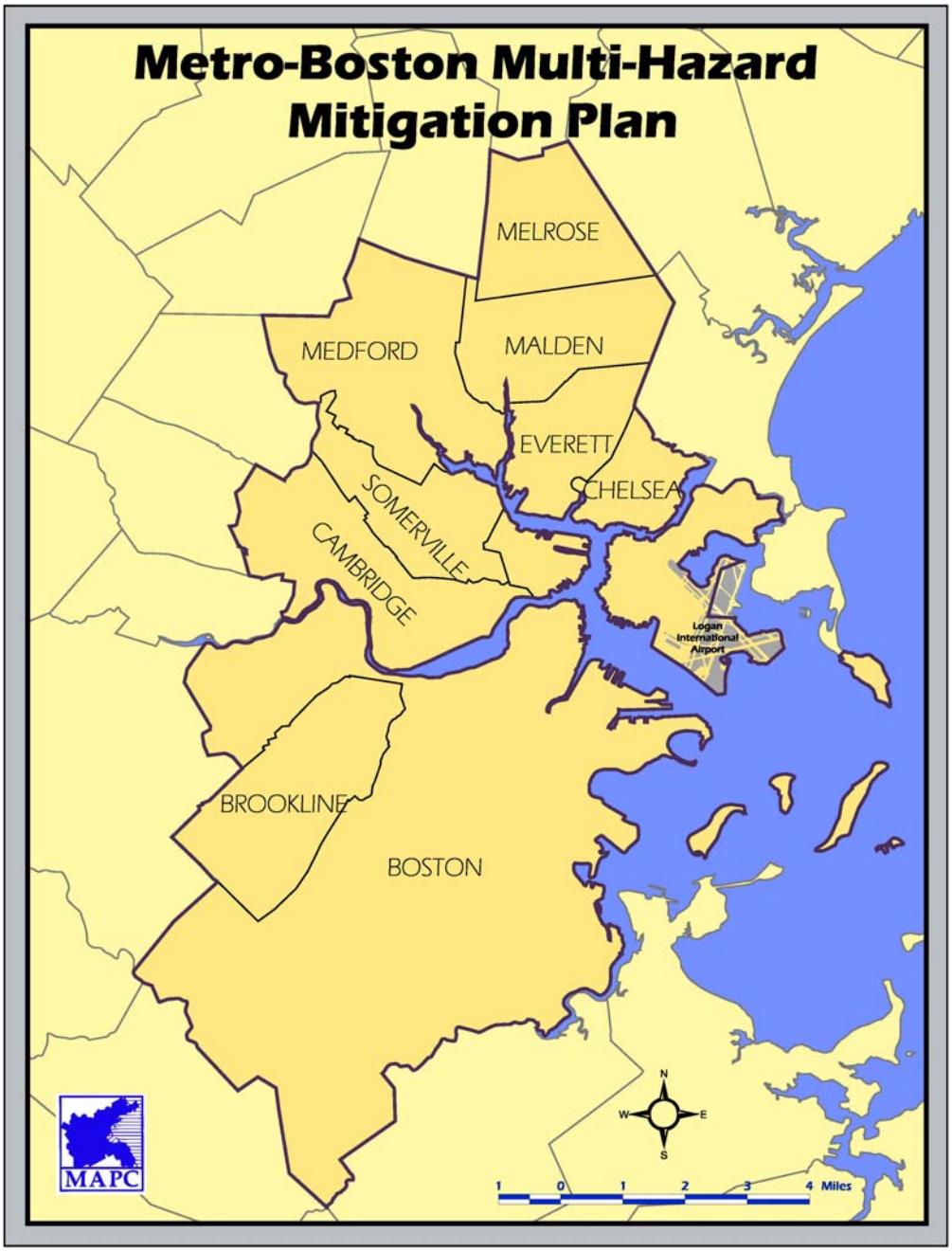


CAMBRIDGE ANNEX
MARCH, 2008

Metropolitan Area Planning Council
60 Temple Place
Boston MA 02111

[This page intentionally left blank]

ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the City of Cambridge 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.

MAPC Officers
President: Richard A. Dimino
Vice President: Gordon Feltman
Secretary: Jeanne E. Richardson
Treasurer: Grace Shepard
Executive Director: Marc D. Draisen

Credits
Project Manager: Martin Pillsbury
Lead Project Planner: Heidi Samokar, AICP
Mapping/GIS services: Allan Bishop, Tarin Comer and David dosReis

Massachusetts Emergency Management Agency
Director: Don Boyce

Department of Conservation and Recreation
Commissioner: Rick Sullivan

City of Cambridge, Department of Public Works
Lisa Peterson: Commissioner

MAPC
Metropolitan Area Planning Council
60 Temple Place
Boston MA 02111

[This page intentionally left blank]

TABLES OF CONTENTS

Introduction 1
Planning Requirements under the Federal Disaster Mitigation Act 1
What is Hazard Mitigation? 1
Community Profile 1
Overview 1
Existing Land Uses 3
Potential Future Land Uses 5
Natural Disaster Planning Structure 7
Public Participation 8
Cambridge's Participation in the Regional Committee 8
The Local Multiple Hazard Community Planning Team 8
The Public Meeting 10
Overview of Hazards and Vulnerabilities 10
Overview of Hazards and Impacts 10
Critical Facilities in Hazard Areas 17
Potential Damages to Existing Development 21
Potential Impacts to Future Development 25
Hazards and Existing Mitigation Measures 25
Flooding 25
Wind 37
Winter-Related Hazards 38
Fire 39
Geologic Hazards 39
Other Hazards 40
Compilation of All Existing Mitigation 42
Hazard Mitigation Goals and Objectives 47
Potential Mitigation 49
What is Hazard Mitigation? 49
Identification of Potential Mitigation Measures 49
High Priority Mitigation Measures 50
Medium Priority Mitigation Measures 52
Other Potential Mitigation Measures 54
Mitigation Summary Table 58
Regional and Inter-Community Considerations 63
Regional Partners 63
Overview of Regional Facilities within Cambridge 63
Overview of Inter-Community Considerations 63
Plan Adoption and Maintenance 64
Plan Adoption 64
Plan Maintenance 64
Implementation Schedule 64
Integration of the Plans with Other Planning Initiatives 65
Resources 67

APPENDICES

Appendix A – Maps 69
Appendix B – Agendas for Metro Boston Regional Hazard Mitigation Community Planning Team 79
Appendix C – Local Multiple Hazard Community Planning Team Meeting Agendas ... 85
Appendix D – Media Advisory and Meeting Agenda for Public Meeting 91
Appendix E – Maps of Cambridge Water System Facilities 95
Appendix F – Compilation of Suggested Mitigation Measures from 5/2/06 Meeting 99
Appendix G – Documentation of Plan Adoption by Cambridge City Council 112

LIST OF TABLES

Table 1. Cambridge Characteristics, 2000 2
Table 2. College Students, Workers, and Buildings, 2004 2
Table 3. 1999 Land Use, Cambridge 4
Table 4. 2003 Land Use, Cambridge 4
Table 5. Buildout Impacts 5
Table 6. Comparison of Buildout to 1990 and Present 5
Table 7. Attendance at the Cambridge Local Multiple Hazard Community Planning Team Meetings 9
Table 8. Other Local Meetings 9
Table 9. Frequency and Severity of Natural Hazards in the State 11
Table 10. Relationship of Critical Facilities and Selected Hazards 19
Table 11. Estimated Damage in Cambridge from a Category 2 or 4 Hurricane 23
Table 12. Estimated Damage in Cambridge from Magnitude 5.0 and 7.0 Earthquakes.. 24
Table 13. Estimated Potential Damages from Flooding 25
Table 14. Future Development in Hazard Areas 25
Table 15. Existing Natural Hazard Mitigation Measures, Cambridge 43
Table 16. Potential Mitigation Measures 59

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 Federal Emergency Management Agency (FEMA) funding for hazard mitigation grants must adopt a local multi-hazard mitigation plan. This planning requirement does not affect disaster assistance funding.

Massachusetts has taken a regional approach and has encouraged regional planning agencies to apply for grants to prepare plans for groups of communities. The Metropolitan Area Planning Council (MAPC) received a grant from FEMA under the Pre-Disaster Mitigation (PDM) Program, to assist the City of Cambridge and eight other communities to develop a regional multiple-hazard mitigation plan. The regional plan and the local annex meet the requirements of the Disaster Mitigation Act.

What is Hazard Mitigation?
Natural hazard mitigation planning is the process of figuring out how to 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 damage resulting from natural hazards through long-term strategies. These long-term strategies can include planning, policy changes, programs, projects and other activities.

COMMUNITY PROFILE

Overview
Cambridge borders Watertown, Belmont, Arlington and Somerville and is separated from Boston by the Charles River. Cambridge was first organized as a town in 1630 and then incorporated as a city in 1846. It is located in Middlesex County. The city has a Council-Manager form of government.

The city's website is at http://www.cambridgema.gov/index.cfm.

In 2000, Cambridge had 101,355 residents and 44,725 housing units. The city's land area is 6.5 square miles. Its total area is 7.13 square miles. The city is served by State Routes 2, 2A, 16, and 38, the MBTA's Red Line, the commuter rail, and a number of bus routes. Table 1 highlights key community data from the 2000 Census.

Cambridge is home to four colleges/universities: Harvard University (including Radcliffe College), the Massachusetts Institute of Technology (MIT), Lesley College, and the Episcopal Divinity School/Weston Seminary. When discussing natural hazards, the presence of the educational institutions is an important consideration. These schools bring in a number of students to Cambridge every year and bring thousands of workers

into Cambridge every day (see Table 2 for details). In addition, they often conduct their own hazard planning and emergency preparedness programs.

Table 1. Cambridge Characteristics, 2000

Population = 101,355

- 4.1% are under age 5
- 9.1% are over age 65
- 11.4% speak English less than "very well" (over age 5)
- 26% of households have no vehicle
- 14.2% have a disability (over age 5)
- 14.5% live in group quarters

Number of Housing Units = 44,725

- 67.7% are renter-occupied housing units
- 56% of housing units were built prior to 1940

Source: U.S. Census, 2000.

Table 2. College Students, Workers, and Buildings, 2004

	Cambridge College	Harvard Univ.	Lesley Univ.	MIT	Total
Total Acres	1	223	12	241	476
Number of Buildings	1	302	32	125*	460
Staff & Faculty	126	10,143	533	7,775	18,577
Students	1,918	21,201	4,690	10,230	38,039
Students in Dormitories	0	7,860	545	5,460	13,865
Students in Off-Campus Affiliated Housing	0	1,350	0	197	1,547

*Only tax exempt buildings included in this number.
Source: 2004 Cambridge Town Gown Annual Report.

Cambridge faces many challenges in terms of hazard mitigation planning. Challenges include:

- The city is among the densest communities in the nation and is more or less built out.
- The city's population quadruples in the daytime.
- The city has topographic challenges. Drainage from many other communities flow through Cambridge to the Charles River. Yet the city is flat.
- Cambridge is an older city with aging infrastructure and narrow streets.
- As of the 2000 census, 828 residents over age 5 have a sensory disability and 1,514 have a physical disability.

- Cambridge has a richly diverse population, speaking a broad range of languages. Households where the primary language is not English, include Spanish (6.8% of households), French or French Creole (5.1%), Chinese (3.7%), Portuguese (2.9%) and Indic languages (1.9%). A significant proportion of households are considered linguistically isolated.

Despite these challenges, Cambridge has the reputation of being a well-managed and progressive city. Because the city is well-managed financially, the city is able to provide high-quality services and a wide array of services that many other communities can not provide. The city has demonstrated a firm commitment to environmental protection on a global and local level. The city's Fire Department has achieved ISO (Insurance Services Office) Class 1 rating – only 32 communities in the country have achieved this rating. The city also has a commitment to all-hazard planning, as discussed later.

Existing Land Uses

The most recent land use statistics available from the state are from 1999 aerial photography. Table 3 breaks the city into 21 land use categories. The table shows the acreage of each land use category and the percentage of land area in Cambridge in each category. The city posts its own land use summary, updated to 2003, on its website. Table 4 presents the city's data.

Both tables show that roughly one-third of the city's land area is developed for residential uses. According to the city's data, almost 20% of Cambridge is devoted to transportation land uses, which includes roadways and transit. Just over eight percent of the city is protected as open space and roughly 170 acres (or 3.7% of the city) is vacant land.

Open Land includes areas with abandoned agriculture, power lines or areas devoid of vegetation. Urban Open Land includes undeveloped land, institutions, cemeteries and protected green space.

Table 3. 1999 Land Use, Cambridge

Land Use	Acres	% of City
Cropland	1	0.02%
Pasture	0	0
Forest	72	1.6%
Non-forested Wetlands	42	0.9%
Mining	0	0
Open Land	33	0.7%
Participatory Recreation	312	6.8%
Spectator Recreation	0	0
Water Recreation	6	0.013%
Multi-family Residential	1,305	28.5%
High Density Residential (less than ¼ acre lots)	360	7.9%
Medium Density Residential (¼ – ½ acre lots)	34	0.75%
Low Density Residential (larger than ½ acre lots)	0	0
Salt Water Wetlands	0	0
Commercial	591	12.9%
Industrial	551	12.0%
Urban Open	631	13.8%
Transportation	173	3.8%
Waste Disposal	10.4	0.23%
Water	461	10.1%
Woody Perennials	0	0
Total	*4,584*	*100%*

Source: MassGIS (see www.mass.gov/mgis/lus.htm. for more information on categories).

Table 4. 2003 Land Use, Cambridge

Land Use	Acres	% of Land Area
Residential	1,418	31.1%
Transportation	856	18.8%
Open Water	494	10.8%
Education	454	10.0%
Protected Open Space	389	8.5%
Commercial	360	7.9%
Government, Health, Charitable	213	4.7%
Industrial	202	4.4%
Vacant	169	3.7%
Total	4,555	100%

Source: http://www.cambridgema.gov/~CDD/data/commdevlu/landuse_2003.html. See web site for details on each land use category.

Potential Future Land Uses

In 2000, MAPC, under contract to the Executive Office of Environmental Affairs, prepared a buildout analysis for every community in the Boston region. A buildout analysis is a tool to help communities understand the potential impacts of future growth that might occur given the amount of developable land remaining and how that land is zoned. The buildout is based on available land within each zoning district and projects the number of additional housing units and commercial development that could be accommodated. Generally, the projections account only for as-of-right development. The results of the 2000 Census were not released when MAPC performed the analyses. See Tables 5 and 6 for the results of Cambridge's buildout analysis.

Table 5. Buildout Impacts

Additional Residents	26,741
Additional K-12 Students	2,239
Additional Residential Units	13,173
Additional Residential Water Use	2,005,585 gallons per day
Additional Commercial/Industrial	16,434,574 square feet
Additional Comm/Ind. Water Use	1,232,593 gallons per day
Additional Solid Waste	13,718 tons per year
Non-Recyclable	9,755 tons per year

Note: The city's land use calculations indicate that there are 170 acres of vacant land. The buildout analysis was based primarily on redevelopment so a developable land total is not included.

Table 6. Comparison of Buildout to 1990 and Present

Residents	1990	95,802
	Current	101,355
	Buildout	128,096
Students (K-12)	1990	7,497
	Current	7,300
	Buildout	9,539
Households	1990	39,405
	Current	42,615
	Buildout	55,788
Water Use (gallons/day)	1990	14,340,000
	Buildout	17,088,179

Current = 2000 Census for Residents and Housing Units; current number of students and water use were taken from build out analysis.

For urban, developed communities like Cambridge, new development tends to be in the form of redevelopment. This means that analyzing vacant land and zoning does not always give an accurate picture of what the future holds. To give a more realistic picture of future growth, officials from the Department of Community Development provided information on where future development was planned or being considered, as of June 2005. Areas include (see Map 2 in Appendix A):

1. University Park

The 27-acre area is owned by MIT and leased to Forest City Enterprises. Most of the project has been built with the last two buildings under construction. The area includes roughly 2.3 million square feet of residences (almost 700 units), biotechnology uses, a dormitory, and a hotel.

2. Cambridge Research Park

This 9.8-acre area, which lies along the Board Canal, is being developed as a Planned Unit Development (PUD) and is currently owned by Lyme Properties. The area will include roughly 1.5 million square feet of a variety of uses, including biotechnology, research and development and residences. The area was a brownfield.

3. 303 Third Street

This project will consist of almost 600 residences. The site is 3.5 acres.

4. North Point

Jones Lange LaSalle is the developer for North Point. Construction will be phased over 15 to 20 years. Five million square feet is planned, with roughly 2 million square feet of residences (over 2,000 units), 3 million square feet of commercial uses, and 10 acres of open space. The area totals 43.7 acres.

5. A.D. Little Site/Cambridge Discovery Park

This area will be redeveloped for commercial uses. The project proposed for this site would increase the amount of office and research space from 416,000 square feet to 820,000 square feet. The project also entails removing parking areas along the Little River Area and providing flood storage capacity.

6. Concord-Alewife

The planning process for this underdeveloped area is at early stages. The city has formulated a vision and new zoning was recently adopted. The vision entails mixed uses throughout the area including housing, allowing development rights to be transferred away from Cambridge Highlands to the area around Alewife Station, and the use of overlay districts to address open space and stormwater issues including the use of Low Impact Development techniques. Much of the 180-acre area is in the 500 year floodplain. Additional approaches to addressing flooding concerns are discussed under potential mitigation for flooding, later.

Within the Concord-Alewife area is the Fresh Pond Shopping Plaza. This plaza likely has high redevelopment potential. The owners have been formulating ideas and it is reasonable to expect that the site will be redeveloped with a mixture of commercial uses and residences over the long term.

Natural Disaster Planning Structure

City

The Emergency Management Department is the lead city entity in terms of disaster preparedness. The Emergency Management Department prepares and updates the city's Comprehensive Emergency Management Plan with input from the relevant departments. The city also has a Local Emergency Planning Committee (LEPC) which plans for the consequences of hazardous material spills. Members of the LEPC include the Public Health Department, Police, Fire, and representatives from local hospitals, universities and businesses.

MIT

While the Department of Facilities plays a primary role in natural hazard mitigation on the MIT campus, a number of other MIT departments are also involved. These include: Police; the Environmental, Health and Safety Office; the Emergency Management Planning Department; the Medical Department; and the Student Emergency Medical Services (student EMTs). In addition, a number of cross-departmental groups have been established including the Business Continuity Management Team, the Emergency Response Team, and the Emergency Operations Center Working Group. The latter is an ad hoc group during emergencies. MIT has prepared an all hazards mitigation plan which was approved by FEMA in 2007.

Harvard

A senior level incident management committee oversees the campuses in Cambridge and Boston. The University serves on the Cambridge (and Boston) LEPC, participates in various trainings with both cities and has regular contact with the city on day-to-day items. Harvard has developed individual plans for handling specific events, such as snow removal. Though the University does not currently have an all-hazards mitigation plan for natural hazards, there are localized plans for particular schools or administrative units.

PUBLIC PARTICIPATION

Public participation in developing this plan occurred primarily at two levels: the regional committee and the Cambridge Multiple Hazard Community Planning Team. The city scheduled a public meeting to present the plan and solicit public input and placed a copy of the meeting presentation and draft plan on its web site.

