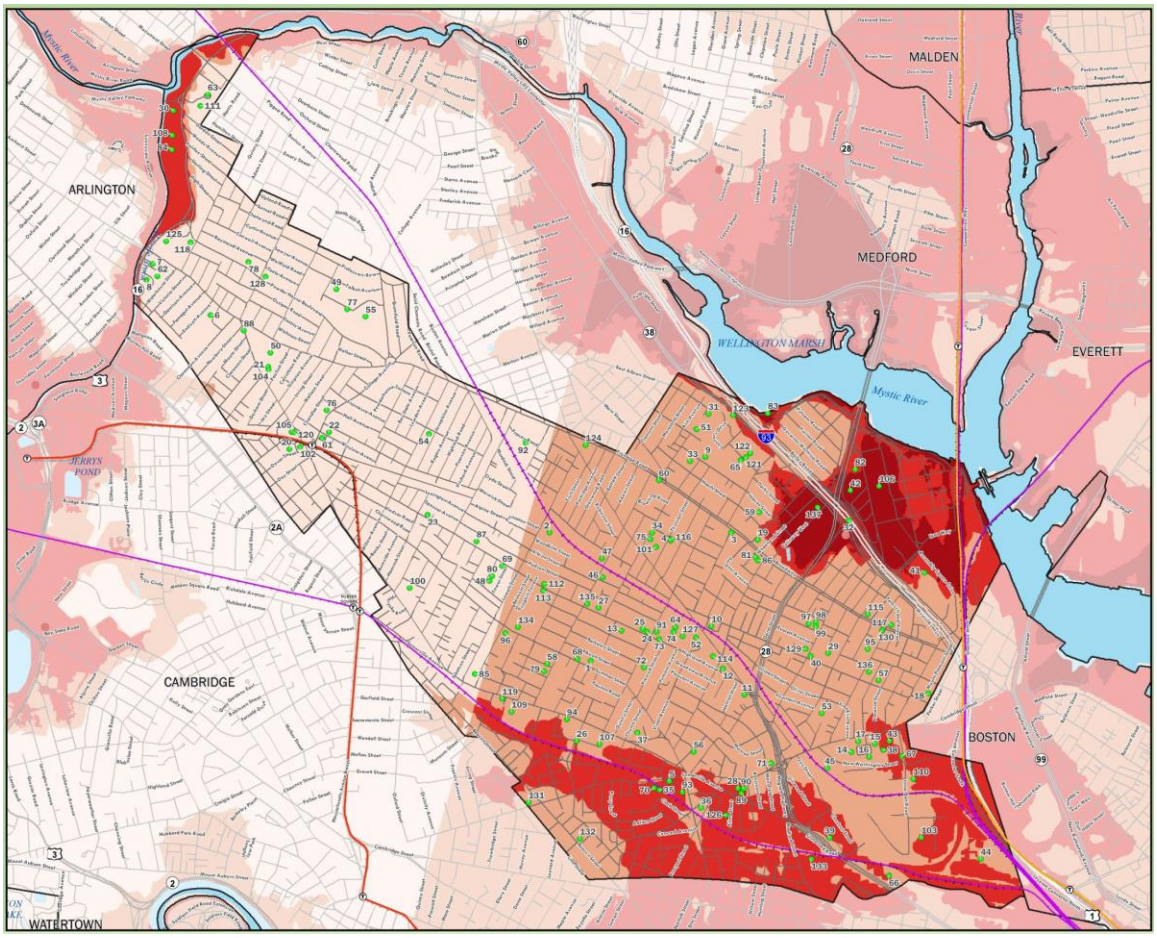
CITY OF SOMERVILLE

HAZARD MITIGATION PLAN 2016 UPDATE



MAPC
METROPOLITAN AREA PLANNING COUNCIL

Metropolitan Area Planning Council

Final Plan
FEMA Approval Pending Adoption
May 16, 2016

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ACKNOWLEDGEMENTS AND CREDITS

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

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 City takes to mitigate them. The City hosted two public meetings, on December 13, 2012 and December 4, 2013 and the plan was posted on the City's website for public review.

Risk Assessment

The Somerville Hazard Mitigation Plan assesses the potential impacts to the City from flooding, high winds, winter storms, brush fire, and geologic hazards. Flooding, driven by hurricanes, northeasters and other storms, clearly presents the greatest hazard to the City, with potential flooding location scattered throughout including transportation facilities such as rail and roadway infrastructure.

The Somerville Local Committee identified those areas where flooding most frequently occurs, comprising 6.37% of the City's land area, and approximately 989 buildings worth nearly an estimated $385,000,000.

Hazard Mitigation Goals

1. Prevent and reduce the loss of life, injury 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.
    - Ensure that the Planning Department considers hazard mitigation in its review and permitting of new development.
    - Review zoning regulations to ensure that the ordinance incorporates all reasonable hazard mitigation provisions.
    - Ensure that all relevant municipal departments have the resources to continue to enforce codes and regulations related to hazard mitigation.
4. Prevent and reduce the damage to public infrastructure resulting from all hazards.
    - Begin to assess the vulnerability of municipal buildings and infrastructure to damage from an earthquake.
    - Maintain existing mitigation infrastructure in good condition.
5. Encourage the business community, major institutions and non-profits to work with the City 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.
    - Participate in the Mystic Region LEPC.
7. Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.
8. Educate the public about natural hazards and mitigation measures that can be undertaken by property-owners.
    - Provide information on hazard mitigation activities in the languages most frequently spoken in Somerville.
9. Take maximum advantage of resources from FEMA and MEMA to educate City staff and the public about hazard mitigation.

Hazard Mitigation Strategy

The Somerville Local Committee identified a number of mitigation measures that would serve to reduce the City's vulnerability to natural hazard events. Largely these are related to maintaining the integrity of the drainage system by addressing maintenance and reconstruction issues at localized flooding locations as well as by making larger, strategic infrastructure investments. There is also a strong emphasis on boosting the general emergency planning capabilities of the City so that both hazard mitigation and emergency management can be handled efficiently and effectively.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Somerville will be an ongoing process as our understanding of natural hazards and the steps that can be taken to mitigate their damages changes over time. Global climate change and the accompanying changes to sea level and average temperatures impact the City's vulnerability, and local officials will need to work together across municipal lines and with

state and federal agencies in order to understand and address these changes. The Hazard Mitigation Strategy will be incorporated into other related plans and policies.

Plan Review and Update Process

Table 1 Plan Review and Update

Chapter	Reviews and Updates
III – Public Participation	The Somerville Local Committee 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 public meetings hosted by the Planning Board and the Public Health and Public Safety Committee of the Board of Aldermen. The plan was also posted on the City's website for public comment.
IV – Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with City staff to identify changes in local hazard areas and development trends. City 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 Local Hazard Mitigation Committee.
VI – Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the City.
VII & VIII – Hazard Mitigation Strategy	Mitigation measures from the 2008 plan were reviewed and assessed as to whether they were completed, on-going, or deferred. The Local Committee determined whether to carry forward measures into the 2016 plan update or delete them. This hazard mitigation strategy reflects both new measures and measures carried forward from the 2008 plan. The Committee re-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 City in incorporating hazard mitigation issues into other City planning and regulatory review processes and better prepare the City to update the plan in 2019.

As indicated on Table 22, Somerville has made progress on implementing mitigation measures identified in the 2008 Hazard Mitigation Plan, including the drainage

improvements along Somerville Avenue and installation of new pumps at the Medford Street Underpass.

While some of the measures identified in that plan were completed or significantly advanced, many more still require the identification of a source of funds to support equipment and additional manpower, or a dependent on more comprehensive projects, such as the drainage changes and improvements that will occur along with the proposed MBTA Green Line extension. Moving forward into the next five year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the City's decision making processes.

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.

Federal hazard mitigation planning and grant programs are administered by the Federal Emergency Management Agency (FEMA) in collaboration with the states. These programs are administered in Massachusetts by the Massachusetts Emergency Management Agency (MEMA) in partnership with the Department of Conservation and Recreation (DCR). 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 FEMA under the Pre-Disaster Mitigation (PDM) Program to assist the City of Somerville, and seven other municipalities in the Inner Core region, to update their local Hazard Mitigation Plans, which were first adopted in 2008 as part of a Metro-Boston Multi Hazard Mitigation Plan. These local Hazard Mitigation Plan updates are designed to 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 meet with their neighboring communities during plan development. A public, regional meeting of the Metro Boston Multiple Hazard Community Planning Team was held April 13, 2012 to re-introduce participating communities to the hazard mitigation planning process and to identify inter-community hazard mitigation issues.

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 City of Somerville 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 Federal Assistance Provided	Declared Areas in MA
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, Suffolk
	FEMA Individual Household Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	Statewide
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	Statewide
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

Table 2. Previous Federal/State Disaster Declarations

Disaster Name (Date of Event)	Type of Federal Assistance Provided	Declared Areas in MA
(1997)	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
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
	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	Statewide
January Blizzard (January 22-23, 2005)	FEMA Public Assistance Project Grants	Statewide
Hurricane Katrina (August 29, 2005)	FEMA Public Assistance Project Grants	Statewide
May Rainstorm/Flood (May 12-23, 2006)	Hazard Mitigation Grant Program	Statewide
April Nor'easter (April 15-27, 2007)	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
Tropical Storm Irene (August 27-28, 2011)	FEMA Public Assistance	Statewide

Table 2. Previous Federal/State Disaster Declarations

Disaster Name (Date of Event)	**Type of Federal Assistance Provided**	**Declared Areas in MA**
Hurricane Sandy (October 27-30, 2012)	FEMA Public Assistance	Statewide
Severe snowstorm and Flooding February 8-09, 2013	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide
Blizzard of 2015 January 26-28, 2015	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide

(Source: database provided by MEMA)

FEMA Funded Mitigation Projects

Over the last 20 years the City of Somerville has received funding from FEMA for one mitigation projects under the Hazard Mitigation Grant Program (HMGP). These projects totaled $40, 000 with $28,445 covered by FEMA grants and $10,000 by local funding. The project is summarized in Table 3 below.

Table 3. FEMA-Funded Mitigation Projects

Project Title (Funding Source)	Scope of Work	Total Cost	Federal Funding	Local Funding
EM Building Retrofitting	Install backwater valve in sewer main that services Somerville's Public Safety Building; install emergency pumping system.	$40,000.00	$28,445.67	$10,000.00

(Source: database provided by MEMA)

Community Profile

Located in the Boston Basin coastal plain, the City of Somerville is bounded to the north by the Mystic River and the City of Medford and the City of Everett; to the west by the Alewife Brook and the Town Arlington; and to the east and south by the cities of Boston and Cambridge.

The City has a strong independent and entrepreneurial identity. From the City's beginnings, it has been a gateway for immigrants, a haven for creative thinkers, and a place where families of all means can establish their homes. Somerville's residents turn the notion of the anonymous urban environment on its head, building and expanding connections between neighbors, business owners and civic leaders that are the envy of communities everywhere.

The City is served by several major transportation corridors including Route 16, Route 28 and Interstate 93, as well as by the MBTA Red Line. Future MBTA Green Line service is planned to serve Somerville with six new stations proposed along the Fitchburg/South Acton commuter rail corridor.

The City has an estimated population of 75,754 in a land area if approximately 4.1 square miles. The population density, based on the population estimate, is approximately 18,500 people per square mile. In 2010 there were an estimated 33,720 housing units.

Table 4. Somerville Characteristics, 2010

Population = 75,754

- 10% are under the age 15
- 9% are over age 65
- 10 % speak English less than "very well" (over age 5)
- 3 % live in group quarters
- 24 % of households have no vehicle

Number of Housing Units = 33,720

- ~ 70% are renter-occupied housing units
- 60% of housing units were built prior to 1940

Source: U.S. Census, 2010, American Community Survey 2006-2010

The City maintains a website at http://www.ci.somerville.ma.us.

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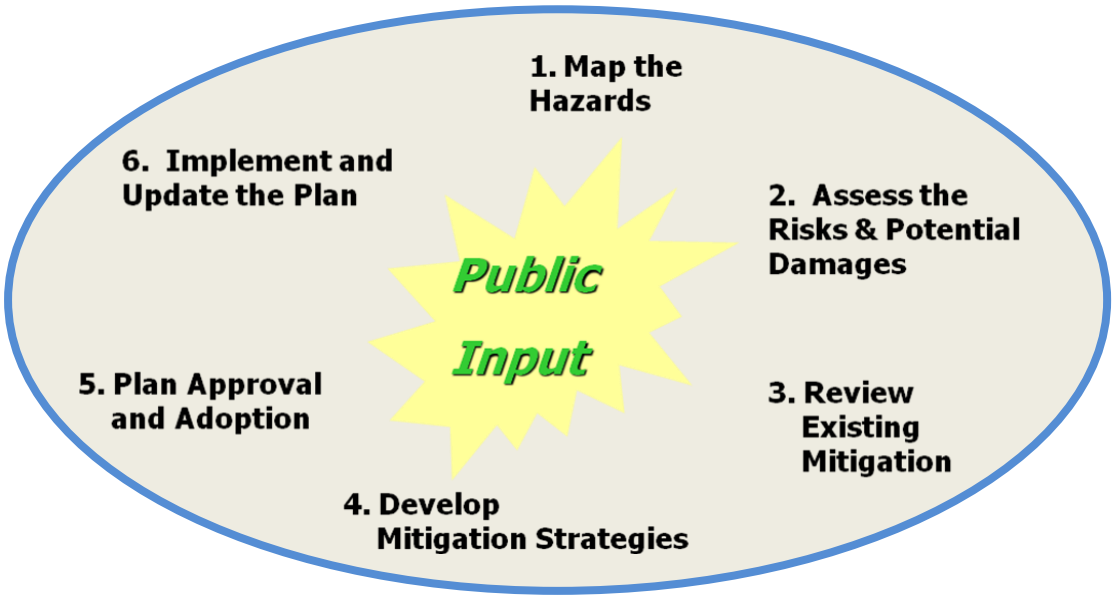
III. PLANNING PROCESS AND PUBLIC PARTICIPATION

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 Regional and Local Hazard Mitigation Planning Committees, two public meetings hosted by the City, posting of the plan to the City's website, and invitations sent to neighboring cities and towns, City 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 and 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 Somerville 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 and 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 and 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.

2008 Plan Implementation and Maintenance

The 2008 Somerville Annex to the Metro Boston Regional Multi-Hazard Mitigation Plan contained a risk assessment of identified hazards for the City and mitigation measures to address the risk and vulnerability from these hazards. Since approval of the plan by FEMA and local adoption, progress has been made on implementation of the measures. The City has advanced a number of projects for implementation, including drainage improvements planned for Somerville Avenue and new pumps at the Medford Street Underpass as well as having joined the Mystic Valley Regional Emergency Planning Committee.

The City has advanced these projects in a fiscal environment that is often constrained and where municipal staff is often conducting work in multiple roles. As such, much of the coordination around projects that either directly or indirectly address mitigation measures has occurred through small groups rather than through a regular convening of a local mitigation team. In addition, the City was prepared to engage in the plan update process from the Regional Committee meeting through to the local team and public meetings.

Somerville's Participation in the Regional Committee

On February 28, 2010 a letter was sent notifying the communities of the first meeting of the Metro Boston Hazard Mitigation Planning Committee 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 Somerville on the regional committee:

Patrick Sullivan III	Somerville Fire Department
Tom Graney	Homeland Security
Robert King	City Engineer

The regional committee serves as an opportunity for neighboring communities to discuss hazard mitigation issues of shared concern. The Metro Boston Regional Committee met on April 13, 2010 and was attended by representatives from the neighboring municipalities of Brookline, Cambridge, Chelsea, Everett, Malden, Medford, Melrose, and Somerville. At that meeting, the communities began the process of reviewing and revising their 2008 Natural Hazard Mitigation Plans and were re-introduced to the following items:

- The Massachusetts State Hazard Mitigation Plan and the FEMA hazard mitigation planning and grant process;
- The concept of each community engaging staff and the public to update its current Natural Hazard Mitigation Plan;
- FEMA plan overview and requirements and plan eligibility;

- Review of the overall scope of work and plan revision schedule
- Discussion of local issues, inter-community and Metro Boston Region hazard mitigation issues and how to address them.
- Re-introduction to identifying and mapping municipal Critical Facilities, municipal Areas of Concern, Inter-Community Areas of Concern, and Regional Shared areas of Concern.
- Municipal representatives were also briefed on the importance of trying to create a diversified presence on the local Multiple Hazard Community Planning Team in advance of local team meetings, being asked to contact major employers, business owners, schools and non-profit organizations to participate in the process.

In addition, as the same group of MAPC staff is working on each community's plan, these issues of shared concern, and other issues that may arise between neighboring communities, are discussed in greater detail in local committee meetings and resulting actions are reflected in the identified mitigation measures, as noted in Chapter VI.

The Local Hazard Mitigation Planning Team

The Local Hazard Mitigation Planning Team is central to the planning process as it is the primary body tasked with developing a mitigation strategy for the community. Given this role, it is important that this committee include a diverse representation of community stakeholders and knowledgeable municipal staff.

Given the City of Somerville's large number of stakeholders and staff whose participation in this process was desirable, it was decided that a project steering committee would be given oversight of the planning process and tasked with setting plan goals while smaller working groups would provide information on the impacts of hazards on the City, existing mitigation measures, and help to develop new mitigation measures. The steering committee membership can be found in the table below. The steering committee met on November 1, 2012 and April 2, 2013.

Table 5. Somerville Hazard Mitigation Plan Steering Committee

Name	Representing
Patrick Sullivan III	Somerville Fire Department
Kevin Kelleher	Somerville Fire Department
Tom Graney	Homeland Security
Robert King	City Engineer
Adam Duchesneau	Office of Strategic Planning & Community Development (formerly of)
Rachel Kelly	Office of Strategic Planning & Community Development
Richard Willette	Department of Public Works

Table 5. Somerville Hazard Mitigation Plan Steering Committee

Steve MacEachern	Department of Public Works
Paul Upton	Police Department
Paulette Renault-Caragianes	Health Department
Maureen Monagle	Health Department

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 City hosted two public meetings, one during the planning process and one after a complete draft plan was available for review.

Natural hazard mitigation plans unfortunately rarely attract much public involvement in the Boston region, unless there has been a recent hazard event. One of the best strategies for overcoming this challenge is to include discussion of the hazard mitigation plan on the agenda of an existing board or commission. With this strategy, the meeting receives widespread advertising and a guaranteed audience of the board or commission members plus those who attend the meeting. These board and commission members represent an engaged audience that is informed and up to date on many of the issues that relate to hazard mitigation planning in the locality and will likely be involved in plan implementation, making them an important audience with which to build support for hazard mitigation measures. In addition, these meetings frequently receive press coverage expanding the audience that has the opportunity to hear the presentation and provide comment by phoning or emailing local staff.

The public had an opportunity to provide input to the Somerville hazard mitigation planning process during a meeting of the Planning Board, on December 12, 2012 held in the Community Meeting Room of the Visiting Nurse Association Building (259 Lowell St). The final draft of the plan was presented at a meeting of the Public Health and Public Safety Committee of the Board of Aldermen held on December 4, 2013. This meeting was held in Somerville City Hall.

The first meeting was publicized as a regular meeting of the Somerville Planning Board. The presentation of the final draft was publicized as a regular meeting of the Public Health and Public Safety Committee. The attendance list for each meeting can be found in

Table 6. Attendance at Public Meetings

First Public Meeting - December 12, 2012	
Name	*Organization or Neighborhood*
Michael Capuano	Somerville Planning Board
Joseph Favaloro	Somerville Planning Board
James Kirylo	Somerville Planning Board
Elizabeth Moroney	Somerville Planning Board
Lori Massa	Office of Strategic Planning & Community Development
Patrick Sullivan III	Somerville Fire Department
Tom Graney	Homeland Security
Second Public Meeting - December 4, 2013	
Name	*Organization or Neighborhood*
John Connolly	Alderman
William White	Alderman
Hayes Morrison	Director of Transportation and Infrastructure
Patrick Sullivan III	Somerville Fire Department
Thomas Pasquarello	Somerville Police Department

In addition, at the second public meeting, there were another 10-12 members of the public present.

Other Opportunities for Public Involvement

Review by Neighboring Communities

Notice was sent to the following neighboring municipalities inviting them to review the Somerville Hazard Mitigation Plan and submit their comments to the City. Many of these organizations were also invited to participate in the collaborative working group meetings.

City of Somerville Boards and Commissions
City of Boston
City of Cambridge
City of Medford
City of Everett
City of Arlington

No public comments on the plan were received by the City.

Website

Draft copies of the Somerville Hazard Mitigation Plan update were posted on the City's website (somervillema.gov). Members of the public could access the draft document and submit comments or questions.

Incorporation of Other Existing Plans and Studies

The Plan incorporates information from a number of other previously produced plans, and studies as well as applicable regulatory documents. These include:

- SomerVision – City of Somerville Comprehensive Plan
- City of Somerville Zoning Ordinance
- City of Somerville Open Space and Recreation Plan Update, 2008-2013

A full listing of the documents incorporated in the development of this plan is included in Section VIII – List of References.

