricane storm surge is an abnormal rise in sea level accompanying a hurricane or other intense storm. Along a coastline a hurricane will cause waves on top of the surge. Hurricane Surge is estimated with the use of a computer model called SLOSH. SLOSH stands for Sea Lake and Overland Surge from Hurricanes. The SLOSH models are created and run by the National Hurricane Center.
>
> The SLOSH model results are merged with ground elevation data to determine areas that will be subject to flooding from various categories of hurricanes. Hurricane categories are defined by the Saffir-Simpson Scale." See http://www.sam.usace.army.mil/hesdata/General/hestasks.htm

According to the Saffir-Simpson Scale, the least damaging storm is a Category 1 (winds of 74-95 miles per hour) and the most damaging storm is a Category 5 (winds greater than 155 miles per hour).

Column 8: Brushfire Risk: The fourth column indicates whether the site falls within an area identified by municipal staff as posing a brushfire risk.

Table 20: Relationship of Critical Infrastructure to Hazard Areas							
ID	**NAME**	**TYPE**	**Landslide Risk**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Hurricane Surge Category**	**Brushfire Risk**
1	Hopkinton Middle School	School	Low incidence	No	No	0	No
2	Elmwood School	School	Low incidence	No	No	0	No
3	High School	School	Low incidence	No	No	0	No
4	Department of Public Works	Municipal Office	Low incidence	No	No	0	No
5	Department of Public Works	Municipal Office	Low incidence	No	No	0	No
6	Wood Street Pump Station	Sewer Pumping Station	Low incidence	No	No	0	No
7	West Main Street Pump Station	Sewer Pumping Station	Low incidence	No	No	0	No
8	Joseph Road Pump Station	Sewer Pumping Station	Low incidence	No	No	0	No
9	Hayden Rowe Pump Station	Sewer Pumping Station	Low incidence	No	No	0	No
10	Fruit Street Wells # 1, 2 & 3	Water Pumping Station	Low incidence	No	No	0	No
11	Lake Shore Pump Station	Sewer Pumping Station	Low incidence	No	No	0	No
12	Grove Street Water Tank	Water Storage Tank	Low incidence	No	No	0	No
13	Bear Hill Water Tank	Water Storage Tank	Low incidence	No	No	0	No
14	Carriage Hill Pump Station	Sewer Pumping Station	Low incidence	No	No	0	No
15	Pond Street Wells # 4 & 5	Water Pumping Station	Low incidence	No	No	0	No
16	Fire Department	Fire Station	Low incidence	No	No	0	No
17	Police Department	Police Station	Low incidence	No	No	0	No
18	Town Hall	Municipal Office	Low incidence	No	No	0	No
19	Fire Department	Fire Station	Low incidence	No	No	0	No
20	Housing Authority	Elderly Housing	Low incidence	No	No	0	No
21	Golden Pond	Nursing Home	Low incidence	No	No	0	No
22	LNG Gas	Gas Distribution	Low incidence	No	No	0	No
23	Tennessee Gas	Gas Distribution	Low incidence	No	No	0	No
24	N-Star	Utility Company	Low incidence	No	No	0	No
25	EMC	Sewer Pumping Station	Low incidence	No	No	0	No
26	Biosource International	Hazardous Materials	Low incidence	No	No	0	No

Table 20: Relationship of Critical Infrastructure to Hazard Areas							
ID	**NAME**	**TYPE**	**Landslide Risk**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Hurricane Surge Category**	**Brushfire Risk**
27	Stryker Biotech	Hazardous Materials	Low incidence	No	No	0	No
28	HTS Biosystems	Hazardous Materials	Low incidence	No	No	0	No
29	Lonza	Hazardous Materials	Low incidence	No	No	0	Interstate 495 Corridor
30	Amino Acid Analogues	Hazardous Materials	Low incidence	No	No	0	No
31	St. John the Evangelist	Place of Worship	Low incidence	No	No	0	No
32	First Congregational Church	Place of Worship	Low incidence	No	No	0	No
33	Korean Presbyterian Church	Place of Worship	Low incidence	No	No	0	No
34	Community Covenant Church	Place of Worship	Low incidence	No	No	0	No
35	Islamic Masumeen Ctr. of New England	Place of Worship	Low incidence	No	No	0	Interstate 495 Corridor
36	St. Paul's Episcopal Church	Place of Worship	Low incidence	No	No	0	No
37	Woodville Baptist Church	Place of Worship	Low incidence	No	No	0	Interstate 495 Corridor
38	Golden Goose Academy	Child Care	Low incidence	No	No	0	No
39	Edward Hopkins School	School	Low incidence	No	No	0	No
40	Center School	School	Low incidence	No	No	0	No
41	Indian Brook Condominium Associates	Sewer Pumping Station	Low incidence	No	No	0	No
42	Grove Street Water Tank	Water Storage Tank	Low incidence	No	No	0	No
43	Ash Street Pump Station	Sewer Pumping Station	Low incidence	No	No	0	No
44	Fruit Street Well # 6	Water Pumping Station	Low incidence	No	No	0	No
45	Lake Masponeck Dam	Dam	Low incidence	AE: Regulatory Floodway	No	0	No

Table 20: Relationship of Critical Infrastructure to Hazard Areas							
ID	**NAME**	**TYPE**	**Landslide Risk**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Hurricane Surge Category**	**Brushfire Risk**
46	Whitehall Lake Dam	Dam	Low incidence	A: 1% Annual Chance of Flooding; no BFE	No	0	No
47	Gatehouse Bridge	Bridge	Low incidence	A: 1% Annual Chance of Flooding; no BFE	No	0	No
48	Duck Pond Dam	Dam	Low incidence	No	No	0	No
49	495 NB at West Main	Bridge	Low incidence	No	No	0	Interstate 495 Corridor
50	495 SB at West Main	Bridge	Low incidence	No	No	0	Interstate 495 Corridor
51	495 SB at Wood Street	Bridge	Low incidence	No	No	0	Interstate 495 Corridor
52	49N SB at Wood Street	Bridge	Low incidence	No	No	0	Interstate 495 Corridor
53	Fruit Street Bridge	Bridge	Low incidence	No	No	0	Interstate 495 Corridor
54	495 NB at Mass Pike	Bridge	Low incidence	No	No	0	Interstate 495 Corridor
55	Mass Pike West Bound Access Ramp	Bridge	Low incidence	No	No	0	Mass Pike

Table 20: Relationship of Critical Infrastructure to Hazard Areas							
ID	**NAME**	**TYPE**	**Landslide Risk**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Hurricane Surge Category**	**Brushfire Risk**
56	495 NB at Mass Pike	Bridge	Low incidence	No	No	0	Interstate 495 Corridor
57	Mass Pike East at Wood Street	Bridge	Low incidence	No	No	0	Mass Pike
58	Mass Pike West at Wood Street	Bridge	Low incidence	No	No	0	Mass Pike
59	Mass Pike Access Ramp over 495	Bridge	Low incidence	No	No	0	Interstate 495 Corridor
60	Cedar Street Extension Bridge	Bridge	Low incidence	AE: Regulatory Floodway	No	0	No
61	Cordaville Street Bridge	Bridge	Low incidence	AE: Regulatory Floodway	No	0	No
62	North Mill Pond Dam	Dam	Low incidence	AE: Regulatory Floodway	Cranberry Lane/ North Hill	0	No
63	North Mill Street Bridge	Bridge	Low incidence	AE: Regulatory Floodway	Cranberry Lane/ North Hill	0	No
64	Bloods Pond Dam	Dam	Low incidence	No	Cranberry Lane/ North Hill	0	No
65	Clinton Street Bridge	Bridge	Low incidence	AE: Regulatory Floodway	No	0	No
66	Bright Horizons	Child Care	Low incidence	No	No	0	No
67	St. Paul's Church Daycare	Child Care	Low incidence	No	No	0	No
68	Learning Center of Hopkinton	Child Care	Low incidence	No	No	0	No
69	Next Generation Children's Center	Child Care	Low incidence	No	No	0	No
70	Kidsborough	Child Care	Low incidence	No	No	0	No
71	Sunshine Preschool	Child Care	Low incidence	No	No	0	No

Table 20: Relationship of Critical Infrastructure to Hazard Areas							
ID	**NAME**	**TYPE**	**Landslide Risk**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Hurricane Surge Category**	**Brushfire Risk**
72	Fire Department -Primary EOC	Emergency Operations Center	Low incidence	No	No	0	No
73	Police Department - Secondary EOC	Emergency Operations Center	Low incidence	No	No	0	No
74	Legacy Farms-Private Waste Water Treatment Plant	Waste Water Treatment	Low incidence	No	No	0	No
75	Public Waste Water Treatment	Waste Water Treatment	Low incidence	No	No	0	No
76	Alprilla Farm Road	Well	Low incidence	No	Alprilla Farm Road	0	No
77	Radio Tower and Radio Control Room	Communications	Low incidence	No	No	0	No
78	Algonquin Gas Line	Gas Line	Low incidence	No	No	0	No
79	Hopkinton Middle School	School	Low incidence	No	No	0	No

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Damage Assessments

The purpose of the vulnerability assessment is to estimate the extent of potential damages from natural hazards of varying types and intensities. A vulnerability assessment and estimation of damages was performed for hurricanes, earthquakes, and flooding. The methodology used for hurricanes and earthquakes was the HAZUS-MH software, using the current version at the time of the analysis in March, 2015. HAZUS uses 2010 US Census data. The methodology for flooding was developed specifically to address the issue in many of the communities where flooding was not solely related to location within a floodplain.

Introduction to HAZUS-MH

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The following overview of HAZUS-MH is taken from the FEMA website. For more information on the HAZUS-MH software, go to http://www.fema.gov/plan/prevent/hazus/index.shtm

> "HAZUS-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). Loss estimates produced by HAZUS-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing and evaluating mitigation plans and policies as well as emergency preparedness, response and recovery planning.
>
> HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods and earthquakes on populations."

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

Level 1 relies upon default data on building types, utilities, transportation, etc. from national databases as well as census data. While the databases include a wealth of information on the Town of Hopkinton, it does not capture all relevant information. In fact, the HAZUS training manual notes that the default data is "subject to a great deal of uncertainty." However, for the purposes of this plan, the analysis is useful. This plan is attempting to only generally indicate the possible extent of damages due to certain types

of natural disasters and to allow for a comparison between different types of disasters. Therefore, this analysis should be considered to be a starting point for understanding potential damages from the hazards. If interested, communities can build a more accurate database and further test disaster scenarios.

Estimated Damages from Hurricanes

The HAZUS software was used to model potential damages to the community from a 100 year and 500 year hurricane event; storms that are .01% and .005% likely to happen in a given year and roughly equivalent to a Category 2 and Category 4 hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the Town, bringing the strongest winds and greatest damage potential.

Though there are no recorded instances of a hurricane equivalent to a 500 year storm passing through Massachusetts, this model was included in order to present a reasonable "worst case scenario" that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms.

Table 21

Estimated Damages from Hurricanes

	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	5,024	5,024
Estimated total building replacement value (Year 2010 $) (Millions of Dollars)	$2,118	$2,118
Building Damages		
# of buildings sustaining minor damage	116	792
# of buildings sustaining moderate damage	4	96
# of buildings sustaining severe damage	0	4
# of buildings destroyed	0	2
Population Needs		
# of households displaced	0	17
# of people seeking public shelter	0	3
Debris		
Building debris generated (tons)	10,748	25,334
Tree debris generated (tons)	8,108	18,205
# of truckloads to clear building debris	16	85
Value of Damages (Thousands of dollars)		

Total property damage	$15,755.55	$52,746.35
Total losses due to business interruption	$286.45	$2,006.09

Estimated Damages from Earthquakes

The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic center of the study area. For the purposes of this plan, two earthquakes were selected: magnitude 5.0 and a magnitude 7.0. Historically, major earthquakes are rare in New England, though a magnitude 5 event occurred in 1963.

Table 22
Estimated Damages from Earthquakes

	Magnitude 5.0	**Magnitude 7.0**
Building Characteristics		
Estimated total number of buildings	5,024	5,024
Estimated total building replacement value (Year 2002 $)(Millions of dollars)	$2,118	$2,118
Building Damages		
# of buildings sustaining slight damage	1,412	80
# of buildings sustaining moderate damage	588	797
# of buildings sustaining extensive damage	104	1,443
# of buildings completely damaged	17	2,700
Population Needs		
# of households displaced	47	2,794
# of people seeking public shelter	25	1,494
Debris		
Building debris generated (million tons)	0.03	0.41
# of truckloads to clear building debris	1,080	16,360
Value of Damages (Millions of dollars)		
Total property damage	$209.02	$2,182.45
Total losses due to business interruption	$20.11	$202.58

Estimated Damages from Flooding

MAPC did not use HAZUS-MH to estimate flood damages in Hopkinton. In addition to technical difficulties with the software, the riverine module is not a reliable indicator of flooding in areas where inadequate drainage systems contribute to flooding even when those structures are not within a mapped flood zone. In lieu of using HAZUS, MAPC developed a methodology to give a rough approximation of flood damages.

Hopkinton is 27.85 square miles or 17,825 acres. Approximately 113.65acres have been identified by local officials as areas of flooding. This amounts to 0.64% of the land area in Hopkinton. The number of structures in each flood area was estimated by applying the percentage of the total land area to the number of structures (5,024) in Hopkinton; the same number of structures used by HAZUS for the hurricane and earthquake calculations.

HAZUS uses a value of $421,576 per structure for the building replacement value. This was used to calculate the total building replacement value in each of the flood areas. The calculations were done for a low estimate of 10% building damages and a high estimate of 50% as suggested in the FEMA September 2002 publication, "State and Local Mitigation Planning how-to guides" (Page 4-13). The range of estimates for flood damages is $1,391,201 - $6,956,004. These calculations are not based solely on location within the floodplain or a particular type of storm (i.e. 100 year flood). The results of the analysis are summarized in Table 23 below.