Cambridge's Participation in the Regional Committee
In November 2004, MAPC notified the nine communities of the first meeting of the Metro Boston Regional Hazard Mitigation Community Planning Team and requested that the Chief Elected Official designate at least two municipal employees and/or officials to represent the community. Cambridge designated Lisa Peterson, Commissioner, Department of Public Works, to represent Cambridge on the regional committee:

Other Cambridge employees/officials participated in one or more regional meetings:

- David O'Connor, Emergency Management Director
- Stacia Joyce, Administrative Assistant, Emergency Management Department
- John Nardone, Assistant Commissioner for Operations, DPW

The Metro Boston Regional Hazard Mitigation Community Planning Team met over the course of the project on the following dates:

- December 16, 2004
- May 19, 2005
- October 14, 2005
- February 23, 2006
- November 16, 2006

Agendas from these meetings are located in Appendix B.

The Local Multiple Hazard Community Planning Team
In addition to the regional committee meetings, MAPC worked with the community representatives to organize a local Multiple Hazard Community Planning Team for Cambridge. MAPC briefed the local representatives as to the desired composition of that team as well as the need for representation from the business community and others.

The Cambridge Multi-Hazard Mitigation Planning Team held its first meeting in April 2005. Attendance for that meeting and other team meetings are found in Table 7 and meeting agendas are included in Appendix C. In addition, MAPC met with other city officials outside of team meetings to collect information. Those other meetings are listed in Table 8; this table does not include meetings held to collect GIS data. MAPC also collected information via phone interviews or email from other officials and private interests in Cambridge including Inspectional Services, Professional Ambulance, Harvard University, MIT, the Housing Authority, Historical Commission, Department of Human Services Programs, and others.

Per the city's request, MAPC also contacted a small number of large developers that have projects underway or will have projects underway in Cambridge to inform them of the project and invite their participation.

Table 7. Attendance at the Cambridge Local Multiple Hazard Community Planning Team Meetings

April 20, 2005
Lisa Peterson, DPW
Stacia Joyce, Emergency Mgmt.
David O'Connor, Emergency Mgmt.
James Wilcox, DPW
John Nardone, DPW
Bill Van Schalkwyk, MIT
Brian Culver, Harvard University
Michael Labosky, Harvard University

July 12, 2005
Lisa Peterson, DPW
Stacia Joyce, Emergency Mgmt.
James Wilcox, DPW
John Nardone, DPW
William Mergendahl, Professional Ambulance

October 20, 2005
Lisa Peterson, DPW
Stacia Joyce, Emergency Mgmt.
David O'Connor, Emergency Mgmt.
James Wilcox, DPW
John Nardone, DPW
Owen O'Riordan, DPW
Rose Makofske, DPW
John Bolduc, Community Development
Sam Lipson, Public Health Dept.
Joe Griffin, Harvard University
Chip Norton, Cambridge Water Dept.

May 2, 2006
Lisa Peterson, DPW
Stacia Joyce, Emergency Mgmt.
David O'Connor, Emergency Mgmt.
James Wilcox, DPW
John Nardone, DPW
Owen O'Riordan, DPW
Rose Makofske, DPW
John Bolduc, Community Development
Sam Lipson, Public Health Dept.
William Mergendahl, Professional Ambulance
Bill Van Schalkwyk, MIT
Christian Lanphere, Cambridge Health Alliance
Bill Schellbach, Cambridge Water Dept.
Sam Corda, Cambridge Water Dept.
Joe Gifun, MIT
Roger Frymire, Resident

Table 8. Other Local Meetings

Date	Participants	Purpose
June 15, 2005	Sam Corda, Cambridge Water Department	Collect information on Water Department facilities and vulnerability to natural hazards.
June 16, 2005	Beth Rubenstein, Assistant City Manager	Collect information on future development.
June 16, 2005	Les Barber, Director of Zoning	Collect information on zoning measures.
June 30, 2005	Sam Lipson, Cambridge Health Alliance	Collect information on public health impacts of various natural hazards.
August 4, 2005	Patrick Johnston, Everett Police Dept.	Boat tour of the Mystic River, Island End River, Chelsea Creek and Boston Harbor.

The Public Meeting
The DPW sponsored a public workshop at its offices on Wednesday, November 29, 2006. The city's weekly newspaper, the Cambridge Chronicle, published the following notice (online, November 17, 2006):

> "DEPARTMENT OF PUBLIC WORKS PUBLIC MEETING - Nov. 29, 5:30 p.m., DPW, 147 Hampshire St. The DPW will present key findings from a draft of the city's multi-hazard mitigation plan collaborated on by the city and the Metropolitan Area Planning Council. For information, call 617-349-4800."

DPW also posted a meeting notice on its website. However, no members of the public attended the meeting. To ensure that anyone interested in the plan would have an opportunity to see the draft, the DPW placed the draft plan on its website along with the powerpoint presentation that had been prepared for the public meeting. The agenda for the meeting and the media advisory are in Appendix D.

OVERVIEW OF HAZARDS AND VULNERABILITIES

This section provides a general overview of how a number of natural hazards impact Cambridge. The next section provides more detail about impacts at specific locations and existing mitigation efforts.

Overview of Hazards and Impacts
The 2004 Massachusetts Hazard Mitigation Plan provides an overview of natural hazards in Massachusetts. It indicates that Massachusetts is subject to the following natural hazards (listed in order of frequency): floods, heavy rainstorms, nor'easters, coastal erosion, hurricanes, tornadoes, urban and wildfires, drought and earthquakes.
Table 9 summarizes the hazard risks for the state and notes where risks in Cambridge differ from the state assessment.

Table 9. Frequency and Severity of Natural Hazards in the State

Hazard	Frequency in State	Severity in State	Issues in Cambridge
Flood	High	Serious to extensive	Same as state.
Dam Failure	Low	Extensive	No dams in Cambridge, but dams upstream could have impacts. Water Dept. owns 2 in watershed communities.
Hurricanes	Medium	Extensive to catastrophic	Higher potential for damages in SLOSH zones.
Severe Storms (wind, hail, lightning)	Medium	Serious	Street tree damage can be a concern.
Tornados	Medium	Extensive to catastrophic	No recorded tornados in Cambridge.
Winter Storms	High	Serious	Same as state. Challenge due to density.
Earthquakes	Low	Catastrophic	Higher potential for damages in areas prone to liquefaction. Boston area at higher risk than rest of state.
Landslides	Low	Minor	Subsidence on filled areas.
Brush Fires	Medium	Serious	Not an issue in Cambridge.

Definitions Used in the Commonwealth of Massachusetts State Hazard Mitigation Plan

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

Severity
- Minor: Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e., 1 or 2 communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.
- Serious: Scattered major property damage (more than 50% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services are briefly interrupted; some injuries and/or fatalities.
- Extensive: Consistent major property damage; major damage to public infrastructure (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and fatalities.
- Catastrophic: Property and public infrastructure destroyed; essential services stopped, thousands of injuries and fatalities.

Flood Hazards

Flooding was the most prevalent natural hazard identified by local officials in Cambridge. Flooding occurs during hurricanes, nor'easters, severe rainstorms and thunderstorms and is often worsened by coastal storm surges and high tides. Much of the flooding in the city is caused by insufficient capacity in the drainage system, the city's topography and, in the Concord-Alewife flood plains.

There have been a number of major rain storms that have resulted in significant flooding in eastern Massachusetts over the last fifty years. Excluding hurricanes, significant rain storms include:

- August 1954
- March 1968
- January 1979
- April 1987
- October 1991 ("The Perfect Storm")
- October 1996
- June 1998
- March 2001
- April 2004
- October 2005
- May 2006

The state plan indicates that Massachusetts is one of the 10 states that cumulatively account for 76% of all repetitive loss buildings in the United States. There is one repetitive loss structure in Cambridge, located in the Concord-Alewife area. 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.

From 1978 to December 2003, Cambridge property owners filed a total of 34 losses with the National Flood Insurance Program. Of these, 24 have been paid, for a total of just over $1.5 million. While three communities in the 9-Community study area saw more claims paid during this period, Cambridge had the highest dollar amount – almost twice as much as any of the other nine communities.

Flooding can cause transportation impacts. Road or lane closures in Cambridge have occurred during storms causing problems for drivers. Road closures in surrounding communities also impact Cambridge because traffic is often diverted through Cambridge. For example, Storrow Drive in Boston was closed during a July 2005 storm and roads in Somerville have been closed during storms. When flooding affects subway stations outside of Cambridge, the MBTA uses buses which impact streets and transit riders in Cambridge. These transportation impacts also can affect emergency response.

In addition to structural impacts, flooding can affect Cambridge and its inhabitants in other ways. Residences subject to chronic dampness can affect the health of its inhabitants. According to city officials, more and more people are living in basement apartments due to the high housing demands. The potential effects on their health are not something that has been studied.

Flooding can also create unsanitary conditions. While Cambridge has worked to separate its combined storm and sanitary sewer system, a large storm can still cause sewage

discharges into water bodies, the ground surface and buildings. Power outages due to flooding also can put public health at risk.

Another type of threat that can be related to drainage problems is discussed later: West Nile Virus and Equine Encephalitis Virus.

Wind-Related Hazards

Wind-related hazards include hurricanes and tornadoes as well as high winds during severe rainstorms and thunderstorms. The city has a 100-year wind speed of 110 miles per hour.

Cambridge has been impacted by hurricanes throughout its history, starting with the Great Colonial Hurricane of 1635. Since 1900, the region has been affected by 24 hurricanes and 14 tropical storms. The eye of one recorded hurricane moved through the center of Cambridge in 1944. Hurricanes that do not pass through Cambridge also can affect the city. Portions of the city lie within hurricane storm surge zones. Hurricane storm surge is an abnormal rise is sea level accompanying a hurricane or other intense storm. This is discussed in more detail later. According the city's Emergency Management Department, hurricanes that affected Cambridge include:

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 Hazel	October 15, 1954
Hurricane Diane	August 17-19, 1955
Hurricane Donna	September 12, 1960
Hurricane Gloria	September 27, 1985
Hurricane Bob	August 19, 1991

*Category 3.

Not included in this list is the Portland Gale of November 26-28, 1898, which may well have been the most damaging coastal storm in Massachusetts history.

Winds during other storms can cause damage. Downed trees and limbs have been a problem in the past due to weather conditions such as strong wind or heavy snow and ice. Damage has occurred from trees falling on houses, cars, and power lines. Many of the city's trees are older and possibly more vulnerable to strong winds due to their age. During high winds, construction scaffolding and tarps have blown off of construction sites or have caused damage on-site.

While Harvard University sees downed trees after a wind storm on campus, it is not a frequent occurrence and has not resulted in significant damages. Past examples of wind damage at MIT include damage to its inflatable tennis dome, to antennae, to radar systems, and other items. Buildings on campus, however, are built to withstand strong winds, including those buildings with extensive glass facades.

Winter Storms

In Massachusetts, northeast coastal storms known as nor'easters occur one to two times per year. Winter storms are a combination of hazards because they often involve wind, flooding and snow fall.

Impacts from snow are a constant concern since storms occur every year. The area has a long history of severe and damaging winter storms. According to data from the hazard mapping, the average annual snowfall for the eastern half of Cambridge is 36.1 to 48 inches and for the western half, 48.1 to 72 inches. Officials point out, however, that greater impacts are seen in the eastern half because of that area's higher density and narrower streets. Recent storms include January 2005, for which it took the city three days to be up and running and clean-up lasted for weeks. According to the city, the top storms of the last hundred years, ranked by the amount of snow that fell are:

- February 6, 1978 – 27.1 inches
- February 24, 1960 – 26.3 inches
- March 31, 1997 – 25.4 inches
- January 20, 1978 – 21.4 inches
- March 3, 1960 – 19.9 inches
- February 15, 1958 – 19.4 inches
- February 8, 1994 – 18.7 inches
- December 20, 1975 – 18.2 inches *(tie)*
- January 7, 1996 – 18.2 inches *(tie)*
- February 5, 1920 – 17.3 inches
- February 20, 1921 – 16.5 inches

As a denser, built-out community with many narrow streets and on-street parking, snow storms pose a number of challenges to the city, including snow removal and storage. Fully developed communities have few, if any, convenient areas that are adequate to hold large amounts of snow. Every winter, the city must find areas to store snow. The city has traditionally used undeveloped areas (areas slated for future development). Recently, property owners have not allowed the use of their property for snow storage. Fortunately, the city was able to find storage space, but this is a recurring challenge every year.

As expected, a number of public safety issues can arise during snow storms. Impassible streets are a challenge for emergency vehicles and affect residents and employers. Snow-covered sidewalks force pedestrians to walk in streets, which are already less safe due to snow, slush, puddles and ice. Large piles of snow can also block sight lines for drivers, particularly at intersections. Not all residents are able to clear their properties, especially the elderly.

And when that snow melts, flooding occurs. Flooding from snow melt has caused a number of problems in Cambridge, including flooding electrical manholes and streets. Snow-covered catch basins can cause drainage problems. Refreezing of melting snow can cause dangerous roadway and sidewalk conditions.

Fire-Related Hazards

According the Fire Department, Cambridge experiences very few brush fires because of the lack of brush in the city. In 2004, the Fire Department responded to 16 brush fires. These were concentrated in West Cambridge along Route 2 and Cambridge Park Drive. Causes of these brush fires are a mixture of careless human behavior and arson. Brush fires have not recently caused property damage or loss of life.

The city has not seen a great number of fires due to lightning strikes. Lightning storms do have the tendency to set off building fire alarms to which emergency officials must respond. This ties up resources in the event a real emergency were to occur.
MIT has experienced $130,000 in damage from lightning strikes over the last few years.

It is important to remember that fire can also be a result of other events, such as the aftermath of an earthquake.

Geologic Hazards

Earthquakes

Although new construction under the most recent building codes generally will be built to seismic standards, much of the development in the city pre-dates the most recent building code. In addition, a substantial portion of Cambridge is at high risk for liquefaction, as discussed below.

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1627 to 1989, 316 earthquakes were recorded in Massachusetts. Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault located off the coast of Rockport. The region has experienced larger earthquakes, of magnitude 6.0 to 6.5 in 1727 and 1755. Other notable earthquakes occurred here in 1638 and 1663 (Tufts University).

Earthquakes can result in many impacts beyond the obvious structural impacts. Buildings may suffer structural damage that is not readily apparent. Earthquakes can cause major damage to roadways, making emergency response difficult. Water lines and gas lines can break, causing flooding and fires. Equipment in buildings can be vulnerable. 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.

One additional impact of particular concern in the Boston metropolitan area is liquefaction, 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 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 and many of those structures likely pre-date the seismic provisions of the current Massachusetts State Building Code.

William Lettis & Associates, Inc., and Tufts University recently prepared regional susceptibility maps using geological maps and soil borings. This data is shown on Map 4. Areas in Cambridge that are at high risk for liquefaction are discussed later.

It is important to remember three points when viewing this map:

- This is a regional map (at a scale of 1:24000) and should not be used for site-specific analysis.
- There can be great variability within a given area. For example, a building located in an area shown as highly susceptible could in fact be built on a pocket of low susceptibility. The reverse is also true.
- When new buildings are built on filled areas, engineered fill replaces the existing fill, thereby strengthening the soils.

Landslides
Mapping, based on geological formations, indicates that the western half of Cambridge is classified as having a low risk for landslides while the eastern half is classified as moderate risk for landslides. However, in reality, these areas labeled as being at moderate risk have not been prone to landslides, nor have landslides been identified as an issue in Cambridge.

Other
A number of areas in Cambridge are built on fill. Construction on fill can be vulnerable to subsidence, possibly causing structural damage. Details on filled areas in Cambridge are provided later.

Other Hazards
Climate change and extreme temperatures are two additional natural hazards that can have impacts on people and property. As noted, later the very young and the elderly are most at risk during extreme temperatures as are the homeless. According to Cambridge's Climate Protection Plan, Federal studies have predicted that the average temperature in New England will increase 6 to 10 degrees Fahrenheit during this century. Impacts include the creation of habitat for disease-carrying insects that do not currently occur here, changes in rain and snowfall patterns, sea-level rise, and greater coastal storm damage. In other words, many of the natural hazards discussed earlier could have greater impacts in the future.

<u>Overarching Impacts from Natural Hazards</u>
There are certain overarching impacts that can occur from virtually any of the natural hazards discussed above that can have great impacts on the city, its residents, businesses and institutions.

Impacts from power outages can result in the closure of commercial establishments, interruptions of research, public health concerns, and overall safety issues. This is a

regional issue in terms of seeking alternative power sources. MIT characterizes the interruption of utility service as having moderate to high impacts, in large part because of impacts to research projects (particularly those that require low temperatures/freezing) and disruption to its business operations. While the university does have some generators, they are generally targeted for life safety functions.

As noted earlier, impacts to the public transportation system in the region can impact Cambridge. In addition, private businesses and universities recognize that natural disasters can impede or restrict workers' ability to get to work, resulting in the loss of operations and loss of revenue.

CEMT (Cultural Emergency Management Team) represents a number of cultural institutions in Boston that are working to protect those resources from damage. CEMT provided information on the vulnerabilities of cultural facilities to natural hazards. As noted earlier, Cambridge is home to a number of cultural institutions. Many of these cultural resources can be highly vulnerable to damage from high winds and tornados, floods, and earthquakes. Even some of the Boston area's newer museums, libraries and archives, because of their need for prime publicly accessible exhibition, study and function space, store collections in basement areas vulnerable to flooding. While some of the newer buildings in the area have been designed and constructed to be earthquake resistant, the vast majority of their collections both in storage and on display have not been retrofitted to protect fragile objects during tremors. Fire remains one of the great risks to cultural heritage because the resultant loss is so often irrecoverable and irreplaceable.

Critical Facilities in Hazard Areas

Maps 1-7 and Table 10 lists critical facilities in Cambridge. Critical facilities include those facilities that perform an important function during a natural disaster such as shelters and emergency operation centers. Critical facilities also include locations that house sensitive populations, such as schools or nursing homes. There are other critical facilities and infrastructure that are not mapped because the information was not available. These include utilities and communication facilities.

The purpose of mapping the natural hazards and critical facilities is to present an overview of hazards in the community and how they relate to critical facilities. In Cambridge, six critical facilities are located in areas that are susceptible to hurricane storm surges <u>and</u> at high risk of liquefaction during an earthquake. These facilities include Harvard and MIT facilities, two schools, a fire station and the Cambridge Water Department. Other facilities located in hurricane surge zones include schools, government buildings, and a health center. A correctional facility is also located in an area at high risk for liquefaction.

This table does not include utilities or transportation corridors. Maps 4 and 5 indicate that components of the city's transportation infrastructure are also located in both hurricane surge zones and areas at high risk for liquefaction. These include: Memorial Drive, Alewife Brook Parkway, and MBTA facilities.

Some of the city's critical facilities are outside of city-limits. The city's water supply and associated facilities and watershed are located in Waltham, Lexington, Lincoln and Weston. Facilities include the Hobbs Brook Reservoir, Stony Brook Reservoir, gatehouses, and two dams. The dams are inspected every two years and have withstood large storms. Appendix E includes two graphics that illustrate the city's water system.

Explanation of Columns in Table 10

Column 1: ID #: ID number which appears on the maps. See Appendix A.

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

Column 3: Site Type: Type of site.

Column 4: Earthquake Liquefaction Risk: Whether there is a high or moderate risk for liquefaction during an earthquake. This data was provided by Tufts University.