Planning Timeline Summary

April 13, 2010	Meeting of the Metro Boston Regional Mitigation Committee
November1, 2012	Meeting of the Somerville Local Hazard Mitigation Steering Committee
April 2, 2013	Meeting of the Somerville Local Hazard Mitigation Steering Committee
December 12, 2012	First Public Meeting Somerville Planning Board
December 4, 2013	Second Public Meeting with the Public Health and Public Safety Committee of the Board of Aldermen
January 16, 2014	Draft Plan submitted to MEMA
March 24, 2015	Revised Draft Plan Submitted to MEMA
March 17, 2016	Revised Draft Plan Submitted to MEMA
May 16, 2016	Approval Pending Adoption issued by FEMA

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IV. RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the City of Somerville 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 Somerville's risk assessment, MAPC gathered the most recently available hazard and land use data and met with City 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 Massachusetts Hazard Mitigation Plan 2013 (state plan) provides an in-depth overview of natural hazards in Massachusetts. The state plan indicates that Massachusetts is subject to the following natural hazards (listed in order of frequency): flooding, nor'easters, winter storms, thunder storms, coastal erosion, hurricanes, ice storms, wildfires, tornadoes, extreme temperatures, landslides, drought, earthquakes, and dam failures. Previous state and federal disaster declarations since 1991 are summarized in Table 2.

Table 7 summarizes the hazard risks for Somerville. 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 in Somerville using the definitions for hazard frequency and severity listed below Table 7.

Table 7. Hazard Risks Summary

Hazard	**Frequency**		**Severity**	
	Massachusetts	**Somerville**	**Massachusetts**	**Somerville**
Flooding	High	High	Serious	Serious
Dam failures	Very Low	Medium	Serious	Serious
Winter storms	High	High	Minor	Minor
Winter - Ice storms	Medium	Medium	Minor	Minor
Hurricanes	Medium	Medium	Serious	Serious
Nor'easters	High	High	Serious	Serious
Thunder Storms	High	High	Minor	Minor

Table 7. Hazard Risks Summary

Hazard	Frequency		Severity	
Tornadoes	Medium	Very Low	Serious	Serious
Brush fires	Medium	Medium	Minor	Minor
Earthquakes	Very Low	Very Low	Extensive	Serious
Landslides	Low	Very Low	Minor	Minor
Extreme Temperatures	Medium	Medium	Minor	Minor
Drought	Low	Low	Minor	Minor

Coastal hazards are not included since Somerville is not a coastal community and these are not a risk for the City.

Definitions used in the Commonwealth of Massachusetts State Hazard Mitigation Plan

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 serious natural hazard identified by local officials in Somerville. Flooding is generally the rising or overflowing of water onto normally dry land and can be caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms among other causes. Global climate change has the potential to increase the frequency and severity of rainstorms and snowstorms, which would be a continuation of trend observed over the past several decades.

Regionally Significant Floods

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

- March 1968
- The blizzard of 1978
- January 1979
- April 1987
- October 1991 ("The Perfect Storm")
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010

Previous Occurrences and Extent of Flooding

The best available data on the previous occurrences of flooding are from the National Climatic Data Center, which are provided by county. Somerville is part of Middlesex County, for which historic flood events from 2005 through December 9, 2014 were compiled and are summarized in Table 8.

Table 8: Middlesex County Flood Events 2005 – 2014

Date	Type	Deaths	Injuries	Property Damage
10/15/2005	Flood	0	0	125.00K
5/13/2006	Flood	0	0	5.000M
5/13/2006	Flood	0	0	0.00K
7/11/2006	Flood	0	0	2.00K
10/28/2006	Flood	0	0	5.00K
4/16/2007	Flood	0	0	25.00K
2/13/2008	Flood	0	0	0.00K
5/27/2008	Flood	0	0	3.00K

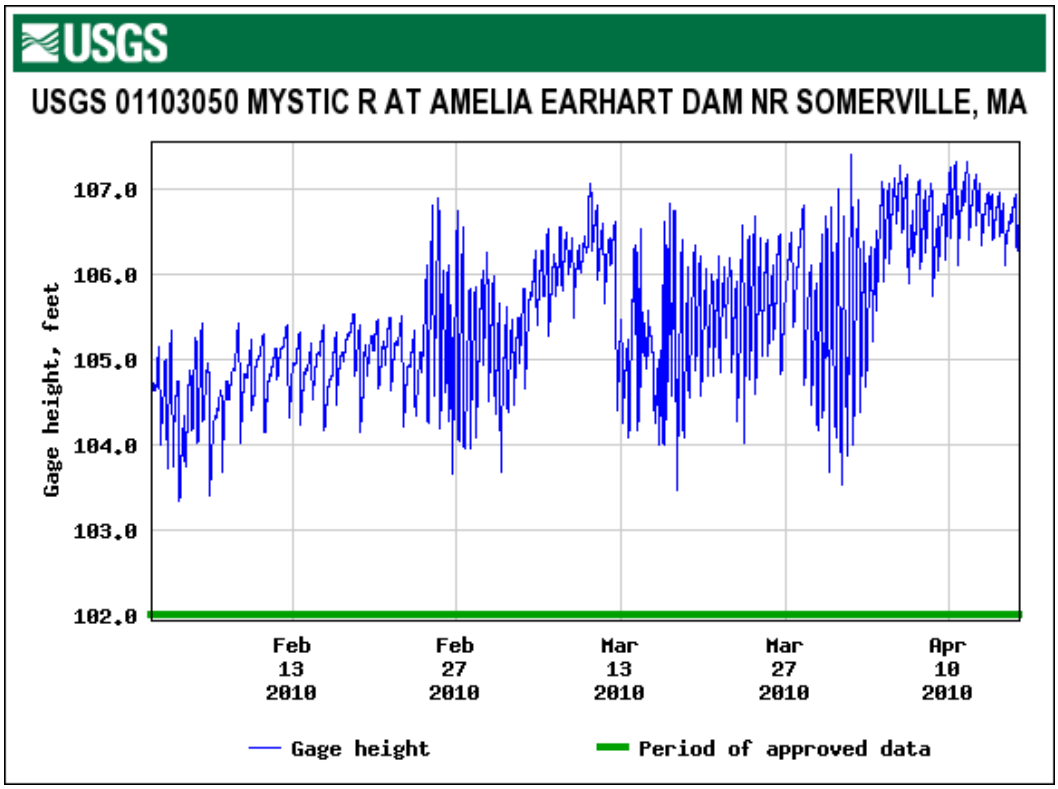
6/24/2008	Flood	0	0	10.00K
6/29/2008	Flood	0	0	5.00K
8/10/2008	Flood	0	0	15.00K
8/10/2008	Flood	0	0	40.00K
9/6/2008	Flood	0	0	15.00K
12/12/2008	Flood	0	0	20.00K
3/14/2010	Flood	0	0	26.430M
3/29/2010	Flood	0	0	8.810M
4/1/2010	Flood	0	0	0.00K
8/28/2011	Flood	0	0	5.00K
10/14/2011	Flood	0	0	0.00K
6/8/2012	Flood	0	0	0.00K
6/23/2012	Flood	0	0	0.00K
6/23/2012	Flood	0	0	0.00K
6/23/2012	Flood	0	0	0.00K
6/23/2012	Flood	0	0	0.00K
6/23/2012	Flood	0	0	15.00K
7/18/2012	Flood	0	0	5.00K
10/29/2012	Flood	0	0	0.00K
6/7/2013	Flood	0	0	0.00K
7/1/2013	Flood	0	0	0.00K
7/1/2013	Flood	0	0	0.00K
7/23/2013	Flood	0	0	0.00K
9/1/2013	Flood	0	0	10.00K
3/30/2014	Flood	0	0	35.00K
3/30/2014	Flood	0	0	0.00K
12/9/2014	Flood	0	0	30.00K
TOTAL		**0**	**0**	**40,540,000**

(Source: NOAA NCDC

The most severe recent flooding occurred during the major storm of March 2010, a total of 14.83 inches of rainfall accumulation was officially recorded by the National Weather Service (NWS). The weather pattern that caused these floods consisted of early springtime prevailing westerly winds that moved three successive storms, combined with tropical moisture from the Gulf of Mexico, across New England. Torrential rainfall lasting ten days caused March 2010 to be the wettest month on record. One indication of the extent of flooding is the level of flow in the Mystic River during this record flood. Based on USGS gage height data,

Figure 1 below shows that Mystic River at the Amelia Earhart Dam exceeded 107 feet after the first storm on March 10, and again after the second storm on March 31. The cumulative impact of multiple storms kept river levels high into April.

Figure 1. Mystic RIver Gage Height, March 2010 Floods



Flooding Location, Impacts and Vulnerabilities

The City of Somerville is subject to inland flooding in the forms of riverine flooding and urban flooding. Riverine flooding occurs when the rate of precipitation and/or amount of stormwater runoff overwhelms the capacity of natural or structured drainage systems causing overflows; urban flooding occurs when precipitation causes the water table to rise and leads to flooding of low-lying areas such as streets and underpasses. These types of flooding are often combined as storm events lead to large amounts of draining stormwater, which can be blocked by elements of the built environment and can be backed up when drainage locations (ponds, streams, etc.) are at or above capacity.

The city is divided into two major watersheds, the Charles River and the Mystic River. In addition, a number of smaller brooks and waterways have flooded in the past, most notable of these being Alewife Brook. Stream piping and development have severely altered the natural flow of water in Somerville. Stormwater drainage from developed areas occurs primarily through the manmade system of storm drains.

Somerville has limited exposure to tidal flooding due to the Amelia Earhart Dam which limits tidal changes on the upper portion of the Mystic River.

Overview of Drainage System

The majority of Somerville's flooding problems are associated with the City's drainage system and the filling or channeling of natural water resource areas.

There are a variety of issues that affect the drainage system in the City. In some cases, the system is served by older infrastructure that has been impacted by additional or increased development and does not have the necessary capacity to accommodate the resulting runoff. There are instances where waterways serve as part of the drainage system, such as along Alewife Brook, but these can become restricted or blocked due to siltation or branches that have fallen into the open channel. Lastly, debris from roadways or from residents dumping (e.g., lawn clippings, raked leaves and other yard waste) have blocked pipes and culverts which has resulted in flooding of homes and public ways.

Information on flood hazard areas was taken from two sources. The first was the National Flood Insurance Rate Maps. The FIRM flood zones are shown on Map 3 in Appendix B and defined below.

Flood Insurance Rate Map Zone Definitions

Zones A1-30 and AE: Special Flood Hazard Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations are shown within these zones.

Zone A (Also known as Unnumbered A Zones): Special Flood Hazard Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations or depths are shown.

Zone AO: Special Flood Hazard Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone.

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

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

The second source of flooding information was discussions with local officials. The Locally Identified Areas of Flooding below were identified by City staff as areas where flooding is known to occur or could occur if certain infrastructure failed. 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, "Locally Identified Hazard Areas".

1. Brickbottom – Located in the southeastern section of the city, the area is primarily impervious surfaces and during large rain events, the drainage system can back up leading to ponding and flooding.
2. Lincoln Park – Open field behind school facility with some low lying areas that can flood during large rain events.
3. Public Safety Building – Building and parking lot area that can be flooded during large rain events.
4. Cedar Street and Hall Street – Low lying elevation along street corridor that can be flooded due to heavy rain and drainage issues.
5. Somerville Community Path – Low point along the Somerville Community Path where there is limited drainage and ponding has been known to occur.
6. Tannery Brook – Area of residential structures where there has been known flooding.
7. Simpson Avenue – Cady Avenue – Broadway - Low lying elevation along street corridor that can be flooded due to heavy rain and drainage issues.
8. Beacon Street – Corridor where there has been historical flooding due to drainage issues.
9. Medford Street Underpass – Low point along roadway that passes under the Fitchburg/South Acton commuter rail where flooding has occurred during large rain events.
10. Washington Street Underpass - Low point along roadway that passes under the Fitchburg/South Acton commuter rail where flooding has occurred during large rain events.
11. Route 28 Underpass - Low point along roadway that passes under the Route 38 where flooding has occurred during large rain events.
12. Commuter Railroad – Low elevation areas along the Fitchburg/South Acton commuter rail where flooding has known to occur.

As shown in Table 8, damages from the March 2010 floods in Middlesex County totaled $35.2 million, while total damages for all floods since 2005 totaled $40.5 million. There were no deaths or injuries reported and the flooding events associated with property damage totaled $25.7 million dollars. The vulnerability analysis conducted by MAPC estimates a range of damages from flooding of $38.5 to $192.4 million (see Table 20).

Repetitive Loss Structures

There is one current repetitive loss structures in Somerville, which is the same number of structures identified in the 2008 plan. The repetitive loss property is a multi-family home. 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.

When flooding does occur in the city, the levels of flooding will vary depending on the topography of the location. Typically, the flooding results in several inches to a couple of feet of standing water. In certain locations, such as underpasses on Medford Street, Washington Street, and Route 28, flooding can exceed several feet of water due to the low elevation beneath underpasses. This has the potential to impact on transportation corridors in the city, including regional facilities like commuter rail.

Based on the record of previous occurrences, floods in Somerville 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).

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 in general is infrequent but has the potential for severe impacts; that said, Somerville has not experienced of dam failure or the impacts from a dam failure.

A review with City staff and information available from the Division of Conservation and Recreation (DCR) was used to identify dams in Somerville. DCR assesses the dams are using the three hazard classifications below:

- High Hazard: Dams located where failure or mis-operation will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).

- Significant Hazard: 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 Hazard: Dams located where failure or mis-operation may cause minimal property damage to others. Loss of life is not expected.

The City of Somerville does not own or operate any dams. There is one dam located in Somerville, the Amelia Earhart Dam, which is owned and operated by the Department of Conservation and Recreation (DCR). This dam is located on the eastside of the City on the Mystic River between Somerville and the City of Everett. The dam is listed as a low hazard, but is estimated to need $5 million dollars in repairs, such as repairs to the current third pump and the possible installation of a fourth pump. The dam separates the tidal and the non-tidal parts of the Mystic River, and is currently able to pump 4,000 cubic feet per second of flow from the Mystic and Malden Rivers against high tide into Boston Harbor. The pump improvements would increase the rate that flood water can travel out of the cities and towns along the Mystic River.

A second DCR dam, the Charles River Dam is not located in Somerville, but is located along the Charles River and associated basin, which is in close proximity to the southern and eastern most sections of the City (adjacent to the Cities of Cambridge and Boston). The Charles River Dam is classified as an urban flood control structure and has been identified as a Significant Hazard according to the DCR Hazard Potential Classification. Due to its location outside of and downstream from Somerville, this dam does not pose a hazard to the city.

Although there has never been a dam failure in Somerville, if one did occur at the Amelia Earhart Dam, the only area that might be impacted is a limited segment of the city's Mystic River waterfront below the dam. This does not include any populated residential areas (see map 1), and comprises vacant and industrial properties.

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).

Wind Related Hazards

Wind-related hazards include hurricanes and tornadoes as well as high winds during severe rainstorms and thunderstorms. The typical wind speed in the Somerville area ranges from around 11 miles per hour to 14 over the course of the year, but independent of storm events, gusts of up to 40 mph can occur. As with many cities and towns, falling trees that result in downed power lines and power outages are an issue in Somerville. 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. Hurricanes generally occur between June and November.

Between 1858 and 2013, Massachusetts has experienced approximately 35 tropical storms, eleven 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 recorded storm track through Somerville, a Category 1 Hurricane in 1944. The storm passed roughly through the central part of the City, traveling from Cambridge and through to Somerville. The City experiences the impacts of the wind and rain of hurricanes and tropical storms regardless of whether the storm track passed through the City. The hazard mapping indicates that the 100 year wind speed is 110 miles per hour (see Map 5 in Appendix B).

Hurricanes typically have regional impacts beyond their immediate tracks, and numerous hurricanes have affected the communities of eastern Massachusetts (Table 9). A hurricane or tropical storm track is the line that delineates the path of the eye of the hurricane or storm. 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.

Table 9. 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:

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

Source: National Oceanic and Atmospheric Administration (NOAA)

Somerville is vulnerable to both the wind and rainfall that come with hurricanes. High winds can damage structures, bring down tree limbs and power lines, leading to blackouts and disruption of the transportation system. Rainfall associated with hurricanes can cause flooding In the city's rivers and streams, as well as localized urban drainage flooding. The vulnerability analysis conducted using HAZUS-MH estimates $64.8 million in damages for a Category 2 Hurricane in Somerville, and $385.2 million for a Category 4 Hurricane. Other damages are also detailed in the analysis (see Table 18)

Based on the record of previous occurrences, hurricanes in Somerville 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.

Tornados

A tornado is a violent windstorm characterized by a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground.. 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.

Some ingredients for tornado formation include:

- Very strong winds in the mid and upper levels of the atmosphere
- Clockwise turning of the wind with height (from southeast at the surface to west aloft)
- Increasing wind speed with altitude in the lowest 10,000 feet of the atmosphere (i.e., 20 mph at the surface and 50 mph at 7,000 feet.)

- Very warm, moist air near the ground with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity

Tornados can form from individual cells within severe thunderstorm squall lines. They can form from an isolated 'supercell' thunderstorm. They can be spawned by tropical cyclones or even their remnants that are passing through. Tornadoes are most common in the summer, June through August, and most form in the afternoon or evening.

Tornados

Typically, there are 1 to 3 tornados in southern New England per year. The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC). The most recent tornado events in Massachusetts occurred in Springfield in June 2011 and in Revere in July 2014. The Springfield tornado caused significant damage and resulted in 4 deaths. 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 tornados within the limits of the City of Somerville, since 1955 there have been 17 tornadoes in surrounding Middlesex County recorded by the Tornado History Project. Two of these were and F3 tornadoes, four were F2, and the rest were F1. These 17 tornadoes resulted in a total of one fatality and six injuries. as summarized in Table 10.

Table 10. Tornado Records for Middlesex County

Date	Fujita	Fatalities	Injuries	Width	Length	Damage
10/24/1955	1	0	0	10	0.1	$500-$5000
6/19/1957	1	0	0	17	1	$5K-$50K
6/19/1957	1	0	0	100	0.5	$50-$500
7/11/1958	2	0	0	17	1.5	$50K-$500K
8/25/1958	2	0	0	50	1	$500-$5000
7/3/1961	0	0	0	10	0.5	$5K-$50K
7/18/1963	1	0	0	50	1	$5K-$50K
8/28/1965	2	0	0	10	2	$50K-$500K
7/11/1970	1	0	0	50	0.1	$5K-$50K
10/3/1970	3	1	0	60	35.4	$50K-$500K
7/1/1971	1	0	1	10	25.2	$5K-$50K

11/7/1971	1	0	0	10	0.1	$50-$500
7/21/1972	2	0	4	37	7.6	$500K-$5M
9/29/1974	3	0	1	33	0.1	$50K-$500K
7/18/1983	0	0	0	20	0.4	$50-$500
9/27/1985	1	0	0	40	0.1	$50-$500
8/7/1986	1	0	0	73	4	$50K-$500K

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 01, 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale), 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, 2010

Given their unpredictable track, tornadoes are a potential city-wide hazard in Somerville, although the impact of any one event is typically limited to a particular area, as was the case with the recent tornado in Revere. There have been no recorded tornadoes in Somerville, so there is no historical data with which to document damages. However, most structures pre-date current building codes and could be subject to damages. Evacuation 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.

Based on the record of previous occurrences since 1950, Tornado events in Somerville 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

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

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

Previous occurrences of Nor'easters include the following which are listed in the Massachusetts State Hazard Mitigation Plan 2013:

February 1978	Blizzard of 1978
October 1991	Severe Coastal Storm ("Perfect Storm")
December 1992	Great Nor'easter of 1992
January 2005	Blizzard/ oreaster
October 2005	Coastal Storm/Nr'easter
April 2007	Severe Storms, Inland & Coastal Flooding/Nor'easter
January 2011	Winter Storm/Nor'easter
October 2011	Severe Storm/NoNor'easter
February 2013	Blizzard of 2013
January 2015	Blizzard of 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, October 2011 and February 2013 were both large nor'easters that caused significant snowfall amounts.

Somerville is vulnerable to both the wind and precipitation that accompanies nor'easters. High winds can cause damage to structures, fallen trees, and downed power lines leading to power outages. Intense rainfall can overwhelm drainage systems causing localized flooding of rivers and streams as well as urban stormwater ponding and localized flooding.

The entire city of Somerville could be at risk from the wind, rain or snow impacts from a nor'easter, depending on the track and radius of the storm, but due to its inland location the city would not be subject to coastal hazards.
Based on the record of previous occurrences, nor'easters in Somerville 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 tornados. 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.

Eastern Massachusetts is at risk of one to two severe thunderstorms per year. Past occurrences that are listed in the Massachusetts Hazard Mitigation Plan 2013 include:

March 1972
March-April 1982
October 1996
June 1998
March-April 2001
October 2005
May 2006
April 2007
March 2010
August 2011

Severe thunderstorms are a city-wide hazard for Somerville. The City is vulnerable to both the wind and precipitation associated with thunderstorms. High winds can cause damage to structures, fallen trees, and downed power lines leading to power outages. Intense rainfall can overwhelm drainage systems causing localized flooding of rivers and streams as well as urban stormwater ponding and localized flooding.

Based on the record of previous occurrences, severe thunderstorms in Somerville 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.

Blizzards and Heavy Snow

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

Winter storms are a combination hazard because they often involve wind, ice and heavy snow fall. The National Weather Service defines "heavy snow fall" as an event generating at least 4 inches of snowfall within a 12 hour period. Winter Storms are often associated with a Nor'easter event, a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain.

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

Source: Massachusetts State Hazard Mitigation Plan, 2010

Since 1958 Massachusetts has experienced two Category 5 Extreme snow storms, nine Category 4 (Crippling) storms, and 13 Category 3 (Major) snow storms. 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. Historically, severe winter storms have occurred in the following years:

Table 11. Severe Winter Storm Records for Massachusetts

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 2004
Severe Snow Storm	January 2005
Severe Snow Storm	April 2007
Severe Snow Storm	December 2010
Blizzard of 2013	February 2013
Blizzard of 2015	January 2015

The City of Somerville does not keep local records of winter storms. Data for Middlesex County, which includes Somerville, is the best available data to help understand previous occurrences and impacts of winter storm events. According to National Climate Data Center (NCDC) records, from 1996 to 2015 Middlesex County experienced 50 heavy snowfall events, resulting in no deaths or injuries and $1.45 million dollars in property damage.. See Table 12 for and heavy snow events and impacts in Middlesex County.