Table 23
Estimated Damages from Flooding

ID	Flood Hazard Area	Approximate Area in Acres	% of Total Land Area in Hopkinton	Estimated Number of Structures	Replacement Value	Low Estimate of Damages	High Estimate of Damages
1	32 Granite Street	1.47	0.01%	1	$421,576	$42,158	$210,788
2	Alprilla Farm Road	9.69	0.05%	3	$1,264,728	126472.8	$632,364
3	Cranberry Lane/ North Hill	102.49	0.57%	29	$12,225,704	$1,222,569	$6,112,852
	Totals	113.65	0.64	33	$13,912,008	$1,391,201	$6,956,004

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V. HAZARD MITIGATION GOALS

The Hopkinton Local Multiple Hazard Community Planning Team met on June 11, 2014 and October 9, 2014. At that meeting, the team reviewed and discussed the goals from the 2008 Hazard Mitigation Plan for the Town of Hopkinton. These goals were found to continue to be reflective of the Town's priorities and concerns relative to natural hazard mitigation.

The following four goals were endorsed by the Committee for the 2015 update of the Hopkinton Hazard Mitigation Plan:

1. Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all identified natural hazards.

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

3. Increase cooperation and coordination among private entities, Town officials and Boards, neighboring communities, State agencies and Federal agencies.

4. Increase awareness of the benefits of hazard mitigation through outreach and education.

VI. HAZARD MITIGATION STRATEGY

The central component of a hazard mitigation plan is the strategy for reducing the community's vulnerabilities to natural hazard events. Responding to the analysis of risk, vulnerabilities, potential impacts, and anticipated future development, the process for developing this strategy is one of setting goals, understanding what actions the community is already taking that contribute to mitigating the effects of natural hazards and assessing where more action is needed to complement or modify existing measures. The following sections include descriptions of existing mitigation measures, a status update on mitigation measures identified in previous plans, and descriptions of proposed new mitigation measures. All mitigation measures are evaluated by their benefits and potential costs to arrive at a prioritized list of action items.

What is Hazard Mitigation?

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects and other activities. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Pre-Disaster Mitigation program (PDM), and the Flood Mitigation Assistance (FMA) program. The three links below provide additional information on these programs.

http://www.fema.gov/government/grant/hmgp/index.shtm

http://www.fema.gov/government/grant/pdm/index.shtm

http://www.fema.gov/government/grant/fma/index.shtm

Hazard Mitigation Measures can generally be sorted into the following groups:

- Prevention: Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.
- Property Protection: Actions that involve the modification of existing buildings or infrastructure to protect them from a hazard or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.
- Public Education & Awareness: Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.
- Natural Resource Protection: Actions that, in addition to minimizing hazard losses also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.

- Structural Projects: Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls (e.g., culverts), floodwalls, seawalls, retaining walls, and safe rooms.
- Emergency Services Protection: Actions that will protect emergency services before, during, and immediately after an occurrence. Examples of these actions include protection of warning system capability, protection of critical facilities, and protection of emergency response infrastructure.
  (Source: FEMA Local Multi-Hazard Mitigation Planning Guidance)

Existing Mitigation Measures

The existing protections in the Town of Hopkinton are a combination of zoning, land use, and environmental regulations, infrastructure maintenance and drainage infrastructure improvement projects. Infrastructure maintenance generally addresses localized drainage clogging problems, while large scale capacity problems may require pipe replacement or invert elevation modifications. The Town's existing mitigation measures are listed by hazard type here and are summarized in Table 24.

There are several mitigation measures that impact more than one hazard. These include the Comprehensive Emergency Management Plan (CEMP), and the Massachusetts State Building Code.

Existing Multi-Hazard Mitigation Measures

Massachusetts State Building Code – The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is "to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake". This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be "prudent and economically justified" for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, cannot be achieved economically for most buildings. Section 1612.2.5 sets up seismic hazard exposure groups and assigns all buildings to one of these groups according to a Table 1612.2.5. Group II includes buildings which have a substantial public hazard due to occupancy or use and Group III are those buildings having essential facilities which are required for post-earthquake recovery, including fire, rescue and police stations, emergency rooms, power-generating facilities, and communications facilities.

Multi-Department Review of Developments – Multiple departments, such as the Town Administrator, Planning, Zoning, Health, Highway, Fire, Police, and Conservation, review all subdivision and site plans prior to approval.

Comprehensive Emergency Management Plan (CEMP) **–** Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain important information regarding flooding, dam failures and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to many of the

hazards discussed in this plan. The CEMP is available online through secure access for town personnel.

Portable Water Pumps – Rivers and ponds in town are available to be tapped into for water supply if necessary.

FEMA Resources – A tanker task force is available through State Fire mobilization. FEMA has 8-12 tankers that can be deployed anywhere in the US within 72 hours.

Emergency Power Generators – The Town maintains emergency power generators in important public facilities and emergency shelters, including several schools, sewer pump locations, public safety buildings, several nursing homes, and several other private facilities.

Local Emergency Management Officer (LEPC) – The Fire Chief serves as the Town's Emergency Management Officer.

Public Education – The Town's Emergency Management Department posts on the Town's website multiple notices and publications, including MEMA notices related to winter weather and hurricane preparedness, links to Code Red, Police and Fire, Mass 211, Recovers Help Hub, Emergency Preparedness Documents, Tune In Radio for Hopkinton Public Safety and Public Works radio, and Google Public Alerts.

Existing Flood Hazard Mitigation Measures

National Flood Insurance Program (NFIP) – Hopkinton participates in the NFIP with 18 policies in force as of the November 30, 2015. FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at http://www.fema.gov/policy-claim-statistics-flood-insurance/policy-claim-statistics-flood-insurance/policy-claim-13

The following information is provided for the Town of Hopkinton:

Flood insurance policies in force (as of November 30, 2015)	18
Coverage amount of flood insurance policies	$4,000,000
Premiums paid	$7,405
Total losses (all losses submitted regardless of the status)	1
Closed losses (Losses that have been paid)	0
Open losses (Losses that have not been paid in full)	0
CWOP losses (Losses that have been closed without payment)	0
Total payments (Total amount paid on losses)	$0

The Town complies with the NFIP by enforcing floodplain regulations, maintaining up-to-date floodplain maps, and providing information to property owners and builders regarding floodplains and building requirements.

Since the 2008 plan, the policies in force have increased by 8 and the total losses have remained the same. The total payments, as of April 30, 2015, were $0, the same as the 2008 plan. .

Street Sweeping – The Hopkinton Department of Public Works conducts year-round street sweeping. All streets are swept at least once per year or as needed in select areas of town. Street sweeping begins

as soon as possible each spring.

Catch Basin Cleaning – All 2,600 catch basins are cleaned out once a year. This service is contracted out. Included in the town's Snow & Ice Management Policy/Guide is a provision to keep catch basins free and clear of snow and ice.

Roadway Treatments – The town uses a mixture of sand and salt with a bit more salt in the mix. This is done to minimize the amount of sand that enters catch basins and streams. Roads are treated when needed for winter storms.

Enforcement of the State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing and snow loads.

The Massachusetts Stormwater Policy – This policy is applied to developments within the jurisdiction of the Conservation Commission.

Community Preservation Act (CPA) – The town adopted the CPA (permitted by Massachusetts General Law Chapter 44B, Sections 3 through 7), in 2001. CPA establishes a dedicated funding source, derived from a 2% surcharge on the annual property tax and state matching funds, for the purpose of preserving open space, historical preservation, community housing and recreation.

Infrastructure Improvements – Within the past 5-10 years, the town upgraded much of the town's infrastructure such as culverts, bridges, roads, and drainage systems.

Regulations and By-Laws – The town has adopted many regulations and bylaws that serve to reduce flooding, preserve open space, and protect the community from natural hazards. Brief descriptions of town-wide regulations, bylaws, and ordinances are included in Appendix E. Updates made since 2008 to address regulatory mitigation recommendations are also listed in Appendix E.

Existing Dam Failure Mitigation Measures

DCR dam safety regulations – All dams are subject to the Division of Conservation and Recreation's dam safety regulations. The dams must be inspected regularly and reports filed with the DCR Office of Dam Safety.

Permits required for construction – State law requires a permit for the construction of any dam.

The Comprehensive Emergency Management Plan – The CEMP addresses dam safety.

Participation in the National Flood Insurance Program (NFIP) – Hopkinton participates in the National Flood Insurance Program. NFIP provides access to funds in the case of flood related damages. Table 13 provides an overview of NFIP information for the Town of Hopkinton (reporting period covers through January 31, 2007). FEMA maintains a database on flood insurance policies and claims.

Existing Wind Hazard Mitigation Measures

Massachusetts State Building Code – The Town enforces the Massachusetts State Building Code whose provisions are generally adequate to protect against most wind damage. The code's provisions are the most cost-effective mitigation measure against tornadoes given the extremely low probability of occurrence. If a tornado were to occur, the potential for severe damages would be extremely high.

Zoning regulations for Wireless Communications Facilities - Article XVI of the Hopkinton Zoning Bylaw controls for personal wireless facilities and states that Tower height shall not exceed one hundred (100) feet above the existing grade.

Tree Trimming- the Hopkinton Tree Warden and local electric company conduct regular tree

trimming. The town responds to downed tree limbs caused by winds, lightning strike reports and other weather related incidents. The town utilizes a bucket truck for tree removal efforts.

Existing Winter Storm Hazard Mitigation Measures

Roadway Treatments – The town uses a mixture of sand and salt with a bit more salt in the mix. This is done to minimize the amount of sand that enters catch basins and streams.

Snow Removal/Disposal – The town Highway Department performs regular snow plow operations during winter storms. The town does not do any snow disposal except for removing snow at municipal building.

Existing Geologic Hazard Mitigation Measures

Massachusetts State Building Code – The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is "to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake". This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be "prudent and economically justified" for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, cannot be achieved economically for most buildings.

Comprehensive Emergency Management Plan –The town has an evacuation plan as specified in its Comprehensive Emergency Management Plan (CEMP).

Portable Water Pumps – Rivers and ponds in town are available to be tapped into for water supply if necessary.

FEMA Resources – A tanker task force is available through State Fire mobilization. FEMA has 8-12 tankers that can be deployed anywhere in the US within 72 hours.

Existing Brush Fire Hazard Mitigation Measures

Permits Required for Outdoor Burning – The Fire Department requires a written permit for outdoor burning. The property-owner must come into the Fire Station and fill out a form.

Fire Hydrant Regulations – The Hopkinton Water Department regulates that fire hydrants be installed at all new developments at the expense of the developer.

Subdivision Review – The Fire Department is involved in reviewing subdivision plans from conceptual design through occupancy to ensure that there is adequate access for fire trucks and an adequate water supply.

Portable Water Pumps – Rivers and ponds in town are available to be tapped into for water supply if necessary.

Local Capacity for Implementation

The Town of Hopkinton has recognized several existing mitigation measures that require implementation, enforcement, or improvements, and has the capacity within its local boards and departments to address these. The Hopkinton Department of Public Works will address the needs for catch basin cleaning, repairs and upgrades to drainage infrastructure and oversight of the Emergency Action Plan for the Town's three dams under Town ownership. The Planning Board will address updates to the Master Plan and implementation of the Floodplain & Wetlands Ordinance and Subdivision Rules and Regulations. The Conservation Commission will oversee implementation of the Wetlands Protection Act and the Open Space Plan.

Table 24

Existing Natural Hazard Mitigation Measures

Type of Existing Protection	Description	Effectiveness /Enforcement	Changes Needed
MULTIPLE HAZARD MITIGATION			
Comprehensive Emergency Management Plan (CEMP)	Addresses mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies.	Emphasis is on emergency response.	None.
Massachusetts State Building Code	Regulates wind loads, earthquake resistant design, flood-proofing and snow loads.	Most effective for new construction.	None.
Multi-Department Review of Developments	Multiple department within town review site plans before development.	Most effective for new construction.	None.
Portable Water Pumps	Rivers and ponds in TON are available to be tapped into for water supply if necessary.	Effective.	None.
FEMA Tankers	FEMA has 8-12 tankers that can be deployed anywhere in the US within 72 hours.	Effective for most situations.	None.
FLOOD RELATED HAZARDS			
Participation in the National Flood Insurance Program (NFIP)	Homeowners in the floodplain can purchase flood insurance.	There are 18 policies in force.	Encourage all eligible homeowners to obtain insurance.

Type of Existing Protection	Description	Effectiveness /Enforcement	Changes Needed
Street Sweeping	Every street gets swept once a year or as needed. High traffic areas are swept more regularly.	Effective.	None.
Catch Basin Cleaning	All 2,600 catch basins are cleaned out once a year.	Effective.	None.
Enforcement of the State Building Code	Regulates for wind loads, earthquake resistant design, flood-proofing and snow loads.	Most effective for new construction.	None.
Massachusetts Stormwater Regulations	This policy is applied to developments within the jurisdiction of the Conservation Commission.	Effective.	None.
Community Preservation Act	The town adopted CPA in 2001.	Effective.	None.
Infrastructure Improvements	Infrastructure improvements include culverts, bridges, roads, and drainage systems.	Partially Effective	Funding, Equipment, Resources
Regulations, By-Laws, and Plans	Includes: Stormwater Management, Floodplain Protection District, Open Space Residential Development, NPDES	Effective.	None.
Comprehensive Emergency Management Plan (CEMP)	The CEMP addresses dam safety issues.	Emphasis is on emergency response.	Plan needs to be updated.

Type of Existing Protection	Description	Effectiveness /Enforcement	Changes Needed
State permits required for dam construction	State law requires a permit for the construction of any dam.	Most effective for new construction.	Improvements needed to the statewide.
DCR Dam Safety Regulations	The state has enacted dam safety regulations mandating inspections and emergency action plans.	Enforcement is an issue.	None.
BRUSH FIRE RELATED HAZARDS			
Permits required for outdoor burning.	The Fire Department requires a written permit for outdoor burning. The permit must be obtained from the Fire Dept.	Effective.	None.
Fire Hydrant Regulations	The Medway Water Department regulates that fire hydrants be installed at all new developments at the expense of the developer.	Effective.	None.
Subdivision Review	The Fire Department is involved in reviewing all subdivision plans.	Effective.	None.
Comprehensive Emergency Management Plan (CEMP)	Addresses mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies.	Emphasis is on emergency response.	None.
Portable Water Pumps	Rivers and ponds in town are available to be tapped into for water supply if necessary.	Effective.	None.