Column 5: Hurricane Surge Area: Whether the site is located within a hurricane surge area and the potential degree of inundation during a hurricane. The following explanation of hurricane surge areas is taken from the U.S. 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. There are about 40 SLOSH models from Maine to Texas. 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." http://www.sam.usace.army.mil/hesdata/General/hestasks.htm

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

Column 6: In Flood Zone or Near Area that has Flooded: Risk of flooding. 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) or not in the general vicinity of an area that has flooded in the past (see Map 8). An entry of "near" means it is near an area that has experience flooding. Entries, as applicable, may also indicate the type of flood zone as follows:

Zone A - 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 - 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 B, C, and X500 - Zones B, C, and X are the flood insurance rate zones that correspond to areas outside of the 100-year floodplains, areas of 100-year sheet flow flooding where average depths are less than 1 foot, areas of 100-year stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 100-year flood by levees. No BFEs or depths are shown within this zone.

Zone VE - 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

Table 10. Relationship of Critical Facilities and Selected Hazards

ID	Name	Type	Earthquake Liquefaction Risk	Hurricane Category	In Flood Zone or Near Area that Has Flooded
1	Amigos School	School			
2	Middlesex Jail Cambridge	Correctional Facilities	High		
3	O'Neill Branch Library	Government			
4	Valente Branch Library	Government		2	
5	O'Connell Branch Library	Government			
6	Collins Branch Library	Government			Near
7	Central Square Branch Library	Government			
8	Boudreau Branch Library	Government			
9	City Hall Annex	Government			
10	Harvard Law School	School			
12	Teen Health Center at Cambridge Rindge and Latin	Hospital			
13	Windsor Street Health Center/Public Health	Hospital		2	Near
14	Senior Center	Hospital			
15	Riverside Health Center	Hospital			
16	North Cambridge Health Center	Hospital			Near
17	Cambridge Family Health North - Porter Square	Hospital			
18	Cambridge Family Health - Inman Square	Hospital			
19	Mount Auburn Hospital	Hospital			
20	Youville Hospital	Hospital			Near
21	Cambridge Hospital	Hospital			
22	MIT	School	High	2	
23	Ecole Bilingue School	School			
24	Lesley University	School			
25	Longy School of Music	School			
26	Harvard John F. Kennedy School of Government	School	High	2	
27	Harvard Division of Continuing Education	School			
28	Harvard Law School	School			
29	Harvard Divinity School	School			
30	Harvard Graduate School of Education	School			
31	Harvard Graduate School	School			

ID	Name	Type	Earthquake Liquefaction Risk	Hurricane Category	In Flood Zone or Near Area that Has Flooded
	of Design				
32	Harvard College	School			
33	Episcopal Divinity School	School			
34	Cambridge Montessori School	School			
35	Cambridge Friends School	School			
36	Shady Hill School	School		2	
37	Buckingham Browne & Nichols School	School		2	
38	Saint Peter's Elementary School	School			
39	Farr Academy	School			
40	Buckingham Middle School	School			
41	Buckingham Elementary School	School			
42	Father Matignon High School	School			
43	North Cambridge Catholic High School	School			
44	New School of Music	School			
45	Benjamin Banneker School	School			
46	Tobin School	School	High	2	Near
48	Rindge School of Technical Arts	School			
49	Rindge & Latin Auto Shop	School			
50	Peabody School	School			
51	Morse School	School		2	
52	Martin Luther King Junior School	School			
53	King Open School	School		2	
54	Kennedy / Longfellow School	School	High	2	
55	High School Extension Program	School			
56	Haggerty School	School			Near
57	Graham & Parks School	School			Near
58	Fletcher / Maynard Academy	School		2	
59	Cambridgeport School	School		2	
60	Cambridge Rindge and Latin School	School			

ID	Name	Type	Earthquake Liquefaction Risk	Hurricane Category	In Flood Zone or Near Area that Has Flooded
61	Water Dept.	Emergency Operations Center	High	2	
62	Cambridge Public Library	Government			
63	Castle School	School			
64	Fire Station - Company 4	Fire Station			
65	Fire Station - Company 8	Fire Station			
66	Fire Station - Company 9	Fire Station			
67	Fire Station - Headquarters	Fire Station			
68	Fire Station - Company 5	Fire Station			
69	Fire Station - Company 3	Fire Station			
70	City Hall	Government			
71	Police Headquarters	Police Station			Near
72	Fire Station - Company 6	Fire Station			Near
73	Fire Station - Company 2	Fire Station	High	2	
74	Emergency Communications	Emergency Operations Center			
75	W. Sullivan Water Treatment Facility	Water Treatment	High	2	
76	Fresh Pond Reservoir	Reservoir		1	500

*Numerous facilities identified listed in this table are within areas that are subject to flooding but not identified as such because they lie outside of the FEMA flood plain.

Potential Damages to Existing Development

HAZUS-MH is a tool to help estimate potential damages from certain types of natural hazards. We used HAZUS to estimate losses from a hurricane and earthquake. We did not use HAZUS to estimate flooding damages, for reasons explained below. The following overview of the HAZUS-MH is taken from the FEMA website. For more information, go to http://www.fema.gov/plan/prevent/hazus/.

> "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 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."

This analysis is level 1 – it relies upon default data on building types, utilities, transportation, etc., from national databases and census data. While the databases include a wealth of information on the nine communities that are a part of this study, 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 allow for a comparison between different types of disasters. Therefore, this analysis should be considered a starting point to understanding potential damage from the hazard events. If interested, communities could build a more accurate database and further test disaster scenarios.

Table 11 displays damages from category 2 and 4 hurricanes. Table 12 displays damages if an historic earthquake were to occur today and if a stronger (7.0) earthquake were to occur.

Damages from Hurricanes

According to the State Hazard Mitigation Plan, between 1858 and 2000, there were 15 hurricanes: 60% were Category 1, 33% were Category 2 and 7% were Category 3. For the purposes of this plan a Category 2 and a Category 4 storms were chosen to illustrate damages. While the region has not experienced a Category 4 hurricane, modeling one helps to illustrate a "worst case scenario." This can help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms.

Table 11. Estimated Damage in Cambridge from a Category 2 or 4 Hurricane

	Cat. 2	Cat 4*
Building Characteristics		
Estimated total buildings	13,557	
Estimated total building replacement value (Year 2002 $)	$9,596,000,000	
General Building Damage		
# of buildings sustaining minor damage	1,424	1,088
# of buildings sustaining moderate damage	414	3,730
# of buildings sustaining severe damage	18	5,513
# of buildings destroyed	3	2,962
Population Needs		
% of hospital beds available on day of event	69%	0%
# of households displaced	333	33,242
# of people seeking public shelter	85	8,310
Debris		
Building debris generated	19,660 tons	678,200 tons
Tree debris generated	13,100 tons	13,840 tons
# of truckloads to clear building debris	790	27,090
Value of Damages		
Total property damage	$85,469,777	$6,698,741,630
Total business interruption loss	$11,481,970	$1,226,675,230

*No category 4 or 5 hurricanes have been recorded in New England.

Damages from Earthquakes

The HAZUS earthquake module allows users to define different types of earthquakes and to input various parameters. The module is more useful where there is a great deal of data available on earthquakes. In New England, defining the parameters of a potential earthquake is much more difficult because there is little historical data. The earthquake module does offer the user the opportunity to select a number of historical earthquakes that occurred in Massachusetts. For the purposes of this plan, two earthquakes were selected: a 1963 earthquake with a magnitude of 5.0 and an earthquake with a magnitude of 7.0.

Table 12. Estimated Damage in Cambridge from Magnitude 5.0 and 7.0 Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	13,557	
Estimated total building replacement value (Year 2002 $)	$9,596,000,000	
Building Damages		
# of buildings sustaining slight damage	95	3,275
# of buildings sustaining moderate damage	23	1,844
# of buildings sustaining extensive damage	2	580
# of buildings completely damaged	0	127
Population Needs		
# of households displaced	9	2,344
# of people seeking public shelter	2	567
Debris		
Building debris generated (tons)	4,000	499,000
# of truckloads to clear building debris	160	19,960
Value of Damages		
Total property damage	$8,540,000	$784,860,000
Total losses due to business interruption	$1,240,000	$198,550,000

Damages from Flooding

HAZUS-MH did not provide useable results for estimating flood damages for this study. In addition to technical difficulties with the software, the riverine module is not a reliable indicator of flooding in densely developed urban areas and floodplain data for the Alewife area is likely outdated in the model because the flood plains are currently being re-mapped. In lieu of using HAZUS, MAPC developed a methodology to give a rough approximation of flood damages.

Cambridge is 4,586 acres. Approximately 500 acres (or 11% of Cambridge's land area) have been identified by local officials as areas of flooding. The number of structures in these flood areas was estimated by assuming that if 11% of the land area is affected by flooding, then 11% of the total buildings are also affected. HAZUS estimates an average of $707,670 as the replacement value per structure in Cambridge. Then, as suggested in the FEMA September 2002 publication, "State and Local Mitigation Planning how-to guides" (Page 4-13), we calculated a low estimate (assuming 10% of the building is damaged) and a high estimate (assuming up to 50% of the building is damaged. The results are in Table 13.

Table 13. Estimated Potential Damages from Flooding

Estimated Area of Flood Hazard Areas	503 acres
Total Cambridge Land Area	4586 acres
Hazard Area as % of Total Land Area	11%
Total Buildings in Cambridge	13,557
Estimated # of Buildings in Hazard Area	1,488
Replacement Value Per Building	$707,670
Low Estimate of Potential Damages (10% Damage)	$105,327,970
High Estimate of Potential Damages (50% Damage)	$526,639,870

Potential Impacts to Future Development

As discussed earlier, future development in Cambridge will occur through redevelopment, since there is virtually no vacant land in the city. Table 14 indicates hazard vulnerabilities in areas where future development is expected.

Table 14. Future Development in Hazard Areas

Area	Flood zone or area prone to flooding	Hurricane surge zone	Earthquake liquefaction
A.D. Little Site	X	X	X
Concord-Alewife	X	X	X
University Park	X	X	X
303 Third Street		X	X
Cambridge Research Park		X	X
North Point		X	X

HAZARDS AND EXISTING MITIGATION MEASURES

This section provides more detail on how certain natural hazards affect specific parts of Cambridge. Existing mitigation measures are discussed under each hazard heading and existing mitigation measures for all natural hazards are compiled in Table 15.

Flooding

Like most older, urban communities, stormwater in Cambridge is generally collected in street side catch basins and is piped away and discharged – usually to either the regional sewerage treatment plant or to the adjacent river. The city straddles two watersheds, the Charles River watershed to the south and east and the Alewife Brook (tributary to the Mystic River) watershed to the northwest. Within the Alewife watershed is the Fresh Pond reservation (the watershed to Fresh Pond Reservoir) which has an overflow valve to the Alewife Brook system, though the valve is rarely if ever used.

The city's stormwater collection system includes approximately 108 miles of sanitary sewer, 88 miles of stormwater drains, 41 miles of combined sewer (sanitary sewerage and stormwater) and around 10,000 assorted sewer and drainage structures (manholes, catch basins, regulators, overflows, etc.). The city recently updated the GIS database of its drainage infrastructure. Some drainage pipes in Cambridge date back to the 1820s. City officials estimate that at least 30% of the drainage system is at least 100 years old. Much of the system is a combined sewer system and in many areas the pipes are undersized or need replacement or rehabilitation due to their age.

Today approximately 30% of the city has been separated, thus stormwater flows directly to a fresh water body and sanitary flow is conveyed for treatment in those areas. The city is a member of the MWRA collection system and generally the MWRA interceptor pipes pick up Cambridge combined and sanitary flow in interceptor pipes that flow adjacent to both the Charles and Alewife rivers and then convey the flow to the Deer Island Treatment Plant. There are 15 Combined Sewer Overflow (CSO) Structures in Cambridge, 11 belong to the City of Cambridge, three belong to the MWRA and one belongs to the City of Somerville. Seven of the CSOs are on the Charles River and eight are on the Alewife Brook. Construction and rehabilitation of the sewer and drainage systems has been accomplished through the use of Federal, State and local funds. Over the past 20 years the city has developed a programmatic approach to system rehabilitation, sewer separation and stormwater management. The budget is structured around 5- and 10-year capital infrastructure program objectives.

Very little land in Cambridge is mapped by FEMA as a 100-year flood plain. The 100-year flood plain is being remapped in the Alewife area and it is expected that the remapping will cover a larger area. A fairly large area of the city is modeled as being in Hurricane Surge zones 1, 2 or greater.

Existing City-Wide Mitigation

Stormwater Management Structural Improvements

Over the past eight years the city has begun to construct sewer separation and stormwater management projects to address community flooding problems as well as water quality issues. The goals of sewer separation and stormwater management include:

- Improving the quality of Cambridge's waterways
- Eliminating and/or reducing CSOs
- Alleviating flooding in residential and commercial neighborhoods
- Reducing/eliminating sanitary sewer backup problems throughout the city

One challenge faced by the city as it separates sewers and storm drains is flat topography. The city has had to look at various unique ways of dealing with flooding and combined sewer overflows. As a result, several areas of the city now have large underground tanks that are designed to operate as retention tanks during heavy rain events. Once an event is over and the drainage system is at a

point where it can take increased flow, the tanks are slowly pumped out. These systems are not reliant on electrical power during the course of the storm events. The city also has some conventional stormwater pump stations that operate during storms and have backup generation systems.

Stormwater Management Maintenance / Best Management Practices (BMPs)
There are approximately 4,300 catch basins in Cambridge. Generally, in-house crews clean and maintain catch basins, though on occasion the city retains contractual help to supplement staff. Catch basins are normally cleaned on the same day street sweeping occurs on a particular street. Crews can normally clean 15 to 30 basins per day depending on the number of dispatched crews.

There are areas of the city where catch basins pose a problem. A small amount of these are due to maintenance issues and any basins needing repairs are scheduled for repair or replacement through a remedial contract. The city responds to requests to clean basins during storms; typically those requests are for a basin already on a repair list or a basin with a lateral connection defect. While problems have diminished to a significant extent over the last few years, there are some basins that, during times of heavy rain, are prone to backups due to problems within the drainage system to which they are connected.

Street sweeping is the main measure used to clear catch basin grates between April and September. If a storm is forecast and there are areas of concern, the city will send crews out to address those areas if necessary. However with 4,300 catch basins, it would be impossible to address all of them when a storm is forecast. Additionally, catch basins that are completely blocked are cleaned within 48 hours of notification of Pubic Works. Residents are also encouraged to assist Public Works by clearing debris off of catch basin grates, cleaning up debris along the curb in front of their property, and by not putting leaves, grass clippings and other yard waste into a catch basin.

The Street Cleaning Division is responsible for maintaining clean public ways through a contractual (currently American Sweeping Services) street sweeping operation which runs from April through December each year. Beginning in fiscal year 1999, the street sweeping operation was extended through the end of December. This added month of street sweeping ensures the cleanliness of Cambridge streets through the early winter months.

Two contract sweepers are used to clean both residential streets and major city squares. The city squares are cleaned very early in the morning (between 4:00 a.m. and 8:00 a.m.). Approximately 11,000 street miles are cleaned each year while over 5,000 tons of street refuse is collected. At the end of each month, the sweepers also clean the industrial areas of Cambridge. This operation is augmented by the Division’s own work force which consists of 18 full-time employees. In addition, this division utilizes the services of several temporary employees during the fiscal year to help with litter pickup and street cleaning.

The Street Cleaning Division also has a small rubbish packer, which collects litter twice daily from the city squares during the week and three times daily on weekends. As noted above, temporary employees also assist with litter pickup.

The city previously used sand on roads during snow storms, but the sand tended to clog catch basins and caused sedimentation. The city has stopped using sand and now relies on salt and calcium chloride.

DCR has begun using GPS to map its catch basins and stormwater outfalls and has developed a new schedule for catch basin cleaning and street sweeping. DCR recently repaired / upgraded a portion of its the drainage system along Memorial Drive between the Longfellow Bridge and Audrey Street.

Public Education on Stormwater Management

The city holds public meetings for major projects. The city also offers a number of brochures to help residents, and businesses understand the impacts of their actions on flooding and pollution problems. Brochures cover topics from water quality issues, to snow removal and street tree care. See the Public Works website: http://www.cambridgema.gov/TheWorks/contents/brochure.html.

Zoning Measures

The city's Zoning Ordinance includes a Flood Plain Overlay District (Article 20.70). This district applies to the 100 year flood plain and requires a special permit from the Planning Board for any structure or building that is constructed, expanded, etc., or for dumping, filling, excavation, etc., within the flood plain. Mobile homes are prohibited from the floodway but are allowed in the flood plain, provided certain standards are met. There is little land within the 100 year flood plain in Cambridge, so this provision does not apply to an extensive area. The Conservation Commission is the lead reviewer of projects that fall under this provision. FEMA is currently revising flood plain delineations and it is expected that the 100 year flood plain may be expanded in certain areas.

Article 19 establishes standards for projects that are likely to have impacts beyond the project's borders. This provision establishes a development review process and requires DPW-review of large projects, allowing potential stormwater issues to be identified and addressed during the permitting process.

The Zoning Ordinance has Permeable Open Space Requirements. Two sections (Articles 5.22 and 19) require a minimum amount of permeable open space. Between these two provisions, this requirement applies to virtually all new development, except non-residential development below 25,000 square feet in size.

Cambridge created a special zoning district at the A.D. Little / Discovery Park site to address flooding issues. This zoning provision is discussed further, under site-specific mitigation measures.

Other Regulatory and Policy Measures

The city has also worked with private development to address stormwater and sewer management on a case by case basis. In Cambridge the majority of commercial and residential development occurs through redevelopment. Being able to address stormwater needs requires innovative measures and cooperation between developers and the city. Over the past six years almost all development in the city has incorporated various forms of stormwater management and, in some instances, sewer flow management on sites to reduce flows to the city's systems during large rainfall events. Specifically, the city requires that development store the difference in volume between the 2 year 24 hour storm event pre-development runoff and the post-development 25 year 24 hour storm event runoff hydrograph. This storage can be provided through underground tanks, infiltration systems, roof storage strategies, increased pervious surfaces or a combination of these approaches.

Over the past 20 years the city has developed a programmatic approach to system rehabilitation, sewer separation and stormwater management and works off 5- and 10-year capital infrastructure program objectives.

The Cambridge Water Department reviews proposed development projects in watershed communities through a site plan review process. Staff also visits construction sites and meets with developers.

The MWRA reviews large development projects (through the State MEPA process) to ensure that potential impacts, including system flooding, are reduced.

Cambridge has entered into the Tri-community Environmental Joint Powers Entity to address flooding in the Alewife area with Belmont and Arlington.

Site-Specific Flooding

The numbers correspond to areas identified on Map 9.

1 and 4. A 66-inch drainage pipe runs through the middle of the city-owned golf course. In Belmont, an undersized 39-inch drainage pipe connects to Cambridge's drainage system. During events in excess of the 5-year event, flooding affects the golf course area, the neighborhood area around Thingvalla Street and the low-lying portion of the Blanchard Road immediately south of the Wellington Brook (see #2, below). In the Golf Course/Fresh Pond Reservation area, manhole covers have been known to been pushed off by the pressure exerted by water in the pipe systems. The majority of the subcatchment being serviced in this area is in Belmont, and it is understood that they have been addressing the significant water quality issues that impact the drainage system

in the area. However, stormwater conveyance quantities are not being addressed as part of the program.