Table 12 - Heavy Snow events and Impacts in Middlesex County 1996 –2015

Date	Type	Deaths	Injuries	Property Damage
1/2/1996	Heavy Snow	0	0	0.00K
1/7/1996	Heavy Snow	0	0	1.400M
2/16/1996	Heavy Snow	0	0	0.00K
3/2/1996	Heavy Snow	0	0	0.00K
3/7/1996	Heavy Snow	0	0	0.00K
4/7/1996	Heavy Snow	0	0	0.00K
4/9/1996	Heavy Snow	0	0	0.00K
12/6/1996	Heavy Snow	0	0	0.00K
3/31/1997	Heavy Snow	0	0	0.00K
4/1/1997	Heavy Snow	0	0	0.00K
12/23/1997	Heavy Snow	0	0	0.00K
1/15/1998	Heavy Snow	0	0	0.00K
1/14/1999	Heavy Snow	0	0	0.00K
2/25/1999	Heavy Snow	0	0	0.00K
3/6/1999	Heavy Snow	0	0	0.00K

Date	Type	Deaths	Injuries	Property Damage
3/15/1999	Heavy Snow	0	0	0.00K
1/13/2000	Heavy Snow	0	0	0.00K
1/25/2000	Heavy Snow	0	0	0.00K
2/18/2000	Heavy Snow	0	0	0.00K
1/20/2001	Heavy Snow	0	0	0.00K
2/5/2001	Heavy Snow	0	0	0.00K
3/5/2001	Heavy Snow	0	0	0.00K
3/9/2001	Heavy Snow	0	0	0.00K
12/8/2001	Heavy Snow	0	0	0.00K
3/16/2004	Heavy Snow	0	0	0.00K
2/24/2005	Heavy Snow	0	0	0.00K
12/13/2007	Heavy Snow	0	0	0.00K
12/16/2007	Heavy Snow	0	0	0.00K
1/14/2008	Heavy Snow	0	0	28.00K
2/22/2008	Heavy Snow	0	0	0.00K
12/19/2008	Heavy Snow	0	0	0.00K
12/20/2008	Heavy Snow	0	0	8.00K
12/31/2008	Heavy Snow	0	0	0.00K
1/11/2009	Heavy Snow	0	0	0.00K
1/18/2009	Heavy Snow	0	0	0.00K
3/2/2009	Heavy Snow	0	0	0.00K
12/20/2009	Heavy Snow	0	0	0.00K
1/18/2010	Heavy Snow	0	0	0.00K
2/16/2010	Heavy Snow	0	0	15.00K
1/26/2011	Heavy Snow	0	0	0.00K
12/29/2012	Heavy Snow	0	0	0.00K
2/8/2013	Heavy Snow	0	0	0.00K
3/7/2013	Heavy Snow	0	0	0.00K
3/18/2013	Heavy Snow	0	0	0.00K
12/14/2013	Heavy Snow	0	0	0.00K
12/17/2013	Heavy Snow	0	0	0.00K
1/2/2014	Heavy Snow	0	0	0.00K
2/5/2014	Heavy Snow	0	0	0.00K
2/13/2014	Heavy Snow	0	0	0.00K
01/24/2015	Heavy Snow	0	0	0.00K
2//2/15	Heavy Snow	0	0	0.00K

Date	Type	Deaths	Injuries	Property Damage
2/8/15	Heavy Snow	0	0	0.00K
2/14/15	Heavy Snow	0	0	0.00K
Total	**50**	**0**	**0**	**1.45 M**

(Source: NOAA NCDC)

Because a major feature of winter storms is heavy precipitation, the same mitigation measures in place for flooding are all important for mitigating the impacts of winter storms.

Blizzards are considered 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.

City-specific data for previous ice storm occurrences are not collected by the City of Somerville. The best available local data is for Middlesex County through the National Climatic Data Center (see Table 13). Middlesex County, which includes the City of Somerville, experienced three events since 1998, which caused a total of $3,155,000 in damages. No injuries or deaths were reported.

Table 13 Middlesex County Ice Storm Events

DATE	EVENT_TYPE	DEATHS	INJURIES	DAMAGE
1/9/1998	Ice Storm	0	0	5,000
11/16/2002	Ice Storm	0	0	150,000
12/11/2008	Ice Storm	0	0	3,000,000
TOTAL		0	0	**3,155,000**

Source: NOAA, National Climatic Data Center.

Ice jams are another potential winter hazard listed in the Massachusetts State Hazard Mitigation Plan 2013. However, these are not a local hazard in the City of Somerville.

Winter Storms are a City-wide hazard in Somerville. Map 6 in Appendix B displays areas of average annual snowfall, which is in the range of 36 to 48 inches in most of the City, with a small area on the northwest side in the 48 to 72 inches per year category.

The impacts of winter storms are most significant on the transportation system. The Somerville DPW works to clear roads as requested by emergency service providers and carries on general snow removal operations, in conjunction with local snow removal contractors. The City continues to ban on-street parking at nights during snow storm events and during snow removal to ensure that streets can be plowed and public safety vehicle access is maximized. Transit operations may also be impacted, as they were in the most recent blizzard which caused the complete closure of the MBTA system for one day and limited services on several transit lines lasting several weeks.

The City's overall vulnerability to winter storms is primarily related to restrictions to travel on roadways, temporary road closures, school closures, and potential restrictions on emergency vehicle access. Other vulnerabilities include power outages due to fallen trees and utility lines, and damage to structures due to heavy snow loads.

Based on the record of previous occurrences, winter storm events in Somerville 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).

Geologic Hazards

Geologic hazards include earthquakes, landslides, sinkhole, subsidence, and unstable soils such as fill, peat, and clay. Although new construction under the most recent building codes generally will be built to seismic standards, there are still many structures which pre-date the most recent building code. Information on geologic hazards can be found on Map 4 in Appendix B.

Earthquakes

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).

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 can also trigger landslides.

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:

Richter Magnitude	**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 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

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2007, 355 earthquakes were recorded in Massachusetts (NESEC) and a sample of these is included in Table 14 below.

Table 14. Historical Earthquakes in Massachusetts or Surrounding Area, 1727-2013

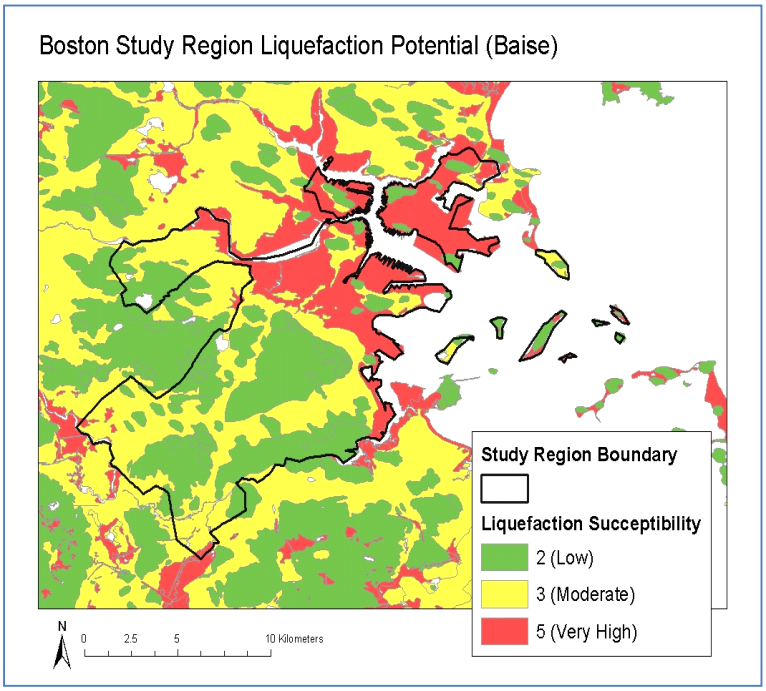
Location	Date	Magnitude*
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA – Cape Ann	2/10/1728	NA
MA – Cape Ann	3/30/1729	NA
MA – Cape Ann	12/9/1729	NA
MA – Cape Ann	2/20/1730	NA
MA – Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape 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

There have been no recorded earthquake epicenters within Somerville.

Liquefaction - One additional impact that is of particular concern in the Boston metropolitan area is liquefaction (see figure below). This is due to the prevalence of filled land. Liquefaction means that loosely packed, water-logged sediments lose strength and therefore move in large masses or lose bearing strength. Soil units susceptible to liquefaction include: non-engineered artificial fill, alluvial deposits, beach deposits, fluvial deposits and flood plain deposits. Non-engineered artificial fill is what is typically known locally as filled land. An earthquake with a magnitude of 5.5 or greater can trigger liquefaction. In the Boston region, these areas of filled land are densely developed with

structures that pre-date the seismic provisions of the current Massachusetts State Building Code. Most of the eastern portion of Somerville is portrayed in Figure 2 below with very high susceptibility to liquefaction, while much of the rest of the city is classified as having medium susceptibility.

Figure 2. Boston Study Region Liquefaction Potential



Source: Baise, Laurie G., Rebecca B. Higgins; and Charles M. Brankman, Tufts University

Earthquakes are a potential city-wide hazard in Somerville, although the figure above indicates that the eastern side of Somerville has more susceptibility to liquefaction.

The City has many un-reinforced, older masonry buildings which would be vulnerable in the event of a severe earthquake. Potential earthquake damages to Somerville have been estimated using HAZUS-MH. Total damages are estimated at $347 million for a 5.0 magnitude earthquake and $4.9 billion for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 19.

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 impacted during an earthquake.

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 2013 classifies earthquakes as "very low" frequency events that occur less frequently than once in 100 years, or a less than 1% per 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. Table 15 represents the estimated intensity for a range of landslides. For a given landslide volume, fast moving rockfalls have the highest intensity while slow moving landslides have the lowest intensity.

Table 15. Landslide 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

According to State data, the city is classified as having areas with a low risk for landslides as well having areas with a moderate risk (Appendix B - Map 4).. The western portion of the city has a low risk for landslides whereas the eastern portion has a moderate risk for

landslides. Although potentially a city-wide hazard, there are no documented previous occurrences of landslides in Somerville. Should a landslide occur in the future in Somerville, the type and degree of impacts would be highly localized, and the city'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 Somerville.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan 2013, landslides are of Very Low frequency, events that can occur less frequently than once in 100 years (less than 1% per year).

Other Natural Hazards

Brush Fires

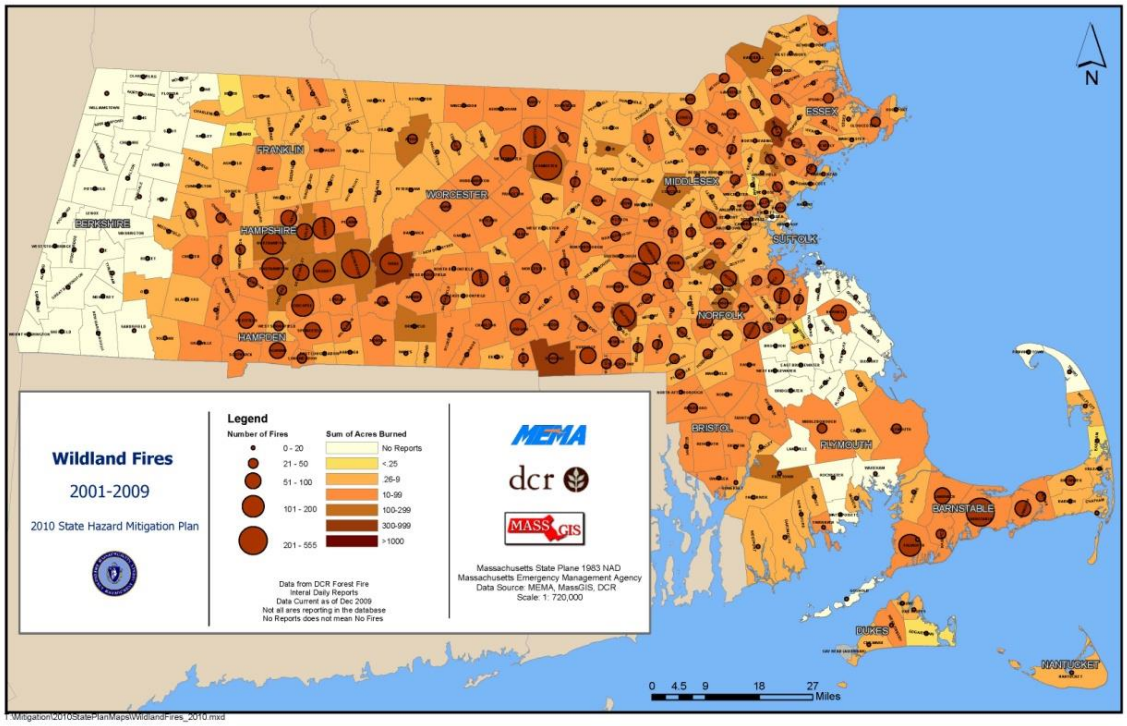
For the purposes of this plan, a brush fire is an uncontrolled fire occurring in a forested or grassland area. In the Boston Metro region these fires rarely grow to the size of a wildfire as seen more typically in the western U.S. As their name implies, these fires typically burn no more than the underbrush 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.

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, shown below in Figure 3 below, indicates that the wildfire extent in Somerville consists of less than 0.25 acres burned, with the City experiencing fewer than 20 recordable fires between 2001-2009.

In the case of Somerville, brushfires, when they occur, are limited to small vegetated pieces of land which may be located along transportation corridors and water bodies. An example of this is areas with stands of phragmites, which are grasses that grow in wetland areas.

The Somerville Fire Department responds to a number of brush fires of varying sizes annually. Within the past year, which represents the best available local data, there were no brush fires that resulted in significant property damage. The incidence of brush fires is distributed throughout the City with the railroad rights-of-way having a higher risk. The Fire Department does not need any additional equipment to deal with brush fires.

Figure 3. MA Wildfires 2001-2009



Potential vulnerabilities to wildfire include injuries and loss of human life, damage to structures and other improvements, and impacts on natural resources. Given the immediate response times to reported wildfires in Somerville, the likelihood of injuries and casualties is minimal. 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. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan 2013, brushfires are of Medium frequency, events that can occur events that occur from once in 5 years to once in 50 years (2% to 20% probability per year).

Extreme Temperatures

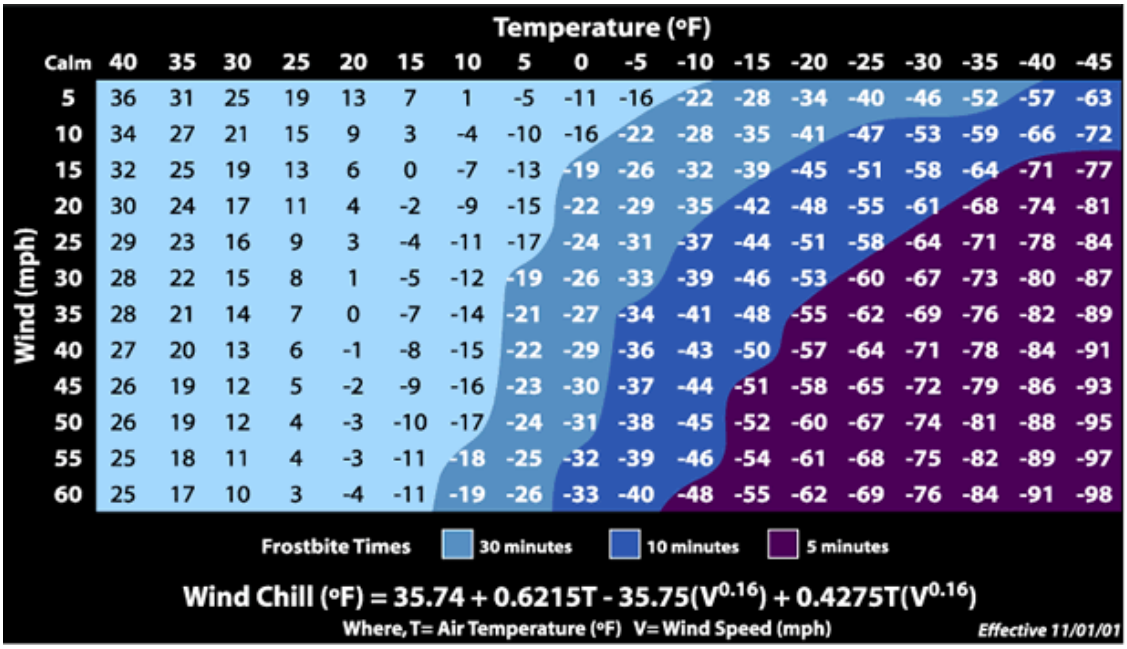
Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time where there is prolonged period of excessively hot or cold weather.

Those that are most vulnerable to extreme heat events are children, the elderly, and those who have a physical disability. These susceptible groups may suffer from dehydration,

heat exhaustion, heat cramps, and heat stokes. 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.

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 4 below.

Figure 4. Wind Chill Temperature Index and Frostbit 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 5 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 above105 degree F.

These events can be exacerbated in more densely settled locations and areas with a high proportion of impervious surfaces, which can lead to a 'heat island' effect that results in higher localized temperatures. Hot summer days can also worsen air pollution, especially in urban areas. In areas of the Northeast that currently face problems with smog, inhabitants are likely to experience more days that fail to meet air quality standards.

Figure 5. Heat Index Chart

Relative Humidity (%) \ Temperature (°F)	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.

Heat waves and lower air quality can threaten the health of vulnerable populations, including the very young, the elderly, and people with certain medical conditions, such as heart disease. In Somerville, slightly more than 7,500 residents are under the age of 15 and approximately 6,800 are 65 years of age or older. Both populations can be found throughout the city. Additionally, Somerville is a densely settled municipality that is mostly urbanized, so city as a whole experiences vulnerability to extreme temperatures.

Previous Occurrences-Excessive Heat

The City does not collect data on excessive heat occurrences. The best available data is from the National Climatic Data Center (NCDC) for Middlesex County, which includes Somerville. The NCDC records indicate that July 6, 2010 the temperature in eastern Massachusetts ranged from 100 to 106 degrees Fahrenheit. There were no reported deaths, injuries or property damage resulting from excessive heat. (NOAA: NCDC)

Previous Occurrences- Extreme Cold

The City of Somerville does not collect data for extreme cold occurrences. The best available data is from the National Climatic Data Center (NCDC) for adjacent Suffolk County, which indicates that an extreme cold event occurred on February 3, 2007.

Probability of Future Occurrences

Based on the record of previous occurrences, extreme temperatures 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.

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. Somerville is located in the Northeast Region. In Somerville drought is a potential city-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.

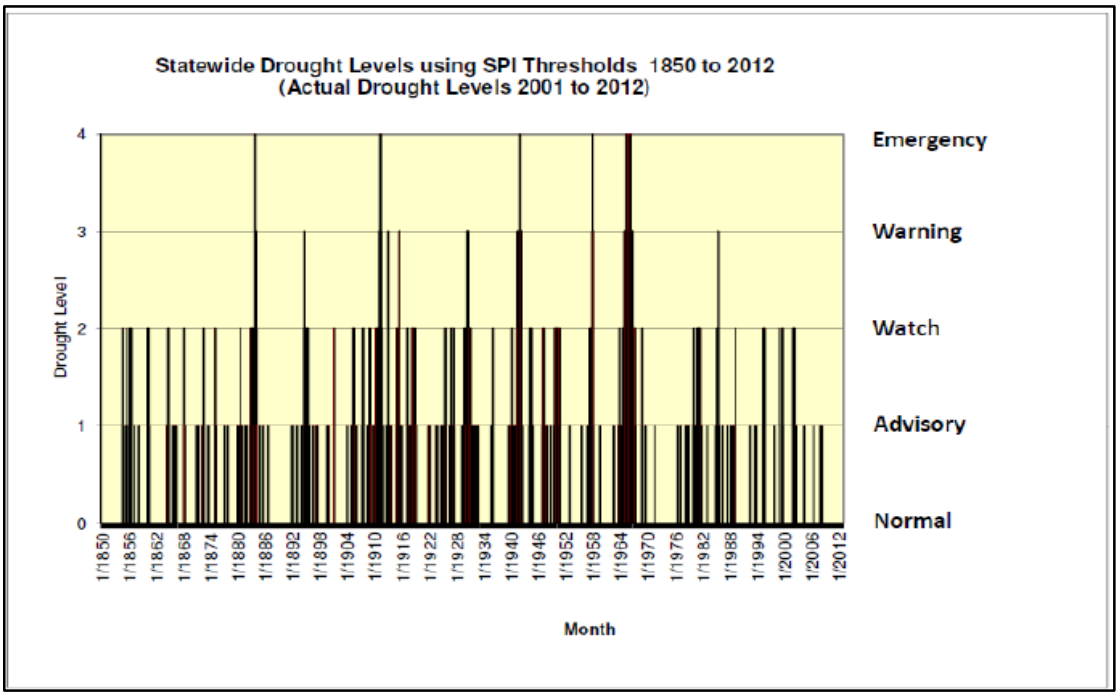
Determinations regarding the end of a drought or reduction of the drought level focus on two key drought indicators: precipitation and groundwater levels. These two factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture and potential for forest fires.