Type of Existing Protection	Description	Effectiveness /Enforcement	Changes Needed
GEOLOGIC HAZARDS			
The Massachusetts State Building Code	The Town enforces the Massachusetts State Building Code.	Effective for most situations.	None.
Portable Water Pumps	Rivers and ponds in town are available to be tapped into for water supply if necessary.	Effective.	None.
FEMA Tankers	FEMA has 8-12 tankers that can be deployed anywhere in the US within 72 hours.	Effective for most situations.	None.
WIND HAZARDS			
Massachusetts State Building Code	The town enforces the Massachusetts State Building Code.	Most effective for new construction.	None.
Tree-Trimming	The Tree Warden and local electric company conduct regular tree trimming.	Effective for most situations.	None.
WINTER-RELATED HAZARDS			
Roadway Treatments	The Highway Department conducts salting, sanding and plowing services throughout the town during winter storms.	Effective for most situations.	None.
Snow Removal & Disposal	The town conducts regular operations.	Effective for most situations.	None.
EXTREME TEMPERATURE-RELATED HAZARDS			
Cooling stations	The Library and Senior Center serve as emergency cooling stations.	Effective for most situations.	None.

Implementation Progress on Previous Plans

At a meeting of the Hopkinton Hazard Mitigation Committee, Town staff reviewed the mitigation measures identified in the 2008 Hopkinton Natural Hazard Mitigation Plan and determined whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into the 2015 Hopkinton Hazard Mitigation Plan Update. The decision on whether to delete or retain a particular measure was based on the committee's assessment of the continued relevance or effectiveness of the measure and whether the deferral of action on the measure was due to the inability of the Town to take action on the measure.

Abbreviations Used in Table 25

TOH = Town of Hopkinton

FEMA Mitigation Grants includes:

FMA = Flood Mitigation Assistance Program
HMGP = Hazard Mitigation Grant Program
PDM = Pre-Disaster Mitigation Program
RFC = Repetitive Flood Claims
SRL = Severe Repetitive Loss

Other Funding Sources include:

ACOE = Army Corps of Engineers.
CMMCP= Central Massachusetts Mosquito Control Project
CZM = Coastal Zone Management
CMRP = Commonwealth of Massachusetts Riverways Program
DAR = Department of Agriculture and Resources
DCR = Department of Conservation and Recreation
DEP = Department of Environmental Protection
DHS = Department of Homeland Security/Emergency Operations
MHD = Massachusetts Highway Department
MAPC = Metropolitan Area Planning Council EOT
= Executive Office of Transportation
USDA = United States Department of Agriculture

Table 25.
Mitigation Measures from the 2008 Plan

Hazard Area	Mitigation Measure	Implementation Responsibility	Time Frame/ 2008 Priority H,M,L	Cost Estimate	Current Status	Carry forward and 2015 priority H,M,L
High Priority Mitigation						
Lake Shore Drive	Culvert upgrades	TOH	2010: H	$200-300,000	Implemented	No
	Drainage Improvements	TOH	2010: H		Implemented	
	Hydro Analysis	TOH, Consultant	2010:H		Implemented	
1 Spring Street	Upgrade Culvert	TOH	2010:H	$250-300,000	Implemented	No
	Hydro Analysis	TOH, Consultant	2010: H		Implemented	
Lake Maspenock Dam	Dam Restoration	DCR, TOH	2010:H	$1 Million	Repairs partially implemented	Carry forward to 2015: H
32 Granite Street	Upgrade Culvert	TOH	2012:H	$100-150,000	Implemented	No
West Main Street and South Street Intersection	Replace Detention Pond Outlet	TOH DPW	2010:H	$20-40,000	Implemented	No
Brush Fire Equipment &Projects	All Terrain Vehicles for Forest Fires	TOH	2009:M	$40-60,000	Implemented	No

Hazard Area	Mitigation Measure	Implementation Responsibility	Time Frame/ 2008 Priority H,M,L	Cost Estimate	Current Status	Carry forward and 2015 priority H,M,L
	Cart-Path Restoration	TOH	2009:M	25-500,000	No longer needed as ATV's have allowed access to fires.	No
Mapping capabilities	Acquire GIS & Mapping Technology	TOH	2010:H	NA	Implemented	No
Sand and Salt Storage	Expand sand and salt storage to meet capacity demands	TOH	2012:H	$25-200,000	Not implemented; part of new DPW facility	Carry forward to 2015:H
DPW Facility	Upgrade to meet capacity needs	TOH	2012:H	$1 Million	Not built	Carry forward to 2015:H
Protection of Open Space	Continue more purchases of prioritized open space parcels Negotiate additional conservation restrictions and easements	TOH, MAPC	2012:H	NA	Partially Implemented; ongoing mitigation goals	Carry both forward to 2015: H
Revisions to Development Bylaws and Regulations	Revise and strengthen existing regulations and by-laws	TOH	2012:H	NA	Partially Implemented: 2014 floodplain ordinance upgrade	Carry forward to 2015: upgrade Nonpoint and stormwater discharge bylaws: H

Medium Priority Mitigation						
Lake Whitehall Dam	Dam Restoration	DCR	2012:M	1 Million	Implemented: fully restored by DCR 2011	No
Clinton Street Beaver Dam	Beaver Control	TOH	2012:M	5-10 K	Implemented	No
Sudbury River at Cordaville Street	Aquatic Analysis during bridge repair	TOH, Consultant	2010:M		Implemented and bridge rebuilt by Mass DOT 2014	No
Fruit Street	Culvert upgrades	TOH	2012:M	100-300 K	Implemented	No
	Drainage Improvements	TOH	2012:M		Implemented	
	Hydro Analysis	TOH, Consultant	2012:M		Implemented	
Emergency Generator for Municipal Facilities	Acquire emergency generators	TOH	2012:M	$5 – 50,000	Implemented	No
Water and Sewer Main Connections and Extensions	Connect and extend water and sewer lines	TOH	2013:M	50-500 K	Implemented	No
Fuel Storage and Dispensing	Expand fuel storage and dispensing capabilities	TOH	2012:M	20-500 K	Not implemented	Carry forward 2015 plan as part of DPW: H
Brush Fire Regulations	Backyard Setback Requirements for Fire Protection	TOH	2011:M	NA	Neither was implemented	Carry forward 2015:M

	Public Education on Brush Fire Prevention	TOH	2011:M			Carry forward 2015:M

Water-Related Public Education	Public education on water resources such as flood prevention and stormwater management	TOH	2013:M	NA	Implemented: Emergency Management and Cons. Comm. web pages	No
Other Potential Mitigation Measures						
Alprilla Farm Road	Develop an operational Plan for Blood's Pond Dam	TOH	2010:M	$10-30,000	Not implemented	Carry forward 2015: H
Hearthstone Road	Upgrade Swale	TOH	2012:M	$50,000	Implemented	No
	Drainage Improvements	TOH	2012:M		Implemented	
North Pond Causeway	Reinforce sewer and water lines with cement	TOH	2013:M	$50-100,000	Implemented	No

Regional and Inter-Community Considerations

Some hazard mitigation issues are strictly local. The problem originates primarily within the municipality and can be solved at the municipal level. Other issues are inter-municipal issues that involve cooperation or a shared hazard risk between two or more municipalities. There is a third level of mitigation which is regional; involving a state, regional, or federal agency or an issue that involves three or more municipalities.

Regional Partners

In many communities, mitigating natural hazards, particularly flooding, is more than a local issue. The drainage systems that serve these communities are a complex system of storm drains, roadway drainage structures, pump stations and other facilities owned and operated by a wide array of agencies including but not limited to the Town of Hopkinton, the Department of Conservation and Recreation (DCR), the

Army Corps of Engineers (ACOE), Massachusetts Highway Department (MHD), Massachusetts Bay Transportation Authority (MBTA), and the Central Massachusetts Mosquito Control Project (CMMCP). The planning, constructions operations and maintenance of these structures are integral to the flood hazard mitigation efforts of communities. These agencies must be considered the communities regional partners in hazard mitigation. These agencies also operate under the same constraints as communities do including budgetary and staffing constraints and numerous competing priorities. In the sections that follow, the plan includes recommendations for activities to be undertaken by these other agencies. Implementation of these recommendations will require that all parties work together to develop solutions.

Regional Facilities within Hopkinton

Major facilities owned operated and maintained by federal, state, regional or private entities in Hopkinton include: I-495, and State Routes 90 (Mass Turnpike), 85 and 135.

Inter Community Considerations

Hopkinton, as well as its surrounding communities, is undergoing significant development. In order to avoid impacts from any residential and commercial development, communication between Hopkinton and the surrounding communities, including input in the review processes, is vital.

Maintaining adequate drainage, floodplains, and water quality of the Charles River watershed is an important consideration for Hopkinton and the surrounding communities. The Charles River runs through 35 communities, through Boston and into the Atlantic Ocean.

The Lake Maspenock Dam is another important regional issue. The Dam is located in northern Milford, but owned and operated by Hopkinton. A breach in the dam could result in catastrophic downstream flooding in Milford. Monitoring and maintaining this dam is a high priority regional concern.

The Hopkinton State Forest resides in both Upton and Hopkinton. There are frequent brush fires in the forest requiring coordinated operations between the two towns.

Proposed Hazard Mitigation Measures

<u>Flood Hazard Mitigation Measures</u>

- Lake Maspenock Dam: Dam upgrades, paid for by Town bonding, were carried out in 2008. Staff estimates that the dam still needs approximately $1 million in further repairs and that the dam is now in fair condition. This measure was carried forward from the 2008 plan.

- Develop an operational Plan for Blood's Pond Dam. In the Mother’s Day 2005 storm, Alprilla Farm Road, as well as houses on both sides of the road flooded. The flooding was caused by the upstream dam (Blood’s Pond) overflowing. The town recently replaced the culvert and indicated that flooding is infrequent in this area. The first step towards mitigating this issue is the development of an operational plan for Blood’s Pond Dam. This measure was carried forward from the 2008 plan.

- Protection of Open Space:
  Although Hopkinton does not sustain significant flooding compared to more urban and densely populated towns, protection of open space is important in order to ensure that future development does not increase flooding. Potential open space protection recommendations include:
  - Continue purchase of prioritized open space parcels. This measure was carried forward from the 2008 plan.

  - Negotiate conservation restrictions and easements. This measure was carried forward from the 2008 plan. This measure was carried forward from the 2008 plan.

- Revisions to Development Bylaws and Regulations:
  In order to prevent future flooding issues in the town due to new development, the following revisions to existing bylaws and regulations should be considered:
  - Upgrade regulations to address the on-going issue of non-point source pollution to protect the drinking water supply. This measure was carried forward from the 2008 plan.
  - Implement a discharge bylaw that would restrict pumping of water into streets in winter months. This will help prevent icing of roads. A provision of this law could allow residents to hook up to storm drains. This measure was carried forward from the 2008 plan.

<u>Wind Hazard Mitigation Measures</u>

- Tree Trimming: The Town will explore the option to increase trim back width from current standard of 2 feet in order to limit future hazards. This work will include coordinating with the power company and other utilities. Additional tree planting and maintenance measures, including encouraging private property owners to plant trees set back from the public way, will be explored.

<u>Winter Storm Hazard Mitigation Measures</u>

- Increase sand and salt storage to meet capacity demands; this is part of the overall effort to build a new DPW facility. Carried forward from 2008 plan.

<u>Geologic Hazard Mitigation Measures</u>

- Seismic Study: The Town will conduct a study of the seismic vulnerability and upgrade needs for critical infrastructure sites, both public and private. This mitigation measure was carried forward from the 2008 plan.

<u>Brush Fire Hazard Mitigation</u>

- <u>Public Education on Brush Fire Prevention</u>

In order to reduce the risk of brush fires, further education of the public should be provided at conservation areas, for example with signage. In addition, homeowners in close proximity to forest areas could be educated on vegetation management on their own properties and how to maintain buffers. This measure was carried forward from the 2008 plan.

- Backyard Setback Requirements for Fire Protection

  A town regulation for a minimum 75-foot backyard setback would help minimize risk to property and personal injury from brush fires, by keeping a buffer between vegetated/forested areas and structures. This measure was carried forward from the 2008 plan.

Extreme Temperature Mitigation

Revise zoning Site Design regulations to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways.

Drought Mitigation

Incorporate drought tolerant landscaping and site design measures into Town zoning regulations.

Climate Resilience and Adaptation

Incorporate climate resilience/adaptation components into the next Comprehensive Plan and Open Space Plan.

Multi-Hazard Mitigation Measures

- Upgrade DPW Facility: The current facility is inadequate to meet the Town's needs as Hopkinton has continued to grow since the 2008 plan update and the old DPW building has become structurally obsolete and undersized. The Town appropriated $250,000 at Town Meeting in 2014 for design and permitting costs and the money to construct it will be requested at the 2016 Town Meeting. This measure was carried forward from the 2008 plan.

- Increase Fuel Storage Capacity

  Currently the DPW can only store 1,000 gallons of fuel. In a natural hazard event, if the public stations were to close, the town would have an inadequate supply of fuel. The town is looking to expand their fuel storage capabilities to 10,000 gallons. This was carried forward from the 2008 plan.

Prioritization of Mitigation Activities

The last step in developing the Town's mitigation strategy is to assign a level of priority to each mitigation measure so as to guide the focus of the Town's limited resources towards those actions with the greatest potential benefit. At this stage in the process, the Local Hazard Mitigation Committee has limited access to detailed analyses of the cost and benefits of any given measure, so prioritization is based on the committee member's knowledge of the existing and potential hazard impacts and an approximate sense of the costs associated with pursuing any given measure.