> *Existing Mitigation* – Belmont is addressing water quality issues. In Cambridge, the city recently rehabilitated the drainage system and installed 10 new catch basins. The city is currently constructing a pump system in Little Fresh Pond (adjacent to Fresh Pond Reservoir) to allow drawdown prior to large storm events. Also, the city intends to construct additional catch basins downstream, rehabilitate small open channels in the reservation and incorporate a standing pipe and drainage swale to allow more efficient flow through the drainage system.

2. Thingvalla Street and Corcoran Park residences (owned by the Cambridge Housing Authority - CHA) have historically flooded. During torrential rain, the building basements and crawl spaces flood at 15, 18, and 19 Corcoran Lane, sometimes as high as the floor joists. The boiler rooms in these buildings have flooded numerous times. The site around these buildings also floods up to the second step of the front entrance.

> *Existing Mitigation* – During the CHA's most recent comprehensive modernization at the site, waterproof hatches were installed in the boiler rooms to stop entry of water from the crawl spaces to the boiler rooms. There was also remediation work done on an open storm line at #18 that acted as a relief area for this surcharged water. The city has done work in this section of the city at the corner of Lawn St. and St. Saveur St. These remediation projects have helped these flooding issues, but there is still potential for major storms to affect this area.
>
> Also see mitigation measures listed under #1, above.

3. The area immediately to the west of Aberdeen Avenue, between Aberdeen Avenue and Homer Avenue tends to flood during intense events, in excess of the 5-year event. The primary reason for this phenomenon is the shallow and undersized nature of the MWRA collection system and the topography of the area.

4. See under #1, above.

5. The area between the two rotaries along Concord Avenue floods during the 10-year storm. Again flooding here is due to the limited capacity of the drainage system, including the MWRA's collection system. Impacts include basement flooding, CSO discharges and surface flooding. The New Street area historically suffered from severe flooding.

> *Existing Mitigation* – The city has recently completed a significant stormwater management project in the New Street area, with a 13 cubic foot per second pump station and stormwater detention tank. This new infrastructure substantially reduces the risk of flooding in the New Street area.

6. Also, an area just east of Fresh Pond Parkway along Vassal Lane and adjacent to the Tobin School is subject to flooding during events equal to or in excess of a 10-year storm. Flooding is due to the limited capacity of the drainage system, including the MWRA's collection system. Impacts include basement flooding, CSO discharges and surface flooding.

7. The western portion of this area adjacent to the Little River/Alewife Brook suffers from significant flooding during events in excess of the 5-10 year storm. Specifically this area encompasses Cambridgeport Drive, Acorn Park and the Alewife Brook Parkway between Route 2 and Massachusetts Avenue. The flooding has resulted in lanes closures on the parkway. The causes of flooding in the area are multiple, including lack of capacity in the Alewife Brook, lack of flood storage capacity on land within the flood plain or adjacent to the Alewife Brook, backwater from the Mystic River and restrictions to conveyance caused by the various bridges over the Brook.

> *Existing Mitigation* – The city has adopted a special zoning district for the Discovery Park area (Special District 4 and 4a) which incorporates stormwater measures. The city has also adopted new zoning for the Concord-Alewife area that includes specific stormwater quantity controls to reduce runoff and improve water quality as it discharges off new development.

8. The parking lot at the Burns Apartments (CHA - 30 Churchill) in North Cambridge has flooded in the past. The storm drains discharge water into the parking lot, which can flood up to 2 feet. This water enters the building and in the past has flooded the elevator pit causing substantial water damage when the elevator responds to the basement level.

> *Existing Mitigation* – The Department of Public Works has done work in this area and the issue appears to have been resolved.

9. CHA housing at 121 Jackson Street has had flooding problems. Basement apartments have flooded during torrential rain episodes due to the exterior lower level area drain pushing water.

> *Existing Mitigation* – In 1990, CHA installed PVC check valves at the front and rear, which stopped the surcharge water from dumping into basement drains.

10. The neighborhoods around the intersection of Dudley Street and Clifton Street and around the Pemberton Street/Yerxa Road intersection also suffer from ponding during large, long duration storm events (October 2006). Again, the primary reason for this phenomenon is the low-lying nature of the area and the elevation of the Alewife Brook during events.

> *Existing Mitigation* – The city eliminated sanitary sewer connections to the local drainage and combined sewer systems in 1998 and 1999 thus reducing the potential for backups into homes in the area during larger storm events. No

additional mitigation is planned at this time specific to the ponding that occurs during larger storm events.

11. Flooding occurs at Jefferson Park at the rear of CHA Buildings 8 and 9, where the CHA property abuts the Field Machinery Road property. Back yards flood, which affects the handicapped access ramp and the lower level handicapped apartments. There are two issues here. First, the drains are surcharged with water and dump water to this low area. Second, the abutting property is at a higher elevation and their drainage system is not adequate, therefore stormwater run-off drains to the CHA property.

12. Previously, an area around Walden Square, Bellis Circle and Bolton Street flooded during longer duration storm events, i.e., intense events in excess of approximately 8 hours in duration (October 1997 and July 1998). Flooding in this area is generally caused by the inability of the conveyance system to wash water into the Alewife Brook which during longer duration events tends to rise in elevation and prohibit the flat pipe systems discharging into the brook. Thus the entire system backs up and flooding results in the low lying areas around Bellis Circle.

Existing Mitigation – The City completed a stormwater management project at Danehy Park and on Sherman Street in 2004. The results increased the detention storage capacity of the Danehy Park wetland and provided a 10 cfs pump station to convey flood waters to the adjacent large stormwater line adjacent to the railroad tracks.

13. At CHA's Lincoln Way, a number of basements flood during torrential rain (Building B, Units 15-25). The city storm system cannot keep up with the rainfall so the sump pumps in the basements cannot pump into the city stormwater system. Thus the basements flood with up to 12 inches of water. At the lower end of the site, a catch basin discharges water and floods during these episodes, leaving a large pond of water, which drains in approximately 5 minutes when the municipal storm system pressure is relieved. This housing development is state-funded and extraordinary maintenance projects are funded on an emergency basis. CHA has proposed several remediation plans to date, but this particular issue has not been funded.

14. CHA's units at 45 Linnaean Street have experienced flooding problems in the basement. Rain in June of 1998 resulted in ankle deep water in basement units.

Existing Mitigation – The unit nearest Linnaean Street has a backwater valve that is shut off during a forecasted storm.

15. The White Street/Somerville Avenue area in the Porter Square area of North Cambridge is an area that has traditionally suffered from poor drainage, impacting businesses. This is caused primarily by a poor collection and conveyance system in this area. It is important to note that critical communications equipment is located below surface at Porter Square.

Existing Mitigation – Construction was recently completed to address flooding in this area, and thus should reduce flooding except in the most extreme events, i.e., in excess of the 25-year event. The MBTA recently replaced two pumps that discharge to Somerville Avenue.

16, 17. The Baldwin and Mid Cambridge area are both part of the same combined sewer sub catchment area – the CAM0011 sub catchment system. That portion of the system south of the intersection of Kirkland Street and Quincy Street has been separated while the area north of that intersection is still combined and has suffered from flooding on countless occasions in the past. This includes the area along Crescent, Sacramento and Carver streets. Also, an area running along parts of Irving Street and Bryant Street tends to flood during a 10-year storm.

Existing Mitigation – The city has recently constructed underground storage systems on Bryant Street, Scott Street, Francis Avenue, Museum Street, Wendell Street and Beacon Street in Somerville. Due to the provision of this tankage volume and the sewer separation and stormwater conveyance improvements that have been made, the problem has been addressed to protect up to the 10 year event and when separation is fully complete the city expects to provide protection up to the 25 year event. Full separation is not anticipated in the area within the next 10 years.

The MBTA recently replaced two pumps along the Red Line between Porter and Harvard due to drainage problems on Garfield Street.

18, 19. On Kirkland Street during smaller storm events (the 1 and 2 year events) ponding occurs along the gutter line. During more significant events this ponding manifests itself into significant flooding on Kirkland Street and most particularly around Myrtle Ave. and Magnolia Ave. The primary reason for flooding in these areas is their relative low lying locations and the inadequacy of the conveyance system. Two hospitals are located along Cambridge Street.

Existing Mitigation – This area is part of a large combined sewer system and the city anticipates sewer separation and stormwater management systems being installed in this portion of the Mid Cambridge neighborhood within the next two years. The city is presently designing a stormwater system that will store stormwater from areas around the Cambridge City Hospital and the Youville Hospital in a 33,000 gallon stormwater storage system adjacent to Cambridge City Library on Broadway.

Cambridge Hospital has taken steps to mitigate flooding – the hospital does not experience a great deal of flooding except during prolonged rain storms or when a high amount of rain falls during a short period. Areas commonly affected are basements and entrances. The Hospital does have an emergency response plan and agreements with vendors to assist if a large-scale event occurs. To keep the

hospital operating during a storm, they use pumps and wet vacuums and retain additional housekeeping personnel.

20. An area near Willard Street experiences flooding.

21, 22, 23. An area extending along Mount Auburn Street just west of Harvard Square floods during the five year plus storm. In addition, an area around the intersection of Grant Street and Banks Street tends to flood during a 10 year storm and a small area along Mount Auburn Street near Plympton Street is affected during 10 year plus storms. Flooding is due to the limited capacity of the drainage system, including the MWRA's collection system. Impacts include basement flooding, CSO discharges and surface flooding.

24. A small area near the intersection of Ellery Street and Broadway experiences localized flooding during larger events.

Existing Mitigation – Problems will be addressed by the new system being installed at the library (see #18, above).

25. During a 10 year plus storm event, Tremont and Norfolk Streets have experienced ponding and flooding. Conveyance capacity is the primary reason for this ponding in this area.

26. The Area IV area is a combined sewer area and is serviced by two large systems: the Cardinal Medeiros Avenue MWRA dry weather interceptor and the Binney Street wet weather pipe which flows to the CAM017 CSO regulator and the Prison Point (MWRA) CSO regulator. These systems are very poor conveyance systems and tend to surcharge and flood in short duration intense events and flood to a significant extent during the longer duration events. An area extending through both of these neighborhoods is affected by 2-5 year storms and sewer systems in the neighborhood have experienced significant surcharging during less than the one-year event. The area that is most adversely impacted from a surcharge and flooding perspective is the Area IV neighborhood around School, Pine and Cherry streets. The primary reason for this flooding is the inadequate conveyance capacity of the regional system to convey water out of this low-lying area. Similarly, the Windsor Street area adjacent to School Street also experiences flooding during intense events.

Existing Mitigation – As part of a multi-phase sewer separation and stormwater management project for the area, the city constructed a large new stormwater conveyance system along South Massachusetts Avenue. The primary purpose of this new drainage line is to provide additional conveyance for those areas immediately surrounding South Massachusetts Avenue to include the Area IV neighborhood. The City anticipates building the first of a number of satellite storage and pump systems in the Columbia Street / Bishop Allen area in the spring of 2007.

Two public housing developments have been affected by flooding in this area – Newtowne Court and Washington Elms. At Newtowne Court, basements flooded as recently as July 2005. One boiler room received 3.5 inches of water. The burners and pumps were under water and had to be rebuilt. Historically this site has experienced major flooding problems.

> *Existing Mitigation* – During comprehensive modernization in the mid 1990's, CHA removed all slop sinks and toilets from the basements and this appears to have remedied the flooding. CHA believe that numerous missing clean out covers exacerbated this most recent problem and has taken corrective measures to alleviate the problem (see Existing Mitigation for Number 26).

In the past, Washington Elms has experienced major flooding issues in buildings along Washington Street. Existing backwater valves were permanently shut in the crawl spaces. The stairwells flood with the storm surcharges of 2 to 4 feet, but water can only creep under the door and the sump pumps manage to keep up with the flow.

> *Existing Mitigation* – In the boiler room exterior stairwells, CHA shut the backwater valves to a trickle to protect the boiler rooms. These exterior stairwells drain into a sump pit in the boiler rooms. The back flow valve is located between the exterior stairwell and the sump pit located in the boiler room (see Existing Mitigation for Number 26).

27. An area east of 2nd Street and north of Charles Street experiences flooding during a 25-year storm. Flooding is due to the limited capacity of the drainage system, including the MWRA's collection system. Impacts include flooded basements and roadways. This area is also part of the larger CAM017 combined sewer area and thus during significant events in excess of the 5 year storm event the sewer system in the area surcharges and can be causative of back-ups and surcharging in homes and businesses in the neighborhood.

28. Historically, and verified through modeling efforts, the areas most impacted by poor drainage have been the Newton Street area which is very low lying and the Green Street/Franklin Street/Sidney Street city block which is also low lying.

> *Existing Mitigation* – The City of Cambridge is presently reconstructing a significant portion of its sewer and drainage infrastructure in the Cambridgeport area of the city. This effort involves constructing new stormwater outfalls, separating combined sewer systems, eliminating common manholes and providing for better collection of stormwater throughout the area. The goal is to eventually provide protection up to the 25 year storm event throughout the area, to ensure that stormwater discharging to the Charles River is properly treated and to reduce/eliminate back-up and surcharge situations throughout the neighborhood. Furthermore, the Green Street system was recently connected to the South Massachusetts Avenue drainage system which significantly increases the conveyance capacity of flood waters out of this area.

29. Harvard Square. The Harvard Square area on Brattle Street between Massachusetts Avenue and Church Street, on Eliot Street between Brattle Street and Bennett Street and Mount Auburn Street between Eliot Street and Story Street has been an area subject to significant flooding and backups due to the poor conveyance capacity of the municipal system and the MWRA system.

> *Existing Mitigation* – The city is presently constructing the 3rd phase of a multiphase project to reduce the hydraulic grade line of the combined sewer system in the area by doing sewer separation and by more efficiently using the various pipe systems in the area.

30. CHA housing at 6-8 Valentine Street has a history of flooding in the basement apartments due to water discharging from area drains in the front and rear of the building. During one storm, the street flooded over the curb and into the basement areaway, flooding the basement units.

> *Existing Mitigation* – Please note response provided in 28.

33. *(note - #'s 31 and 32 on map relate to other hazards).* The Western Avenue area of the city is that portion of the city along Western Avenue between Central Square and Memorial Drive. It is a combined sewer area and discharges storm and sanitary flow to the MWRA interceptor systems adjacent to Memorial Drive. The combined sewer and sanitary sewer systems in the area are old and in very poor condition. During intense storm events, back ups, flooding and subsequent system collapses have occurred in this area. The trunk lines and adjacent branch systems need comprehensive rehabilitation and replacement.

> *Existing Mitigation* – The City is in the process of developing a Designer Selection Proposal for this area. It is anticipated that the design process will involve the development of a Comprehensive Infrastructure Renewal Facilities Report that will include sewer separation, stormwater management and flood protection as primary goals. It is anticipated that this program will be a multi-phase program extending over many years. The city anticipates awarding the design contract in the summer of 2007 and expects to proceed with the first construction project 18 months to 2 years subsequently.

<u>Memorial Drive</u>

Even during lesser rain events, sections of Memorial Drive tend to pond and can impact traffic due to lane closures. DCR has replaced catch basins on Memorial Drive between the Longfellow Bridge and Audrey Street. However, between the BU Bridge and Harvard Square, there are a number of areas that continue to pond to a significant extent during heavy rainfall events.

MIT Campus

MIT considers localized flooding to be a low-frequency event with low impacts. Since 1999, the campus has experienced roughly $380,000 in damages due to flooding from rainstorms. More damage ($2 million over the last six years) has occurred due to flooding in buildings, due to water main breaks and other accidents unrelated to natural hazards.

> *Existing Mitigation* – Please note response provided in 28.

Harvard University

Flooding from rain is localized and does not result in significant damage. Some buildings need to be pumped out on occasion. The University maintains a number of spare pumps. New construction is typically built to minimize the potential for flooding.

> *Existing Mitigation* – Please note responses provided in 16, 17, 18, and 19.

Dams

The Charles River Dam, owned and operated by the DCR, is the only dam bordering Cambridge. The dam, which replaced an earlier dam in 1978, has six pump stations to control water levels in the river and a lock system to allow boats to pass through. According to data from the Army Corps of Engineers (ACOE), the dam is 160 feet long; it is composed of rolled earth fill, rock slope protection and sheet piling; and its top elevation is 12.35 feet NGVD.

Other dams affecting Cambridge include the Amelia Earhart Dam and the Craddock Dam. All are owned, maintained and operated by DCR. The regional annex provides more information on these two dams.

The Cambridge Water Department (CWD) owns and operates dams outside of the city at its water supply reservoirs. It also controls water levels at the reservoirs.

> *Existing Mitigation* – The Charles River and Amelia Earhart dams are inspected regularly. The state has recently adopted new dam safety regulations. DCR is conducting modeling for the Amelia Earhart dam and is currently studying options for the Craddock Dam.
>
> CWD regularly inspects its dams and recently repaired the hurricane gates. CWD staff is trained to anticipate large storms so that control gates can release water appropriately. CWD and the US Geological Service (USGS) jointly collect technical information, including real-time stream information.

Wind

As discussed earlier, impacts from high winds include tree limbs damaging property (especially vehicles) and materials at construction sites being blown off-site. These issues are not confined to one area of the city.

Existing Mitigation – In terms of minimizing damage from trees, the city has taken a number of steps. The city has created a GIS layer of trees in the public right of way and has created a brochure, "Residential Street Tree Planting and Care".

The city's urban forestry program provides high quality tree care along city rights-of-way, in parks, and around public buildings. The staff is dedicated to pruning, treating, planting, and protecting trees using the most current arboricultural and safety standards. The staff is led by a Forestry Supervisor, who directs two crews, each with a Tree Climber and Forestry Worker (on-ground). These personnel handle the acute hazards, routine pruning requests made by the public, and respond to storm events. They receive technical guidance and planning support from the City Arborist, who is certified by the International Society of Arboriculture. The Superintendent of Parks and Forestry oversees the urban forestry effort, as well as the park maintenance program. The City is dedicated to pruning every public tree, both on the street and in its parks and cemeteries, every four to five years. Approximately 3,000 street trees are pruned each year. The city contracts with private sector tree companies to assist with these initiatives. The City Arborist develops the specifications for this work, and also monitors the performance of the contractors.

The forestry crew is well trained to handle downed limbs and response time has been very good. Currently the city is equipped with several vehicles to deal with any tree issue including bucket and crane trucks, chippers and stump grinders. The city also has a debris contract in place, which deals specifically with wood products, and several varying size dump trucks to handle transport.

The building code provides structural protections from high winds. To minimize damage at construction sites, the city inspects construction sites prior to forecast storms and recommends measures for contractors to take to minimize potential damage.

Winter-Related Hazards

It is a large task in terms of resources and timing to clear streets, sidewalks, curb cuts and catch basins after a snow storm. The city finds that using contractors is not a viable option because when the need is greatest in Cambridge, it is also great in other communities, so contractor resources dwindle. The city depends upon DCR to clear the roadways and sidewalks that it owns.

While the city does have emergency parking bans during storms, the city is limited by the number of cars that can be towed. The city is generally successful at clearing cars from arterials, but neighborhood streets remain a problem.

While it is important to be aware of potentially heavy snow loads on roofs, roof collapses are not common in Cambridge. The city's building inspectors recommend that residents monitor the roof and look for signs of concern, but it is dangerous for residents to climb

on the roof to clear it. Rather they should depend upon a trained professional inspector or engineer.