Previous Occurrences

Cambridge 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).

Figure 6 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

Figure 6 - Statewide Drought Levels using SPI Thresholds



Source: Mass. State Drought Management Plan 2013)

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.

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.

Somerville Potential Drought Vulnerability

Somerville's potential vulnerability to a severe long term drought could be a reduction in the availability of water supplies, which in turn could affect public health and economic activity. However, the City is a member of the Massachusetts Water Resources Authority (MWRA). Given the resilience of the MWRA system due to the very large amount of storage in the Quabbin and Wachusett Reservoirs, severe impacts of drought on the City of Somerville have never occurred and are unlikely.

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 10 categories. Residential uses make up nearly 55% of the area of the City (approx. 1,443 acres). Commercial, industrial land and non-residential developed land uses also comprise a significant portion of the city (36%). Less than 2% of the land in the City is identified as undeveloped (45 acres).

Table 17. 2005 Land Use

Land Use Type	Acres	Percent
High Density Residential	1,443	54.6%
Medium Density Residential	-	-
Low Density Residential	-	-
Non-Residential, Developed	327	12.4%
Commercial	323	12.2%
Industrial	303	11.4%
Transportation	203	7.7%
Agriculture	-	-
Undeveloped	38	1.4%
Undeveloped Wetland	7	0.3%
Total	**2,643**	**100%**

Economic Elements

Somerville has economic assets throughout the City. Significant centers of economic development include Davis Square, Union Square, Ball Square, Teele Square, Magoun Square and Assembly Square. There are also commercial corridors along Broadway in East Somerville and a concentration of industrial uses in Brickbottom.

These centers and corridors consist of historic structures and businesses as well as more recent developments that include retail, office, and residential uses. The City also has the potential for additional mixed use growth around proposed transit nodes along the proposed Green Line Extension and through the redevelopment of industrial areas like Assembly Square and Brickbottom.

Historic, Cultural, and Natural Resource Areas

There are several locations and areas of historical and cultural importance to Somerville, some of which are listed on the State and National historic registers and many which are included in local historic districts. In addition, there are sites that are of importance locally even if not listed on historic registers.

Although the City does not have a large open spaces, Somerville does prioritize the green spaces that is has and is actively adding more natural elements to its built environment. The city values it current set of street trees and is working to plant more trees each year. The City is also participating in efforts to address water quality issues related to the Mystic River and Alewife Brook through open space preservation and enhancement.

Development Trends

Under current zoning, the City of Somerville is largely built out. Much of the land area is occupied by existing residential neighborhoods, commercial centers and corridors, industrial developments and parks, schools and recreation space. The development that is occurring in the City is primarily redevelopment that consists of mixed use and transit-oriented development projects.

Development Since the 2008 Hazard Mitigation Plan

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 20 developments in the City of Somerville completed since 2008, and an additional 10 developments that were under construction when this plan update was drafted. These are listed in Table 18 below.

The database also includes several attributes of the new development, including site acreage, housing units, and commercial space. The 20 developments completed from 2009 to 2015 are sited on a total of 69 acres and include a total of 1,204 housing units, and 556, 482 square feet of commercial space. With the addition of 10 other projects under construction, a total of 30 new developments in Somerville since 2008 are sited on 75.9 acres and include a total of 1,552 housing units and 1,476,694 square feet of commercial space.

Of the 30 new projects, seven located on parcels that are at least partially within a flood zone. These parcels comprise 8.6 acres of the total 69 acres of new development, and are within the X Zone, 0.2% chance of flooding (the "500 year" flood zone." However,

any development located within floodplain areas must comply with Somerville's Flood Plain ordinance.

Table 18 New Developments in Somerville 2009-2015

DEVELOPMENT NAME	ACRES	HOUSING UNITS	COMM SF
Developments Completed 2009-2015			
Assembly Square - Block 10	0.03	-	4,500
Self-Storage- 50 Middlesex Ave	0.93	-	138,500
221 Morrison Avenue	0.18	1	3,113
272 Broadway	0.11	-	1,923
Assembly Row: Block 3 (completed)	0.03	96	24,795
181 Cedar Street	0.20	6	-
70 Webster Avenue	-	46	-
131 Middlesex Avenue	-	-	234,000
VNA- 259 Lowell Street	-	97	-
1188 Broadway	-	20	-
SHA Capen Court	-	31	-
VNA Conwell School	1.88	99	-
1 Benton Rd.	-	3	-
46 Craigie St.	0.19	3	-
377 Summer St.	0.23	6	-
Maxpak Project	5.49	199	-
St. Polycarp's	3.50	84	5,000
Assembly Row: Block 4	0.03	246	35,979
Assembly Row: Block 2	0.03	123	31,688
Assembly Row: Block 1	56.2	144	76,984
Total Developments Completed 2009-2015	**69.02**	**1,204**	**556,482**
Developments Under Construction 2015			
60 Howard Street	0.74	5	-
100 Fellsway West	-	19	-
52 Thurston St.	-	2	-
42 Craigie St.	0.03	2	-
515 Somerville Ave.	1.47	-	27,000
Cobble Hill Center: Phase 1	4.00	160	13,000
Assembly Row: Block 11 (Phase 1)	0.03	-	874,297
181 Washington Street	0.63	30	2,413
197 Union Square	-	30	3,502
Millbrook Lofts	-	100	-
Total Under Construction-2015	**6.89**	**348**	**920,212**
TOTAL ALL DEVELOPMENTS 2009-2015	**75.91**	**1,552**	**1,476,694**

Potential Future Development

MAPC consulted with the local team to determine areas that may experience development or redevelopment in the future, defined for the purposes of this plan as a ten year time horizon. These areas are shown on Map 8, "Potential Future Development Areas" and are described below. The letter for each site corresponds to the letters on Map 8.

A. North Point - This development will include approximately 5,000,000 square feet of total space (residential and commercial) with 2,7000 dwelling units, approximately 2,180,000 gross square feet of retail/commercial/office space, 400,000 square feet of open space, 2,190 non-residential parking spaces, and 2,800 residential parking spaces. This development is also partially within Boston and Cambridge. Strictly within Somerville there will be approximately 300 dwelling units, approximately 242,222 gross square feet of retail/commercial/office space, 44,444 square feet of open space, 243 non-residential parking spaces, and 311 residential parking spaces.

B. Boynton Yards - There have been discussions about the development of this parcel for 220 units of residential.

C. Prospect Street - A Special Permit application has been submitted for this property proposing a five story, mixed use building with 14 residential units, first floor commercial space, and 14 at-grade parking spaces.

D. 380 Somerville Ave - A project for the site was permitted for a five story, mixed use building with 6,500 square feet of retail space, 30 residential units, and 36 parking spaces. The current owner is attempting to sell the property with the approved Special Permit.

E. 515 Somerville Ave - There is no permitted project for this site at this time, however, a developer is soon expected to submit a Special Permit application for a mixed use development with approximately 46 units of housing. The Applicant is saying that the site has been environmentally cleaned up.

F. 343-351 Summer Street - This property belonged to the MBTA but was sold. There is a subway vent shaft which needs to be taken into consideration during construction. The site has been permitted for 29 residential units and a private lodge/club, but the project is currently in litigation at the moment.

G. Mystic Valley Parkway - The Somerville Housing Authority received a Comprehensive Permit under M.G.L. Chapter 40B for an Inclusionary Housing Development at this site. The proposal would create 60 affordable one-bedroom residential dwelling units for seniors and person with disabilities in two buildings. The project would consist of the redevelopment and conversion of the existing Mystic Water Works into a 25 affordable housing unit rental apartment building

and the demolition of the existing office and garage outbuilding to be replaced with a newly constructed 35 affordable housing unit rental apartment building.

H. City Yard/DPW - The City will probably sell this site and relocated the DPW. Development would occur under an RFP. There are no specific plans or proposals at this time.

I. St. Polycarps, Phase III - This site is being developed by the Somerville Community Corporation as low-income housing in three separate phases. Phase I, which consists 4,000 square feet of commercial space, 2,000 square feet of office space, and 24 residential units, was recently completed. The same is true for Phase II which consists of 30 residential units. The Applicant has also been approved for and will mostly likely pull building permits for Phase III of the project which consists of another 30 residential units.

J. Assembly Square – This is the site of a major mixed used development that is comprised of multiple blocks. Block 1 is permitted to include a mix of approximately 67,000 square feet of retail, restaurant, and commercial space along with nearly 200 residential units. Block 3 is also currently under construction and is permitted to include approximately 417,000 gross square feet of development that will have two levels of retail, restaurant, and commercial space, including a cinema complex. Block 4 is under construction as well and is permitted for a mix of retail, restaurant, commercial and residential units.

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 three 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	Brush Fire
North Point	Moderate Susceptibility	No	No
Boynton Yards	Moderate Susceptibility	No	No
Prospect Street	Moderate Susceptibility	No	No
380 Somerville Ave	Moderate Susceptibility	No	No
515 Somerville Ave	Moderate Susceptibility	No	No
343-351 Summer Street	Low Susceptibility	No	No
Mystic Valley Parkway	Low Susceptibility	No	No
City Yard/DPW	Low Susceptibility	No	No
St. Polycarps, Phase III	Moderate Susceptibility	No	No
Assembly Square	Moderate Susceptibility	No	No

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 17 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.

Explanation of Columns in Table 20

Column 1: ID #: The first column in Table 13 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 City 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).

Table 20: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide	FEMA Flood Zone	Locally-Identified Flood Area	Hurricane Surge Category
1	Somerville Home For The Aged	Elderly Housing	Moderate Susceptibility	No	No	0
2	Visiting Nurse Association	Elderly Housing	Moderate Susceptibility	No	No	0
3	Broadway Health Center	Medical Facility	Moderate Susceptibility	No	No	0
4	Board of Health / Annex	Medical Facility	Moderate Susceptibility	No	No	0
5	Hagan Manor	Elderly Housing	Moderate Susceptibility	No	No	2
6	Weston Manor	Elderly Housing	Low Susceptibility	No	No	0
7	Clarendon Hill Towers	Elderly Housing	Low Susceptibility	No	No	0
8	Clarendon Hill Towers	Elderly Housing	Low Susceptibility	No	No	0
9	Corbett Housing	Elderly Housing	Moderate Susceptibility	No	No	0
10	Pearl Street Park	Elderly Housing	Moderate Susceptibility	No	No	0
11	Brady Towers	Elderly Housing	Moderate Susceptibility	No	No	0
12	Faulkner Towers	Elderly Housing	Moderate Susceptibility	No	No	0
13	Highland Gardens	Elderly Housing	Moderate Susceptibility	No	No	0
14	Cobble Hill Apartments	Elderly Housing	Moderate Susceptibility	No	No	0
15	Cobble Hill Apartments	Elderly Housing	Moderate Susceptibility	No	No	0
16	Cobble Hill Apartments	Elderly Housing	Moderate Susceptibility	No	No	0
17	Cobble Hill Apartments	Elderly Housing	Moderate Susceptibility	No	No	0
18	Mount Pleasant Apartments	Elderly Housing	Moderate Susceptibility	No	No	0
19	Elizabeth Peabody House	Child Care	Moderate Susceptibility	No	No	0
20	Mulberry Child Care	Child Care	Low Susceptibility	No	No	0
21	Tufts Educational Day	Child Care	Low Susceptibility	No	No	0

Table 20: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide	FEMA Flood Zone	Locally-Identified Flood Area	Hurricane Surge Category
	Care Center					
22	Cambridge Economic Opportunity Committee Preschool	Child Care	Low Susceptibility	No	No	0
23	Bright Future Day Care	Child Care	Low Susceptibility	No	No	0
24	YMCA Pre-school	Child Care	Moderate Susceptibility	No	No	0
25	YMCA After School Program	Child Care	Moderate Susceptibility	No	No	0
26	Peabody Ames Child Care	Child Care	Moderate Susceptibility	No	No	0
27	Learning Center Pre-school	Child Care	Moderate Susceptibility	No	No	0
28	Primary Emergency Operations Center	Police Station	Moderate Susceptibility	No	Public Safety Building	2
29	East Somerville Community School	School	Moderate Susceptibility	No	No	0
30	Mass. Water Res. Authority Sewer Pumping Station	Sewer Pumping Station	Low Susceptibility	AE	No	1
31	Mass. Water Res. Authority Pumping Station Shaft 9	Water Pumping Station	Moderate Susceptibility	No	No	0
32	Mass. Water Res. Authority Chemical Vault	Hazardous Materials	Moderate Susceptibility	No	No	2
33	NSTAR Substation	Power Substation	Moderate Susceptibility	No	No	0
34	NSTAR Substation	Power Substation	Moderate Susceptibility	No	No	0
35	NSTAR Substation	Power Substation	Moderate Susceptibility	No	No	2
36	NSTAR Substation	Power Substation	Moderate Susceptibility	No	No	0
37	NSTAR Substation	Power Substation	Moderate Susceptibility	No	No	0

Table 20: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide	FEMA Flood Zone	Locally-Identified Flood Area	Hurricane Surge Category
38	NSTAR Substation	Power Substation	Moderate Susceptibility	No	No	4
39	NSTAR Substation	Power Substation	Moderate Susceptibility	No	No	2
40	NSTAR Substation	Power Substation	Moderate Susceptibility	No	No	0
41	Home Depot	Place of Assembly	Moderate Susceptibility	No	No	0
42	LaQuinta Inn	Hotel	Moderate Susceptibility	0.2 pct Annual Chance Flood Hazard	No	2
43	Holiday Inn	Hotel	Moderate Susceptibility	No	No	2
44	Amtrak Commuter Rail Maintenance	Transportation Facility	Moderate Susceptibility	No	No	0
45	Rail Distribution Center	Transportation Facility	Moderate Susceptibility	No	Brickbottom	0
46	Verizon Central Office	Switching Station	Moderate Susceptibility	No	No	0
47	Rogers Foam Corporation	Hazardous Materials	Moderate Susceptibility	No	Commuter Railroad	0
48	Cambridge Health Alliance	Hazardous Materials	Low Susceptibility	No	No	0
49	Pearson / Michaels Chemical Laboratory	Hazardous Materials	Low Susceptibility	No	No	0
50	Powder House Community School	School	Low Susceptibility	No	No	0
51	Author D. Healey School	School	Moderate Susceptibility	No	No	0
52	Somerville Vocational High School	School	Moderate Susceptibility	No	No	0
53	Capuano Early Education Center	School	Moderate Susceptibility	No	No	0
54	Benjamin Brown School	School	Low Susceptibility	No	No	0
55	Tufts University Campus	School	Low Susceptibility	No	No	0

Table 20: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide	FEMA Flood Zone	Locally-Identified Flood Area	Hurricane Surge Category
56	Properzi Manor	Elderly Housing	Moderate Susceptibility	No	No	0
57	Bryant Manor	Elderly Housing	Moderate Susceptibility	No	No	0
58	Monmouth Street	Special Needs	Moderate Susceptibility	No	No	0
59	Corbett Housing	Elderly Housing	Moderate Susceptibility	No	No	0
60	Prospect House	Special Needs	Moderate Susceptibility	No	No	0
61	Ciampa Manor	Elderly Housing	Low Susceptibility	No	No	0
62	Clarendon Hill Towers	Elderly Housing	Low Susceptibility	No	No	0
63	Capen Court Apartment Building	Elderly Housing	Low Susceptibility	No	No	0
64	Teen Connection	Medical Facility	Moderate Susceptibility	No	No	0
65	Somerville Section Eight House	Public Housing	Moderate Susceptibility	No	No	0
66	District Attorney's Office	Court House	Moderate Susceptibility	No	No	0
67	Ralph & Jenny Memorial Center	Elderly Housing	Moderate Susceptibility	No	No	0
68	Somerville Home	Elderly Housing	Moderate Susceptibility	No	No	0
69	Hutchins Transitional Care	Elderly Housing	Low Susceptibility	No	No	0
70	Argenziano at Lincoln Park	School	Moderate Susceptibility	No	No	2
71	Caas Head Start-Boys and Girls Club	Child Care	Moderate Susceptibility	No	No	0
72	Cummings School	School	Moderate Susceptibility	No	No	0
73	Somerville Armory	Armory	Moderate Susceptibility	No	No	0
74	Somerville High School	School	Moderate Susceptibility	No	No	0
75	Winter Hill Community	School	Moderate	No	No	0

Table 20: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide	FEMA Flood Zone	Locally-Identified Flood Area	Hurricane Surge Category
	School		Susceptibility			
76	West Somerville Library	Library	Low Susceptibility	No	No	0
77	Police Academy Training Center	Police Station	Low Susceptibility	No	No	0
78	West Somerville Neighborhood School	School	Low Susceptibility	No	No	0
79	Central Street Health Center	Hospital	Moderate Susceptibility	No	No	0
80	Cambridge Health Alliance	Hospital	Low Susceptibility	No	No	0
81	Secondary Emergency Operation Center	Emergency Operations Center	Moderate Susceptibility	No	No	0
82	Somerville District Court	Court House	Moderate Susceptibility	No	No	2
83	Blessing of the Bay Boathouse	Municipal Office	Moderate Susceptibility	0.2 pct Annual Chance Flood Hazard	No	2
84	Ellis Oval Stadium	Place of Assembly	Low Susceptibility	AE	No	1
85	Engine 1 & Tower 1 Fire Station	Fire Station	Low Susceptibility	No	No	0
86	Somerville Fire Dept Headquarters	Fire Station	Moderate Susceptibility	No	No	0
87	Engine 7 Fire Station	Fire Station	Low Susceptibility	No	No	0
88	Engine 6 & Ladder 3 Fire Station	Fire Station	Low Susceptibility	No	No	0
89	Engine 3	Fire Station	Moderate Susceptibility	No	Public Safety Building	2
90	Police Station	Police Station	Moderate Susceptibility	No	Public Safety Building	2
91	City Hall	Municipal office	Moderate	No	No	0

Table 20: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide	FEMA Flood Zone	Locally-Identified Flood Area	Hurricane Surge Category
			Susceptibility			
92	Dept. of Public Works Fuel Distribution Center	Gas Distribution	Low Susceptibility	No	No	0
93	Prospect Hill Academy	School	Moderate Susceptibility	No	No	2
94	St. Anthony's School	School	Moderate Susceptibility	No	No	0
95	Prospect Hill Academy	School	Moderate Susceptibility	No	No	0
96	St. Catherine's School	School	Moderate Susceptibility	No	No	0
97	Full Circle High School	School	Moderate Susceptibility	No	No	0
98	Edgerly Education Center	School	Moderate Susceptibility	No	No	0
99	Next Wave Junior High School	School	Moderate Susceptibility	No	No	0
100	John F. Kennedy School	School	Low Susceptibility	No	No	0
101	St. Ann Elementary School	School	Moderate Susceptibility	No	No	0
102	Somerville Theatre	Place of Assembly	Low Susceptibility	No	No	0
103	70 Inner Belt Road	Hazardous Materials	Moderate Susceptibility	No	Brickbottom	4
104	Tufts Administration Building (TAB)	Child Care	Low Susceptibility	No	No	0
105	Harvard Vanguard Medical Associates	Medical Facility	Low Susceptibility	No	No	0
106	Assembly Square Market Place	Place of Assembly	Moderate Susceptibility	0.2 pct Annual Chance Flood Hazard	No	2
107	Somerville Boxing Club	Place of Assembly	Moderate Susceptibility	No	No	0
108	Dilboy Stadium	Place of Assembly	Low Susceptibility	AE	No	1

Table 20: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide	FEMA Flood Zone	Locally-Identified Flood Area	Hurricane Surge Category
109	Veterans Memorial Skating Rink	Place of Assembly	Moderate Susceptibility	No	No	0
110	Angelica Laundry Mat	Hazardous Materials	Moderate Susceptibility	No	Brickbottom	4
111	Visiting Nurse Association (Alewife Brook)	Elderly Housing	Low Susceptibility	No	No	0
112	Arts at the Armory	Place of Assembly	Moderate Susceptibility	No	No	0
113	Jeanne Jugan Residence	Elderly Housing	Moderate Susceptibility	No	No	0
114	Somerville Public Library (Main Branch)	Place of Assembly	Moderate Susceptibility	No	No	0
115	Somerville Public Library (East Branch)	Place of Assembly	Moderate Susceptibility	No	No	0
116	City Hall Annex	Municipal Building	Moderate Susceptibility	No	No	0
117	East Somerville Police Sub-Station	Police Station	Moderate Susceptibility	No	No	0
118	Clarendon Hill Apartments	Municipal Building	Low Susceptibility	No	No	0
119	Kesher Hebrew School	Child Care	Moderate Susceptibility	No	No	0
120	Kinder Care Centers	Child Care	Low Susceptibility	No	No	0
121	CAAS Headstart	Child Care	Moderate Susceptibility	No	No	0
122	Mystic Three	Child Care	Moderate Susceptibility	No	No	0
123	Mystic Learning Center	Child Care	Moderate Susceptibility	No	No	0
124	Somerville Early Head Start	Child Care	Moderate Susceptibility	No	No	0
125	CAAS Head Start	Child Care	Low Susceptibility	No	No	0
126	CAAS Head Start	Child Care	Moderate Susceptibility	No	No	2
127	Somerville Child Care Center	Child Care	Moderate Susceptibility	No	No	0

Table 20: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide	FEMA Flood Zone	Locally-Identified Flood Area	Hurricane Surge Category
128	Open Center for Children	Child Care	Low Susceptibility	No	No	0
129	Bellas Manitas Learning Center	Child Care	Moderate Susceptibility	No	No	0
130	Broadway Babies Daycare	Child Care	Moderate Susceptibility	No	No	0
131	Tree House Academy	Child Care	Moderate Susceptibility	No	No	0
132	Tree House Academy	Child Care	Moderate Susceptibility	No	Beacon Street	0
133	Cambridge, Somerville Early Intervention	Child Care	Moderate Susceptibility	No	No	2
134	Agassiz Pre-School	Child Care	Moderate Susceptibility	No	No	0
135	Pooh and Friends	Child Care	Moderate Susceptibility	No	No	0
136	Agapanto Day Care	Child Care	Moderate Susceptibility	No	No	0
137	Little Busy Bodies Day Care	Child Care	Moderate Susceptibility	0.2 pct Annual Chance Flood Hazard	No	2

Damage Assessments

An estimation of damages was performed for hurricanes, earthquakes, and flooding. The methodology used for hurricanes and earthquakes was the HAZUS-MH software. 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 City of Somerville, 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 City, bringing the strongest winds and greatest damage potential.