Prioritization occurred through discussion at the second meeting of the local committee and through subsequent review by committee members and public comment. Priority setting was based on local knowledge of the hazard areas, including impacts of hazard events and the extent of the area impacted and the relation of a given mitigation measure to the Town's identified goals. In addition, through the discussion, the local committee also took into consideration factors such as the number of homes and businesses affected, whether or not road closures occurred and what impact closures had on delivery of emergency services and the local economy, anticipated project costs, whether the Town currently had the technical and administrative capability to carry out the mitigation measures, whether any environmental constraints existed, and whether the Town would be able to justify the costs relative to the anticipated benefits.

The table below demonstrates the prioritization. For each mitigation measure, the geographic extent of the potential benefiting area is identified, an overall benefit in terms of High, Medium or Low is estimated, a cost in terms of High (greater than $50,000), Medium ($10,000 to $49,000), or Low (less than $10,000 or staff time) is identified, and based on these factors, each mitigation measure is categorized as High, Medium or Low. The level of benefit created by a project was based on an estimate of the number of homes, businesses, or people served by the mitigation action and an estimate of the costs or damages avoided via implementation of the mitigation measure. Where a more exact estimate of cost was know, this number was used instead. With this assessment, an approximate timeframe has been identified in which the municipality would attempt to achieve the mitigation measure.

Table 26- Mitigation Measure Prioritization

Mitigation Action	Geographic Area	Benefit	Estimated Cost	Priority	Time Frame
Flood Hazard Mitigation Measures					
Complete upgrades to Maspenock Dam	Identified Areas	High	High	High	2015 - 2018
Develop an operational Plan for Blood's Pond Dam	Identified Areas	Low	Low	Medium	2015 - 2016
Purchase prioritized open space parcels	Town Wide	High	High	Medium	2015 - 2020
Negotiate additional conservation restrictions and easements on prioritized land parcels.	Town Wide	High	High	Medium	2015 - 2020
Revisions to Development Bylaws and Regulations	Town Wide	High	Low	Medium	2015 - 2020

Table 26- Mitigation Measure Prioritization

Mitigation Action	Geographic Area	Benefit	Estimated Cost	Priority	Time Frame
Wind Hazard Mitigation Measures					
Tree Trimming	Town Wide	Medium	Low	Medium	2015 - 2020
Winter Storm Hazard Mitigation Measures					
Increase sand and salt storage to meet capacity demands	Town Wide	High	Medium	Low	2015 - 2017
Geologic Hazard Mitigation Measures					
Seismic Study	Town Wide	Low	Low	Low	2017 - 2020
Brush Fire Hazard Mitigation					
Public Education on Brush Fire Prevention	Town Wide	Medium	Low	Low	2015 - 2020
Backyard Setback Requirements for Fire Protection	Brush Fire Hazard Areas	Medium	Low	Medium	2015 - 2018
Extreme Temperature Mitigation Measures					
Revise zoning Site Design regulations to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways.	Town Wide	Medium	Low	Low	2015 - 2018

Table 26- Mitigation Measure Prioritization

Mitigation Action	Geographic Area	Benefit	Estimated Cost	Priority	Time Frame
Climate Resilience and Adaptation Mitigation Measures					
Update Master and Open Space Plans	Town Wide	Medium	Medium	Medium	2015-2020
Multi-Hazards Mitigation Measures					
Upgrade DPW Facility	Town Wide	High	High	High	2015-2017
Increase Fuel Storage Capacity	Town Wide	Medium	High	Medium	2016-2017

Introduction to Potential Mitigation Measures (Table 27)

Description of the Mitigation Measure – The description of each mitigation measure is brief and cost information is given only if cost data were already available from the community. The cost data represent a point in time and would need to be adjusted for inflation and for any changes or refinements in the design of a particular mitigation measure.

Priority – The designation of high, medium, or low priority was done at the meeting of the Local Multiple Hazard Community Planning Team meeting. The designations reflect discussion and a general consensus developed at the meeting but could change as conditions in the community change. . In determining project priorities, the local team considered potential benefits and project costs.

Implementation Responsibility – The designation of implementation responsibility was done by MAPC based on a general knowledge of what each municipal department is responsible for. It is likely that most mitigation measures will require that several departments work together and assigning staff is the sole responsibility of the governing body of each community.

Time Frame – The time frame was based on a combination of the priority for that measure, the complexity of the measure and whether or not the measure is conceptual, in design, or already designed and awaiting funding. Because the time frame for this plan is five years, the timing for all mitigation measures has been kept within this framework. The identification of a likely time frame is not meant to constrain a community from taking advantage of funding opportunities as they arise.

Potential Funding Sources – This column attempts to identify the most likely sources of funding for a specific measure. The information on potential funding sources in this table is preliminary and varies depending on a number of factors. These factors include whether or not a mitigation measure has been studied, evaluated or designed, or if it is still in the conceptual stages. MEMA and DCR assisted MAPC in reviewing the potential eligibility for hazard mitigation funding. Each grant program and agency has specific eligibility requirements that would need to be taken into consideration. In most instances, the measure will require a number of different funding sources. Identification of a potential funding source in this table does not guarantee that a project will be eligible for, or selected for funding. Upon adoption of this plan, the local committee responsible for its implementation should begin to explore the funding sources in more detail.

Additional information on funding sources – The best way to determine eligibility for a particular funding source is to review the project with a staff person at the funding agency. The following websites provide an overview of programs and funding sources.

> Army Corps of Engineers (ACOE) – The website for the North Atlantic district office is http://www.nae.usace.army.mil/. The ACOE provides assistance in a number of types of projects including shoreline/streambank protection, flood damage reduction, flood plain management services and planning services.

Massachusetts Emergency Management Agency (MEMA) – The grants page http://www.mass.gov/dem/programs/mitigate/grants.htm has a useful table that compares eligible projects for the Hazard Mitigation Grant Program and the Flood Mitigation Assistance Program.

United States Department of Agriculture – The USDA has programs by which communities can get grants for firefighting needs. The following link provides some examples: http://www.rurdev.usda.gov/rd/newsroom/2002/cfg.html

Abbreviations Used in Table 27

FEMA Mitigation Grants includes:
- FMA = Flood Mitigation Assistance Program.
- HMGP = Hazard Mitigation Grant Program.
- PDM = Pre-Disaster Mitigation Program
- FP&S=Fire Prevention and Safety Program

ACOE = Army Corps of Engineers.

DHS/EOPS = Department of Homeland Security/Emergency Operations

EPA/DEP (SRF) = Environmental Protection Agency/Department of Environmental Protection (State Revolving Fund)

USDA = United States Department of Agriculture

Mass DOT = Massachusetts Department of Transportation

DCR = MA Department of Conservation and Recreation

DHCD = MA Department of Housing and Community Development

*: indicates mitigation measures carried forward from the 2008 Hopkinton Hazard Mitigation Plan.

Table 27
Hopkinton Potential Mitigation Measures

Mitigation Action	Measure Type	Implementation Responsibility	Priority	Time Frame	Estimated Cost	Potential Funding Sources
Flood Hazard Mitigation Measures						
Lake Maspenock Dam Upgrades*	Structure and Infrastructure	DPW	High	2015 - 2017	$1.0 million	Bonding/Town Budget/DCR
Operational Plan for Blood's Pond Dam *	Structure and Infrastructure	DPW	Medium	2016 - 20818	$7,500	Town Budget
Purchase prioritized open space parcels	Natural Systems Protection	Planning	Medium	2015 - 2020	High	Town Budget
Negotiate additional conservation restrictions and easements on prioritized land parcels.	Natural Systems Protection	Planning	Medium	2015 - 2020	Low	Town Budget
Revisions to Development Bylaws and Regulations *	Natural Systems Protection	DPW	Medium	2015 - 2020	Low	Town Budget
Wind Hazard Mitigation Measures						

Table 27
Hopkinton Potential Mitigation Measures

Mitigation Action	Measure Type	Implementation Responsibility	Priority	Time Frame	Estimated Cost	Potential Funding Sources
Tree Trimming	Natural Systems Protection	DPW	Medium	2014 - 2019	Low	Hopkinton/Utility Companies
Winter Storm Hazard Mitigation Measures						
Increase sand and salt storage*	Structure and Infrastructure	DPW	High	2015 - 2017	Low	Town Budget
Geologic Hazard Mitigation Measures						
Seismic Study*	Local Plans and Regulations	DPW / Building	Low	2017 - 2019	$10,000	Town Budget
Brush Fire Hazard Mitigation Measures						
Backyard Setback Requirements for Fire Protection	Local Plans and Regulations	Planning/Fire	Medium	2015 - 2018	Low	Town Budget
Brush Fire Education	Education and Awareness	Fire / Emergency Management	Medium	2014 - 2019	Low	Town Budget/FEMA Fire Prevention and Safety Program

Table 27
Hopkinton Potential Mitigation Measures

Mitigation Action	Measure Type	Implementation Responsibility	Priority	Time Frame	Estimated Cost	Potential Funding Sources
Extreme Temperature Mitigation Measures						
Revise zoning Site Design regulations to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways.	Local Plans and Regulations	Planning	Medium	2017-2020	Low	Town Budget
Climate Resilience and Adaptation						
Comprehensive and Open Space Plans climate adaptation updates	Prevention	Planning	Medium	2017 - 2020	$50,000	Town budget
Multi-Hazard Mitigation Measures						

Table 27
Hopkinton Potential Mitigation Measures

Mitigation Action	Measure Type	Implementation Responsibility	Priority	Time Frame	Estimated Cost	Potential Funding Sources
Upgrade DPW Facility*	Prevention	DPW	High	2015 - 2017	$1 million	Town Budget
Increase Fuel Storage Capacity*	Prevention / Natural Resource Protection	Hopkinton/MAPC	Medium	2016 - 2017	$25,000 - $200,000	Town Budget

VII. PLAN ADOPTION AND MAINTENANCE

Plan Adoption

The Hopkinton Hazard Mitigation Plan was adopted by the Board of Selectmen on January 10, 2017. See Appendix D for documentation. The plan was approved by FEMA on [ADD DATE] for a five-year period that will expire on [ADD DATE].

Plan Maintenance

Although several of the mitigation measures from the Town's previous Hazard Mitigation Plan have been implemented, since that plan was adopted there has not been an ongoing local process to guide implementation of the plan and integrate it with other town planning processes. Such a process is needed over the next five years for the implementation of this plan update, and will be structured as described below.

MAPC worked with the Hopkinton Hazard Mitigation Planning Team to prepare this plan. This group will continue to meet on a regular basis, at least annually, to function as the Local Hazard Mitigation Implementation Group, with the Fire Chief/Emergency Management Director designated as the coordinator. Additional members could be added to the local implementation group from businesses, non-profits and institutions. During the next five-year planning cycle the Town will continue to invite the public to review and comment on the plan during all aspects of the planning process, through postings on the town web site and meetings hosted by a local board in accordance with city and state open meeting laws.

Implementation Schedule

Mid-Term Survey on Progress– The coordinator of the Hazard Mitigation Implementation Team will prepare and distribute a survey in Year 3 of the plan. The survey will be distributed to all of the local implementation group members and other interested local stakeholders. The survey will poll the members on any changes or revisions to the plan that may be needed, progress and accomplishments for implementation, and any new hazards or problem areas that have been identified.

This information will be used to prepare a report or addendum to the local hazard mitigation plan in order to evaluate its effectiveness in meeting the plan's goals and identify areas that need to be updated in the next plan. The Hazard Mitigation Implementation Team, coordinated by the Fire Chief/Emergency Management Director, will have primary responsibility for tracking progress and updating the plan.

Begin to Prepare for the next Plan Update -- Given the lead time needed to secure funding and conduct the planning process, the Hazard Mitigation Implementation Team will convene the team to begin to prepare for an update of the plan, in Year Three. The

team will use the information from the Mid-Term progress review to identify the needs and priorities for the plan update and seek funding for the plan update process. Potential sources of funding may include FEMA Pre-Disaster Mitigation grants and the Hazard Mitigation Grant Program. Both grant programs can pay for 75% of a planning project, with a 25% local cost share required.

Prepare and Adopt an Updated Local Hazard Mitigation Plan – FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the Town's approved plan status and its eligibility for FEMA mitigation grants. Once the resources have been secured to update the plan, the Hazard Mitigation Implementation Team may decide to undertake the update themselves, contract with the Metropolitan Area Planning Council to update the plan or to hire another consultant. However the Hazard Mitigation Implementation Team decides to update the plan, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes. The update of the Hopkinton Hazard Mitigation Plan will be forwarded to MEMA and DCR for review and to FEMA for approval.

Integration of the Plans with Other Planning Initiatives

Upon approval of the Hopkinton Hazard Mitigation Plan by FEMA, the Local Hazard Mitigation Implementation Team will provide all interested parties and implementing departments with a copy of the plan and will initiate a discussion regarding how the plan can be integrated into that department's ongoing work. At a minimum, the plan will be reviewed and discussed with the following departments:

- Fire / Emergency Management
- Police
- Public Works / Engineering
- Planning Board
- Conservation Commission
- Parks and Recreation
- Board of Health
- Building Department

The Hazard Mitigation Plan will be integrated into other town plans and policies as they are updated and renewed, including the Hopkinton Comprehensive Plan, Open Space Plan, Comprehensive Emergency Management Plan, and Capital Investment Program.

Other groups that will be coordinated with include large institutions, Chambers of Commerce, land conservation organizations and watershed groups. The plans will also be posted on a community's website with the caveat that local team coordinator will review the plan for sensitive information that would be inappropriate for public posting. The posting of the plan on a web site will include a mechanism for citizen feedback such as an e-mail address to send comments.

VIII. LIST OF REFERENCES

In addition to the specific reports listed below, much of the technical information for this plan came from meetings with Town department heads and staff.

Town of Hopkinton, General By-laws

Town of Hopkinton, Zoning Bylaw

NPDES Phase II Stormwater General Permit Annual Reports

Town of Hopkinton Open Space and Recreation Plan

Town of Hopkinton Master Plan

Commonwealth of Massachusetts, State Hazard Mitigation Plan, 2013

FEMA Hazard Mitigation Plan Review Guide, September 2011

FEMA, Local Multi-Hazard Mitigation Planning Guidance; July 1, 2008.