City-wide Existing Mitigation – The city has routine snow operations for clearing snow, sanding, etc. DPW goals are to chemically treat all major arteries within 3 hours of start of snow (prioritizing the most traveled roads), plow main arteries throughout the storm, and clear all streets and sidewalks bordering city property once the snow has stopped. The city implements emergency parking bans prior to forecast major snow storms. The city has created a brochure for the public – "Snow: Our Winter Challenge". In addition, the Council on Aging can provide residents with contact information for students for hire for snow shoveling.

In 2005, DCR created its first Storm Management Plan, with plans and schedules for snow removal. DCR also partnered with MassHighway to share snow removal responsibility.

Site-Specific Issues

Cambridgeport stands out as a particular challenge during snow storms due to its density and narrow streets. Map 1 clearly shows that this area is among the most densely populated in the city.

Over the last 10 years, MIT has had roughly $1.5 million in damage due to various storms including snow storms and hurricanes. Employees not being able to get to campus are a large concern.

Harvard University feels that damage from past storms has been insignificant and the campus is not at a high risk for damage in the future. The University has staff for plowing, but does hire contractors as needed. They keep the plowed snow on their property. Similar to MIT, Harvard is affected when employees can not get to the campuses.

Fire

As discussed earlier, the risk of brush fire is minimal.

Existing Mitigation – The city does not allow outdoor burning.

Geologic Hazards

Earthquake

As discussed earlier, there are 7 critical infrastructure sites that are within areas at high risk of liquefaction. Areas with a high potential for liquefaction include the following areas:

- Much of the land near the Charles River, extending west to Windsor Street and Sydney Street. This area includes Memorial Drive, the MIT Campus, transit facilities and many other uses.

- An area around Harvard Square that extends to the Charles River.
- An area north of Fresh Pond, along the Fresh Pond Parkway and Alewife Brook Parkway.
- Various small patches of fill land in the western part of the city.

Existing Mitigation – New construction must abide by the state building code.

Landslide
Landslides have not been an issue in Cambridge.

Other
Similar to other communities in the area, parts of Cambridge are built on fill. The Cambridge Historical Commission provided the following information on areas of fill in the city (Sullivan, 2005):

- Structures constructed on streambeds and marshes that were filled in the 19th century have been affected by subsidence. These occurrences have been observed on Gerry Street, Chestnut Street, Newton Street and along Western Avenue backing up to Hoyt Field.
- The Pine Swamp, in what is now the Agassiz neighborhood, was filled for agricultural purposes in the 18th century. Current-day effects of this include drainage problems.
- Cambridge was home to a number of clay pits. The clay was excavated and the pits – some up to 30 feet deep – were filled with various materials such as ash, rubbish and building debris. In many cases, the filled land was then sold as building lots while others became parks. The north side of Concord Avenue, and Orrin, Tierney and Winslow streets are filled or partially filled pits. Impacts include a house on Newell Street that had to be razed due to settlement issues.

Other Hazards

Extreme Cold
The elderly, the very young, and the homeless are most at risk during extreme cold temperatures, referred to as an Immediate Cold Emergency or I.C.E. According to 2000 census data, 4.1% of the city's population was under age 5 (4,125 persons) and 9.2% were age 65 or older (9,282 persons). While the census does not specifically indicate how many children are under age 2, it is apparent that at least 10% (under 5 plus over 65) of the city's population could be considered vulnerable to excessive cold. The 2005 Cambridge Homeless Census counted 484 homeless persons in Cambridge on one very cold night in January. Despite the cold temperatures, 41 were not in shelters, transitional housing nor inpatients – i.e., they were sleeping in streets, subways and other areas not well protected from extreme temperatures.

In addition to the immediate health impacts, the city also experiences a large number of water main breaks in winter months. On occasion the service pipes to buildings burst during cold weather.

MIT has seen damage due to frozen pipes – $250,000 over 6 years. The damage is due mostly to human error in winter months, such as leaving windows open.

Existing Mitigation – Various entities cooperate to address vulnerable populations during extreme cold and a protocol is in place to delineate efforts and responsibilities.

In terms of the protection of water pipes, Inspectional Services reviews construction plans to be sure that service pipe placement meets codes and will make recommendations on how to better prevent service pipes from bursting. Television news casts provide warnings for people to leave water dribbling.

The CWD has been replacing older mains, some of which are 100 years old. The older mains are cast iron. Of the 100 miles of old mains, 20% has been replaced so far.

Extreme Heat

According to the Emergency Management Department, elderly and children under two years old are most at risk in extreme heat. Records for heat emergencies over the past six years show that the number of declared heat emergencies fluctuates:

- In 1999 the city declared heat emergencies on 6/27/99, 7/3/99-7/6/99 and 7/16/99-7/18/99.
- There were no emergencies in 2000.
- In 2001 the city declared one three-day emergency from 8/7/2001- 8/10/01.
- In 2002 the city declared two emergencies on 7/2/02- 7/3/02 and 8/13/02-8/14/02.
- No emergencies were declared in 2003 and 2004.
- In 2005, one 2 day emergency was declared from 7/19/05 -7/20/05.

Existing Mitigation – Similar to extreme cold, various entities cooperate to address vulnerable populations during extreme heat events and a protocol is in place to delineate efforts and responsibilities. The city has a cool shelter for elderly and conducts public outreach during heat emergencies along with other entities such as Professional Ambulance. Often they will provide fans to the elderly.

Mosquito-Borne Viruses

At a local team meeting, the city expressed concern about West Nile virus and EEEV. Risks can partly result from flooding and drainage problems and intentional or inadvertent open water storage around the city. The city is served by the Eastern Middlesex Mosquito Control Project (EMMCP). Staff at EMMCP indicated that urban areas such as Cambridge do not see as many mosquitoes as more rural or suburban communities, but the type of mosquito found in Cambridge is more likely to carry West Nile virus than other types. According to the Center for Disease Control, people over 50 are most at risk of developing serious symptoms if they contract the disease.

Existing Mitigation – Cambridge created a West Nile Response Plan. The city and EEMCP collect dead birds and send them to the State for testing. The Department of Public Health (DPH) reviews site plans for certain development proposals. The city Inspectional Services Department responds to habitat concerns on construction sites. DPW treats the city-owned right-of-ways with larvicide while EMMCP treats state-owned land and right-of-ways. MIT and Harvard conduct their own treatment program. Harvard University employs an entomologist who addresses West Nile Virus in addition to other issues such as bed bugs.

The city also provides public education through brochures, community events, and informal phone inquiries.

Climate Change

The city found that most of its contribution to climate change is related to energy use in buildings. Smaller sources include transportation and solid waste disposal. The city set targets for greenhouse gas reduction and outlined goals and actions in its Plan.

The city established the following goals to reduce greenhouse gases:

- Improve efficiency of electricity use by 12.5%.
- Reduce natural gas and fuel oil use by 10%.
- Reduce emissions associated with electricity generation by 40%.
- Purchase 20% of electricity from green power sources.
- Increase average fuel economy to 40 miles per gallon.
- Reduce vehicle miles traveled by 10%.
- Increase recycling rates to 60%.

Existing Mitigation – The city joined Cities for Climate Protection in 1999 and adopted a Climate Protection Plan. The city has worked to make municipal and private facilities more energy efficient. The city has also incorporated sustainable building measures into a number of city-facilities: the City Hall Annex received a LEED Gold Rating; the city is aiming to have the Russell Field Fieldhouse certified as Silver; and both the library expansion and renovated police headquarters will incorporate sustainable building measures.

Compilation of All Existing Mitigation

The following table summarizes many existing natural hazard mitigation measures already in place in Cambridge. Because of the number of entities, public and private, involved in natural hazard mitigation, it is likely that this list is a starting point for a more comprehensive inventory of all measures. Updates of the plan should continue to add to this table.

Table 15. Existing Natural Hazard Mitigation Measures, Cambridge

Hazard	Area	Mitigation Measure
Multi-hazard	City-wide	Emergency preparedness entity
		Emergency management plan
	MIT	Emergency preparedness entity
		SIMTest Team analyzes various disaster scenarios
		Performs exercises to improve disaster response
		MIT is hiring a full-time emergency coordinator that can be liaison to city
	Harvard University	Incident management committee
		Serves on Cambridge LEPC
		Trainings
		Individual plans for specific events
Flooding	City-wide	Catch basin cleaning, maintenance and repairs
		Street cleaning and litter pick-up
		City uses salt & calcium chloride instead of sand on roads in winter
		Zoning -- Flood Plain Overlay District, Article 19 review, & Permeable Open Space Requirements
		City requires development store difference in volume between 2 year 24 hour storm event pre-development runoff & post-development 25 year 24 hour storm event runoff hydrograph through its stormwater policy
		5- and 10-year capital infrastructure program objectives
		MWRA reviews large developments (through State MEPA process) to reduce potential impacts, including system flooding
		Public education with meetings and brochures
		Remedial reconstruction of storm sewer & drainage infrastructure
		DCR uses GPS to map its catch basins and stormwater outfalls
		DCR developed new schedule for catch basin cleaning and street sweeping
	Areas downstream of dams	State is adopting new dam safety regulations
		Dams are regularly inspected
	Water supply watershed communities	CWD reviews proposed development projects in watershed communities
		CWD staff visits construction sites & meets with developers
		Dams are inspected every 2 years
		CWD staff is trained to anticipate large storms so that control gates can release water appropriately

Table 15. Existing Natural Hazard Mitigation Measures, Cambridge

Hazard	Area	Mitigation Measure
Flooding (continued)	Water supply watershed communities (con't)	CWD & USGS jointly collect technical information, including real-time stream information
		CWD recently repaired hurricane gates
	1, 2 & 4. Golf course, Blanchard Rd., Thingvalla St., Fresh Pond Res.	Belmont is addressing stormwater quality issues, but water quantity issues are not being addressed
		Rehabilitation of existing drainage system including 10 new catch basins
		Currently constructing next phase - pump system in Little Fresh Pond to allow drawdown prior to large storm events
		Future phase – construct more catch basins downstream, rehabilitate small open channels in reservation, incorporate stand pipe & drainage swale for more efficient drainage system
		CHA waterproofing, remediation work at Corcoran Park
	5. Concord Avene, New Street	City installed 12 cubic foot per second pump station & stormwater detention tank in New Street area
	7. Little River, Alewife Brook Reservation, Acorn Park	Special District 4 & 4a for Discovery Park redevelopment. Completed Concord-Alewife rezoning which included provisions for stormwater management
		Tri-Community Compact
	8. Burns Apartments	DPW work in this area has helped
	9. Jackson Housing	CHA installed check valves
	10. Dudley & Clifton Sts., Pemberton/Yerxa Rd and Bellis Circle	The city constructed new stormwater system – raised berm elevations in wetland at Danehy Park & installed storage tank & online pump station adjacent Danehy Park Parking lot to handle up to 25-year event which improves flood protection for the Bellis Circle neighborhood and the surrounding area.
	14. Linnaean St. Housing	CHA installed backwater valve which is shut off during forecasted storm
	15. Porter Square	Construction complete that will partially alleviate flooding in the White Street, Somerville Avenue area
		MBTA replaced 2 pumps
	16, 17. North of Kirkland/Quincy sts., Irving, Bryant, Crescent, Sacramento, Carver sts.	Underground storage systems constructed & some sewer separation. Remaining sewer separation & stormwater management scheduled over next 10-20 years
		MBTA replaced 2 pumps to address problems on Garfield St.

Table 15. Existing Natural Hazard Mitigation Measures, Cambridge

Hazard	Area	Mitigation Measure
	18, 19. Kirkland, Myrtle, Magnolia, & Cambridge streets	Sewers will be separated & stormwater storage facilities (330,000 gallon storage) will be installed
		Adjacent to the Cambridge City Main Library. Cambridge Hospital - emergency response plan & agreements with vendors to assist in large-scale event. To keep hospital operating during storm, use pumps, wet vacuums & have additional housekeeping personnel.
	24. Ellery St. & Broadway	See 18, 19 above
	26. School, Pine, Cherry Sts., Windsor & other areas. Newtowne Court & Washington Elms housing	Phase I of a multiphase sewer separation and stormwater management program for area has been completed on South Massachusetts Ave. & Phase II at Bishop Allen Drive is scheduled to begin in early 2007
		CHA corrective steps at Newtowne Court and Washington Elms
	28. Near Newton, Green, Franklin & Sydney streets	City is reconstructing portion of sewer and drainage infrastructure (see text for details). Goal to accommodate up to 25 year storm, reduce/eliminate back-up and surcharges
	29. Harvard Square	City is presently in middle of multi-phase program to separate sewers & provide more efficient conveyance system in Brattle/Eliot/Mt Auburn areas of Harvard Square
	33. Western Ave.	Multi-phase Infrastructure Renewal Program Proposed by city. Anticipate contract for Comprehensive Infrastructure Renewal Report will be awarded in summer 2007
Wind	City-wide	Creating GIS layer of trees
		Well-equipped to handle damaged trees
		Building code
		Preventative tree maintenance – pruning, treating, planting, protecting trees
		Public education – "Residential Street Tree Planting and Care" brochure
		Inspection of construction sites prior to forecasted storms
Winter-Related	City-wide	Routine snow operations for clearing snow, sanding, etc. DPW goals to chemically treat all major arteries within 3 hours of start of snow (prioritizing most traveled roads), plow main arteries throughout storm, clear all streets & sidewalks bordering city property once snow has stopped

Table 15. Existing Natural Hazard Mitigation Measures, Cambridge

Hazard	Area	Mitigation Measure
Wind Related (continued)		The city implements emergency parking bans prior to forecasted major snow storms
		In 2005, DCR created its first Storm Management Plan, with plans & schedules for snow removal. DCR partnered with MHD to share snow removal responsibility.
		Public education – "Snow: Our Winter Challenge" brochure
		Council on Aging can provide residents with contact information for students for hire for snow shoveling
Extreme heat	City-wide	Cooperation among various entities
		There is an established protocol
		The city has a cool shelter for elderly
		Public outreach during heat emergencies
Extreme cold	City-wide protection of those at risk	Cooperation among various entities
		There is an established protocol
	City-wide protection of infrastructure	Inspectional Services reviews construction plans to ensure service pipe placement meets codes; makes recommendations on preventing pipes from bursting
		Television provides warnings for people to leave water dribbling
		CWD has been replacing older mains
Fires	City-wide	The city does not allow outdoor burning
	MIT	Approximately 99% of MIT's building area is protected by alarms and sprinklers systems
Earthquake	City-wide	The State Building Code addresses earthquake standards
Mosquito-borne disease	City-wide	Cambridge West Nile Response Plan
		Surveillance -- The city & EEMCP collect dead birds and send them to the State for testing
		Habitat Control -- DPH reviews site plans for certain development proposals. Inspectional Services Dept. responds to habitat concerns on construction sites.
		Treatment -- DPW treats city-owned catch basins with larvicide, EMMCP treats state-owned land & ROWs. MIT & Harvard conduct own treatment program.
		Public Education – Brochures, community events, informal phone inquiries
	Harvard Campus	Harvard University employs entomologist to addresses West Nile Virus

Table 15. Existing Natural Hazard Mitigation Measures, Cambridge

Hazard	Area	Mitigation Measure
Climate Change	City-wide	The city joined Cities for Climate Protection in 1999
		The city adopted a Climate Protection Plan
		Programs to make municipal and private facilities more energy efficient
		City Hall Annex was constructed as a green building and recently received a LEED Gold Rating.
		Russell Field Fieldhouse is nearing completion of construction. LEED documentation is ongoing and the building will hopefully reach LEED Silver.
		Library expansion will incorporate sustainable building measures
		Renovated police headquarters will incorporate sustainable building measures

HAZARD MITIGATION GOALS AND OBJECTIVES

At the October 20, 2005 Local Team meeting, attendees formulated goals and objectives for natural hazard mitigation planning in Cambridge.

Goal: Protect the health and safety of the public.

- Encourage people to be prepared before, during and after a hazard event.
- Ensure that services related to public health can function during and after a hazard, e.g., sanitation, water, debris removal, hospitals and emergency services.
- Ensure that evacuation can happen in an organized and efficient manner.
- Minimize secondary impacts from hazards, such as the release of pollutants.

Goal: Protect existing properties and structures.

- Provide resources for residents and businesses to make their buildings and properties more disaster resistant.
- Educate the public on measures they can take to protect their property.
- Maintain existing mitigation structures.
- Ensure that future development / redevelopment does not make existing properties more vulnerable to hazards.
- Ensure that critical facilities are protected from hazards.

Goal: Ensure that essential services can function during and after a hazard event.

- Ensure that critical infrastructure is protected from natural hazards.
- Ensure that people (key service providers and employees) can get into the city to provide services.
- Build resiliency into the system for faster recovery, e.g., electricity distribution system.

Goal: Avoid chaos and confusion with good communication.

- Have an effective communication plan.
- Outreach to non-English speakers.
- Coordinate efforts with the private sector and institutions and with neighboring communities.

Goal: Work regionally to mitigate impacts from natural hazards and to respond and recover from hazard events.

- Continue to participate in regional efforts.
- Cooperate with other agencies, communities, and private entities.
- Understand priorities and capabilities of other entities to allow for resource-sharing, mutual aid, and entering into memoranda of understanding (MOU).

Goal: Determine priorities for directing resources for hazard mitigation and response.

- Prioritize mitigation projects.
- Continue to program mitigation projects in the 5 and 10 year CIP.
- Pursue various funding sources.
- Encourage private property-owners to implement measures to protect their own property.

Goal: Complete separation of combined sewers.

- Finish planning and designing the remaining separations.
- Find funding.

POTENTIAL MITIGATION

What is Hazard Mitigation?
Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries and property damage resulting from natural and human-made hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, 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.

See http://www.fema.gov/government/grant/government.shtm for more information.

Identification of Potential Mitigation Measures
The local team met on October 20, 2005 to brainstorm possible mitigation measures for the various natural hazards that have impacted or could impact Cambridge. Meeting attendees and other local officials continued to suggest additional ideas via email. In addition, MAPC solicited suggestions for mitigation measures when it collected hazard information from city officials and others. MAPC developed a matrix of all suggested strategies, which totaled over 140 measures.

Process for Setting Priorities

The decision on priorities was made at a meeting of the local committee. Priority setting was based on local knowledge of the hazard areas, cost information and an assessment of benefits.

MAPC staff attended the Benefit-Cost Analysis Training Course on October 31-November 1, 2005. Information from this training was shared with local officials when MAPC made a Power Point presentation on the Benefit/Cost Analysis at the February 23, 2006 meeting of the Metro Boston Hazard Mitigation Community Planning Team. This was done in order to help local officials understand the role of a benefit/cost analysis.

Based on information gained from the Benefit-Cost Analysis training and a review of the STAPLEE criteria (a checklist for evaluating social, technical, administrative, political, legal, economic and environmental issues) MAPC instructed City staff to take 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, anticipated costs, whether the City 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 Local Team met on May 2, 2006 to prioritize these measures and invited a number of other stakeholders to help set priorities (see attendance for this meeting listed earlier in Table 7). Participants added two more mitigation measures to the list and then each picked their top 20 priorities.

Prior to choosing priorities, participants reviewed the project Goals and STAPLEE evaluation considerations, such as;

- Is there political support and public support to implement the mitigation measures?
- Can the city provide the necessary maintenance when the mitigation measure is completed?
- Does the cost seem reasonable when considering the size of the problem and likely benefits from mitigation?