Table 21. Estimated Damages from Hurricanes

	100 Year	**500 Year**
Building Characteristics		
Estimated total number of buildings	15,535	15,535
Estimated total building replacement value (Year 2006 $) (Millions of Dollars)	6,044	6,044
Building Damages		
# of buildings sustaining minor damage	1,362	4,885
# of buildings sustaining moderate damage	277	2,274
# of buildings sustaining severe damage	18	297
# of buildings destroyed	0	36
Population Needs		
# of households displaced	234	1,675
# of people seeking public shelter	56	416
Debris		
Building debris generated (tons)	16,463	65,600
Tree debris generated (tons)	1,976	6,560
# of truckloads to clear building debris	578	2377
Value of Damages (Thousands of dollars)		
Total property damage	64,860	385,187
Total losses due to business interruption	10,303	61,470

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.

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	15,535	15,535
Estimated total building replacement value (Year 2006 $)(Millions of dollars)	6,043	6,043
Building Damages		
# of buildings sustaining slight damage	2,613	1,044
# of buildings sustaining moderate damage	1,067	3,969
# of buildings sustaining extensive damage	212	4,174
# of buildings completely damaged	31	6,211
Population Needs		
# of households displaced	466	18,990
# of people seeking public shelter	283	11,562
Debris		
Building debris generated (tons)	0.070 million	2.060 million
# of truckloads to clear building debris	2,680	82,240
Value of Damages (Millions of dollars)		
Total property damage	347	4,922
Total losses due to business interruption	40	1,035

Estimated Damages from Flooding

MAPC did not use HAZUS-MH to estimate flood damages in Somerville. 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.

Somerville is 4.1 square miles or 2,624 acres. Approximately 168 acres have been identified by local officials as areas of flooding. This amounts to 6.37% of the land area in Somerville. The number of structures in each flood area was estimated by applying the percentage of the total land area to the number of structures (15,535) in Somerville; the same number of structures used by HAZUS for the hurricane and earthquake calculations. HAZUS uses a value of approximately $388,993 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 *$38,490,278 - $192,451,391*. These calculations are not based solely on location within the floodplain or a particular type of storm (i.e. 100 year flood).

Table 23. Estimated Damages from Flooding

ID	Flood Hazard Area	Approximate Area in Acres	% of Total Land Area in Somerville	Estimated Number of Structures	Replacement Value	Low Estimate of Damages	High Estimate of Damages
1	Brickbottom	77.77	2.94	457	$177,781,123	$17,778,112	$88,890,561
2	Lincoln Park	5.69	0.22	33	$13,012,827	$1,301,283	$6,506,414
3	Public Safety Building	3.30	0.13	19	$7,553,957	$755,396	$3,776,979
4	Cedar Street and Hall Street	2.08	0.08	12	$4,743,574	$474,357	$2,371,787
5	Somerville Community Path	3.67	0.14	22	$8,385,512	$838,551	$4,192,756
6	Tannery Brook	2.11	0.08	12	$4,819,852	$481,985	$2,409,926
7	Simpson Avenue - Cady Avenue - Broadway	5.13	0.19	30	$11,717,723	$1,171,772	$5,858,861

Table 23. Estimated Damages from Flooding

ID	Flood Hazard Area	Approximate Area in Acres	% of Total Land Area in Somerville	Estimated Number of Structures	Replacement Value	Low Estimate of Damages	High Estimate of Damages
8	Beacon Street	26.45	1.00	155	$60,473,511	$6,047,351	$30,236,756
9	Medford Street Underpass	1.34	0.05	8	$3,064,904	$306,490	$1,532,452
10	Washington Street Underpass	2.99	0.11	18	$6,843,005	$684,301	$3,421,503
11	Route 28 Underpass	9.99	0.38	59	$22,833,511	$2,283,351	$11,416,756
12	Commuter Railroad	27.85	1.05	164	$63,673,282	$6,367,328	$31,836,641
Totals		168.37	6.37	989	$384,902,782	$38,490,278	$192,451,391

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V. HAZARD MITIGATION GOALS

The Somerville Local Multiple Hazard Community Planning Team met on November 1, 2012. At that meeting, the team reviewed and discussed the goals from the 2008 Hazard Mitigation Plan for the City of Somerville. After some discussion, the existing goals were found to still be reflective of the City's objectives with regard to addressing hazard mitigation in the community.

1. Prevent and reduce the loss of life, injury 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.
    - Ensure that the Planning Department considers hazard mitigation in its review and permitting of new development.
    - Review zoning regulations to ensure that the ordinance incorporates all reasonable hazard mitigation provisions.
    - Ensure that all relevant municipal departments have the resources to continue to enforce codes and regulations related to hazard mitigation.
4. Prevent and reduce the damage to public infrastructure resulting from all hazards.
    - Begin to assess the vulnerability of municipal buildings and infrastructure to damage from an earthquake.
    - Maintain existing mitigation infrastructure in good condition.
5. Encourage the business community, major institutions and non-profits to work with the City 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.
    - Participate in the Mystic Region LEPC.
7. Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.
8. Educate the public about natural hazards and mitigation measures that can be undertaken by property-owners.
    - Provide information on hazard mitigation activities in the languages most frequently spoken in Somerville.
9. Take maximum advantage of resources from FEMA and MEMA to educate City staff and the public about hazard mitigation.

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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

Existing Multi-Hazard Mitigation Measures

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

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 still in place in the City and has recently been updated (2013) to include an electronic version. Recent update occurred in coordination with MEMA.

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.

Regional Emergency Planning Committee (REPC) – The Mystic REPC serves as the emergency planning committee for 19 cities and towns. These include: Arlington, Burlington, Chelsea, Everett, Lynn, Lynnfield, Malden, Somerville, Melrose, North Reading, Reading, Revere, Saugus, Somerville, Stoneham, Wakefield, Winchester, Winthrop, and

Woburn. The Mystic REPC's 19 member cities and towns work together to develop plans to educate, communicate, and protect their communities in case of natural and man-made emergencies. The Mystic REPC is the first regional planning committee to be certified by State of Massachusetts. Also, the REPC now has Triumverate Environmental (private business) participating and sharing information.

Existing Flood Hazard Mitigation Measures

Participation in the National Flood Insurance Program - FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at http://www.fema.gov/business/nfip/statistics/pcstat.shtm. The reporting period covers January 1, 1978 through January 31, 2015. The following information is provided for the City of Somerville.

Flood insurance policies in force (as of January 31, 2015)	46
Coverage amount of flood insurance policies	$11,848,000
Premiums paid	$20,088
Total losses (all losses submitted regardless of the status)	23
Closed losses (Losses that have been paid)	21
Open losses (Losses that have not been paid in full)	0
CWOP losses (Losses that have been closed without payment)	2
Total payments (Total amount paid on losses)	$839,723.01

Since the 2008 plan, the policies in force have increased by 36 and coverage amount increased by $9.7 million. Total losses have increased by 3, and total payments increased by $15,600.

Sacramento Street Foot Bridge – This is a foot bridge where the City installed new pumps to alleviate flooding in 2006. New pumps continue to operate well with no issues.

Somerville Avenue– Due to past flooding along the corridor between Porter and Union Squares, a relief drain project was implemented. The project is now complete from the Cambridge Line to Union Square. The remaining portion of the program is ongoing from Union Square to McGrath Highway (Rt. 28) to address additional flooding concerns.

Valve Turner – At the time of the previous plan, the City had just purchased a valve turner in order to implement a program of valve exercising. Work is still occurring and the City is using the new valve machine, which is mobile and can be transported around City.

Catch basin cleaning – The City maintains a map of "storm-challenged" catch basins. When a storm is forecast, the DPW goes out and checks the grates on these catch basins to ensure that there is no debris clogging the gate. Catch basin cleaning is done by city personnel. The city occasionally contracts out for services in order to catch up if there is a

back log of basins that need to be cleaned. The City has also purchased a new Vector Truck to improve equipment used in cleaning.

Street sweeping – Street sweeping is still occurring although daytime sweeping is now performed through a contract with a private provider. City staff still sweeps major corridors over night during the week. The City also has machines that it uses for sidewalk sweeping.

Waterfront Overlay Zoning District – The purpose of this district is to preserve significant open space along the Mystic River and to enforce high standards of architectural design. All developments in this district require review by the Special Permit Granting Authority (Planning Board). There is a bonus incentive for publicly accessible usable open space. The zoning ordinance has recently been updated and now any proposed changes that occur within 100 feet of either the Mystic River or Alewife Brook must go through a review with the Conservation Commission prior to approval of proposed development.

Floodplain Overlay District - The purpose of this district is to ensure public safety through reducing threats to life, personal injury and property from flooding. All development within the overlay district must be in compliance with Chapter 131, Section 40 of the Massachusetts General Laws and Section 2102 of the Mass. State Building Code. The district encompasses all special flood hazard areas designated on the FIRM maps issued by FEMA, which were recently updated. The City approved an amendment to the Floodplain Overlay District, to incorporate the updated FEMA FIRMs and bring the City into compliance with federal regulations on June 10, 2010.

Existing Dam Failure Mitigation Measures

Outfall Projects - There are no dams owned or operated by the City, although the Amelia Earhart dam is partially within the City limits. The city is looking at outfall projects in the vicinity of the Earhart Dam, but these are not expected to impact the dam.

Existing Wind Hazard Mitigation Measures

Tree trimming program - The City now has a Tree Warden and the city also recently purchased a forestry truck. The DPW trims trees and tree plantings are performed by the Conservation Commission.

Massachusetts State Building Code – The City enforces the Massachusetts State Building Code. The Massachusetts State Building Code contains detailed regulations regarding wind loads. The code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence. If a tornado were to occur in Somerville, damages would be extremely high due to the prevalence of older construction and the density of development.

City of Somerville Comprehensive Emergency Management Plan (CEMP) – The CEMP does address wind-related hazards such as hurricanes, although the emphasis is on emergency response rather than mitigation.

Existing Winter Storm Hazard Mitigation Measures

Snow Emergency Plan – The Department of Public Works consults with the Mayor to determine when a snow emergency should be declared. The City has installed blue flashing beacons at entry points to the City to alert residents and others a snow emergency is in effect and associated rules apply. Parking is restricted and the police alert residents to move their cars. Plowing begins after two inches of snow have fallen. Residents must clear their sidewalks and may not shovel snow into the street. There are designated parking lots that are available for residents to use during a snow emergency.

Underground utilities - The City has a 25 year plan to put the utilities along Beacon Street underground. The City will continue to try and coordinate with street reconstruction projects so that additional conduit is placed underground to accommodate future burying of utilities. Beacon Street is still a potential candidate in the short term.

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.

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.

Existing Other Hazard Mitigation Measures

Ban on outdoor burning – The City has a prohibition on outdoor burning.

Development review –The Fire Prevention Department is involved in reviewing new developments.

Local Capacity for Implementation

The City of Somerville has recognized several existing mitigation measures that require implementation or improvements, as well as new mitigation measures identified in the 2008 plan, and the City has the capacity within its local boards and departments to address these. The Somerville Department of Public Works will address the drainage improvements needed for Somerville Avenue, Tannery Brook, Cedar and Hall Streets, and the Somerville Bike Path. The Conservation Commission and Engineering will implement the Green Infrastructure measures. The Office of Strategic Planning and Community Development will address the implementation and enforcement of the Zoning Ordinance, Floodplain District, and Subdivision Rules and Regulations. The Public Safety Department will oversee the elevation of emergency generators in Public Safety Building and a unified communications system. The Building Department and Engineering will address seismic upgrades to the communications center.. The Conservation Commission will implement and enforce the Wetlands Protection Act.

Table 24. Somerville Existing Mitigation Measures

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
MULTIPLE HAZARDS			
Comprehensive Emergency Management Plan (CEMP)	City-wide	Emphasis is on emergency response.	None.
Massachusetts State Building Code	City-wide.	Most effective for new construction. Many buildings in the City pre-date the most recent, more stringent requirements.	None.
The Mystic Region LEPC.	City-wide, Regional	Provides a forum for regional cooperation on issues related to natural and man-made disasters.	None.
FLOOD HAZARDS			
Participation in the National Flood Insurance Program.	Flood hazard areas on FIRM maps.	Effective for owners who participate in the program. However, many areas that flood are not in floodplain zones.	Encourage greater participation amongst eligible property-owners.
Sacramento Street Foot Bridge pumps	Local area only.	Effective. Pumps are operating effectively.	None.
Somerville Avenue storm drain project.	Somerville Avenue.	Significant portion of project constructed between Porter and Union Squares	Continue to pursue funding to compete remainder of project to McGrath Highway
Valve exercising	City-wide.	Effective. Operating well	None.

Table 24. Somerville Existing Mitigation Measures

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
		and mobile for use around city.	
Catch basin cleaning.	City-wide.	Effective. City purchased a new Vector truck to improve cleaning efficiency.	None.
Street sweeping	City-wide.	Effective.	None.
Waterfront Overlay Zoning District	Updated to zoning requires any proposed changes that occur within 100 feet of either the Mystic River or Alewife Brook must go through a review with the Conservation Commission	Effective.	None.
Floodplain Overlay District	All special flood hazard areas designated on the FIRM maps issued by FEMA.	Effective.	City approved updated maps in 2010.
DAM HAZARDS			
Outfall Projects	Vicinity of Amelia Earhart Dam	Effective.	None. Not expected to impact dam.
WIND HAZARDS			
Comprehensive Emergency Management Plan (CEMP)	City-wide.	Effective primarily for emergency response; less geared towards mitigation.	No changes needed; plan fulfills the requirements for a CEMP.
The Massachusetts State Building Code.	City-wide.	Effective for most situations except	None.

Table 24. Somerville Existing Mitigation Measures

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
		severe storms.	
Tree inventory and management	City-wide.	Effective. The City hired a Tree Warden and purchased a new forestry truck.	None.
WINTER HAZARDS			
Massachusetts State Building Code	City-wide.	Most effective for new construction. Many buildings in the City pre-date the most recent, more stringent requirements.	None.
Underground utilities	Beacon Street and city-wide.	Effective in the long-term.	Funding.
Snow emergency plan	City-wide.	Effective. City now has beacon program to alert residents to declaration of a snow emergency.	None.
GEOLOGIC HAZARDS			
The Massachusetts State Building Code	City-wide.	Effective for most situations.	None.
BRUSH FIRE HAZARDS			
Ban on outdoor burning	City-wide.	Effective.	None.
Development review	City-wide.	Effective.	None.

Implementation Progress on Previous Plans

At a meeting of the Somerville Hazard Mitigation Committee, City staff reviewed the mitigation measures identified in the 2008 Metro Boston Regional Pre-Disaster Mitigation Plan Somerville Annex and determined whether measures identified in the plan 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 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 City to take action on the measure.

Table 25. Proposed Measure from 2008 Plan

Mitigation Measures	Priority	Implementation Responsibility	Status
Inner Belt Industrial Park – Drainage Improvements	High	MBTA, the City, EPA, DEP; City of Cambridge involvement will also be necessary	Mitigation work is occurring as part of MBTA Green Line extension project which is underway)
Somerville Ave. – Drainage Improvements	High	MHD (Now Massachusetts Dept. of Transportation / MassDOT)	Complete Project complete, but second phase is under planning and design from Union Square to McGrath Highway
Lincoln Park – Combined Sewers Separation	Medium	City	Project continues to undergo design and engineering work
Tannery Brook – Drainage Improvements	Medium	DPW	Project continues to undergo design and engineering work
Medford Street Underpass – Installation of New Pumps	Medium	City	Complete New pumps were installed, but additional drainage work may occur as part of MBTA Green Line extension project which is underway

Table 25. Proposed Measure from 2008 Plan

Mitigation Measures	Priority	Implementation Responsibility	Status
137 Washington St. Bridge – Installation of New Pumps	Medium	MBTA	Project included as part of mitigation work of MBTA Green Line extension project which is underway
Route 28 N Underpass – Installation of Warning Device and Boat Purchase	Medium	City, MHD (MassDOT) and DCR	City has boat available for water rescues, and is pursuing opportunities for larger vessel. Pumps are owned by MassDOT and the City is coordinating with the agency on improvements
Commuter rail line – Drainage Improvements	Medium	City and the MBTA	Project included as part of mitigation work of MBTA Green Line extension project which is underway
City-wide – Purchase Additional Street Sweeper	Medium	DPW	**Complete** City has purchased a new street sweeper and sidewalk sweepers which are used in evenings outside times when privately operated sweeper maintenance is in operation
Public Safety Building – Drainage Improvements	Low	City	**Complete** City has installed new pumps, new roof, and emergency generators as part of maintaining building and its functions
Cedar and Hall Streets – Drainage Improvements	Medium	City, DPW	Project is currently in design phase
Somerville Bike Path – Drainage Improvements	Low	City	Project is entering contract phase for design

Table 25. Proposed Measure from 2008 Plan

Mitigation Measures	Priority	Implementation Responsibility	Status
Water rescues – Purchase Water Rescue Boat	Low	City	Mini boat purchased, and the City continues to pursue purchase of larger vessel to support rescue operations that may include multiple victims
Regional – Participation in the Mystic Region LEPC	High	City	**Complete** Somerville is now a participating member of the Mystic Regional Emergency Planning Committee

Somerville's staff continually demonstrates commitment and a high level of professionalism with regard to addressing natural hazard mitigation needs in order to protect the lives and property of the residents and businesses located in the City. As has been previously stated, flooding represents the greatest hazard for the community and staff diligently maintain the structures and enforce the regulations that contribute to minimizing the potential impacts of this hazard, within the resources available. The action items identified above represented a wish list of activities that would further reduce hazard risks, but the ability to implement improvements, especially capital investments, was highly dependent on the availability of greater resources.

2016 Hazard Mitigation Strategy

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*)

New Development and Infrastructure

As part of the process of developing recommendations for new mitigation measures for this plan update, the City considered the issues related to new development, redevelopment, and infrastructure needs in order reduce and limit future risks of natural hazards. Taking into consideration a host of measures to regulate new development and mitigate its impacts, including the city's Floodplain Overlay Zoning District enforced for new development, the stormwater management requirements enforced for new development by the Department of Public Works, the Building Code enforced for new development by the Inspectional Services Division, the Wetlands Protection Act enforced for new development by the Conservation Commission, the city's Comprehensive Plan, *SomerVision,* and the Open Space and Recreation Plan implemented by the Conservation Commission, the City has determined that existing policies and regulatory measures are taking full advantage of local Home Rule land use regulatory authority to minimize natural hazard impacts of new development and redevelopment. As a mature city with older infrastructure, the major priorities that emerged for the City are strategic infrastructure upgrades in the most problematic areas. These upgrades will provide greater capacity to reduce hazard risks for both existing and new development as well as redevelopment in the City.

Proposed Hazard Mitigation Measures

<u>Flood Hazard Mitigation Measures</u>

A) *Inner Belt Industrial Park drainage improvements* - The culvert and drain pipes in this area are silted up, resulting in reduced capacity. In addition, the drain pipe is undersized for current flows and has not been properly maintained. A comprehensive storm drainage system improvement is needed in this area. Improvements are being coordinated with the construction of the MBTA Green Line Extension which impacts this area.
B) *Somerville Avenue drainage improvements* - Flooding on Somerville Avenue can be significant and cause impacts to the road and the integrity of its base. This improvement would address the remaining flooding issues from Union Square to McGrath Highway with in line storm drain improvements (replacement of existing pipes to increase capacity) between Union Square the Cambridge line.
C) *Lincoln Park sewer separation* – There are flooding and drainage issues in this area are due to combined sewers. A project to separate the combined sewers would alleviate flooding in this neighborhood.
D) *Tannery Brook drainage improvemetns* – There is flooding in this area is due to combined sewers. The City continues work to address and implement the drainage improvement strategy identified for this area, which includes increasing the

capacity of the drainage pump that connects Tannery Brook Drain and the MWRA sewer on Alewife Brook Parkway.

E) *Medford Street Underpass **pumps***- The City maintains pumps at this bridge; however, the pumps have failed in past resulting in the flooding and closure of the road. The installation of new pumps is planned as part of the MBTA Green Line Extension which will utilize the overpass.

F) *137 Washington St. Bridge **pumps*** - The railroad bridge at 137 Washington Street floods during large rain events and due to older pumps which do not function well. The MBTA has plans for a new bridge, including new automatic pumps, which will be part of the MBTA Green Line Extension.

G) *Route 28 N Underpass **drainage improvements***- The underpass is served by gates and pumps owned and operated by DCR as well as a combined sewer overflow station owned by the MWRA. The gates are prone to jamming and which leads to flooding of the underpass. The City has expressed a desire to obtain warning devices that could alert motorists to flooded underpasses and is interested in upgrades to the gates and pumps to reduce the risk of flooding.