FEMA, Flood Insurance Rate Maps for Hopkinton, MA, 2010

Metropolitan Area Planning Council, Geographic Information Systems Lab

Metropolitan Area Planning Council, Regional Plans and Data

Northeast States Emergency Consortium (NESEC)

U.S. Census, 2010

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APPENDIX A
MEETING AGENDAS

Meeting Agenda
Local Natural Hazard Mitigation Plan
Town of Hopkinton
June 11, 2014, 10:00 – 11:30 AM

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1) Welcome and Introductions

2) MEMA Presentation on Hazard Mitigation Planning

- Questions and discussion

3) Overview of Project Scope (See attached summary)

1. Planning Process and Community Participation
2. Hazard Identification, Critical Facilities, and Vulnerability Analysis
3. Assessment of Existing Mitigation Measures
4. hazard Mitigation Strategies
5. Local Hazard Mitigation Plan Maintenance
6. Local hazard Mitigation Plan Adoption and Approval

4) Local Team Meeting #1 (Information Gathering/Outreach)

a) Hazard Mitigation Planning Map Series and Digitized Ortho Photo Map
b) Identify Critical Facilities
c) Identify local hazards:
   i) Flood Hazard Areas
   ii) Fire Hazard Areas (brushfires./ wildfires)
   iii) Dams
   iv) Future Potential Development Areas
d) Review Plan Goals and Objectives
e) Discuss Public Involvement and Outreach
   i) Identify local stakeholders
   ii) Schedule first public meeting

5) Local Team Meeting #2 (Analysis and Review)

a) Review and finalize Critical Facilities
b) Review and finalize local hazard identification
c) Review vulnerability analysis
d) Review Existing Mitigation Measures
e) Discuss Potential Mitigation Measures

6) Local Team Meeting #3 (Recommendations and Draft Plan)

a) Review and finalize Potential Mitigation Measures

b) Prioritize Potential Mitigation Measures
c) Review draft plan
d) Schedule 2nd Public Meeting and outreach to stakeholders

7) Next Steps/Adjourn

Meeting Agenda
Local Natural Hazard Mitigation Plan
Town of Hopkinton, Town Hall, Room 215
October 9, 2014, 2:00 PM – 4:00 PM

Local Team Meeting #1 (Information Gathering)

a) Hazard Mitigation Planning Map Series and Digitized Ortho Photo Map
b) Identify Critical Facilities
c) Identify local hazards:
   i) Flood Hazard Areas
   ii) Fire Hazard Areas (brushfires/wildfires)
   iii) Dams
   iv) Ice jams
   v) Thunderstorms
   vi) Drought
   vii) Extreme Temps
   viii) Tornadoes
   ix) High winds
   x) Snow and Blizzards
   xi) Ice storms
   xii) Earthquakes
   xiii) Landslides
   xiv) Future Potential Development Areas

d) Review Plan Goals and Objectives- see over

e) Discuss Public Involvement and Outreach
   i) Identify local stakeholders
   ii) Schedule first public meeting

Project Overview - MAPC received a grant to prepare natural hazards *Pre-Disaster Mitigation Plan* for the communities of Burlington, Dover, Hanover, Holliston, Hopkinton, Marlborough and Wilmington. MAPC is working with the seven communities to update their plans to mitigate potential damages of natural hazards such as floods, winter storms, hurricanes, earthquakes and wild fires, before such hazards occur. The federal *Disaster Mitigation Act of 2000* requires that all municipalities adopt a *Pre-Disaster Mitigation Plan* for natural hazards in order to remain eligible for FEMA Disaster Mitigation Grants.

This FEMA planning program is separate from new or ongoing homeland security initiatives, and is focused solely on addressing natural hazards, although some of the data collected for this plan may be useful for other aspects of emergency planning as well.

2008 Hopkinton Goals

1. Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all major natural hazards.

2. Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

3. Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.

4. Prevent and reduce the damage to public infrastructure resulting from all hazards.

5. Encourage residents, the business community, major institutions and non- profits to work with the Town to develop review and implement the hazard mitigation plan.

6. Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

7. Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.

8. Take maximum advantage of resources from FEMA and MEMA to educate Town staff and the public about hazard mitigation.

Recommended for 2015 to align with State 2013 Plan and FEMA Guidelines

1. Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all identified natural hazards.

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

3. Increase cooperation and coordination among private entities, Town officials and Boards, State agencies and Federal agencies.

4. Increase awareness of the benefits of hazard mitigation through outreach and education.

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APPENDIX B
HAZARD MAPPING

The MAPC GIS (Geographic Information Systems) Lab produced a series of maps for each community. Some of the data came from the Northeast States Emergency Consortium (NESEC). More information on NESEC can be found at http://www.serve.com/NESEC/. Due to the various sources for the data and varying levels of accuracy, the identification of an area as being in one of the hazard categories must be considered as a general classification that should always be supplemented with more local knowledge. The documentation for some of the hazard maps was incomplete as well.

The map series consists of four panels with two maps each plus one map taken from the State Hazard Mitigation Plan.

Map 1.	Population Density
Map 2.	Potential Development
Map 3.	Flood Zones
Map 4.	Earthquakes and Landslides
Map 5.	Hurricanes and Tornadoes
Map 6.	Average Snowfall
Map 7.	Composite Natural Hazards
Map 8.	Hazard Areas

Reduced-scale copies of the map series are included in this Appendix for general reference. Full sized higher resolution PDF's of the Hopkinton maps can be downloaded using this link:

https://www.dropbox.com/sh/pauok0hsrorxnfx/AACX9nJCJLki0LulpQ6rW7nma?dl=0

Map1: Population Density – This map uses the US Census block data for 2010 and shows population density as the number of people per acre in seven categories with 60 or more people per acre representing the highest density areas.

Map 2: Development – This map shows potential future developments, and critical infrastructure sites. MAPC consulted with Town staff to determine areas that were likely to be developed or redeveloped in the future. The map also depicts current land use.

Map 3: Flood Zones – The map of flood zones used the FEMA NFIP Flood Zones as depicted on the FIRMs (Federal Insurance Rate Maps) as its source. At the time this plan was developed, these flood zones had not yet been officially adopted and were therefore considered draft. This map is not intended for use in determining whether or not a specific property is located within a FEMA NFIP flood zone. The currently adopted FIRMS for Hopkinton are kept by the Town. For more information, refer to the FEMA Map Service Center website http://www.msc.fema.gov. The definitions of the flood zones are described in detail on this site as well. The flood zone map for each community also shows critical infrastructure and repetitive loss areas.

Map 4: Earthquakes and Landslides – This information came from NESEC. For most communities, there was no data for earthquakes because only the epicenters of an earthquake are mapped.

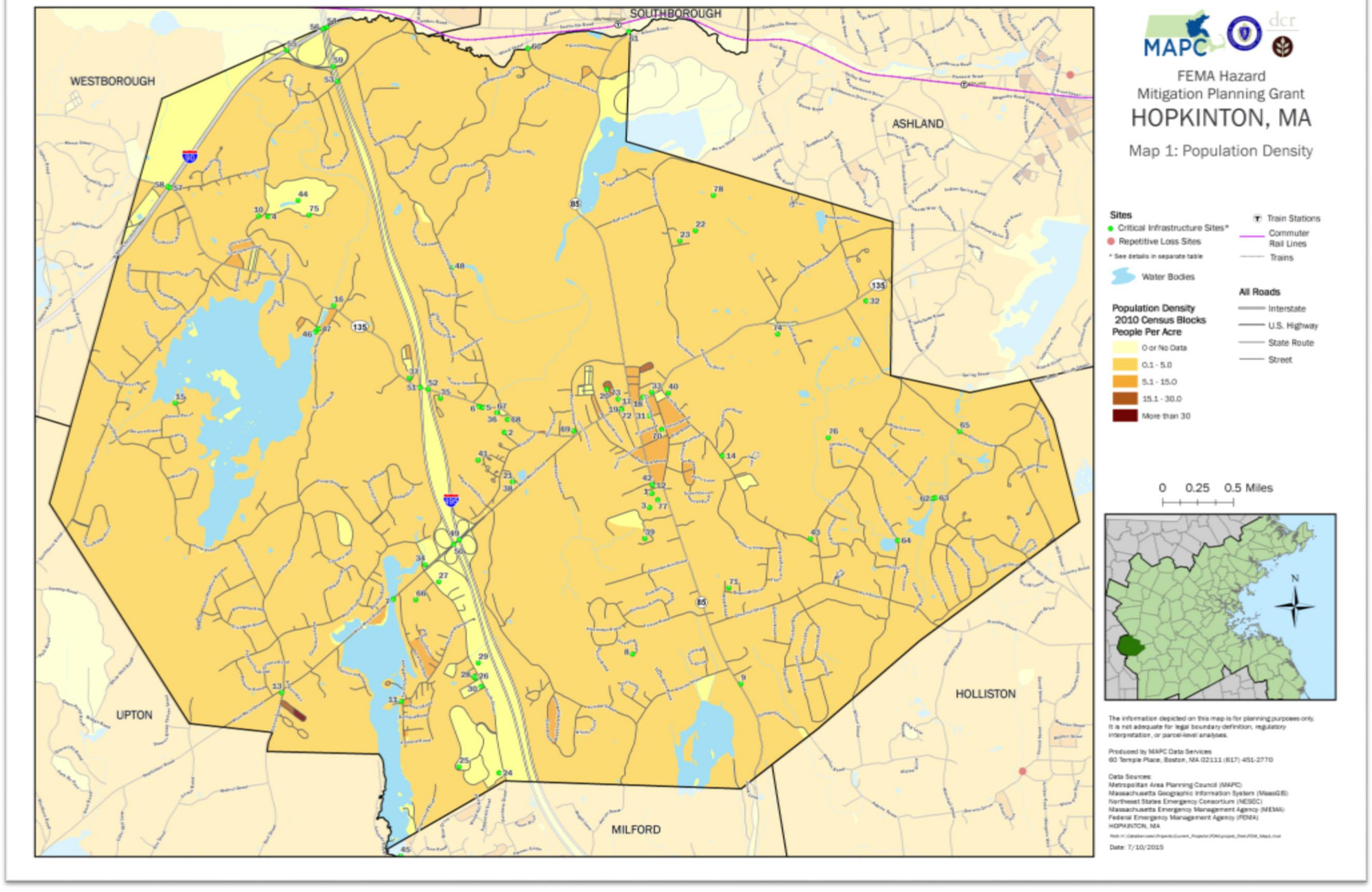
The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to http://pubs.usgs.gov/pp/p1183/pp1183.html.

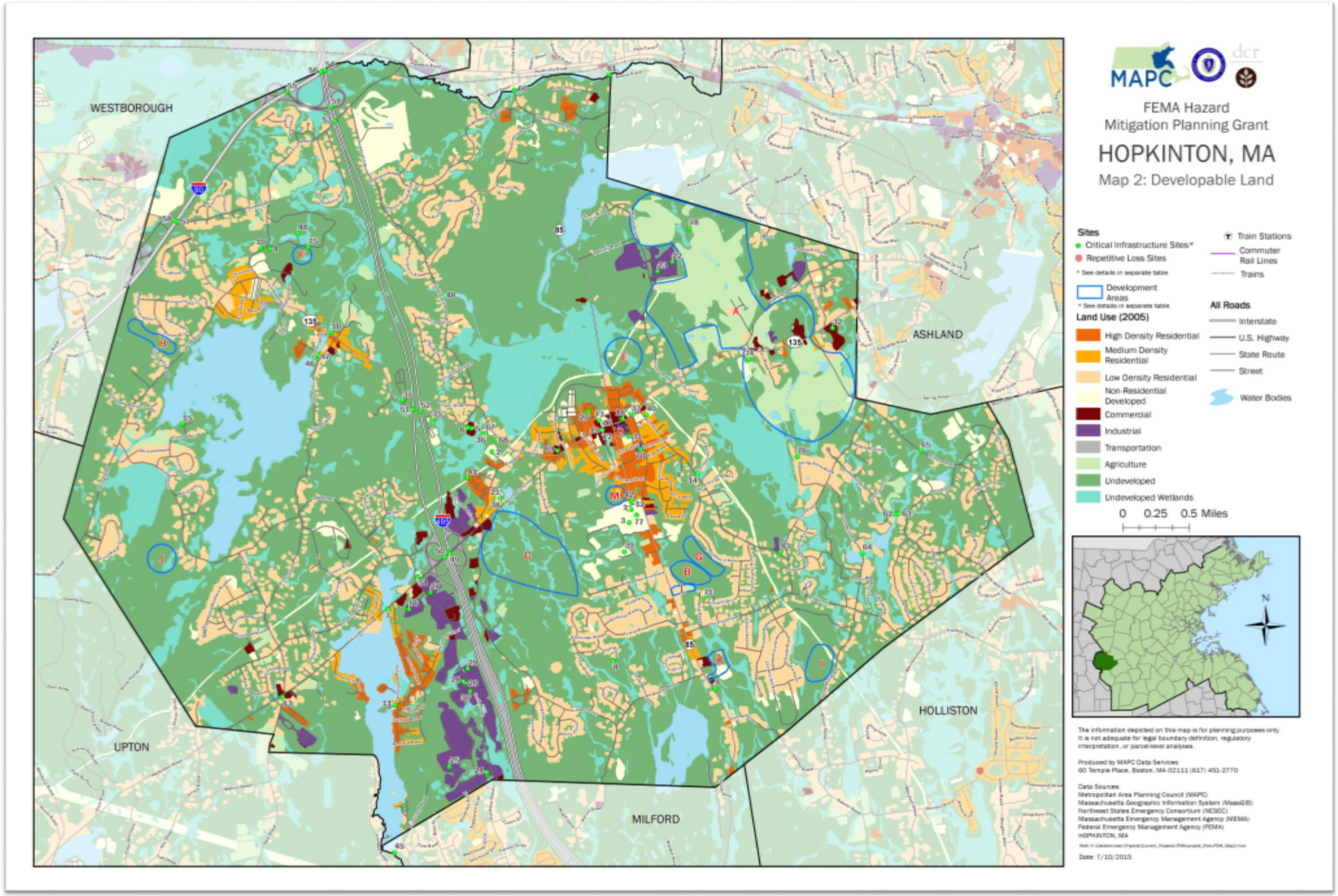
Map 5: Hurricanes and Tornadoes – This map shows a number of different items. The map includes the storm tracks for both hurricanes and tropical storms. This information must be viewed in context. A storm track only shows where the eye of the storm passed through. In most cases, the effects of the wind and rain from these storms were felt in other communities even if the track was not within that community. This map also shows the location of tornadoes with a classification as to the level of damages. What appears on the map varies by community since not all communities experience the same wind-related events. These maps also show the 100 year wind speed.