The participants also decided that certain projects on the list are important enough that they were deemed a priority prior to voting. Participants then voted to prioritize the remaining mitigation measures. The comprehensive range of all suggested measures from the earlier brainstorming process and voting result from the prioritization meeting are in Appendix F. The Local Team further refined the results.

High Priority Mitigation Measures

<u>City-wide measures to reduce flooding impacts</u>

- Complete hydraulic modeling
- Complete new stormwater regulations and update guidelines
- Continue to program flood mitigation projects and sewer separation projects in the Capital Improvement Program
- As noted throughout this plan, Cambridge's drainage infrastructure is old. Continue remedial reconstruction and upgrade aging infrastructure

<u>Help private landowners install back flow preventers in targeted areas</u>

<u>Install SCADA system at Fresh Pond to allow remote monitoring & control of elevations at Little Fresh Pond</u>

<u>Complete sewer separation to address flooding in a number of areas</u>

- East of Fresh Pond Parkway (area #6)
- Area between Concord Avenue rotaries and New Street (area #5) – 5 to 10 years
- CAM 002 CSO area at Porter Square
- Agassiz area (CAM011)
- Cambridgeport area
- CAM017 area around the Area IV neighborhood
- Harvard Square area
- Western Ave.

Address flooding at golf course

- Complete construction of stormwater infrastructure at the golf course

Improve collection and conveyance system

- In area east of 2nd Street and north of Charles Street (area #27)
- Western Ave.

Implement additional stormwater management measures/programs in certain areas

- Area near School Street, Pine Street, Cherry Street and Windsor Street (area #26)
- CAM 017 stormwater management program near Tremont Street and Norfolk Street (area #25) and near Newton Street, Green Street, Franklin Street and Sydney Street (area #28)
- Western Ave.

Complete sewer separation and stormwater management program for CAM011

- Areas near Irving Street, Bryant Street, Crescent Street, Carver Street, and Sacramento Street (areas #16 and 17)
- Areas near Kirkland Street, Myrtle Street, Magnolia Street and Cambridge Street (areas #18 and 19)
- Area near Ellery Street and Broadway (area #24)

Investigate potential hazardous releases due to any and all natural hazards

- The local team raised questions about what types of hazardous materials could be released during a storm, flooding, earthquake, etc. For example, there are facilities that currently store hazardous materials and there are contaminated sites in the city. The team felt that it is important to minimize potential releases and the first step would be to investigate the issue.

Minimize risk of water main breaks during cold weather

- Again, the city's infrastructure is old and the CWD has been working to replace its water infrastructure. Completing replacements should remain a high priority.

Develop role-specific emergency and evacuation plans and develop a comprehensive communications plan

- While this measure is more related to disaster response, the local team felt that it is important that the city develop plans that spell out specific roles of city and regional entities during an emergency or evacuation. The plan should account for residents that do not have cars. In addition, the city should develop a comprehensive communications plan that also addresses communication with non-English speakers.

Assess risks to infrastructure from all natural hazards

- There are many entities that provide important services to Cambridge, including utilities (electric, gas and steam) and transit. However, determining the vulnerability of this infrastructure to various hazards was beyond the scope of this project, in part because much of the data was not available and because it

likely requires in-depth engineering studies. An important next step would be for the city to work closely with these service providers and utilities to better understand risks, existing mitigation measures and additional mitigation measures to better protect the infrastructure.

Create a power-loss plan for major power outages

- This is a critical measure that applies to any natural hazard.

Share resources

- The importance of working with neighboring communities and with entities located within Cambridge emerged as an important theme. One specific mitigation measure is to develop MOUs with these various partners in order to share resources. This may include the sharing of equipment, personnel, etc.

Keep right-of-ways free and clear

- By ensuring that public rights-of-way are unobstructed prior to a natural disaster, impacts during and after an event can be minimized – evacuations may proceed more smoothly and the delivery of essential services will suffer less interruptions. ROWs should be maintained and remain unobstructed.

Medium Priority Mitigation Measures

Provide a cool shelter for infants

- The city's cool shelter can not accept infants, who are also at high risk during a heat emergency. The city should work to provide a cool shelter that allows parents to bring infants.

Improve communications

- Participants felt that there was room for improvement in communications between city departments and between the city and universities when it comes to disaster preparedness and response. One way to further communications is to provide opportunities for "knowledge exchanges". Ideally, the exchanges would involve the city, the universities and other private entities such as businesses.

Help property-owners flood proof their properties

- Setting up a funding program (whether by grant or loan) could help residential property owners make improvements to minimize potential damages from flooding.

Ensure operability of connection between city water system and MWRA system

- It is important to ensure that this connection operates properly. Regular testing/exercising along with proper maintenance and ensuring the connection is not vulnerable to hazards is critical to ensuring that this connection does not fail when needed.

Locate critical shut-off's for utilities

- Under snow cover, it is not always easy to find these important shut-off's.

Ensure that state-owned dams can withstand a major hurricane

- The local team raised questions over preparedness for storms that are more powerful than what the region has experienced historically. One question that arose is whether the region's dams, such as the Charles River Dam and the Amelia Earhart Dam are engineered to withstand a larger storm.

Determine vulnerability of roadways and utilities to earthquakes in the high liquefaction areas

- A fairly large portion of Cambridge may be highly susceptible to liquefaction should an earthquake occur. It is uncertain how utilities and roadways would withstand an earthquake and further study may be needed to identify vulnerabilities and protection measures for specific facilities.

Provide generator at cool shelter or provide back-up shelter

- As noted, the city has one cool shelter, so having provisions for a power loss is critical.

Protect generators at public facilities

- The city should ensure that all public facilities have generators and that staff are trained to operate and maintain the generators. In addition, the city should ensure that all generators are located in areas that are protected from hazards.

Improve response time when utilities are damaged

- This is especially important when the damage creates a danger, such as with live wires.

Complete SCADA and encourage other departments to use it

Develop a staffing plan for sustained winter events

Undertake a number of measures to address climate change

Those measures that were considered to be a medium priority are:

- Improve the energy efficiency of city buildings and facilities
- Encourage the purchase of fleet and private vehicles with higher fuel economy
- Use biodiesel for all city owned diesel vehicles and equipment
- Utilize improved vehicle emission technology

Improve communication regarding the Charles River Dam

- Not all city departments are aware of the schedule for changing the dam's water levels.

Reduce flooding potential of new development and redevelopment

- In addition to measures already in place, additional techniques include replacing pavement with pervious surfaces, encouraging green roofs, and using low impact development (LID) techniques.

Expand catch basin cleaning and repair program

- More funding for equipment and staff would allow the city expand this effective program.

Educate the public on post-flooding risks

- Educating the public about things to be aware of after flooding can help reduce secondary impacts. Specific risks mentioned by the local team include mold issues and structural damage.

Refine the hurricane surge analysis

- Similar to many cities, much of the flooding problems in Cambridge are due to structural deficiencies and aging infrastructure – not necessarily topography and flood plains. An analysis of the hurricane surge zone based on actual drainage could be useful to better gauging potential hurricane surge impacts.

Improve snow fighting equipment

- Funding for additional snow fighting equipment would help to further reduce impacts from large snow storms.

Other Potential Mitigation Measures

A number of additional mitigation measures arose during the course of the project. These additional measures were either considered to be a low priority, a better alternative was deemed a medium or high priority, or they were not considered feasible. However, it is worth recording them in the plan, because they could be revisited in the future. They include:

Multi-Hazard

- Drilling for communications
- Ensure that information is distributed to stakeholders of the various communities in Cambridge.
- Plan for oil delivery disruptions.
- Provide live wire information to the public.

Flooding

- DCR should create a plan outlining dam operations and potential impacts *[due to security concerns, this information is not publicly available]*. DCR should be provided additional resources for maintaining the dams.
- Assess long term impacts to dams due to projected sea level rise per the CLIMB study and other studies and determine dam adaptations that may be warranted.
- Determine if the Watertown Square Dam has/could have flooding impacts on Cambridge.
- Determine potential impacts to Cambridge from Upper Mystic Lake Dam.

- Study if the operation of the Amelia Earhart dam affects water levels in the Mystic River and Alewife Brook *[CDM has conducted two studies on this issue]*.
- Explore the possibility of eliminating the remaining superstructure at the old Craddock Locks Dam along the Mystic River which is reported to cause additional flooding in the Alewife area (Winchester DEIR 2005).
- Work more closely with water supply watershed communities on flood control issues, including public education. Current efforts are effective and should continue. More staff time to work at more coordinated efforts with watershed communities could further strengthen this program.
- Work to make project review standards for flooding & stormwater used for projects in watershed communities consistent with city's standards.
- CWD should revise its 1998 Emergency Action Plan to reflect recently-implemented mitigation measures. The update should include a dam inundation study and evaluate the feasibility of a remote control system for gates. Install back-up generators for gates to complement manual control.
- CWD should conduct a feasibility study for the abandoned gatehouse on Trapelo Road on the Lincoln and Waltham line. It may be possible to use the gatehouse to better control flooding and better address water quality issues.
- Train more CWD staff to use data collection equipment.
- Development reviews should require an assessment of potential impacts during significant rain events.
- DCR should improve the frequency of catch basin cleaning and repairs on parkways.
- Preserve flood plain storage.
- MassHighway should reduce the use of sand and salt in city's water supply watershed. Mass Highway's new pavement type in the watershed requires more sand.
- Property owner education tied to renovations.
- Further studies of causes of flooding.
- Belmont should fully eliminate illicit connections and cross connections to its drainage system as it conveys flows through Cambridge.
- Other agencies and neighboring communities should maintain their infrastructure.
- MBTA and MassHighway – Route 2, better control of water levels at Spy Pond and Spot Pond.
- *Areas # 1 & 4-Golf Course, Fresh Pond Reservoir, Blanchard Rd., Thingvalla St.*
    - Improve stormwater management
- *Area #3 - Aberdeen & Homer -*
    - Conduct analysis of CAM 005
    - Examine structural measures to protect affected buildings from flooding. This includes roughly 20 buildings (apartment buildings and single-family houses)
    - Do nothing to address flooding
- *Area #5 - Between Concord Ave. rotaries & New Street –*
    - Monitor discharges near Danehy Park
- *Area # 6 - East of Fresh Pond Pkwy. –*

    - Structural upgrades for Tobin School (the generator is affected during floods)
    - Flood proof affected buildings
    - Implement new zoning regulations
- *Area # 7 - Adjacent to Little River –*
    - Study how the lowering of water levels before storms at Spot Pond, Spy Pond and Claypit Pond could address flooding
    - Channel maintenance
    - Determine if operations of Amelia Earhart Dam affect water levels of Alewife Brook
    - Separate stormwater sewers (Cambridge and Somerville)
    - Acquire flood plain properties
- *Area # 12 - Walden Square, Bellis Circle & Bolton Street, Dudley & Clifton streets & Pemberton/Yerxa Road -*
    - Study to confirm if the Massachusetts Avenue bridge to Arlington is contributing to flooding issues
    - Over the next 5 years, plan for additional CSO separation in this area, along with stormwater management
    - Improve channel clearing in Alewife Brook
- *Area # 15 - Porter Square* - Alter pumping operations of flood water from MBTA facilities
- *Areas # 21-23 - Grant & Bank Streets* - Improve collection and conveyance system
- *Areas # 21-23 - Mt. Auburn near Plympton Streets* - Complete CAM011 sewer separation and stormwater management program
- *Area #26 - School, Pine, Cherry Streets, Windsor* - Complete CAM017 Sewer Separation and Stormwater Management
- *Area #33. Western Avenue* - Complete Sewer Separation and Stormwater Management

<u>Earthquake</u>

- Determine which buildings may be most vulnerable during an earthquake and conduct structural assessments.
- Encourage critical land uses in high susceptible areas to secure equipment.

<u>High Winds and Hurricanes</u>

- Create a debris management plan.
- Increase tree maintenance with more equipment and more personnel.
- Provide funding for property owners to practice preventative tree maintenance on private property.
- Increase public education on the benefits and proper care of trees.
- Create a brochure on preventative measures for construction sites which could be handed out to contractors and developers before they begin construction.
- Develop a text communication mechanism to alert contractors to high wind warnings.
- Zoning should consider hurricane surge zones.

Winter Storms

- Better clearing of sidewalks and bridges (DCR). Encourage the use of transit by keeping sidewalks clear.
- Explore the feasibility of putting snow in the harbor.
- Place SCADA temperature controls in streets to monitor temperatures.
- Consider partnerships for snow melting technology and snow storage facilities/locations.
- Investigate alternatives to road salt and calcium chloride. Explore de-icing and liquids.
- Provide GPS in snow plows.
- Relieve snow build up on roofs.
- Educate homeowners about snow load hazards.

Extreme Temperatures

- Optimize building design and the use of vegetation to shade buildings and reduce the urban heat island effect.
- Develop a process to waive limitations on homeless shelters during a heat emergency.
- Purchase more fans and air conditioners to provide to seniors during heat emergencies.
- Provide more staffing for senior center (cool shelter) during heat emergencies.

Fire

- Make sure all public facilities including City Hall, have appropriate fire protection systems installed including sprinklers, when appropriate.

Climate Change

- Provide incentives for planting trees and creating additional green space to help address climate change.
- Use computer imaging (such as GIS) to accurately determine current canopy cover, assess environmental benefits, and plan plantings.
- Create small-scale public gathering places with well-adapted vegetation.
- Conduct open space review during the permitting process for development projects to incorporate open space into project design.
- Strengthen zoning incentives to include LEED in project review and PUD processes.
- Provide developers, citizens, and city staff with information to assist them in applying LEED standards.
- Develop green standards for city-owned properties.
- Improve facilities for walking and cycling.
- Support greening of the regional electric grid through the purchase of bundled renewable electricity and renewable energy certificates and local installation of renewable energy systems.
- Support environmentally preferable purchasing practices.
- Foster mixed-use, transit oriented development.

- Reduce single-occupancy vehicle travel through regulatory measures.
- Reduce single-occupancy vehicle travel through public education campaigns.
- Reduce waste and expand recycling programs and household and business. hazardous waste collection/options. Expand the city's recycling drop off center
- Expand the use of district steam.

Mosquito Borne Viruses

- New catch basins should not retain water for extended periods of time.
- Provide more education to residents to reduce outdoor water containers.

Mitigation Summary, Table 16

The following columns are included in the mitigation summary table below:

Mitigation Measure – A brief description of each mitigation measure.

Priority – The designation of high or medium was based on input by the Local Multiple Hazard Community Planning Team and the key project staff at DPW. The designations could change as conditions in the community change. Low priority and non-prioritized measures are not included in the table.

Lead Implementation – This column lists the most logical implementer. 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. In some cases, a non-local entity ideally would be the lead implementer.

Time Frame – The time frame was based on the level of priority for the measure, the complexity of implementing the measure, and whether or not the measure is conceptual, in design, or already designed and awaiting funding. Time frames could change as funding opportunities arise.

Estimated Cost – Where available, cost estimates are provided. The cost data would need to be adjusted for inflation and for any changes or refinements in the design of a particular mitigation measure as a project progresses.

Potential Funding Sources – This column attempts to identify possible sources of funding for a specific measure. This information is preliminary and varies depending on a number of factors such as whether a mitigation measure has been studied, evaluated or designed or is still in the conceptual stages. 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.

The best way to determine eligibility for a particular funding source is to review the project with 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 for a number of types of projects including shoreline/streambank protection, flood damage reduction, flood plain management services and planning services.

FEMA – As noted earlier, see http://www.fema.gov/government/grant/government.shtm for more information.

Table 16. Potential Mitigation Measures

Mitigation Measure	Priority	Lead Implementation*	Time Frame	Estimated Cost	Potential Funding Sources
Complete hydraulic modeling for city	High	DPW	Short term	$500,000	MWRA II Funds
Complete new stormwater regulations & update guidelines	High	DPW	Short term	$400,000	$300,000 already funded
Continue to program flood mitigation & sewer separation projects in CIP.	High	DPW	ongoing	Staff time	City
Continue remedial reconstruction city-wide.	High	DPW	ongoing	$1m - $2m annually	City
Upgrade aging infrastructure	High	DPW	ongoing	Greater than $1m	City
Help private landowners install back flow preventers in targeted areas.	Medium	DPW	Short term	$25,000	HMGP
Install SCADA system at Fresh Pond to allow remote monitoring & control of elevations at Little Fresh Pond	High	DPW	Short term	$40,000	HMGP
Sewer separation east of Fresh Pond Pkwy (area #6)	High	DPW	Mid-term	$100m	MWRA/City
Sewer separation and stormwater management	High	DPW	Ongoing	$15m annually, on average	City
Sewer separation between Concord Ave. rotaries & New St. (area #5)	High	DPW	Mid to long term	Greater than $1m	City
Complete stormwater infrastructure at golf course	High	DPW/Water Dept	Short term	$600,000	City
Sewer separation (CAM 002 CSO area), Porter Square	High	DPW	Long term	$15m	Same
Improve collection & conveyance system east of 2nd St & north of Charles St. (area #27)	High	DPW	Long	n/a	City
Implement additional stormwater management measures, School, Pine, Cherry Streets, Windsor (area #26)	High	DPW	Mid-term	$70m	City
Implement CAM017 Stormwater Management Program near Tremont & Norfolk Sts (area #25)	High	DPW	Mid-term	Greater than $1m	Same
Complete Cambridgeport / CAM017 stormwater management program, Newton, Green, Franklin & Sydney streets (area #28)	High	DPW	Mid-term	$10m	MWRA II/City

Table 16. Potential Mitigation Measures

Mitigation Measure	Priority	Lead Implementation*	Time Frame	Estimated Cost	Potential Funding Sources
Complete CAM011 sewer separation & stormwater management program - Irving, Bryant, Crescent, Carver, Sacramento (areas 16, 17); Kirkland, Myrtle, Magnolia, Cambridge (areas #18, 19); Ellery St. & Broadway (area # 24)	High	DPW	Mit-term	$130m	City over 20yrs
Investigate potential hazardous releases due to any/all natural hazard	High	DPH, Fire Dept.	Ongoing	$50,000 to $100,000	
Pursue a more aggressive program to replace older water mains (minimize bursts in cold weather)	High	CWD	On-going	Greater than $1m	City
Emergency & evacuation plan that spells out roles. Include options for residents without cars	High	EMD	Short term	Less than $50,000	City, investigate Homeland Security programs
Develop comprehensive communications plan. Include communication with non-English speakers	High	EMD	Short term	Less than $50,000	City, investigate Homeland Security programs
Assess risks to infrastructure including electric, gas, & steam distribution & MBTA subway system	High	DPW	Long term	$50,000 to $100,000	City, investigate Homeland Security programs and PDM
Have a power-loss plan for major power outages	High	Electrical Dept.	Mid term	Less than $50,000	City, investigate Homeland Security programs
Develop MOU between cities, universities, etc., that provides shared access to resources	High	Various	Mid term	Staff time	City
Ensure public ROWs are properly maintained & accessible so essential services and deliveries can continue	High	DPW	On-going	Staff time	City
Provide facility for parents to bring infants during heat emergency	Medium	DHSP, EMD	Mid term	Staff time	City, maybe CDBG
Improve communications between City Departments & between universities & the City	Medium	Various	On-going	Staff time	City, universities
Provide opportunities for "knowledge exchanges" between city agencies & private interests, such as universities on issues relating to hazards	Medium	EMD	Short term	Staff time	City