H) C*ommuter Rail Line drainage improvemnts* – The City will continue to work with the MBTA to remediate flooding along the commuter rail line right-of-way through drainage system improvements.

I) *Cedar and Hall Streets relief drain* - To reduce street flooding in this area, which is a major access route for emergency vehicles, the City proposes the construction of a relief drain.

J) *Somerville Bike Path drainage improvements* – During the original construction of the path, a drainage system was not included. To address the flooding in this low lying area, the City would like to install dry wells and reconstruct the path.

K) Elevate Emergency Generators in Public Safety Building – As the City plans to keep this building in use for municipal purposes, there is a desire to elevate the emergency generators that serve the building. As a building that has been flooded in the past, elevation of the generators would allow the building to continue to operate in the event of flooding or loss of power.

L) Green Infrastructure Measures – The City continues to be interested in opportunities to reduce stormwater runoff and improve water quality through use of drainage natural systems. This would include reduction of impervious surfaces that encourage runoff as well as installation of landscaped and vegetated spaces to retain and infiltrate stormwater.

Measures to Ensure Compliance with NFIP

M) *Floodplain Management*: Continue to enforce the Floodplain Zoning District (Section 470) and associated building regulations for floodplain areas. Update this district to remain consistent with FEMA guidelines and floodplain mapping.

N) *Floodplain Mapping*: Maintain up to date maps of local FEMA identified floodplains.

Winter Storm Hazard Mitigation Measures

O) *Underground Utilities* - Snow loading on trees has led to falling branches and the downing of electrical and other overhead utility lines. The City continues to pursue its plan, where possible, to place overhead utilities underground. The current focus for this effort is Beacon Street.
P) *Develop a Snow Disposal Plan* – With the development of Assembly Square, the city is losing a snow dump location. The City looks to develop a snow disposal plan to address where snow will be placed after removal from city streets.
Q) *Purchase a Snow Melter* – To address the need to dispose of snow resulting from large winter storm events, the City would like to purchase a snow melter that would liquefy the snow and allow for it to drain into the storm sewer system.

Geologic Hazard Mitigation Measures

R) *Seismic upgrades to the communications center*- The Public Safety building should be reviewed to determine if changes are need in order to be brought up to seismic standards. This review would help determine and address the potential for a collapse of the communications system.

Other Natural Hazards

S) Develop Unified/Centralized Communications System – City departments that address and response to natural hazard events are currently are separate communication systems. It is proposed that the city develop a unified communication system for public safety officials and emergency responders to facilitate more centralized and efficient communications.

Prioritization of Mitigation Activities

The last step in developing the City's mitigation strategy is to assign a level of priority to each mitigation measure so as to guide the focus of the City'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 third 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 City's identified goals. and consideration of a measure's priority in the previous plan. For

the measures carried forward from the 2008 plan, there was no change in priority. These are indicated with an asterisk in Tables 26 and 27.

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 City currently had the technical and administrative capability to carry out the mitigation measures, whether any environmental constraints existed, and whether the City 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 as is an estimate of the overall benefit and cost of the measures. The benefits and costs were evaluated in terms of:

Benefits

High	Action will result in a significant reduction of hazard risk to people and/or property from a hazard event
Medium	Action will likely result in a moderate reduction of hazard risk to people and/or property from a hazard event
Low	Action will result in a low reduction of hazard risk to people and/or property from a hazard event

Costs

High	Estimated costs greater than $50,000
Medium	Estimated costs between $10,000 to $50,000
Low	Estimated costs less than $10,000 or staff time

Table 26. Mitigation Measure Prioritization

Mitigation Action	Geographic Area	Benefit	Estimated Cost	Priority	Time Frame
Flood Hazard Mitigation Measures					
A) *Inner Belt Industrial Park* – Drainage Improvements *	Inner Belt/Brickbottom	High	High	High	2014-2018
B) *Somerville Avenue* – Drainage Improvements *	Union Square	High	High	High	2014-2018
C) *Lincoln Park* Combined Sewer Separation *	Union Square	Medium	High	Medium	2014-2018

Table 26. Mitigation Measure Prioritization

Mitigation Action	Geographic Area	Benefit	Estimated Cost	Priority	Time Frame
D) *Tannery Brook*– Drainage Improvements *	Davis Square	High	High	Medium	2014-2018
E) *Medford Street Underpass—New Pump**	Union Square	Medium	High	Medium	2014-2018
F) *137 Washington St. Bridge—Installation of new pumps**	East Somerville	Medium	High	Medium	2013-2017
G) *Route 28 Underpass* Installation of Warning Device and Boat Purchase*	East Somerville	Medium	High	Medium	2014-2017
H) *Commuter Rail Line*– Drainage Improvements *	Ball Square / Tufts University	Medium	High	Medium	2014-2017
I) *Cedar and Hall Streets*– Drainage Improvements *	Spring Hill	Medium	High	Medium	2014-2015
J) *Somerville Bike Path—Drainage Improvements**	Davis Square	Medium	Medium	Medium	2014-2015
K) Elevate Emergency Generators in Public Safety Building	Gilman Square	Low	Medium	Low	2014-2017
L) Green Infrastructure Measures	Citywide	High	Low-High	Medium	2014-2017
M) Floodplain Management	Floodplains	Floodplains	High	Low	2014-2017
N) Floodplain Mapping	Floodplains	Floodplains	High	Low	2014-2017
Snow Hazard Mitigation Measures					
O) *Underground Utilities**	City wide	High	High	Medium	2014-2018
P) *Develop a Snow Disposal Plan*	City wide	High	Low	High	2014-2015

Table 26. Mitigation Measure Prioritization

Mitigation Action	Geographic Area	Benefit	Estimated Cost	Priority	Time Frame
Q) *Purchase a Snow Melter*	City wide	High	High	Low	2016-2018
Geologic Hazard Mitigation Measures					
R) *Seismic upgrades to the communications center*	Communication Center	Medium	High	Low	2016-2018
Other Hazard Mitigation Measures					
S) *Unified/ Centralized Communications System*	Citywide	High	High	Low	2015-2018

** Mitigation measures carried forward from the 2008 Somerville Hazard Mitigation Plan.*

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 as well as the priorities for measures that were carried forward from the previous plan.

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. See the link below for some example. 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
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
MBTA = Massachusetts Bay Transportation Authority
DCR = MA Department of Conservation and Recreation

Table 27. Somerville Potential Mitigation Measures

Mitigation Measure	Measure Type	Implementation Responsibility	Priority	Time Frame	Potential Funding Sources
Flood Hazard Mitigation Measures					
A) *Inner Belt Industrial Park-- Drainage Improve* *	Structural Projects	MBTA / City of Somerville	High	2014- 2018	MassDOT/MBTA
B) *Somerville Avenue— Drainage Improvements* *	Structural Projects	DPW/ Engineering	High	2014-2018	Somerville/FEMA
C) *Lincoln Park* Combined Sewer Separation *	Structural Projects	DPW/ Engineering	Medium	2014-2018	Somerville
D) *Tannery Brook— Drainage Improvements* *	Structural Projects	DPW/ Engineering	Medium	2014-2018	MassDOT
E) *Medford Street Underpass* – New Pump*	Structural Projects	MBTA / City of Somerville	Medium	2014-2018	MassDOT/MBTA
F) *137 Washington St. Bridge* – New Pump*	Structural Projects	MBTA / City of Somerville	Medium	2013-2017	MassDOT/MBTA
G) *Route 28 N Underpass* Installation of Warning Device and Boat Purchase *	Natural Resource Protection/ Prevention	MassDOT/ City of Somerville	Medium	2014-2017	MassDOT
H) *Commuter Rail Line—Drainage Improvements* *	Structural Projects	MBTA / City of Somerville	Medium	2014-2017	MassDOT/MBTA
I) *Cedar and Hall Streets— Drainage Improvements* *	Structural Projects	DPW/ Engineering	Medium	2014-2015	City of Somerville
J) *Somerville Bike Path—Drainage Improvements* *	Structural Projects	City of Somerville	Medium	2014-2015	City of Somerville

Table 27. Somerville Potential Mitigation Measures

Mitigation Measure	Measure Type	Implementation Responsibility	Priority	Time Frame	Potential Funding Sources
K) *Elevate Emergency Generators in Public Safety Building*	Property Protection	Public Safety	Low	2014-2017	City of Somerville/ FEMA
L) *Green Infrastructure Measures*	Structural Projects / Prevention	Engineering / Conservation Commission	Medium	2014-2017	Private Developers, EPA, City of Somerville
M) *Floodplain Management*	Prevention	Office of Strategic Planning and Community Development/ Conservation Commission	Low	2014-2017	City of Somerville
N) *Floodplain Mapping*	Prevention	Office of Strategic Planning and Community Development/ Conservation Commission	Low	2014-2017	City of Somerville
Winter Storm Hazard Mitigation Measures					
O) *Underground Utilities **	Structural Project	Engineering	Medium	2013-2018	City of Somerville/ MassDOT
P) *Develop a Snow Disposal Plan*	Prevention	DPW	High	2013-2015	City of Somerville
Q) *Purchase a Snow Melter*	Prevention	DPW	Low	2016-2018	City of Somerville

Table 27. Somerville Potential Mitigation Measures

Mitigation Measure	Measure Type	Implementation Responsibility	Priority	Time Frame	Potential Funding Sources
Geologic Hazard Mitigation Measures					
R) *Seismic upgrades to the communications center*	Property Protection	Building Department/ Engineering	Low	2016-2018	City of Somerville
Other Hazard Mitigation Measures					
S) *Develop Unified/ Centralized Communications System*	Prevention	Public Safety	Low	2015- 2018	City of Somerville

** Mitigation measures carried forward from the 2008 Somerville Hazard Mitigation Plan.*

Regional and Inter-Community Considerations

Regional Issues

Some hazard mitigation issues are strictly local. The problem originates primarily within the municipality and can be solved at the municipal level (e.g., capacity issues in local drainage system). Other issues are inter-community issues that involve cooperation between two or more municipalities (e.g., upstream issues related to upstream flooding on the Mystic River or on Alewife Brook). 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 (e.g., any potential issues related to the Amelia Earhart Dam, which is owned by the DCR).

Regional Partners and Hazard Mitigation Coordination

In the densely developed communities of the study area, 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 City of Somerville, the Department of Conservation and Recreation (DCR), the Massachusetts Water Resources Authority (MWRA), Massachusetts Department of Transportation (MassDOT) and the Massachusetts Bay Transportation Authority (MBTA).

The planning, construction, 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. The following is a list of recommendations from the 2008 plan that had planned to be undertaken in coordination with or by regional agencies.

Green Line Extension – The City of Somerville believes that the MBTA Green Line extension needs to continue to be monitored so that the new construction does not negatively impact drainage in Somerville. Drainage issues are now being considered as part of the Green Line extension design and construction project, especially where there are roads passing under the rail line. The project currently extends as far as the planned College Avenue station in Somerville, and may be extended to Mystic Valley Parkway by Medford and Arlington.

State highways – The City identified the condition of state highways as contributing to flooding problems and hindering emergency response. As identified at the Route 28 underpass, state facilities still need to be addressed in order to reduce the risk of flooding

and emergency response needs in the event of heavy flooding and blockage of state-controlled roadways.

Two Penny Brook in Medford – The drainage system for Two Penny Brook has historically been unable to handle the necessary amount flow to drain in heavy rain events. As a result it can back up and flood areas around Tufts University, which is located in both Medford and Somerville.

Climate Change

The entirety of Massachusetts, and in particular the Commonwealth's coastal cities and towns, faces potential risk from Climate Change. Many of the natural hazards that cities like Somerville have historically experienced are likely to be exacerbated by climate change in future years. This is particularly true for flooding caused by extreme precipitation, flooding, and extreme heat. For example, according to the 2012 report *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation from 1948 to 2011,* intense rainstorms and snowstorms have become more frequent and more severe over the last half century in the northeastern United States. Extreme downpours are now happening 30 percent more often nationwide than in 1948. In other words, large rain or snow storms that happened once every 12 months, on average, in the middle of the 20th century, now happen every nine months.

Attempts to mitigate climate change or adapt to its potential impacts are largely outside the scope of this Hazard Mitigation Plan, which relies primarily on historic trends to assess risk and vulnerability. The potential changes to the State's storm damage profile caused by Climate Change will be well outside of historic trends, making those trends uncertain predictors of future risk and vulnerability at best. Cities, towns, Regional Planning Agencies and other regional and state agencies will need to advocate for a statewide response that includes using the best available information to map and model climate change data related to natural hazards and disseminate this information for use in hazard mitigation planning and land use policy development. In Somerville, this should include the Commission on Energy Use and Climate Change in addition to other city boards and departments.

Lastly, in addition to understanding how the physical infrastructure will be impacted, it is important to identify how vulnerable populations may suffer greater impacts under future Climate Change scenarios. These populations could include the elderly, the very young, low-income groups, immigrants and the homeless, among others, and could disproportionately suffer the effects of extreme events, like flooding and heat waves, be least-equipped to adapt. Efforts should be undertaken to identify the locations of possible vulnerable populations. This could include coordination with updates to the City's demographic data (e.g., Census data for where those 65 and over, low-income and/or

are linguistically isolated are located) and collaboration with other boards that serve these population groups such as the Council on Aging Board, the Commission for Persons with Disabilities, and the Human Rights Commission.

After identifying locations, strategies should be developed and implemented to educate, engage and include these populations in hazard and emergency response planning efforts.

VII. PLAN ADOPTION AND MAINTENANCE

Plan Adoption

The City of Somerville Hazard Mitigation Plan was adopted by the City Council on [ADD DATE]. 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 City'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 city 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 Somerville Hazard Mitigation Planning Team to prepare this plan. This group will continue to meet on an as-needed basis to function as the Local Hazard Mitigation Implementation Group, with Deputy Chief of Operations, Somerville Fire Department designated as the coordinator. Additional members could be added to the local implementation group from businesses, non-profits and institutions.

The City will continue public participation during the next 5-year planning cycle. Updates and reviews of the plan will be publicly noticed in accordance with City and state open meeting laws, and the current plan will be available to the public on the City's website.

Implementation Schedule

Bi-Annual Survey on Progress– The coordinator of the Hazard Mitigation Implementation Team will prepare and distribute a biannual survey in years two and four 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, the effectiveness of the plan in achieving its goals, 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. The Hazard Mitigation Implementation Team will have primary responsibility for tracking progress and updating the plan.

Develop a Year Four Update – During the fourth year after initial plan adoption, the coordinator of the Hazard Mitigation Implementation Team will convene the team to begin

to prepare for an update of the plan, which will be required by the end of year five in order to maintain approved plan status with FEMA. The team will use the information from the year four biannual evaluate the effectiveness of the plan and identify the needs and priorities for the plan update.

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 City's approved plan status and its eligibility for FEMA mitigation grants. Because of the time required to secure a planning grant, prepare an updated plan, and complete the approval and adoption of an updated plan, the local Hazard Mitigation Planning Team should begin the process by the end of Year 3. This will help the City avoid a lapse in its approved plan status and grant eligibility when the current plan expires.
At this point, 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 Somerville 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 Somerville Hazard Mitigation Plan by FEMA, the coordinator of the Hazard Mitigation Implementation Team with support from other members of the 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 during the first six (6) months following plan adoption:

- Fire / Emergency Management
- Police
- Public Works
- Engineering
- Office of Strategic Planning and Community Development
- Recreation
- Health
- Building

The plan's recommendations will be integrated into the City's Capital Investment Program; implementation and updates to *SomerVision,* the City's Comprehensive Plan; Somerville by Design, focusing on neighborhood plans; implementation and updates to the City's Open Space and Recreation Plan; and the City's Comprehensive Emergency Management Plan.

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.

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VIII. LIST OF REFERENCES

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

SomerVision – City of Somerville Comprehensive Plan

City of Somerville Zoning Ordinance

City of Somerville Open Space and Recreation Plan Update, 2008-2013

City of Somerville Five Year Consolidated Plan 2008-2013

Metro-Boston Multi-Hazard Mitigation Plan, Somerville Annex, 2008.

Metropolitan Area Planning Council, Geographic Information Systems data.

Metropolitan Area Planning Council, Regional Plans and Data.

Commonwealth of Massachusetts State Hazard Mitigation Plan, 2010.

FEMA, Local Multi-Hazard Mitigation Planning Guidance, 2008.

FEMA, Flood Insurance Rate Maps for Somerville, MA, 2010.

New England Seismic Network, Boston College Weston Observatory, website: http://aki.bc.edu/index.htm

Northeast States Emergency Consortium, website: http://www.nesec.org/

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APPENDIX A
MEETING AGENDAS

Don Boyce
Director

Edward M. Lambert Jr.
Commissioner

Marc D. Draisen
Executive Director

The Commonwealth of Massachusetts

Deval Patrick, Governor

Massachusetts Emergency Management Agency
400 Worcester Road, Framingham, MA 01702-5399 508-820-2000 FAX 508-820-1404

Department of Conservation and Recreation
251 Causeway Street, Suite 600-900, Boston, MA 02114-2104 617-626-1250 Fax 617-626-1351

Metropolitan Area Planning Council
60 TEMPLE PLACE, 6TH FLOOR, BOSTON, MA 02111 617-451-2770 FAX 617-482-7185

Metro Boston Hazard Mitigation Planning Team

First Meeting

Wednesday, April 13, 10:00 AM
Everett City Hall, Keverian Room (3rd floor)
484 Broadway (Route 99), Everett

AGENDA

Metro Boston Hazard Mitigation Planning Team

Boston
Brookline
Cambridge
Chelsea
Everett
Malden
Medford
Somerville

10:00 WELCOME & INTRODUCTIONS

10:10 OVERVIEW OF HAZARD MITIGATION PLANNING & GRANTS

- State Hazard Mitigation Plan & FEMA Grants–Sarah White, MEMA
- FEMA Hazard Mitigation Program and Grants – Nan Johnson, FEMA
- Regional & Local Mitigation Plans - Martin Pillsbury, MAPC

10:30 UPDATING THE METRO BOSTON HAZARD MITIGATION PLAN

- FEMA Requirements & Grant Eligibility
- Review of Scope of Work & Schedule –MAPC
- Questions & Discussion – Local issues & Priorities

11:00 GETTING STARTED: MAPPING AND CRITICAL FACILITIES DATABASE FOR THE METRO BOSTON PLAN UPDATE

- Susan Brunton, GIS Analyst, MAPC

11:20 NEXT STEPS

11:30 ADJOURN

If you have any questions please contact Martin Pillsbury at MAPC:
617-451-2770, ext. 2012 or mpillsbury@mapc.org

Meeting Agenda
Local Multiple Hazard Community Planning Team
Somerville City Hall
November 1, 2012

1) Overview of Project Scope and Status

2) Introduce City of Somerville Hazard Mitigation Planning Map Series and Digitized Ortho Photo Map.

3) Identify:

   a) Flood Hazard Areas (incl. areas with concentration of repetitive loss properties)
   b) Fire Hazard Areas (incl. approximate number of annual wildfires and recent incidences that resulted in property damage)
   c) Future Potential Development Areas
   d) Historical, Cultural or Natural Resource Areas
   e) Dams (incl. type and ownership)

4) Review and Assess Plan Goals (see over)

5) Discuss Public Involvement and Outreach (see over)

6) Set Date for First Public Meeting and Discuss Public Outreach

7) Set Tentative Date Second Staff Meeting to:

   a) Review Existing Mitigation Measures
   b) Review Mitigation Measures from the 2008 Plan
   c) Discuss Potential Mitigation Measures
   d) Prioritize Mitigation Measures

Project Overview - MAPC received a grant to prepare natural hazards *Pre-Disaster Mitigation Plan* for the communities of Boston, Brookline, Cambridge, Chelsea, Everett, Malden, Medford and Somerville. MAPC is working with the eight 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.

2005 Goals

1. Prevent and reduce the loss of life, injury 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.
    - Ensure that the Planning Department considers hazard mitigation in its review and permitting of new development.
    - Review zoning regulations to ensure that the ordinance incorporates all reasonable hazard mitigation provisions.
    - Ensure that all relevant municipal departments have the resources to continue to enforce codes and regulations related to hazard mitigation.
4. Prevent and reduce the damage to public infrastructure resulting from all hazards.
    - Begin to assess the vulnerability of municipal buildings and infrastructure to damage from an earthquake.
    - Maintain existing mitigation infrastructure in good condition.
5. Encourage the business community, major institutions and non-profits to work with the City 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.
    - Participate in the Mystic Region LEPC.
7. Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.
8. Educate the public about natural hazards and mitigation measures that can be undertaken by property-owners.
    - Provide information on hazard mitigation activities in the languages most frequently spoken in Somerville.
9. Take maximum advantage of resources from FEMA and MEMA to educate City staff and the public about hazard mitigation.

Public Participation

1. MAPC presents at 2 public meeting
2. Coordinate public outreach and information for meetings
3. Post on Town/City website with a set public review period
4. Distribute to specified organizations or boards/commissions for their review
5. Distribute announcement to adjacent municipalities about Draft Plan Update
6. Other opportunities for local involvement and participation in process

Meeting Agenda
Local Multiple Hazard Community Planning Team
Somerville, MA

April 2, 2013

10:00 AM - 12:00 PM

Somerville Fire Department Headquarters

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1. Confirm Goals
2. Review Existing Mitigation Measures
3. Review Mitigation Measures from the 2008 Plan
4. Discuss Potential Mitigation Measures
5. Prioritize Mitigation Measures
6. Set Date for Final Review Team
7. Prepare for final public meeting

Project Overview - MAPC received a grant to prepare natural hazards *Pre-Disaster Mitigation Plan* for the communities of Boston, Brookline, Cambridge, Chelsea, Everett, Malden, Medford and Somerville. MAPC is working with the eight 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.