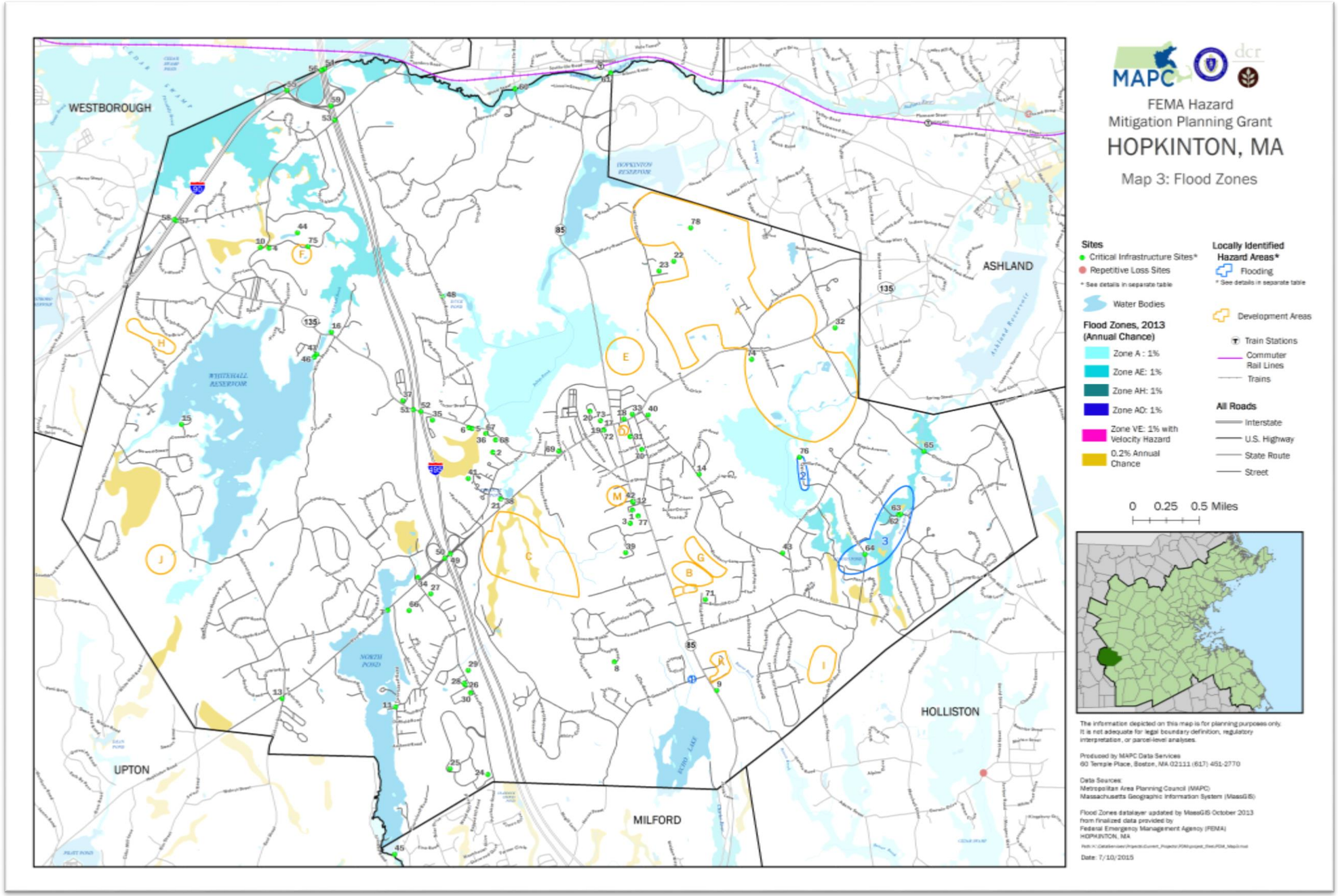
Map 6: Average Snowfall - - This map shows the average snowfall and open space. It also shows storm tracks for nor'easters, if any storms tracked through the community.

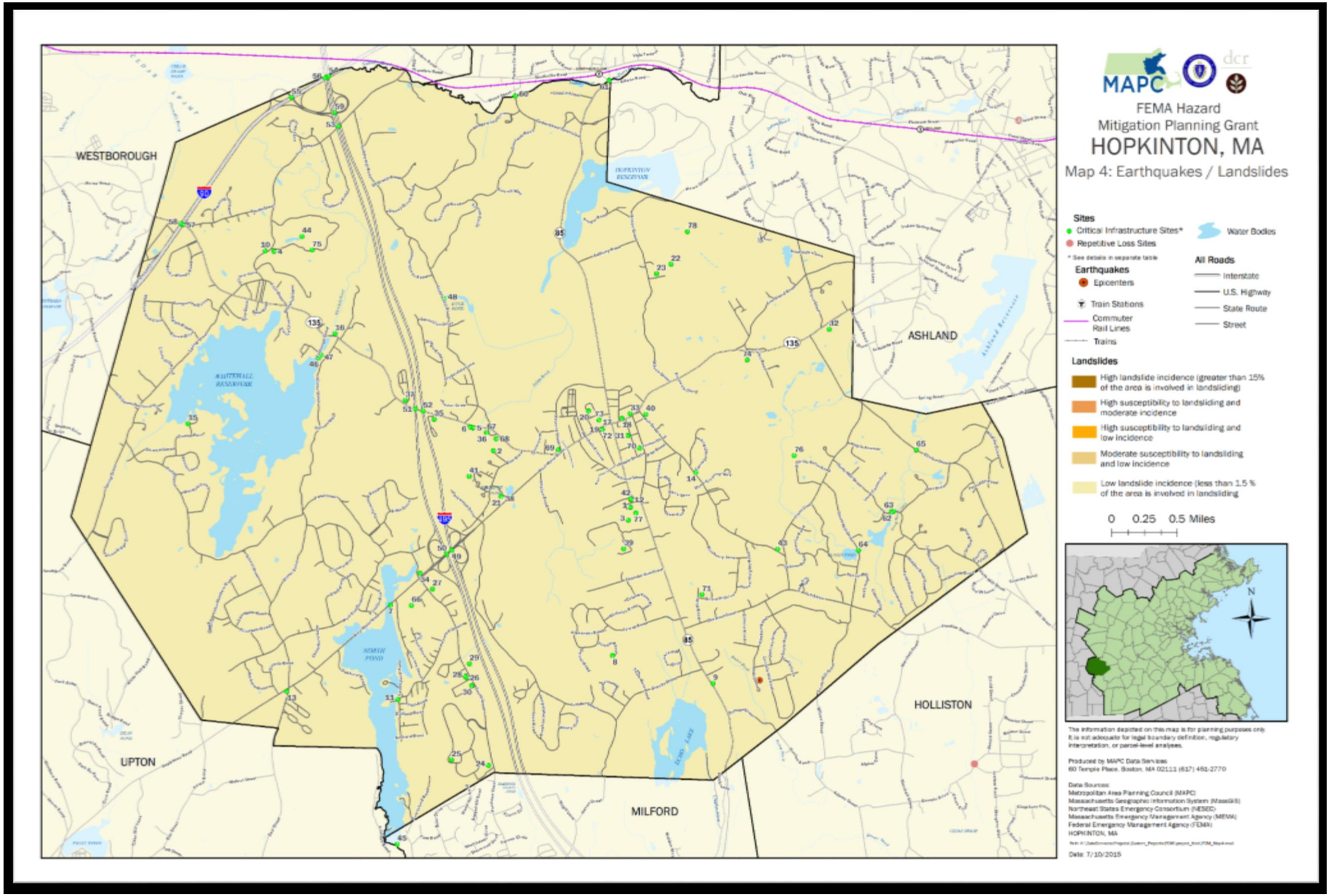
Map 7: Composite Natural Hazards - This map shows four categories of composite natural hazards for areas of existing development. The hazards included in this map are 100 year wind speeds of 110 mph or higher, low and moderate landslide risk, FEMA Q3 flood zones (100 year and 500 year) and hurricane surge inundation areas. Areas with only one hazard were considered to be low hazard areas. Moderate areas have two of the hazards present. High hazard areas have three hazards present and severe hazard areas have four hazards present.

Map 8: Hazard Areas – For each community, locally identified hazard areas are overlaid on an aerial photograph dated April, 2008. The critical infrastructure sites are also shown. The source of the aerial photograph is Mass GIS.


SOUTHBOROUGH
WESTBOROUGH
ASHLAND
HOLLISTON
UPTON
MILFORD
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HOPKINTON, MA
Map 1: Population Density
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Population Density
2010 Census Blocks
People Per Acre
0 or No Data
0.1 - 5.0
5.1 - 15.0
15.1 - 30.0
More than 30
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HOPKINTON, MA
Date: 7/10/2015


WESTBOROUGH
ASHLAND
HOLLISTON
UPTON
MILFORD
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HOPKINTON, MA
Map 2: Developable Land
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Development Areas
* See details in separate table
Land Use (2005)
High Density Residential
Medium Density Residential
Low Density Residential
Non-Residential Developed
Commercial
Industrial
Transportation
Agriculture
Undeveloped
Undeveloped Wetlands
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Water Bodies
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HOPKINTON, MA
Date: 7/10/2015


WESTBOROUGH
ASHLAND
HOLLISTON
UPTON
MILFORD
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HOPKINTON, MA
Map 3: Flood Zones
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
Flood Zones, 2013
(Annual Chance)
Zone A : 1%
Zone AE: 1%
Zone AH: 1%
Zone AO: 1%
Zone VE: 1% with Velocity Hazard
0.2% Annual Chance
Locally Identified Hazard Areas*
Flooding
* See details in separate table
Development Areas
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
0 0.25 0.5 Miles
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Flood Zones datalayer updated by MassGIS October 2013
from finalized data provided by:
Federal Emergency Management Agency (FEMA)
HOPKINTON, MA
Date: 7/10/2015


WESTBOROUGH
ASHLAND
HOLLISTON
MILFORD
UPTON
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HOPKINTON, MA
Map 4: Earthquakes / Landslides
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
Earthquakes
Epicenters
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Landslides
High landslide incidence (greater than 15% of the area is involved in landsliding)
High susceptibility to landsliding and moderate incidence
High susceptibility to landsliding and low incidence
Moderate susceptibility to landsliding and low incidence
Low landslide incidence (less than 1.5 % of the area is involved in landsliding
0 0.25 0.5 Miles
N
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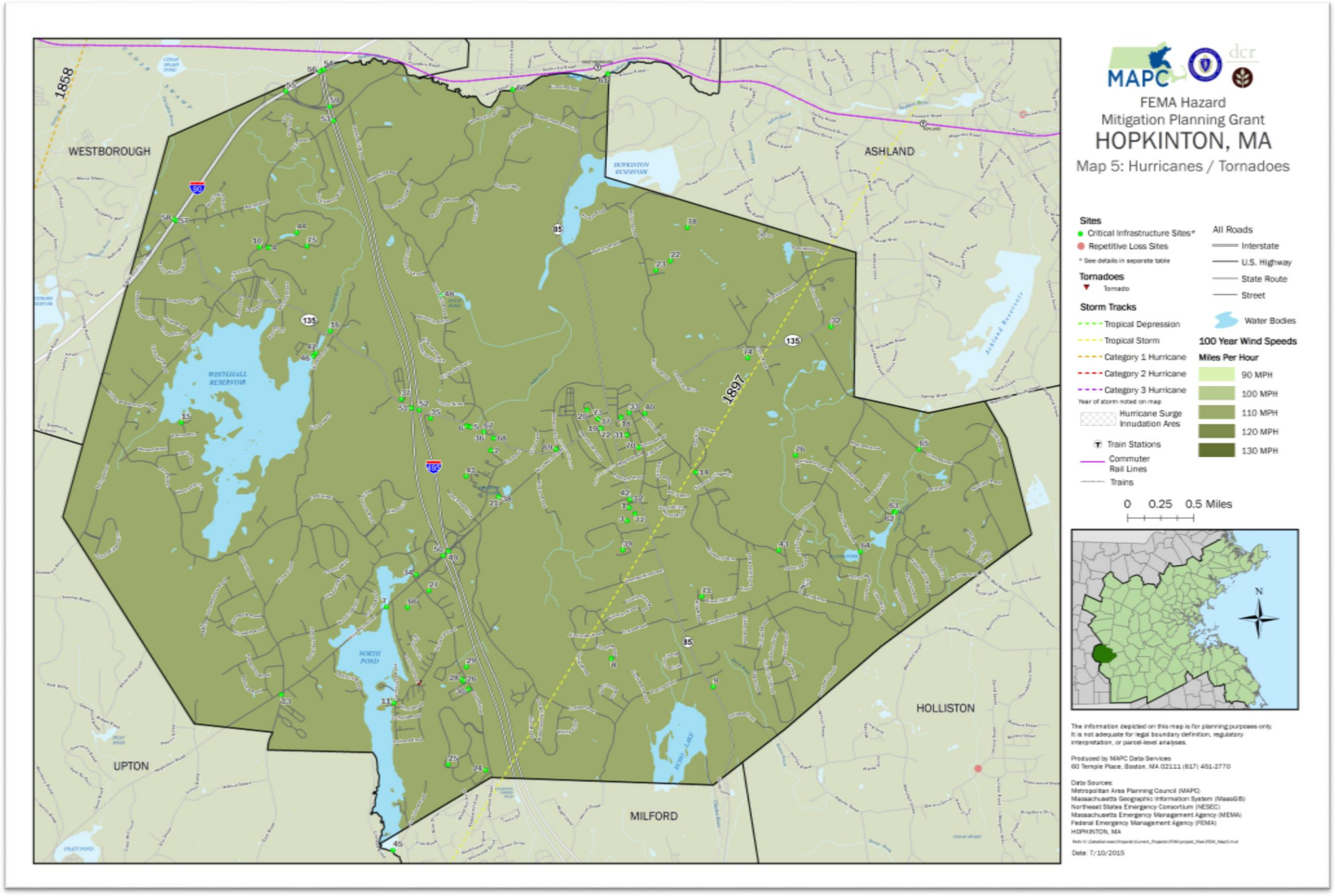
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HOPKINTON, MA
Date: 7/10/2015