Table 16. Potential Mitigation Measures

Mitigation Measure	Priority	Lead Implementation*	Time Frame	Estimated Cost	Potential Funding Sources
Establish funding program for residential structural improvements / flood proofing	Medium	DPW	Mid-term	$50,000 to $100,000	HMGP
Maintain, protect, & exercise connection between City's water system & MWRA to ensure operability during emergencies	Medium	CWD	On-going	Staff time	City, MWRA
Locate critical shut-off's for gas, electricity, etc. so they can be located under snow	Medium	DPW	Short-term	Staff time	City
Identify measures to adapt state dams to withstand storm surge of major hurricanes	Medium	DCR, State	Long term	State staff time	State
Determine vulnerability of roadways and utilities to earthquakes in the high liquefaction areas	Medium	EMD	Long term	$50,000 to $100,000	PDM
Provide generator at cool shelter or provide back-up shelter	Medium	Electrical Dept.	Short-term	$50,000 to $100,000	City
Ensure public facilities have back-up generators & staff are trained to use & maintain generators	Medium	Electrical Dept.	On-going	$100,000 to $1m	City
Ensure generators are located in areas protected from hazards	Medium	Electrical Dept. , DPW	Short term	Less than $50,000	City
Improve response time by private utilities, especially electrical due to live wire hazards	Medium	Private utilities	On-going	n/a	n/a
Complete SCADA & encourage other depts. to use	Medium	DPW	Short term	$50,000 to $100,000	City
Develop staffing plan for sustained winter events	Medium	DPW	Short term	Staff time	City
Improve energy efficiency of buildings & facilities to address climate change	High	DPW, CDD	On-going	Over $1m	City
Encourage purchase of fleet & private vehicles with higher fuel economy. Use biodiesel for all city owned diesel vehicles & equipment. Utilize improved vehicle emission technology. (climate change)	High	DPW, CWD, CDD	On-going	$1m plus	City
Improve communication so city is aware when levels at the Charles River Dam change	Medium	DPW	Short term	Staff time	City

Table 16. Potential Mitigation Measures

Mitigation Measure	Priority	Lead Implementation*	Time Frame	Estimated Cost	Potential Funding Sources
Reduce impervious area through pavement replacement, green roofs, & use of low impact development (LID) techniques	Medium	CDD, DPW	On-going	n/a	n/a
Expand City catch basin cleaning & repairs with more equipment & more staff	Medium	DPW	Mid term	$100,000 to $1m	City
Public education on post-flooding risks. E.g., mold issues, structural impacts due to dampness or flooding, etc.	Medium	DPH	Mid term	Less than $50,000	City
Hurricane surge zone modeling is based on topography. Need research based on actual drainage issues to see if surge zone is different than this model.	Medium	DPW	Long term	Less than $50,000	City, investigate if fundable under PDM
Improve snow-fighting equipment	Medium	DPW	On-going	$100,000 to $1m	City

* Abbreviations are: DPW – Dept. of Public Works; DPH – Dept. of Public Health; CDD – Community Development Dept.; EMD – Emergency Management Dept.; CWD – Water Dept.; DHSP – Dept. of Human Services Programs; Short term = 1 to 4 years; Mid-term = 5 to 9 years and Long term = 10 years plus.

REGIONAL AND INTER-COMMUNITY CONSIDERATIONS

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

Regional Partners

Mitigating natural hazards in densely developed communities often requires the efforts of more than a single community. This is particularly true for flooding issues. The drainage systems that serve the communities in this study area are complex systems of storm drains, tide gates, roadway drainage structures, pump stations and other facilities owned and operated by various agencies including the city, the Department of Conservation and Recreation (DCR), the Massachusetts Water Resources Authority (MWRA), Massachusetts Highway Department (MHD) and the Massachusetts Bay Transportation Authority (MBTA). Planning, constructing, operating and maintaining these structures are integral to the hazard mitigation efforts of communities. These agencies must be considered regional partners in hazard mitigation. These agencies also operate under the same constraints as communities do including budgetary and staffing constraints and they must make decisions about numerous competing priorities. The Regional Annex provides details on region-wide natural hazard mitigation strategies. Following, is a brief overview of regional facilities found in Cambridge and a discussion of inter-municipal issues.

Overview of Regional Facilities within Cambridge

Major facilities owned, operated and maintained by state or regional entities include:

- Memorial Drive, Greenough Boulevard, McGrath Highway, O'Brien Highway, Fresh Pond Parkway, and Alewife Brook Parkway (DCR)
- Sewer and emergency water supply facilities (MWRA)
- Five commuter rail and red line subway stations and tracks and tunnels (MBTA)
- Conservation and recreation areas including Alewife Reservation and Magazine Beach (DCR)

Overview of Inter-Community Considerations

- As noted under the section on site-specific flooding issues, the flooding in the Alewife area is affected by and has effects on the neighboring communities of Belmont and Arlington. The communities have participated in discussions on the flooding issue.
- A number of areas that flood due to inadequate drainage infrastructure occur along the border with Somerville.
- Determining evacuation routes for Cambridge and for neighboring communities also requires cooperation between communities.
- Major transportation construction activities in neighboring communities can impact Cambridge, so dialogue early on is important. Examples of upcoming major construction projects include the Longfellow Bridge and Storrow Drive.

PLAN ADOPTION AND MAINTENANCE

Plan Adoption

The Cambridge Annex of the Metro Boston Regional Multi-Hazard Mitigation Plan was adopted by the City Council on xx, 2008. See Appendix G for documentation.

Plan Maintenance

Regional Implementation Group

In order to ensure that the regional plan is monitored, evaluated and updated, the Metro Boston Hazard Mitigation Community Planning Team which was established for the planning process will continue to meet on an as-needed basis to function as the Regional Implementation Group for the regional plan.

This group will select a chair that is willing to provide regional leadership, oversee the implementation schedule detailed below and provide administrative support to the process. An alternative approach would be for each community to secure funding to hire a consultant such as MAPC to provide support for the process. Because the plan was prepared by MAPC, having MAPC continue to monitor and prepare an updated plan would ensure a level of continuity and consistency that would benefit the communities.

Local Implementation Group

MAPC worked with a local team to prepare this annex. In Cambridge, this Team was an ad hoc group pulled together for this project. This group will continue to meet on an as-needed basis to function as the Local Implementation Group. Additional members will be added to the local implementation group from businesses, non-profits and institutions.

Implementation Schedule

Yearly Survey and Annual Report

Once a year the chair of the Regional Implementation Group will prepare and distribute a survey to the local implementation groups from each of the nine communities. The survey will poll the local groups on changes, revisions and accomplishments from the local and regional perspective and whether any new hazards or problem areas have been identified in the communities.

This information will be used to prepare an annual report or addendum to the regional plan and the annexes. The Local Implementation Groups will have primary responsibility for updating the annexes.

The Regional Implementation Group will meet after all communities have responded to the survey to review any changes in regional goals or mitigation measures and to be briefed on any changes that may have occurred in the Federal Disaster Mitigation Act or hazard mitigation guidelines.

Yearly Review of Regional Mitigation Measures
The Regional Implementation Group will meet twice a year (at a minimum) to review the list of regional mitigation measures and begin to develop a priority list for implementation.

Develop Fourth Year Update Subcommittee
At the start of the fourth year after initial plan adoption, the chair of the Regional Implementation Group will convene a subcommittee to prepare an update of the plan. At this point, the Regional Implementation Group may decide to undertake the update themselves, contract with MAPC to update the plan or to hire another consultant.

As the Regional Implementation Group prepares for a full update of the regional plan and annexes, an evaluation of the plan's effectiveness will be undertaken. This will include the following:

- The membership of the Regional Implementation Group and local committees.
- Issues related to integration of the plans with local and regional plans and procedures.
- An analysis of the relevance of the hazard mitigation goals.
- The successfulness of the plan in accomplishing mitigations measures.

Prepare and Adopt New Community Annexes and Regional Plan
However the Regional Implementation Group decides to update the plan, the group will need to review the current disaster mitigation plan guidelines for any changes. The plan update subcommittee will present the full Regional Implementation Group with a new plan for each community to adopt and forward to MEMA for approval.

Integration of the Plans with Other Planning Initiatives
Upon approval of the regional plan and annexes by MEMA, each local committee 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:

- Public Works Department
- Traffic, Parking and Transportation Department
- Emergency Management Department
- Community Development Department
- Conservation Commission
- Public Health Department

The actions in the hazard mitigation plan will be incorporated into the City's Capital Improvement Plan and departmental budgets where relevant. The actions will also be incorporated into the Community Development Plan and Open Space Plan where relevant. Hazard mitigation concerns are already included in various ordinances and city

programs as summarized on pages 43-47. For a list of local plans where integration may be relevant, see page 66.

Other groups that will be coordinated with include large institutions (hospitals, colleges), Chambers of Commerce, land conservation organizations and watershed groups. The plans or components of the plan will also be posted on a community's website with the caveat that each community 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.

In addition, the plan will be reviewed with state and regional agencies such as the Department of Conservation and Recreation and the MWRA.

RESOURCES

Please see maps for mapping data sources.

City of Cambridge Homeless Census, 2005.

City of Cambridge On-Line Zoning Ordinance.

City of Cambridge Climate Protection Plan.

Concord-Alewife Rezoning Petition. Submitted to the City Council by the Planning Board April 2005.

North Cambridge Flood Reconnaissance Study. Jacobs Consulting Services. Prepared for Alewife Neighbors, Inc. May 18, 2000.

Sullivan, Charles. Cambridge Historical Commission. Letter to Lisa Peterson dated September 21, 2005.

State Hazard Mitigation Plan. Commonwealth of Massachusetts. October 2004.

State and Local Mitigation Planning How-To Guides. FEMA.

William Lettis & Associates, Inc. and Tufts University.

Winchester, Draft Environmental Impact Report, 2005

U.S. Census.

Appendix A – Maps

Maps 1 & 2
Maps 3 & 4
Maps 5 & 6
Maps 7 & 8

Appendix B
Agendas for Metro Boston Regional Hazard Mitigation Community Planning Team

The Commonwealth of Massachusetts

MITT ROMNEY, GOVERNOR

Cristine McCombs
Director

Massachusetts Emergency Management Agency
400 WORCESTER ROAD, FRAMINGHAM, MA 01702-5399 508-820-2000 FAX 508-820-1404

Katherine F. Abbott
Commissioner

Department of Conservation and Recreation
251 CAUSEWAY STREET, SUITE 600-900, BOSTON, MA 02114-2104 617-626-1250 FAX 617-626-1351

Marc D. Draisen
Executive Director

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

METRO BOSTON PRE-DISASTER MTITGATION PLAN

Boston
BROOKLINE
CAMBRIDGE
CHELSEA
EVERETT
MALDEN
MEDFORD
MELROSE
SOMERVILLE

Metro Boston

Hazard Mitigation Community Planning Team

First Meeting

THURSDAY, DECEMBER 16, 9:30 AM

Everett City Hall, Keverian Room (3rd floor)
484 Broadway (Route 99), Everett*

AGENDA

9:30 WELCOME & INTRODUCTIONS *(Please sign contact sheet)*

9:45 OVERVIEW OF FEDERAL DISASTER MITIGATION ACT & PRE-DISASTER MITIGATION PLANNING

- *Presentation, Questions & Discussion*
  --Martin Pillsbury, MAPC

10:15 GETTING STARTED: THE METRO BOSTON REGIONAL PRE-DISASTER MITIGATION PLAN

- *Review of Scope of Work & Schedule –MAPC project team:*
  --Martin Pillsbury, Joan Blaustein, Heidi Samokar & Alan Bishop
- *Questions & Discussion – Local Issues & Priorities*

11:00 PREVIEW OF MAPPING AND DATABASES FOR THE PLAN

- *Examples from the North & South Shore PDM Plans*
  --Alan Bishop, GIS Manager, MAPC

11:20 NEXT STEPS / MEETING SCHEDULE

11:30 ADJOURN

**There is a parking lot behind City Hall. If the lot is full, you will need to park in a metered on-street space.*

The Commonwealth of Massachusetts

MITT ROMNEY, GOVERNOR

Cristine McCombs
Director

Massachusetts Emergency Management Agency
400 WORCESTER ROAD, FRAMINGHAM, MA 01702-5399 508-820-2000 FAX 508-820-1404

STEPHEN R. PRITCHARD
Acting Commissioner

Department of Conservation and Recreation
251 CAUSEWAY STREET, SUITE 600-900, BOSTON, MA 02114-2104 617-626-1250 FAX 617-626-1351

Marc D. Draisen
Executive Director

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

METRO BOSTON PRE-DISASTER MTITGATION PLAN

BOSTON
BROOKLINE
CAMBRIDGE
CHELSEA
EVERETT
MALDEN
MEDFORD
MELROSE
SOMERVILLE

Metro Boston

Hazard Mitigation Community Planning Team

Regional Meeting

THURSDAY, MAY 19, 2005, 9:30 AM

Everett City Hall, Keverian Room (3rd floor)
484 Broadway (Route 99), Everett*

AGENDA

9:30 WELCOME, INTRODUCTIONS & OVERVIEW OF AGENDA

- *Martin Pillsbury, MAPC*

9:40 REVIEW OF MAPPING – CRITICAL INFRASTRUCTURE AND SAMPLE MAP SERIES

- *Allan Bishop, MAPC will review progress to date on mapping*

10:00 REVIEW OF SUGGESTED PUBLIC PARTICIPATION APPROACH

- *Joan Blaustein, MAPC will discuss a strategy for public participation in development of the local plans.*

10:10 OVERVIEW OF LOCAL ACTIVITIES AND EMERGING REGIONAL ISSUES

- *Joan Blaustein and Heidi Samokar, MAPC will discuss initial findings and regional issues that have emerged while working with the local teams.*

10:30 OTHER ANNOUNCEMENTS

10:40 NEXT STEPS / MEETING SCHEDULE

- *Martin Pillsbury.*

10:50 ADJOURN

**There is a parking lot behind City Hall. If the lot is full, you will need to park in a metered on-street space.*

The Commonwealth of Massachusetts

MITT ROMNEY, GOVERNOR

Cristine McCombs
Director

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

STEPHEN H. BURRINGTON
Commissioner

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

Marc D. Draisen
Executive Director

METRO BOSTON PRE-DISASTER MTITGATION PLAN

BOSTON
BROOKLINE
CAMBRIDGE
CHELSEA
EVERETT
MALDEN
MEDFORD
MELROSE
SOMERVILLE

Metro Boston

Hazard Mitigation Community Planning Team

Regional Meeting

FRIDAY, OCTOBER 14, 2005, 9:30 AM

Everett City Hall, Keverian Room (3rd floor)
484 Broadway (Route 99), Everett*

AGENDA

9:30 WELCOME, INTRODUCTIONS & OVERVIEW OF AGENDA

- *Martin Pillsbury, MAPC*

9:40 ISSUES AND CONCERNS RAISED BY KATRINA, RITA, ETC.

- *Recent natural disasters have heightened public awareness of the need for preparedness. Heidi Samokar will moderate a discussion and encourage the committee to brainstorm the ways these events will affect our Pre-Disaster Mitigation Plan for Metro Boston.*

10:00 REGIONAL ISSUES IN THE PDM PLAN

- *Joan Blaustein will moderate a discussion of multi-community and regional issues that should be addressed in the PDM Plan.*

11:00 DISTRIBUTION OF COMMUNITY MAP SERIES

- *Allan Bishop, GIS Manager, will distribute copies of the PDM local map series and lead a brief discussion on how the maps will be used in the development of the PDM Plan.*

11:15 NEXT STEPS / MEETING SCHEDULE

- *Martin Pillsbury.*

11:30 ADJOURN

**There is a parking lot behind City Hall. If the lot is full, park in a metered on-street space.*

The Commonwealth of Massachusetts

MITT ROMNEY, GOVERNOR

Cristine McCombs
Director

Massachusetts Emergency Management Agency
400 WORCESTER ROAD, FRAMINGHAM, MA 01702-5399 508-820-2000 FAX 508-820-1404

STEPHEN H. BURRINGTON
Commissioner

Department of Conservation and Recreation
251 CAUSEWAY STREET, SUITE 600-900, BOSTON, MA 02114-2104 617-626-1250 FAX 617-626-1351

Marc D. Draisen
Executive Director

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

Metro Boston

Hazard Mitigation Community Planning Team

Regional Meeting

THURSDAY, FEBRUARY 23, 2006, 9:30 AM

Everett City Hall, Keverian Room (3rd floor)
484 Broadway (Route 99), Everett*

METRO BOSTON PRE-DISASTER MTITGATION PLAN

BOSTON
BROOKLINE
CAMBRIDGE
CHELSEA
EVERETT
MALDEN
MEDFORD
MELROSE
SOMERVILLE

AGENDA

9:30 WELCOME, INTRODUCTIONS & OVERVIEW OF AGENDA

- *Martin Pillsbury, MAPC*

9:40 OVERVIEW OF BENEFIT/COST ANALYSIS

- *In order to apply for funding for mitigation projects under FEMA grant programs, a Benefit Cost Analysis must be submitted to FEMA. Joan Blaustein will present a summary of the process and requirements and moderate a discussion on Benefit/Cost Analysis.*

10:15 FOLLOW-UP ON REGIONAL ISSUES: DCR & MBTA

- *MAPC has met with DCR and MBTA to review regional issues raised at the last meeting in December. Heidi Samokar will moderate a discussion that will include voting by committee members to prioritize regional issues so they can be addressed in the plan.*

11:00 SUMMARY OF EXISTING MITIGATION MEASURES

- *The existing mitigation measures of each community have been summarized in a matrix; copies will be distributed for review.*

11:15 NEXT STEPS AND TIMELINE TO COMPLETE THE PDM PLAN

- *Martin Pillsbury will summarize the remaining tasks and the timeline to complete the PDM Plan for the Metro Boston region.*

11:30 ADJOURN

**There is a parking lot behind City Hall. If the lot is full, park in a metered on-street space.*

The Commonwealth of Massachusetts

MITT ROMNEY, GOVERNOR

Cristine McCombs
Director

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

STEPHEN H. BURRINGTON
Commissioner

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

Marc D. Draisen
Executive Director

METRO BOSTON PRE-DISASTER MTITGATION PLAN

BOSTON
BROOKLINE
CAMBRIDGE
CHELSEA
EVERETT
MALDEN
MEDFORD
MELROSE
SOMERVILLE

Metro Boston

Hazard Mitigation Community Planning Team

Regional Meeting

THURSDAY, NOVEMBER 16, 2006, 9:30 AM

Everett City Hall, Keverian Room (3rd floor)
484 Broadway (Route 99), Everett*

9:30 WELCOME, INTRODUCTIONS & OVERVIEW OF AGENDA

- *Martin Pillsbury, MAPC*

9:40 OVERVIEW OF THE DRAFT REGIONAL PLAN

- *Joan Blaustein and Heidi Samokar, MAPC will walk through the regional plan to provide an overview of the draft.*

10:15 REVIEW AND ADOPT THE HAZARD MITIGATION GOALS

- *This will be an opportunity to review regional hazard mitigation goals that MAPC has developed based on discussions at the previous meetings. Participants will be given an opportunity to suggest revisions or new goals. The goals will then need to be approved by the group.*

10:35 DISCUSS THE REGIONAL IMPLEMENTATION CHAPTER OF THE PLAN

- *The final chapter of the plan discusses how to implement, review and update the plan. This will be an opportunity to discuss how best to accomplish this.*

11:15 NEXT STEPS AND TIMELINE TO COMPLETE THE PDM PLAN

- *Martin Pillsbury will summarize the remaining tasks and the timeline to complete the PDM Plan for the Metro Boston region.*

11:30 ADJOURN

**There is a parking lot behind City Hall. If the lot is full, park in a metered on-street space.*

Appendix C
Local Multiple Hazard Community Planning Team Meeting Agendas

[This page intentionally left blank]

Cambridge Multi-Hazard Mitigation Planning Team
Meeting Agenda

Wednesday, April 20
10 – 11:30 a.m.
DPW, 147 Hampshire Street, Cambridge

- ✓ Welcome and introductions
- ✓ Overview of project and MAPC
- ✓ Review project scope of work
  - Assist MAPC in identifying hazard areas
  - Identify existing mitigation measures
  - Identify potential mitigation measures
  - Prioritize potential mitigation measures
  - Determine goals and objectives
- ✓ Role of this committee (local committee) and the regional committee
- ✓ Discussion of other city officials, businesses, institutions, etc. that should be involved
- ✓ Next Steps

Project Overview - MAPC has received a grant to prepare a natural hazards *Pre-Disaster Mitigation Plan* for the communities of Boston, Brookline, Cambridge, Chelsea, Everett, Malden, Medford, Melrose, and Somerville. MAPC will work with the nine communities to develop a plan 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.