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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 maps can be downloaded from the MAPC File Transfer Protocol (FTP) website at:

ftp://ftp.mapc.org/Hazard_Mitigation_Plans/PDM-2R/Somerville/

Map1: Population Density – This map uses the US Census block data for 2000 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 City 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 Somerville are kept by the City. 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.

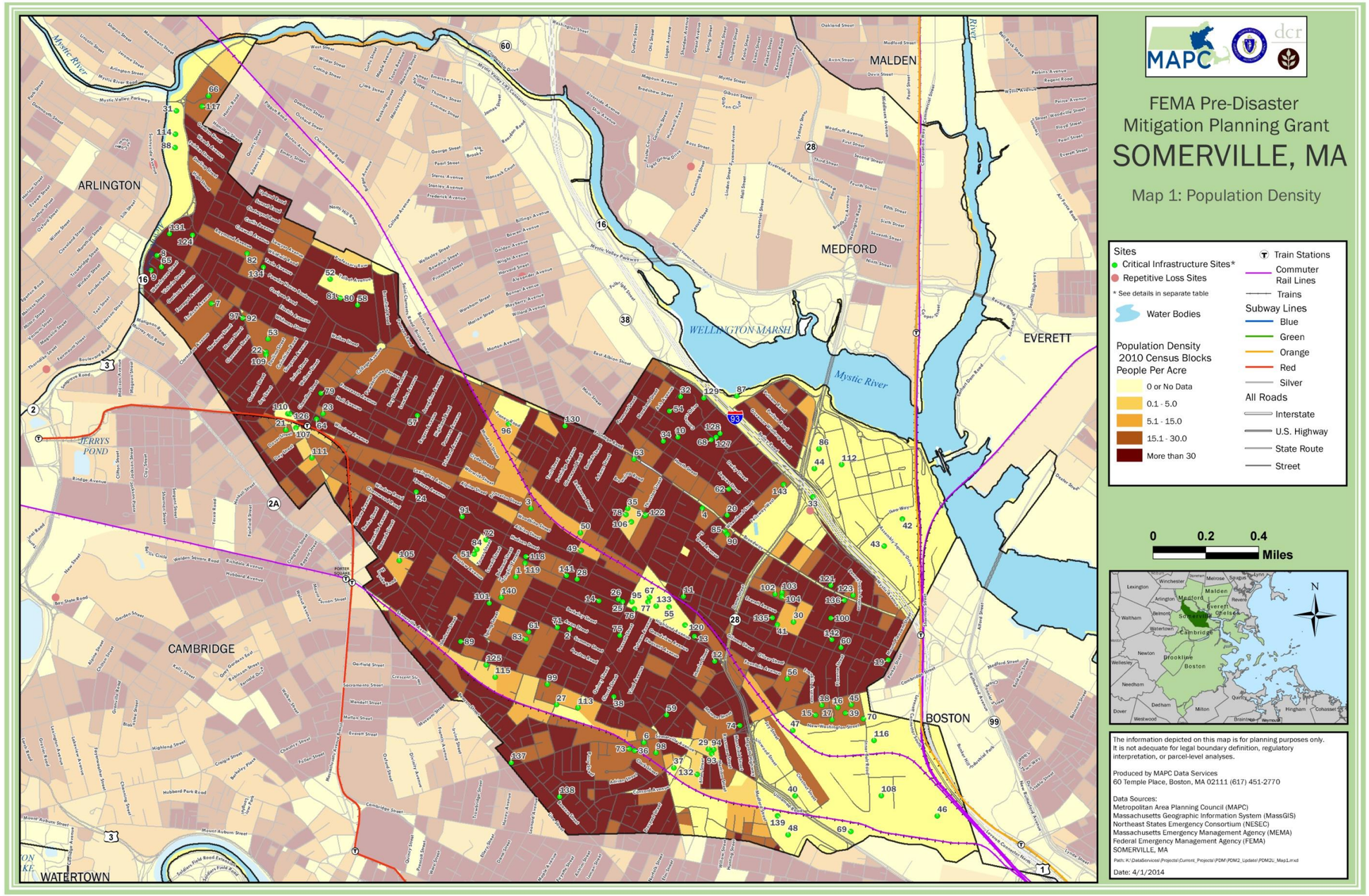
The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to http://pubs.usgs.gov/pp/p1183/pp1183.html.

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.


MAPC
dcr
FEMA Pre-Disaster
Mitigation Planning Grant
SOMERVILLE, MA
Map 1: Population Density
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
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
Train Stations
Commuter Rail Lines
Trains
Subway Lines
Blue
Green
Orange
Red
Silver
All Roads
Interstate
U.S. Highway
State Route
Street
0 0.2 0.4
Miles
N
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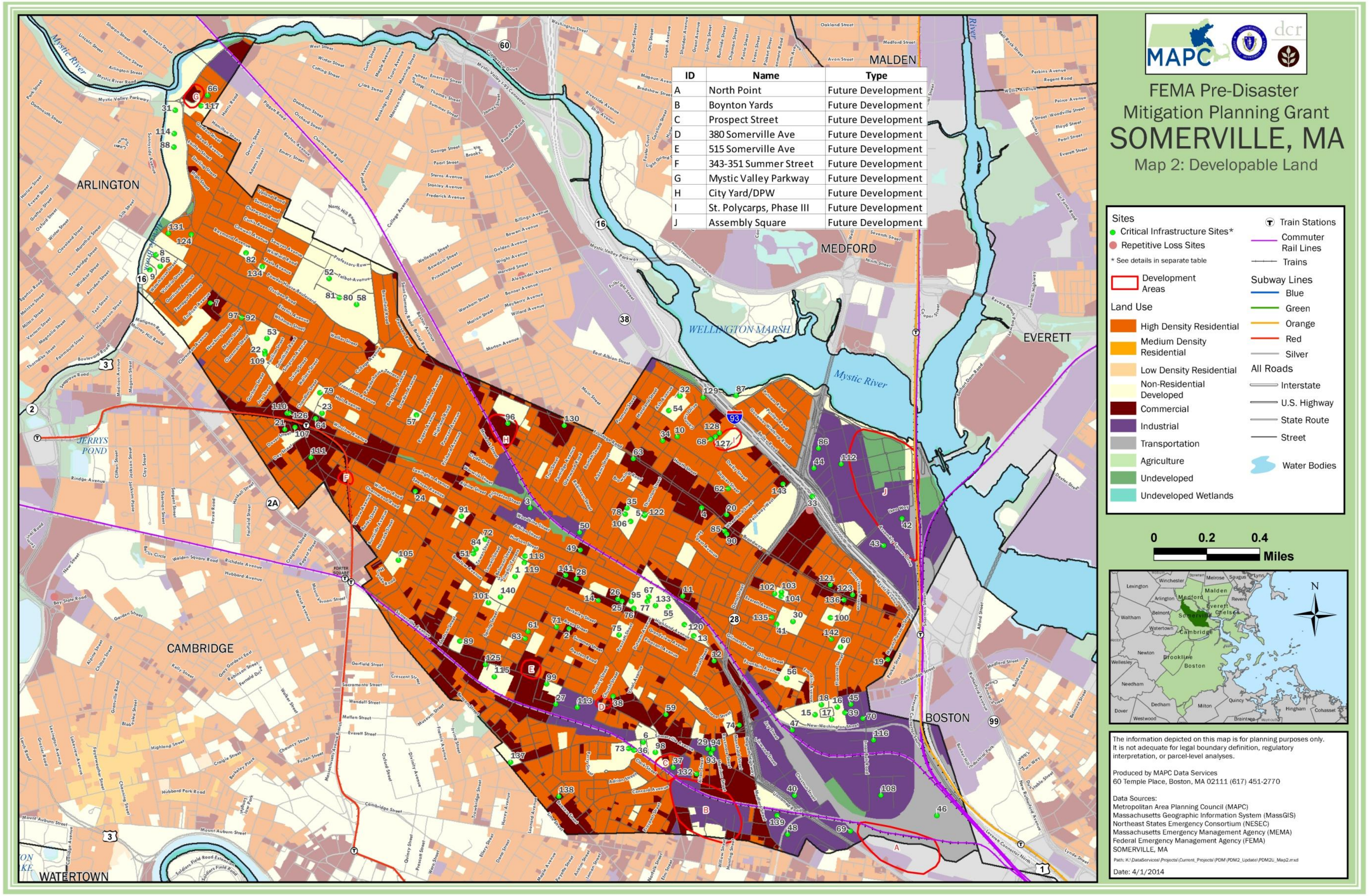
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
SOMERVILLE, MA
Date: 4/1/2014
ARLINGTON
CAMBRIDGE
WATERTOWN
MALDEN
MEDFORD
EVERETT
BOSTON
WELLINGTON MARSH
Mystic River
JERRYS POND


FEMA Pre-Disaster
Mitigation Planning Grant
SOMERVILLE, MA
Map 2: Developable Land
MAPC
ID | Name | Type
A | North Point | Future Development
B | Boynton Yards | Future Development
C | Prospect Street | Future Development
D | 380 Somerville Ave | Future Development
E | 515 Somerville Ave | Future Development
F | 343-351 Summer Street | Future Development
G | Mystic Valley Parkway | Future Development
H | City Yard/DPW | Future Development
I | St. Polycarps, Phase III | Future Development
J | Assembly Square | Future Development
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Development Areas
Land Use
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
Subway Lines
Blue
Green
Orange
Red
Silver
All Roads
Interstate
U.S. Highway
State Route
Street
Water Bodies
0 0.2 0.4 Miles
ARLINGTON
MEDFORD
MALDEN
EVERETT
CAMBRIDGE
BOSTON
WATERTOWN
WELLINGTON MARSH
Mystic River
JERRYS POND
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Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
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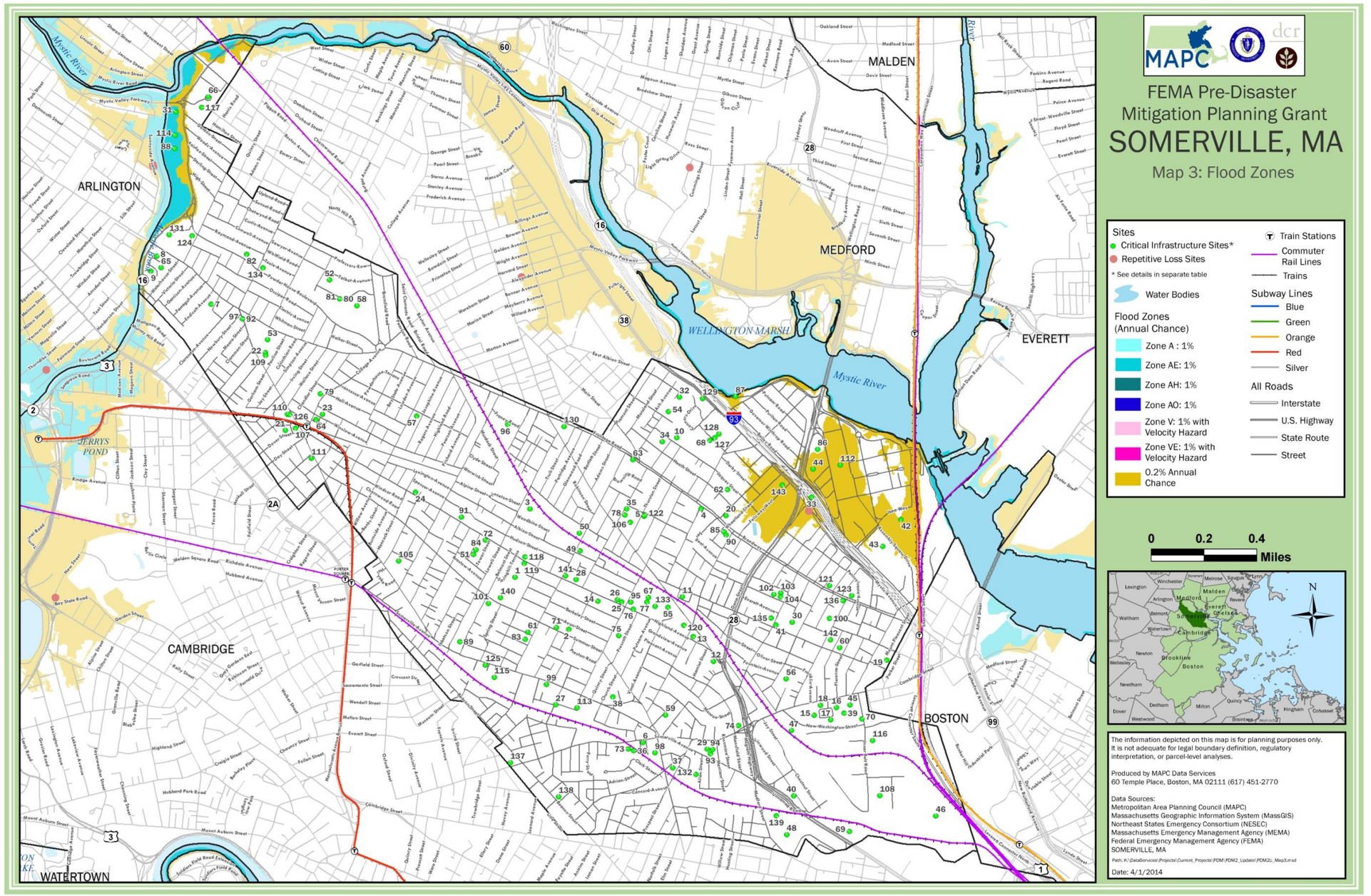
MAPC
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Mitigation Planning Grant
SOMERVILLE, MA
Map 3: Flood Zones
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
Flood Zones
(Annual Chance)
Zone A : 1%
Zone AE: 1%
Zone AH: 1%
Zone AO: 1%
Zone V: 1% with Velocity Hazard
Zone VE: 1% with Velocity Hazard
0.2% Annual Chance
Train Stations
Commuter Rail Lines
Trains
Subway Lines
Blue
Green
Orange
Red
Silver
All Roads
Interstate
U.S. Highway
State Route
Street
0 0.2 0.4
Miles
N
ARLINGTON
MALDEN
MEDFORD
EVERETT
CAMBRIDGE
BOSTON
WATERTOWN
WELLINGTON MARSH
Mystic River
JERRYS POND
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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)
SOMERVILLE, MA
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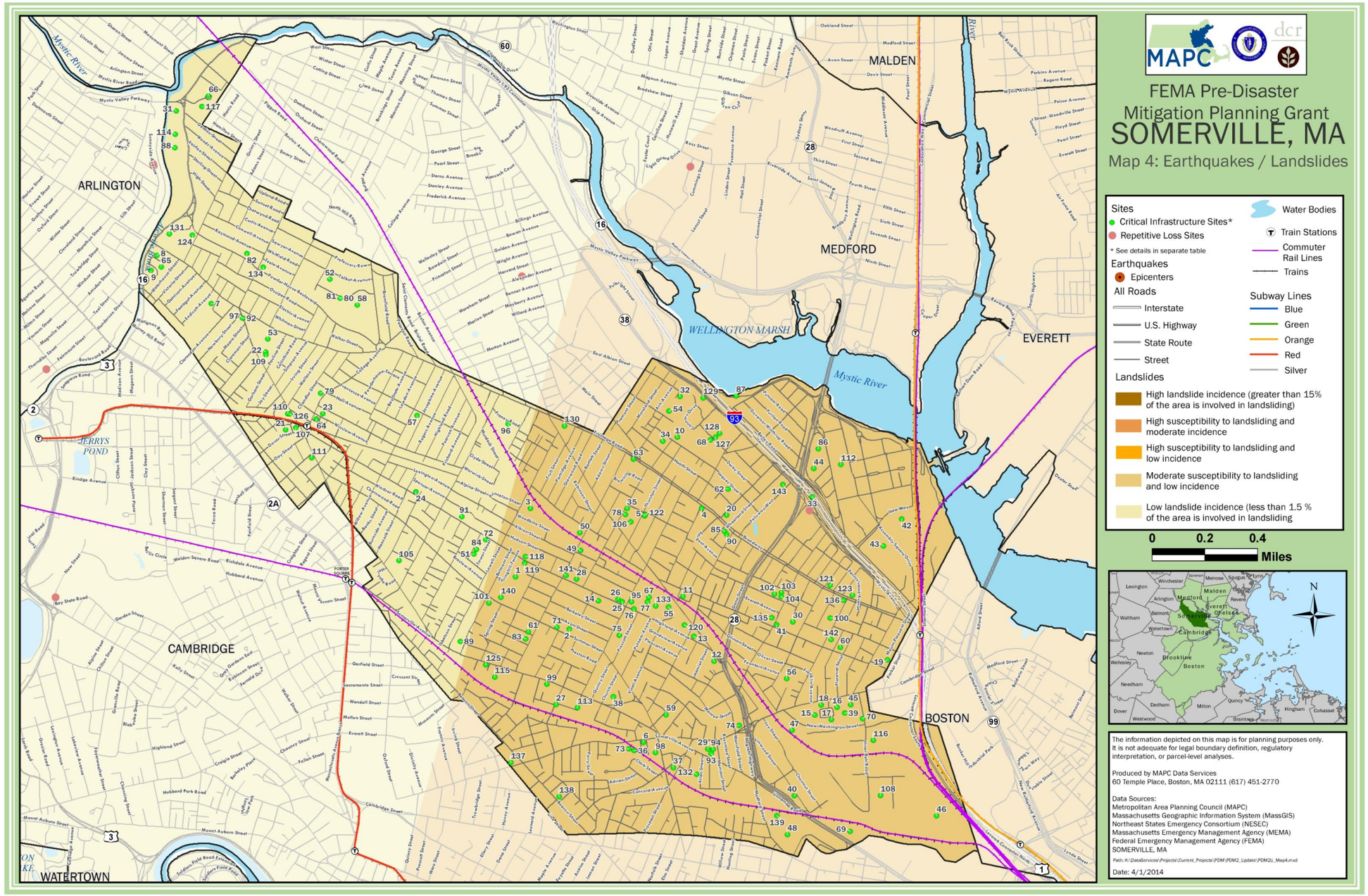
MAPC
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FEMA Pre-Disaster
Mitigation Planning Grant
SOMERVILLE, MA
Map 4: Earthquakes / Landslides
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Earthquakes
Epicenters
All Roads
Interstate
U.S. Highway
State 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)
Water Bodies
Train Stations
Commuter Rail Lines
Trains
Subway Lines
Blue
Green
Orange
Red
Silver
0 0.2 0.4
Miles
N
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Data Sources:
Metropolitan Area Planning Council (MAPC)
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Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
SOMERVILLE, MA
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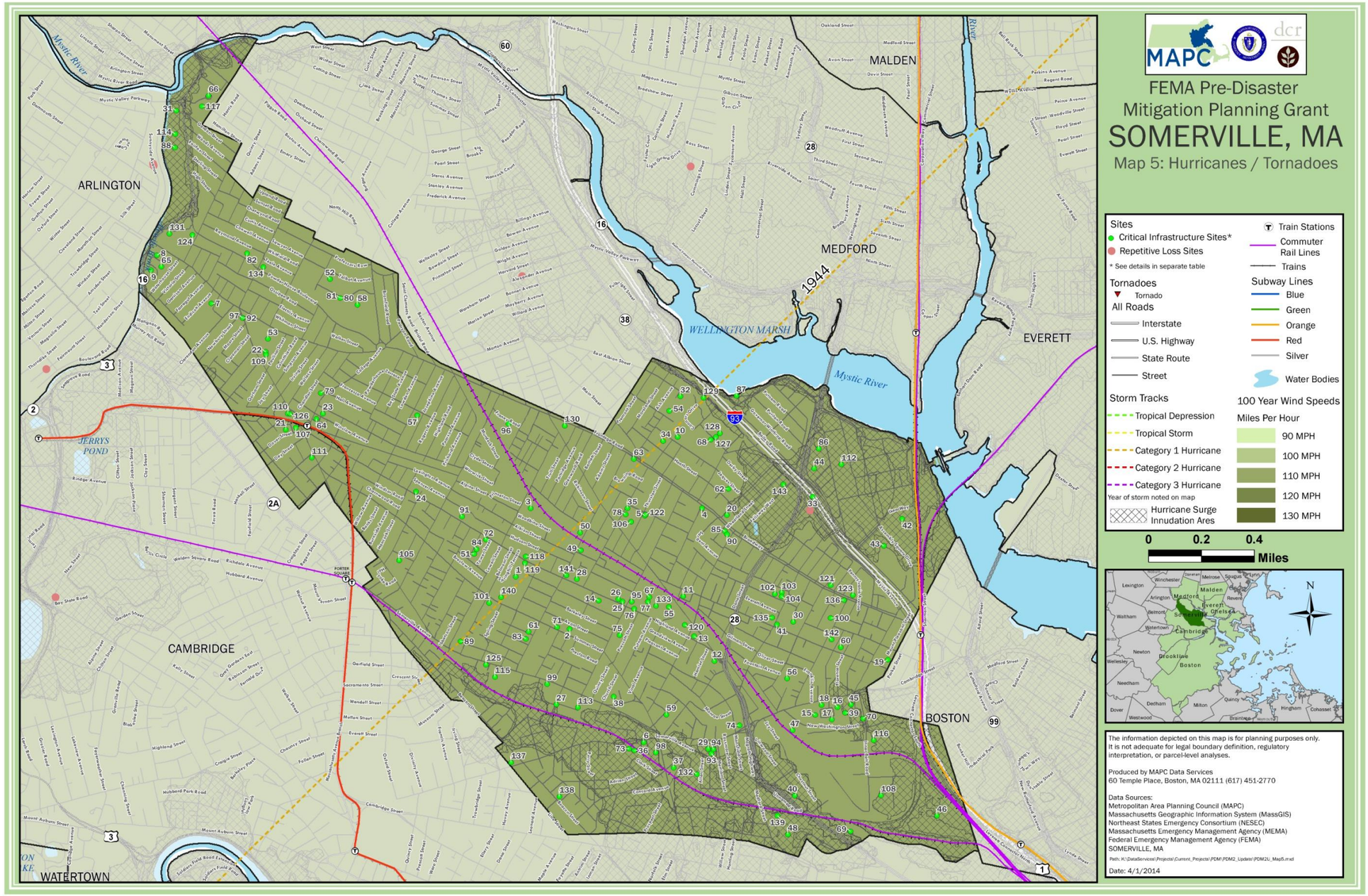
ARLINGTON
CAMBRIDGE
WATERTOWN
MALDEN
MEDFORD
EVERETT
BOSTON
WELLINGTON MARSH
Mystic River
JERRYS POND