WESTBOROUGH
ASHLAND
HOLLISTON
UPTON
MILFORD
1858
1697
WINTHROP RESERVOIR
HOPKINTON RESERVOIR
NORTH POND
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HOPKINTON, MA
Map 5: Hurricanes / Tornadoes
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Tornadoes
Tornado
Storm Tracks
Tropical Depression
Tropical Storm
Category 1 Hurricane
Category 2 Hurricane
Category 3 Hurricane
Year of storm noted on map
Hurricane Surge Innudation Area
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Water Bodies
100 Year Wind Speeds
Miles Per Hour
90 MPH
100 MPH
110 MPH
120 MPH
130 MPH
0 0.25 0.5 Miles
N
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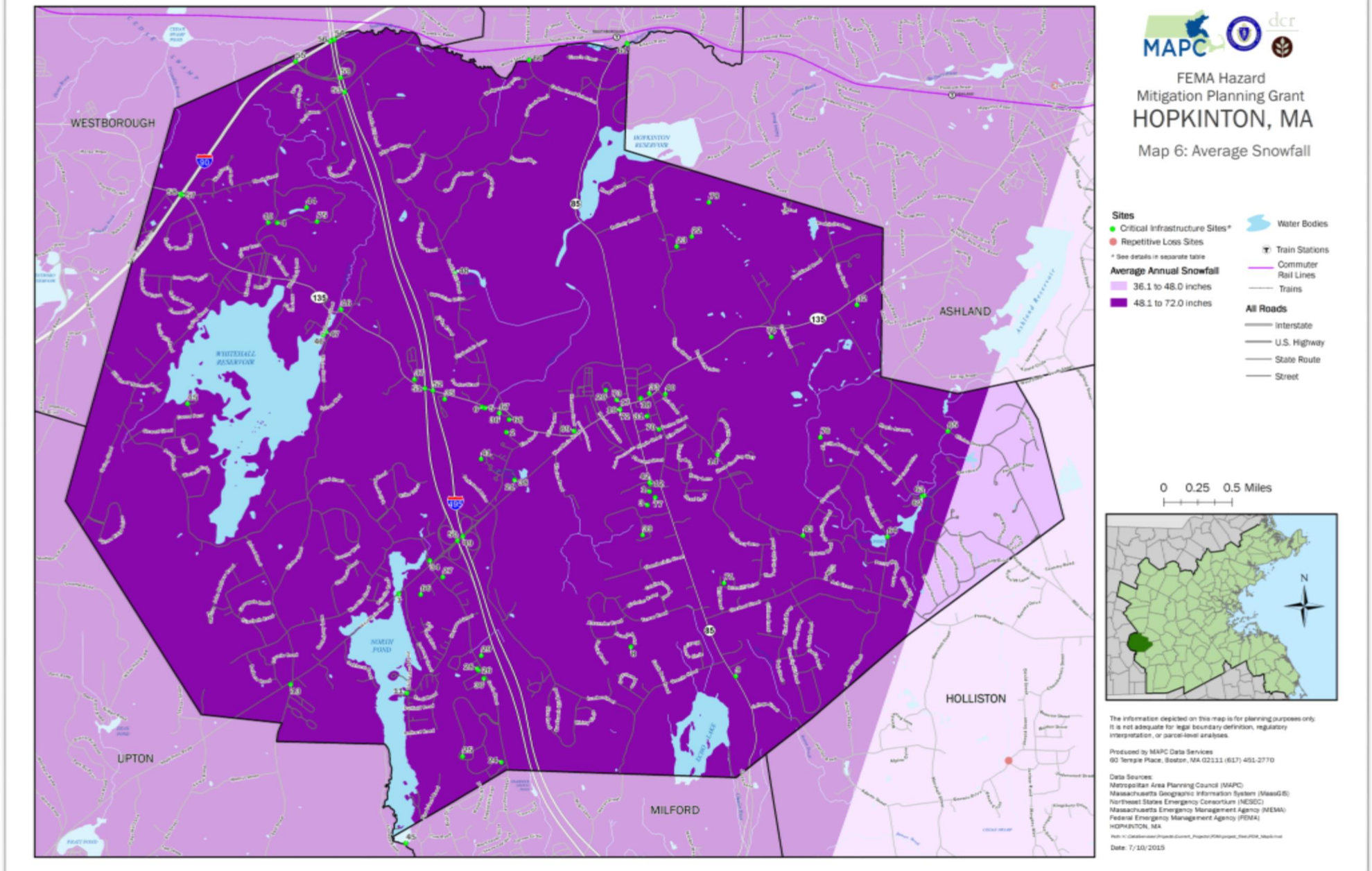
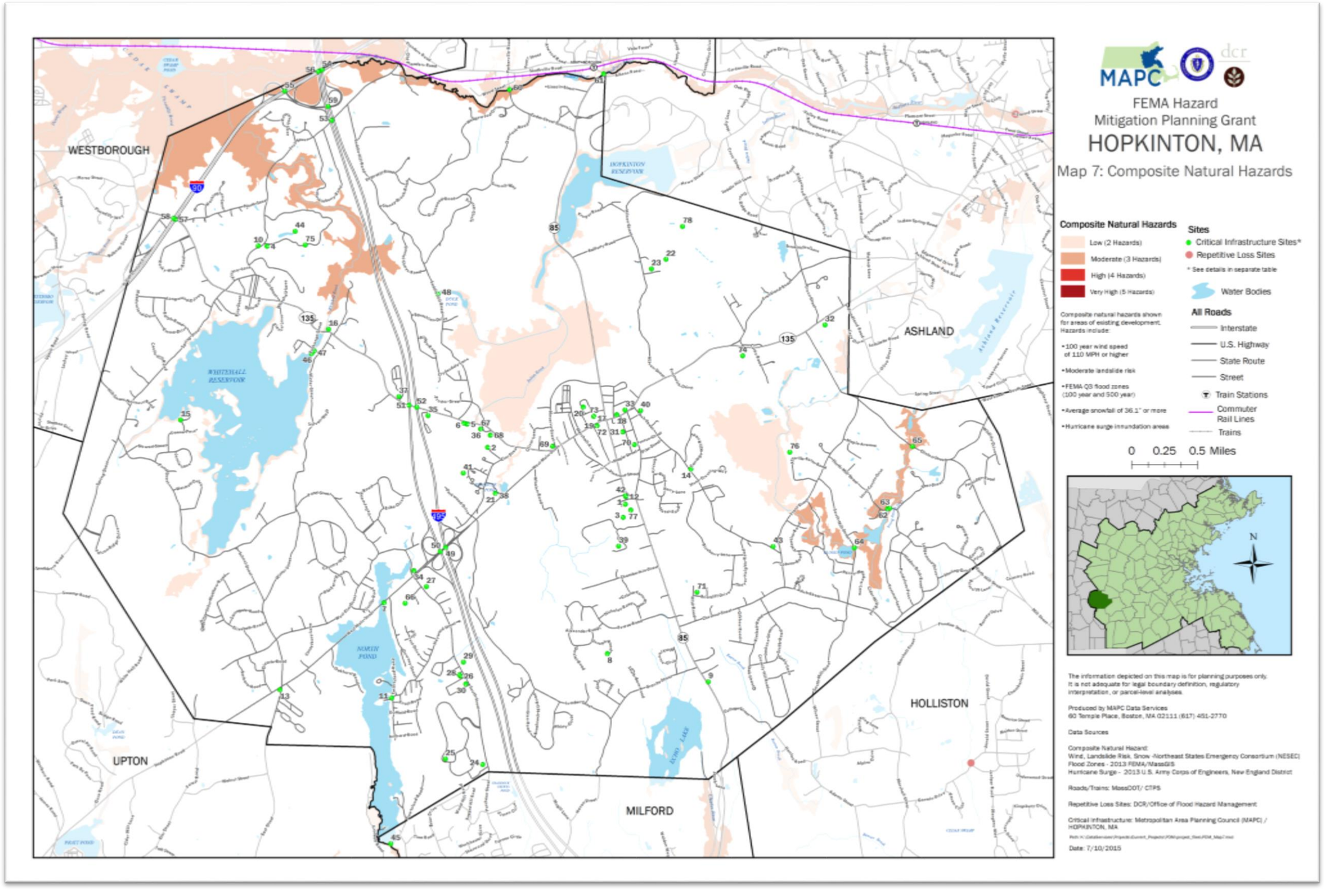
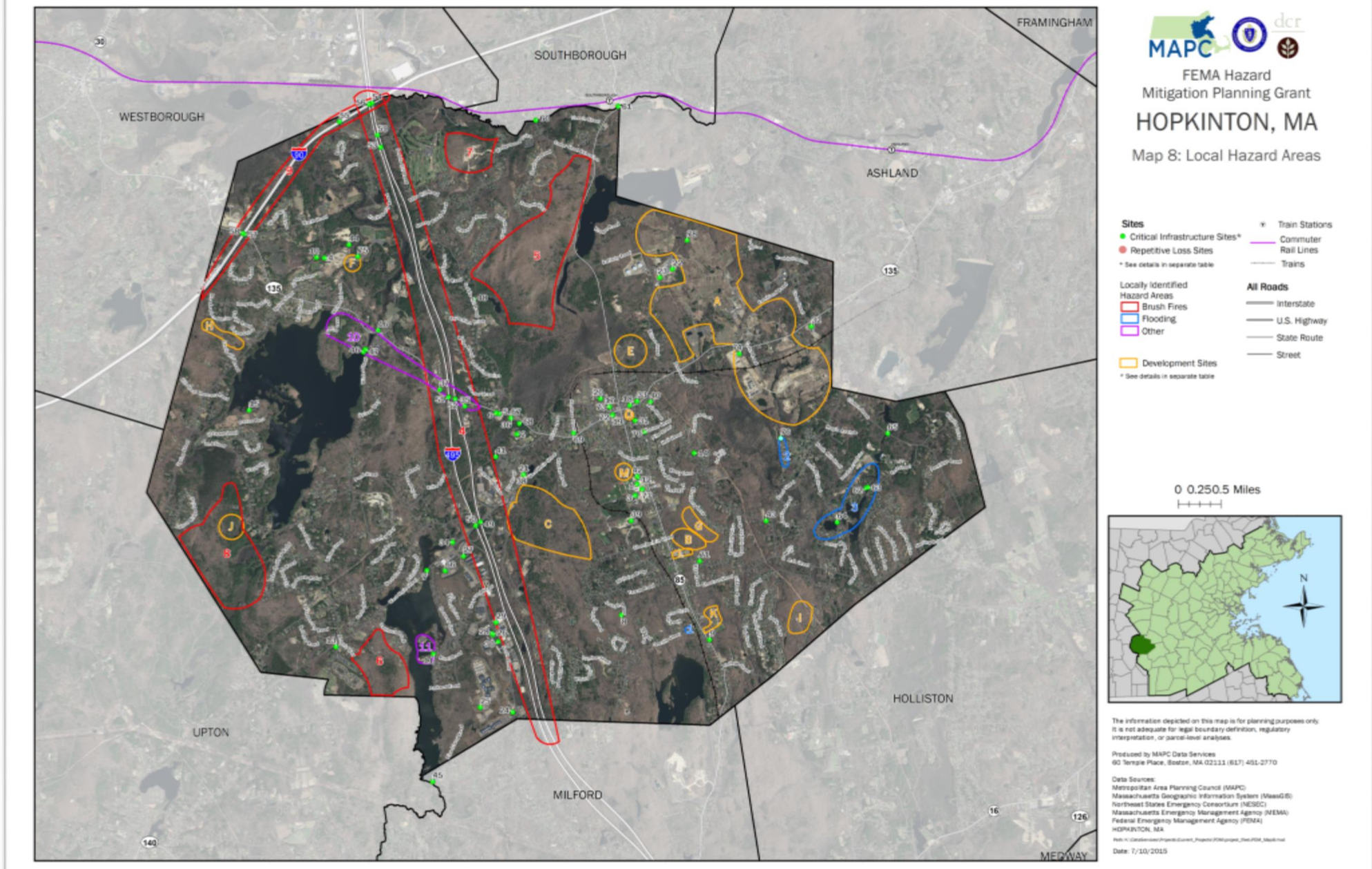
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HOPKINTON, MA
Date: 7/10/2015


WESTBOROUGH
ASHLAND
HOLLISTON
UPTON
MILFORD
HOPKINTON RESERVOIR
WHITEHALL RESERVOIR
NORTH POND
LONG POND
ASHLAND RESERVOIR
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HOPKINTON, MA
Map 6: Average Snowfall
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Average Annual Snowfall
36.1 to 48.0 inches
48.1 to 72.0 inches
Water Bodies
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HOPKINTON, MA
Date: 7/10/2015


WESTBOROUGH
ASHLAND
HOLLISTON
MILFORD
UPTON
HOPKINTON RESERVOIR
WHITEHALL RESERVOIR
NORTH POND
LAKE LOCKE
CEDAR SWAMP
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HOPKINTON, MA
Map 7: Composite Natural Hazards
Composite Natural Hazards
Low (2 Hazards)
Moderate (3 Hazards)
High (4 Hazards)
Very High (5 Hazards)
Composite natural hazards shown for areas of existing development. Hazards include:
•100 year wind speed of 110 MPH or higher
•Moderate landslide risk
•FEMA Q3 flood zones (100 year and 500 year)
•Average snowfall of 36.1" or more
•Hurricane surge inundation areas
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Train Stations
Commuter Rail Lines
Trains
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources
Composite Natural Hazard:
Wind, Landslide Risk, Snow -Northeast States Emergency Consortium (NESEC)
Flood Zones - 2013 FEMA/MassGIS
Hurricane Surge - 2013 U.S. Army Corps of Engineers, New England District
Roads/Trains: MassDOT/ CTPS
Repetitive Loss Sites: DCR/Office of Flood Hazard Management
Critical Infrastructure: Metropolitan Area Planning Council (MAPC) / HOPKINTON, MA
Date: 7/10/2015


FRAMINGHAM
SOUTHBOROUGH
WESTBOROUGH
ASHLAND
HOLLISTON
UPTON
MILFORD
MEDWAY
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HOPKINTON, MA
Map 8: Local Hazard Areas
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
Locally Identified Hazard Areas
Brush Fires
Flooding
Other
Development Sites
* See details in separate table
All Roads
Interstate
U.S. Highway
State Route
Street
0 0.250.5 Miles
N
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Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HOPKINTON, MA
Date: 7/10/2015

APPENDIX C
DOCUMENTATION OF PUBLIC PARTICIPATION

Town of Hopkinton
Natural Hazard Mitigation Plan Update Public Meeting
Hopkinton Town Hall, Room 215
December 16th, 2014, 5-6 PM

1. Welcome and Introductions
2. Overview of Natural Hazard Mitigation Plan and Update Process-Sam Cleaves, Senior Regional Planner, MAPC
3. Questions and Public Comment on Areas of Concern and Potential Strategies
4. Adjourn

Background: ***Project Overview*** - MAPC received a grant to prepare natural hazards *Pre-Disaster Mitigation Plan* for the communities of Burlington, Dover, Hanover, Holliston, Hopkinton, Marlborough and Wilmington. MAPC is working with the seven communities to update their plans to mitigate potential damages of natural hazards such as floods, winter storms, hurricanes, earthquakes and wild fires, before such hazards occur. The federal *Disaster Mitigation Act of 2000* requires that all municipalities adopt a *Pre-Disaster Mitigation Plan* for natural hazards in order to remain eligible for FEMA Disaster Mitigation Grants.
This FEMA planning program is separate from new or ongoing homeland security initiatives, and is focused solely on addressing natural hazards, although some of the data collected for this plan may be useful for other aspects of emergency planning as well.

Town of Hopkinton
Natural Hazard Mitigation Plan Update Public Meeting
Hopkinton Town Hall, Room 215
August 11, 2015, 5-6 PM

1. Welcome and Introductions
2. Review of Draft Plan and Recommendations-Sam Cleaves, Senior Regional Planner, MAPC
3. Questions and Public Comment
4. Adjourn

Background: ***Project Overview*** - MAPC received a grant to prepare natural hazards *Pre-Disaster Mitigation Plan* for the communities of Burlington, Dover, Hanover, Holliston, Hopkinton, Marlborough and Wilmington. MAPC is working with the seven communities to update their plans to mitigate potential damages of natural hazards such as floods, winter storms, hurricanes, earthquakes and wild fires, before such hazards occur. The federal *Disaster Mitigation Act of 2000* requires that all municipalities adopt a *Pre-Disaster Mitigation Plan* for natural hazards in order to remain eligible for FEMA Disaster Mitigation Grants.
This FEMA planning program is separate from new or ongoing homeland security initiatives, and is focused solely on addressing natural hazards, although some of the data collected for this plan may be useful for other aspects of emergency planning as well.

HAZARD MITIGATION PLAN PUBLIC MEETING

Natural hazards can have serious impacts on the Town of Hopkinton and its residents



The Hopkinton Hazard Mitigation Plan is being updated to help the town reducing its vulnerability to the impacts of natural hazard events such as flooding, hurricanes and winter storms.

Join the town's Emergency Management Team for a presentation and discussion about the 2015 update to the Hopkinton Hazard Mitigation Plan at a public meeting:

Date: Tuesday, August 11, 2015
Time: 5:00 PM
Location: Hopkinton Town Hall

For more information, please contact
Sam Cleaves at (617) 933-0748

scleaves@mapc.org

MAPC

Public Comment Notices Sent for Draft Plan Review

The Hazard Mitigation Plan Public Meeting Flyer was sent by the Hopkinton Town Administrator to the following, Communities, Boards and Organizations inviting them to attend the two public meetings concerning the draft Plan:

Planning Board

Board of Selectmen

Town media contacts including the Hopkinton Independent

Upper Charles River, Inc.

Town wide list serve including members of all town Boards, Commissions, volunteers and concerned citizens

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The following was emailed to Hopkinton's neighboring communities:

Subject: Draft Hopkinton Hazard Mitigation Plan

Greetings,
The Town of Hopkinton has been working on an update of the Hopkinton Hazard Mitigation Plan, a plan intended to reduce the Town's vulnerability to the impacts of natural hazard events such as flooding and hurricanes.
The plan identifies as set of hazard mitigation measures, which include structural improvements, regulatory changes for development in identified hazard areas, educational and outreach efforts related to natural hazards in the Town and other actions. The Federal Emergency Management Agency (FEMA) requires that the Town have a FEMA approved hazard mitigation plan updated on a five year basis in order to qualify for various hazard mitigation grants that can be used to pay for measures identified in the plan.
We wanted to share with you that the final draft of the plan is available on the Town's website for review. Comments and questions may be submitted in writing to Sam Cleaves, MAPC Senior Regional Planner at scleaves@mapc.org by August 24 in order to be considered for incorporation into the final draft of the plan that will be submitted to the Massachusetts Emergency Management Agency (MEMA) and FEMA.
Thank you,
Sam Cleaves, MAPC
Metropolitan Area Planning Council

The notice was sent to Town planners for the following neighboring communities:

Town of Southborough-Jennifer Burney

Town of Ashland-Nathaniel N. Strosberg

Town of Holliston- Karen Sherman

Town of Milford-Larry Dunkin, AICP

Town of Upton-Denise Smith

Town of Westborough-Jim Robbins

APPENDIX D
DOCUMENTATION OF PLAN ADOPTION

TOWN OF HOPKINTON
OFFICE OF THE SELECTMEN

TOWN OF HOPKINTON HAZARD MITIGATION PLAN
2015 UPDATE

CERTIFICATE OF ADOPTION
BOARD OF SELECTMEN

TOWN OF HOPKINTON, MASSACHUSETTS

A RESOLUTION ADOPTING THE TOWN OF HOPKINTON
HAZARD MITIGATION PLAN UPDATE

WHEREAS, the Town of Hopkinton established a Committee to prepare the Hazard Mitigation plan; and

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

WHEREAS, duly-noticed public meetings were held by the LOCAL HAZARD MITIGATION PLANNING COMMITTEE ON DECEMBER 16, 2014 AND AUGUST 11, 2015, and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Hopkinton BOARD OF SELECTMEN adopts the *Hopkinton Hazard Mitigation Plan Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Hopkinton.

ADOPTED AND SIGNED this Date. January 10, 2017

Name(s) Brian Herr

Title(s) Chairman, Board of Selectmen

Signature(s)

18 Main Street, Hopkinton, MA 01748 508-497-9700 | selectmen@hopkintonma.gov

APPENDIX E

LOCAL BYLAWS, ORDINANCES AND REGULATIONS

Regulations and By-Laws – The town has adopted many regulations and bylaws that serve to reduce flooding, preserve open space, and protect the community from natural hazards.

- *Town of Hopkinton, Board of Health Regulations*: Includes regulations sewerage disposal, private well and drinking water.

- Town of Hopkinton, Board of Water & Sewer Commissioners, Rules & Regulations for Sewer Main Extensions & Connections, Online

- *Earth Removal, Chapter 96, General By-Law*: This general bylaw provides comprehensive review procedure of plans for earth removal which may affect traffic, environmental quality, water resources, and drainage and community character with the objective that the public health, safety, convenience and general welfare is protected.

- *Easement Management, Chapter 99, General By-Law:* The purpose of this chapter is to provide a mechanism for the management and enforcement of certain obligations concerning easements which exist for a public purpose or benefit. Drainage easement regulations are included in this bylaw.

- *Flexible Community Development Bylaw, Article XI, Zoning By-Law*: The purpose of this Article is to increase the inventory of affordable housing in Hopkinton. It is intended that the affordable housing units that result from this Article be considered as Local Initiative Program (LIP) units, in compliance with the requirements for the same as specified by the Department of Housing and Community Development (DHCD) and that said units shall count toward the Town's requirements under G.L. c.40B sec. 20-23.

- *Floodplain District, Article X, Zoning By-Law:* The purposes of the Floodplain District are to protect public health, safety and general welfare; to protect human life and property from the hazards of periodic flooding; to preserve natural flood control characteristics and the flood storage capacity of the floodplain; and to preserve and maintain the groundwater table and water recharge areas within the floodplain.

- *NPDES Plan*: The town continues to implement its NPDES Phase II stormwater program which includes public education programs. The Highway Department provides education on stormwater.

- *Open Space Mixed Use Development Overlay District, Article XXVI, Zoning By-Law*: The purposes of the Open Space Mixed Use Development Overlay District (OSMUD District) are to balance conservation and development goals and to protect and enhance the character of the natural and cultural resources of the Town, while promoting planned development and appropriate use of land in accordance with

community goals and design guidelines. Toward that end, the OSMUD District is intended to permit the clustering of residential and commercial uses on large tracts of land that have open space as an integral characteristic, and to ensure quality site planning to accommodate a site's physical characteristics, including its topography, vegetation, water bodies, wetlands, open spaces, historic resources and major scenic views.

- *Open Space and Landscape Preservation Development, Article XVII, Zoning By-Law*: As an alternative to a conventional subdivision and in order to provide for the public interest by the preservation of open space and natural and historic landscape features in perpetuity and to promote variety in single-family residential housing patterns by encouraging development which is designed to accommodate a site's physical characteristics, such as topography, vegetation, water bodies, wetlands, open spaces, such as farmlands and meadows, historic resources major scenic views and wildlife habitats, the following regulations are established. It is not the intent of this article to make undevelopable land developable or to permit an increase in the number of building lots that would otherwise be possible on a conventional plan but rather to encourage the preservation of important site features.

- *Village Housing in Residential Districts, Article XIIIA, Zoning By-Law*: General intent and purposes. It is the intent and purpose of this Village Housing in Residential Districts Article to maintain a working balance in the Town of Hopkinton between the demand for new development and the provision of affordable housing and its rewards on the one hand, and the human need for our natural resources and their maintenance on the other.

- *Water Resources Protection Overlay District, Article XII, Zoning By-Law:* Promote the health, safety and general welfare of the community by ensuring an adequate quality and quantity of drinking water for the residents, institutions and businesses of the Town of Hopkinton and surrounding communities; preserve and protect existing and potential sources of drinking water supplies; conserve the natural resources of the Town; and prevent temporary and permanent contamination of the environment.

- *Wetlands Protection, Chapter 206, General By-Law*: The purpose of this chapter is to protect the wetlands, related water resources and adjoining land areas in the Town of Hopkinton by controlling activities deemed by the Conservation Commission likely to have a significant adverse effect, immediate or cumulative, upon wetland values, including but not limited to the following: protection of public or private water supply, protection of groundwater, flood control, erosion and sediment control, storm damage prevention, prevention of water pollution, fisheries, wildlife, wildlife habitat, rare species habitat, including rare plant species, and recreational values. These values are to be known collectively as the "wetlands values protected

Regulatory Updates Made Since 2008 that address the 2008 mitigation measure to *conduct revisions to development bylaws and regulations*

2008 Mitigation- Amend zoning bylaws to exclude wetlands from the density calculations.

Action- 2010: No more than 50% of common open space in Open Space and Landscape Preservation District developments may be wetlands.

2008 Mitigation: Expand the Water Resource Protection District to protect water flowing into surrounding communities.

Action-2011: Updated Water Resources Protection District to limit storage of hazardous materials in subsurface parking areas and added more specifically prohibited uses within the Town's Zone A wellhead districts.

2008 Mitigation- Continue to address the on-going issue of non-point source pollution to protect the drinking water supply.

Action-2009- Adopted stormwater management and erosion control bylaw.

Actions-2008 Created Open Space Mixed Use Overlay District which reduces impervious surfaces and nonpoint source pollution by clustering buildings and preserving open space.

2014: Created new Neighborhood Mixed Use District which encourages compact, downtown development and discourages the development of outlying undeveloped land thereby reducing overall impervious surfaces and runoff.

2008 Mitigation-Require aggressive and legally-binding operation and maintenance plans and reporting, with enforcement mechanisms, for private drainage facilities

Action-2014: All private drainage facilities are covered under either the Town's Stormwater Management Bylaw or Subdivision Control Regulations, which require the posting of a bond to ensure that drainage facilities can be maintained by the town even if the land owner fails to do so.

2008 Mitigation-Include construction and post-construction slope stabilization requirements in the site plan and subdivision regulations.

Action-2009: Stormwater management and erosion control bylaw adopted.

2008 Mitigation-Require the use of the new LID guidance manual for all developments in town, and not just those within the Aquifer Protection District.

Action- 2014: LID standards must be met for Neighborhood Mixed Use and Open Space Mixed Use Development Overlay Districts

2008 Mitigation- Expand the requirements of the state stormwater policy to not just locations within Conservation Commission jurisdiction, but to all developments in the town.

Action-2012: New Site Plan review standard requires that all developments must meet all applicable MA DEP Stormwater Management Regulations, also required for all subdivisions.