MAPC
dcr
FEMA Pre-Disaster
Mitigation Planning Grant
SOMERVILLE, MA
Map 5: Hurricanes / Tornadoes
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Tornadoes
Tornado
All Roads
Interstate
U.S. Highway
State Route
Street
Storm Tracks
Tropical Depression
Tropical Storm
Category 1 Hurricane
Category 2 Hurricane
Category 3 Hurricane
Year of storm noted on map
Hurricane Surge Innudation Ares
Train Stations
Commuter Rail Lines
Trains
Subway Lines
Blue
Green
Orange
Red
Silver
Water Bodies
100 Year Wind Speeds
Miles Per Hour
90 MPH
100 MPH
110 MPH
120 MPH
130 MPH
0 0.2 0.4
Miles
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Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
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Date: 4/1/2014
ARLINGTON
MALDEN
MEDFORD
EVERETT
CAMBRIDGE
BOSTON
WATERTOWN
WELLINGTON MARSH
Mystic River
JERRYS POND
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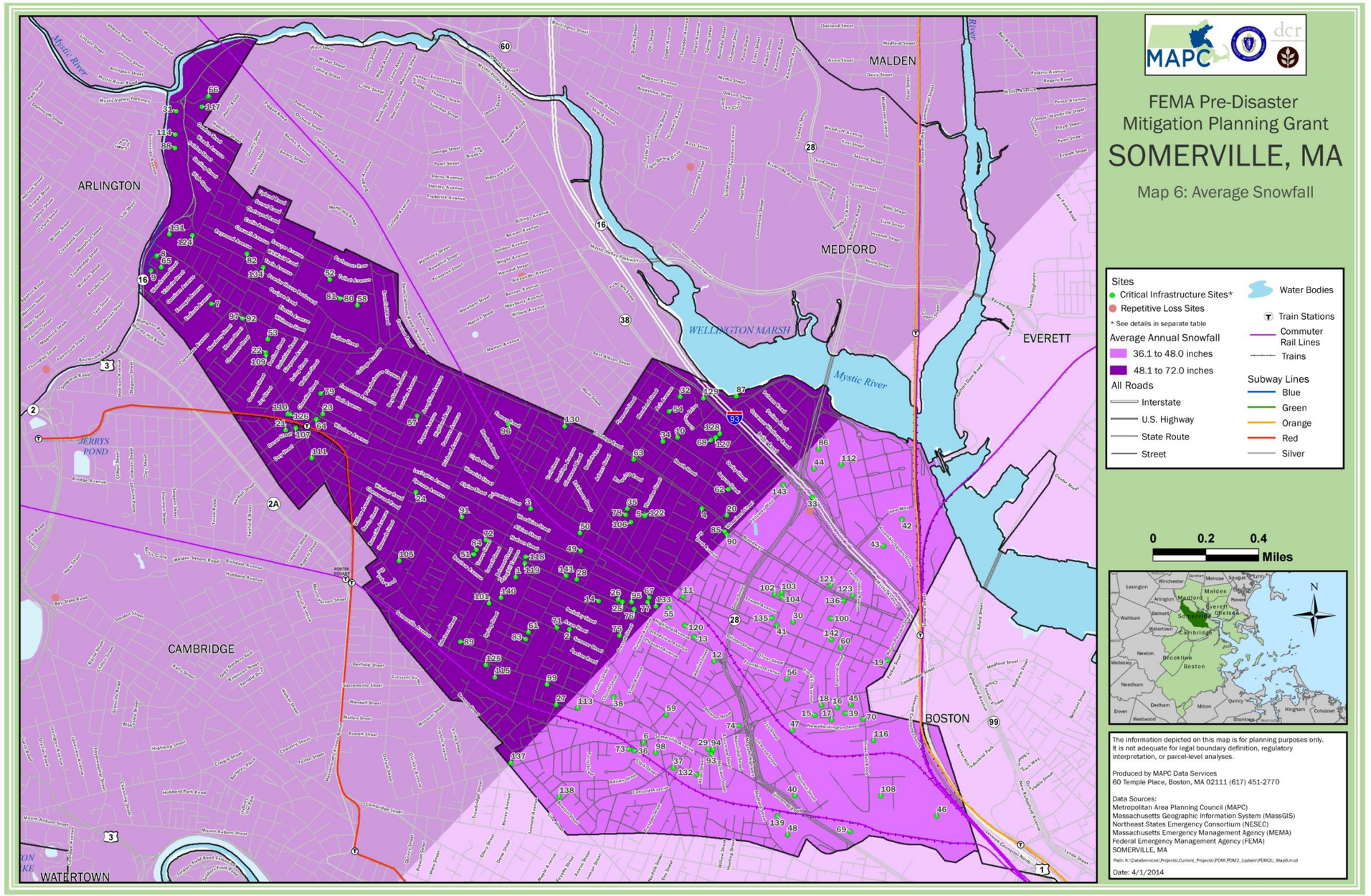
MAPC
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Mitigation Planning Grant
SOMERVILLE, MA
Map 6: Average Snowfall
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Average Annual Snowfall
36.1 to 48.0 inches
48.1 to 72.0 inches
All Roads
Interstate
U.S. Highway
State Route
Street
Water Bodies
Train Stations
Commuter Rail Lines
Trains
Subway Lines
Blue
Green
Orange
Red
Silver
0 0.2 0.4
Miles
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Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
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MEDFORD
EVERETT
CAMBRIDGE
BOSTON
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WELLINGTON MARSH
Mystic River
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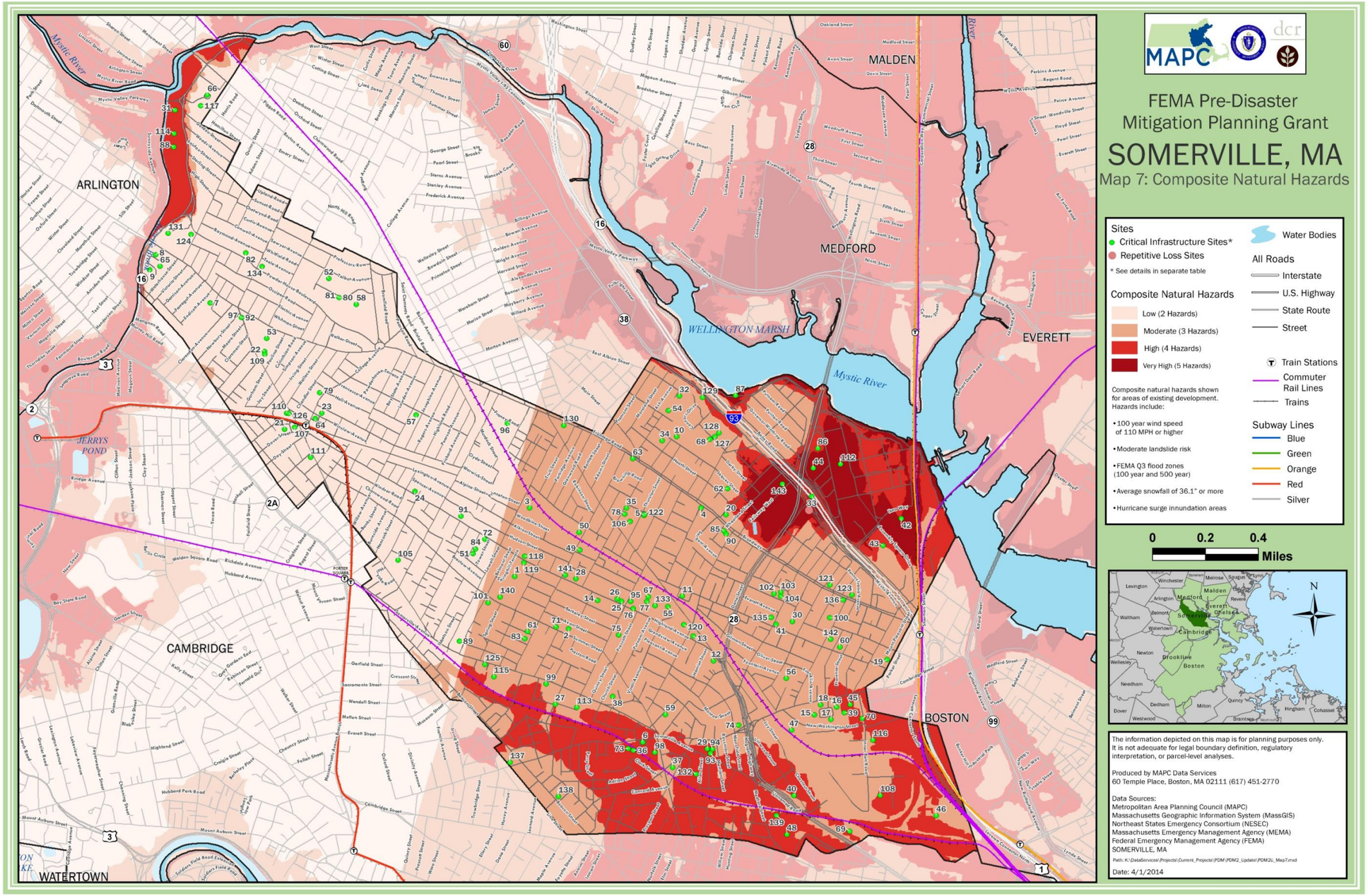
MAPC
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Mitigation Planning Grant
SOMERVILLE, MA
Map 7: Composite Natural Hazards
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Composite Natural Hazards
Low (2 Hazards)
Moderate (3 Hazards)
High (4 Hazards)
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 innundation areas
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Train Stations
Commuter Rail Lines
Trains
Subway Lines
Blue
Green
Orange
Red
Silver
0 0.2 0.4
Miles
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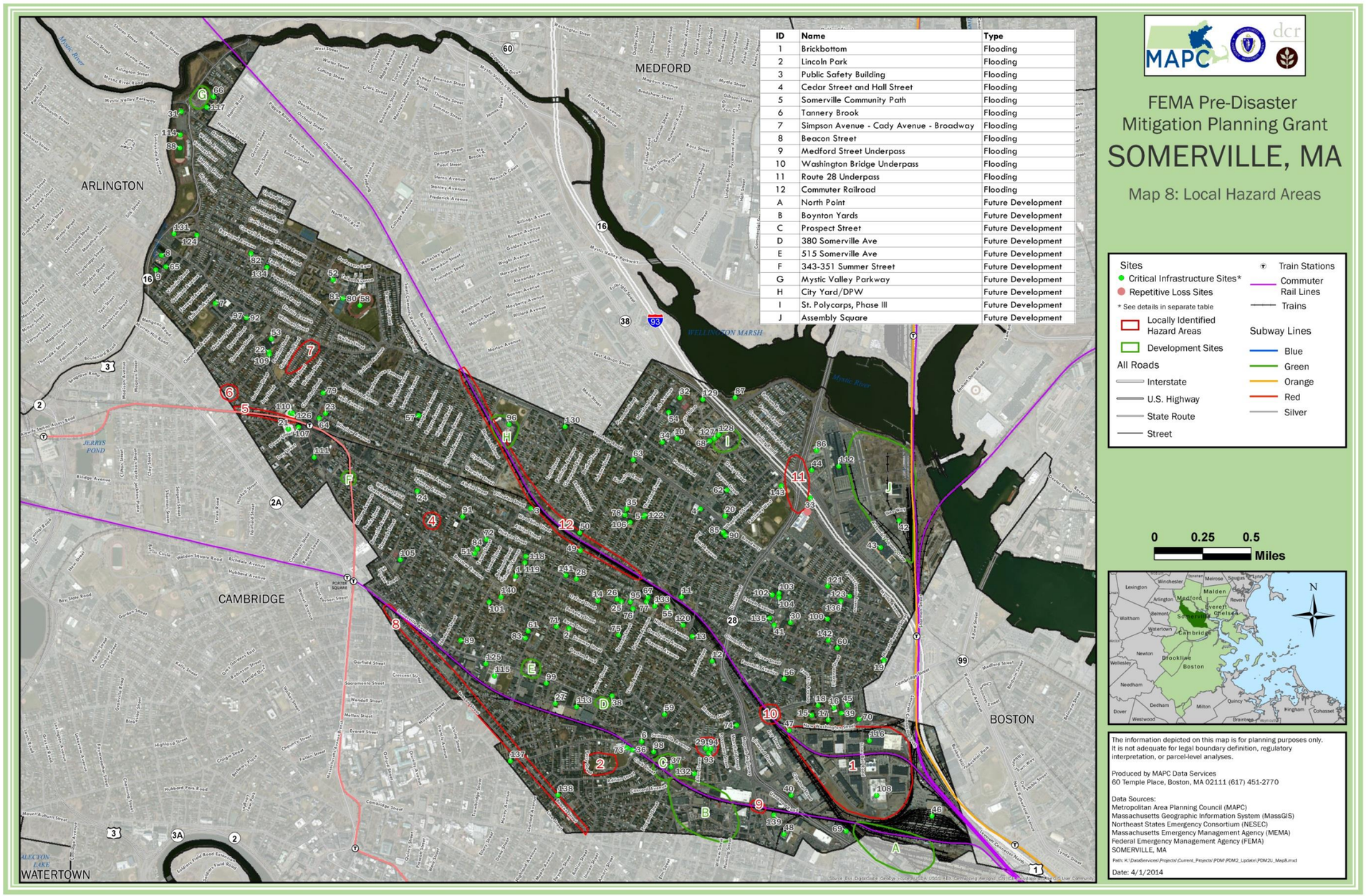

ID	Name	Type
1	Brickbottom	Flooding
2	Lincoln Park	Flooding
3	Public Safety Building	Flooding
4	Cedar Street and Hall Street	Flooding
5	Somerville Community Path	Flooding
6	Tannery Brook	Flooding
7	Simpson Avenue - Cady Avenue - Broadway	Flooding
8	Beacon Street	Flooding
9	Medford Street Underpass	Flooding
10	Washington Bridge Underpass	Flooding
11	Route 28 Underpass	Flooding
12	Commuter Railroad	Flooding
A	North Point	Future Development
B	Boynton Yards	Future Development
C	Prospect Street	Future Development
D	380 Somerville Ave	Future Development
E	515 Somerville Ave	Future Development
F	343-351 Summer Street	Future Development
G	Mystic Valley Parkway	Future Development
H	City Yard/DPW	Future Development
I	St. Polycarps, Phase III	Future Development
J	Assembly Square	Future Development

MAPC

FEMA Pre-Disaster Mitigation Planning Grant

SOMERVILLE, MA

Map 8: Local Hazard Areas

Sites
- Critical Infrastructure Sites*
- Repetitive Loss Sites

* See details in separate table

- Locally Identified Hazard Areas
- Development Sites

All Roads
- Interstate
- U.S. Highway
- State Route
- Street

Train Stations
- Commuter Rail Lines
- Trains

Subway Lines
- Blue
- Green
- Orange
- Red
- Silver

0 0.25 0.5 Miles

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Data Sources:
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Massachusetts Emergency Management Agency (MEMA)
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SOMERVILLE, MA

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Date: 4/1/2014

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APPENDIX C
DOCUMENTATION OF PUBLIC PARTICIPATION

CITY OF SOMERVILLE, MASSACHUSETTS
MAYOR'S OFFICE OF STRATEGIC PLANNING & COMMUNITY DEVELOPMENT
JOSEPH A. CURTATONE
MAYOR

MICHAEL F. GLAVIN
EXECUTIVE DIRECTOR

PLANNING DIVISION

STAFF
GEORGE PROAKIS, *DIRECTOR OF PLANNING*
LORI MASSA, *SENIOR PLANNER*
AMIE HAYES, *PLANNER*
DAWN PEREIRA, *ADMINISTRATIVE ASSISTANT*

MEMBERS
KEVIN PRIOR, *CHAIRMAN*
MICHAEL A. CAPUANO, ESQ.
JOSEPH FAVALORO
JAMES KIRYLO
ELIZABETH MORONEY

PLANNING BOARD AGENDA REVISED

A public hearing for all interested parties will be held by the Planning Board on **Thursday, December 13, 2012** at 6:00 p.m. at the Visiting Nurse Association, 259 Lowell St, 3rd Floor Community Room, Somerville, MA.

No Cases to be Heard

Other Business
FEMA Pre-Disaster Mitigation Plan Presentation by the Metropolitan Area Planning Council.

Update ASQ Block 4 garage

Plans and reports are available at the City of Somerville website at the following link:
www.somervillema.gov/planningandzoning/reports

CITY HALL • 93 HIGHLAND AVENUE • SOMERVILLE, MASSACHUSETTS 02143
(617) 625-6600 EXT. 2500 • TTY: (617) 666-0001 • FAX: (617) 625-0722
www.somervillema.gov

HAZARD MITIGATION PLAN PUBLIC MEETING

Natural hazards can have serious impacts on the City of Somerville and its residents



The Somerville Hazard Mitigation Plan presents a strategy for reducing the City's vulnerability to the impacts of natural hazard events such as flooding, hurricanes and winter storms.

Join the City for a presentation and discussion about the update to the Somerville Hazard Mitigation Plan at a Public Health and Public Safety Committee Meeting

Date: Wednesday, December 4, 2013

Time: 6:00PM

Location: Committee Room, 2nd Floor
Somerville City Hall (93 Highland Ave)

For more information, please contact Barry Keppard via phone at (617) 933-0750 or email bkeppard@mapc.org

MAPC
METROPOLITAN AREA PLANNING COUNCIL

If you need any special accommodations, such as language interpretation, assistive listening devices or meeting materials in alternate formats, please use the contact information above to notify us in advance. We would appreciate notice as soon as possible, but at least one week prior to the event would be appreciated.

CITY OF SOMERVILLE, MASSACHUSETTS
CLERK OF COMMITTEES

PUBLIC HEALTH AND PUBLIC SAFETY COMMITTEE

Wednesday - December 4, 2013, 6:00 PM

Committee Room – 2nd Floor – City Hall

AGENDA – Part 1

- **190058: Discuss in Committee** That the Director of SPCD Provide This Board with the Latest Revision to the City's Rodent Control Policies before the Next Meeting of the Committee on Public Health and Public Safety, and appear with Appropriate Designees at Said Meeting. (Paulette Renault-Caragianes, Goran Smiljic)
- **194984: Discuss in Committee** That the Committee on Public Health and Safety request that the Executive Director of the Cambridge Health Alliance appear to explain, at a public hearing, its recent proposal to reduce funding for services to Somerville's youth community. (Paulette Renault-Caragianes, Omar Boukili)
- **195593: Discuss in Committee** That the Director of SPCD (ISD), the Director of Health and the Administration appear before this Board to report on their strategy to deal with the rodent epidemic being experienced in most parts of the city. (Paulette Renault-Caragianes, Goran Smiljic)
- **195594: Discuss in Committee** That the Director of SPCD (ISD) appear before this Board to report on the mechanics of the city's rodent baiting strategy. (Paulette Renault-Caragianes, Goran Smiljic)
- **195625: Discuss in Committee** The this Board's Committee on Public Health and Safety review the city's enforcement of the prohibition of riding bicycles on sidewalks. (Police Department Representative)
- **195644: Discuss in Committee** That this Board's Committee on Public Health and Safety examine the feasibility of registering bicycles. (Police Department Representative)
- **195880: Recommend** Requesting review and approval of the MAPC's 2013 Update to the 2008 Hazardous Mitigation Plan. (Pat Sullivan et al)

APPENDIX D
DOCUMENTATION OF PLAN ADOPTION

<CITY LETTERHEAD>

CERTIFICATE OF ADOPTION
BOARD OF ALDERMEN

CITYOF SOMERVILLE, MASSACHUSETTS

A RESOLUTION ADOPTING THE
CITY OF SOMERVILLE HAZARD MITIGATION PLAN UPDATE 2016

WHEREAS, the City of Somerville, MA established a Committee to prepare the *City of Somerville Hazard Mitigation Plan Update 2016*; and

WHEREAS, the *City of Somerville Hazard Mitigation Plan Update 2016* contains several potential future projects to mitigate potential impacts from natural hazards in the City of Somerville, and

WHEREAS, a duly-noticed public meeting was held by the Somerville Public Health and Public Safety Committee of the Board of Aldermen on December 4, 2013, and

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

NOW, THEREFORE BE IT RESOLVED that the Somerville Board of Aldermen adopts the *City of Somerville Hazard Mitigation Plan Update 2016*, in accordance with M.G.L. 40 §4 or the charter and ordinances of the City of Somerville.

ADOPTED AND SIGNED this Date. _____

Name(s) / Title(s) Signature(s)

ATTEST