It is important to note that this FEMA planning program is separate from any of the new or ongoing homeland security initiatives, and is focused solely on addressing natural hazards, such as flooding, winter storms, hurricanes, tornados, wildfires, earthquakes, and coastal storm damage, although some of the data collected for this plan may be useful for other aspects of emergency planning as well.

Cambridge Multi-Hazard Mitigation Planning Team
Meeting 2
Agenda

Tuesday, July 12, 2005
9 – 11:00 a.m.
DPW, 147 Hampshire Street, Cambridge

- ✓ Welcome and introductions (5 minutes)
- ✓ Update of MAPC's Progress (5 minutes)
- ✓ Discussion of Cambridge's challenges and uniqueness when dealing with natural hazards and mitigation (10 minutes)
- ✓ Review of Natural Hazards (90 minutes)
  - o Have we generally covered all hazards?
  - o What are the impacts or special considerations from each hazard?
    - ▪ e.g., historic resources, environmental resources, sensitive populations, infrastructure, businesses, etc.
  - o Begin to develop simple "Problem Statements". E.g., if a community has chronic flooding in an area and two nursing homes are located in that area, the problem statement is "Two nursing homes have chronic flooding."
- ✓ Next Steps – existing and proposed mitigation and additional information on hazards (10 minutes)

Project Overview - MAPC has received a grant to prepare a natural hazards *Pre-Disaster Mitigation Plan* for the communities of Boston, Brookline, Cambridge, Chelsea, Everett, Malden, Medford, Melrose, and Somerville. MAPC will work with the nine communities to develop a plan 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.

It is important to note that this FEMA planning program is separate from any of the new or ongoing homeland security initiatives, and is focused solely on addressing natural hazards, such as flooding, winter storms, hurricanes, tornados, wildfires, earthquakes, and coastal storm damage, although some of the data collected for this plan may be useful for other aspects of emergency planning as well.

Cambridge Multi-Hazard Mitigation Planning Team
Meeting 3 Agenda

Thursday, October 20, 2005
2:00 – 4:00 p.m.
DPW, 147 Hampshire Street, Cambridge

2:00	**Welcome and Introductions**
2:10	**Overview of Agenda**
2:15	**Develop Goals and Objectives for Natural Hazard Mitigation** ▪ Based on specific community-wide hazards and risks ▪ See examples on reverse
2:35	**Review Hazards/Hazard Areas and Existing Mitigation and Brainstorm Potential Mitigation Measures** ▪ Briefly review problem areas and existing mitigation ▪ Identify mitigation alternatives
3:50	**Next Steps** ▪ Complete project impact analysis ▪ Evaluate alternatives

Project Overview - MAPC has received a grant to prepare a natural hazards *Pre-Disaster Mitigation Plan* for the communities of Boston, Brookline, Cambridge, Chelsea, Everett, Malden, Medford, Melrose, and Somerville. MAPC will work with the nine communities to develop a plan 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.

It is important to note that this FEMA planning program is separate from any of the new or ongoing homeland security initiatives, and is focused solely on addressing natural hazards, such as flooding, winter storms, hurricanes, tornados, wildfires, earthquakes, and coastal storm damage, although some of the data collected for this plan may be useful for other aspects of emergency planning as well.

Cambridge Multi-Hazard Mitigation Planning Team
Meeting 4 Agenda

Tuesday, May 2
9:00 – 11:30 a.m.
DPW, 147 Hampshire Street, Cambridge

9:00	**Welcome and Introductions**
9:10	**Overview of Agenda** *(Heidi Samokar, MAPC)*
9:20	**Overview of Project and Information Collected to Date** *(H. Samokar)*
9:45	**Review of Suggested Mitigation Measures** • Brief recap of suggested measures *(H. Samokar with input from Local Team)* • Last call for additional measures
10:25	**Voting on Priorities** • Review of mitigation goals, funding programs and evaluation criteria *(H. Samokar)* • Each participant will choose 20 priorities (location or actual project) • Review results and discuss feasibility of measures with most votes
11:00	**Next Steps** • Team will use input to develop priorities • Review public meeting protocol and select date, time and location for public meeting

Project Overview - MAPC received a grant to prepare a natural hazards *Pre-Disaster Mitigation Plan* for the communities of Boston, Brookline, Cambridge, Chelsea, Everett, Malden, Medford, Melrose, and Somerville. MAPC is working with the 9 communities to develop a plan 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.

Appendix D
Media Advisory and Meeting Agenda for Public Meeting

[This page intentionally left blank]

CAMBRIDGE'S NATURAL HAZARDS PLAN IS FOCUS OF NOVEMBER 29th PUBLIC MEETING

The Public Works Department will hold a public meeting to present key findings from a draft of the City of Cambridge's multi-hazard mitigation plan. City of Cambridge and the Metropolitan Area Planning Council collaborated on its development.

The multi-hazard mitigation plan identifies actions that the city can take to lessen the impacts of natural hazards, including floods, earthquakes, tornadoes, hurricanes, winter storms and brush fires. The City Council's approval of this plan will make Cambridge eligible to apply for certain grants to fund the mitigation projects highlighted in the plan.

When: Wednesday, November 29, 2006
5:30 pm

Where: Department of Public Works
147 Hampshire Street

Why: The Federal Disaster Mitigation Act, passed in 2000, required that after November 1, 2004, all municipalities must adopt a local multi-hazard mitigation plan to remain eligible for Federal Emergency Management Agency (FEMA) funding. Through a grant from the Massachusetts Emergency Management Agency (MEMA), the Metropolitan Area Planning Council (MAPC) developed natural hazard mitigation plans for Boston, Brookline, Cambridge, Chelsea, Everett, Malden, Medford, Melrose and Somerville. Since the project's start in December 2004, MAPC has worked with the communities to identify hazard areas and potential solutions.

MAPC is the regional planning agency for 101 metro Boston communities, promoting inter-local coordination and advocating for the region's sustainable growth and development. More information about MAPC is available at www.mapc.org.

Contact: Public Works Commissioner Lisa Peterson, City of Cambridge
(617) 349-4800
Andrea Hurwitz, Metropolitan Area Planning Council
617-451-2770 ext. 2030

Cristine McCombs
Director

Stephen h. burrington
Commissioner

Marc D. Draisen
Executive Director

The Commonwealth of Massachusetts
MITT ROMNEY, 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

Public Meeting on the Draft Cambridge Natural Hazard Mitigation Plan
Wednesday, November 29, 2006
5:30 p.m.
DPW Conference Room, at 147 Hampshire Street

5:30 - 5:40 p.m. Welcome and Introductions – Lisa Peterson, Commissioner, Public Works Department

5:40 – 6:10 p.m. Overview of the draft Cambridge Natural Hazard Mitigation Plan – Heidi Samokar, Planner, Metropolitan Area Planning Council (MAPC)

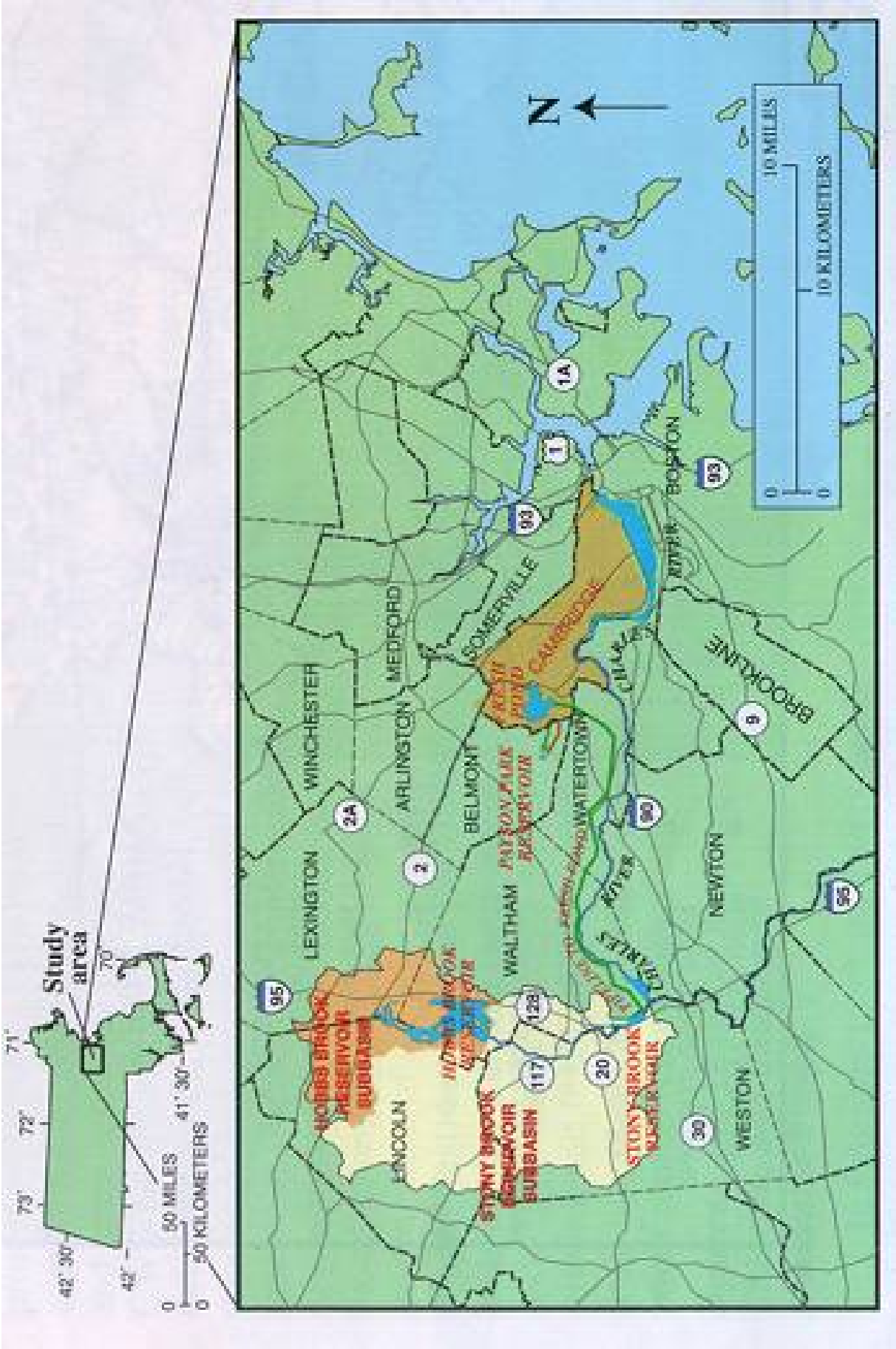
6:10 – 6:30 p.m. Community Comments and Questions – Ms. Samokar will facilitate a question/comment period.

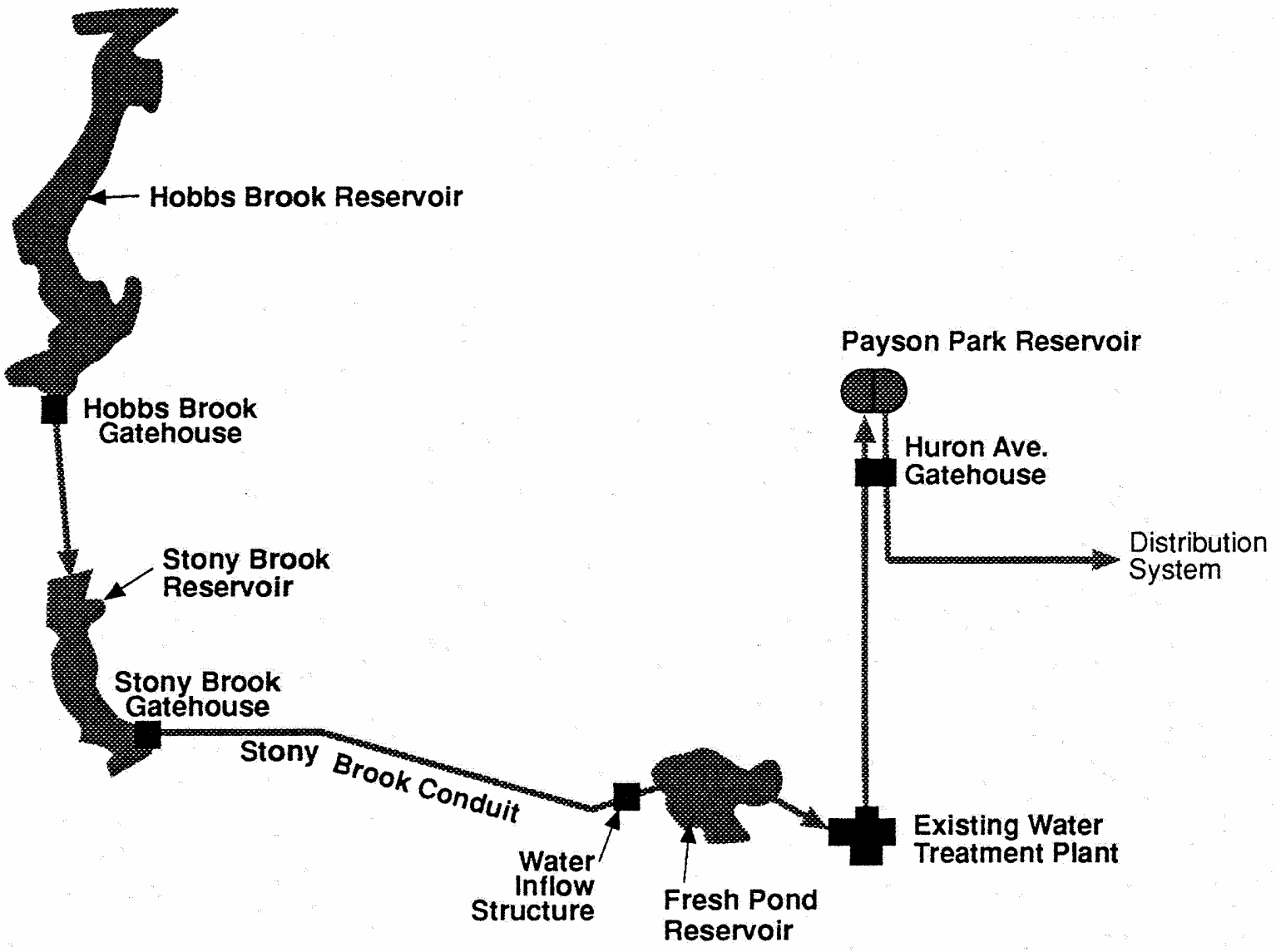
This will be an opportunity for attendees to:

- Ask questions
- Share how natural hazards have affected them as residents or business owners
- Respond to the potential mitigation measures

Appendix E
Maps of Cambridge Water System Facilities
(maps provided by Cambridge Water Department)

[This page intentionally left blank]


Study area
50 MILES
50 KILOMETERS
42° 30'
42°
73°
72°
71°
70°
41° 30'
N
10 MILES
10 KILOMETERS
LEXINGTON
WINCHESTER
ARLINGTON
MEDFORD
SOMERVILLE
BELMONT
WALTHAM
WATERTOWN
BROOKLINE
NEWTON
WESTON
LINCOLN
BOSTON
CAMBRIDGE
CHARLES RIVER
PAYSON PARK RESERVOIR
HOBBS BROOK RESERVOIR SUBBASIN
STONY BROOK RESERVOIR SUBBASIN
STONY BROOK RESERVOIR
95
2A
2
128
117
20
30
90
9
93
1
1A


Hobbs Brook Reservoir
Hobbs Brook Gatehouse
Stony Brook Reservoir
Stony Brook Gatehouse
Stony Brook Conduit
Water Inflow Structure
Fresh Pond Reservoir
Payson Park Reservoir
Huron Ave. Gatehouse
Distribution System
Existing Water Treatment Plant

Appendix F
Compilation of all Suggested Mitigation Measures and Votes from May 2, 2006 Meeting

[This page intentionally left blank]

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	**Hazard**	**Area that will benefit**	**Mitigation**	**Total Votes**	**Of Total Votes, # that were First Priority**
112	Multi-Hazard	City-wide	MIT hire a full-time emergency coordinator that can also serve as a liaison to the City.	COMPLETED	
43	Flood	City-wide	Complete hydraulic modeling for City.	ALREADY PRIORITY	
46	Flood	City-wide	City is completing new storm water regulations & updating its guidelines.	ALREADY PRIORITY	
47	Flood	City-wide	Continue to integrate flood mitigation & sewer separation projects into CIP	ALREADY PRIORITY	
54	Flood	City-wide	Continue remedial reconstruction	ALREADY PRIORITY	
57	Flood	City-wide	Upgrade aging infrastructure	ALREADY PRIORITY	
84	Flood	Area # 6 - East of Fresh Pond Pkwy	Sewer separation.	ALREADY PRIORITY	
87	Flood	Area #5 - Between Concord Ave. & New St rotaries	Sewer separation in 5 – 10 years.	ALREADY PRIORITY	
90	Flood	Areas # 1 & 4 - Golf Course, Fresh Pond Res, Blanchard Rd., Thingavilla St	Complete storm water infrastructure at golf course	ALREADY PRIORITY	
96	Flood	Area # 15 - Porter Square	Part of CAM 002 CSO area. Separate the sewers.	ALREADY PRIORITY	
98	Flood	Area # 27 - East of 2nd St & north of Charles St	Improve Collection and conveyance system	ALREADY PRIORITY	
100	Flood	Area #26 - School, Pine, Cherry Streets, Windsor	Implement additional storm water management measures.	ALREADY PRIORITY	
101	Flood	Area # 25 - Near Tremont & Norfolk Sts	Implement CAM017 Stormwater Management Program	ALREADY PRIORITY	
102	Flood	Area # 28 - Newton, Green, Franklin and Sydney streets	Complete Cambridgeport/CAM017 stormwater management program	ALREADY PRIORITY	
105	Flood	Area # 24 - Ellery St. & Broadway	Complete CAM011 sewer separation and stormwater management program	ALREADY PRIORITY	
106	Flood	Areas # 18 & 19 - Kirkland, Myrtle, Magnolia, Cambridge sts	Complete CAM011 sewer separation and stormwater management program	ALREADY PRIORITY	
107	Flood	Areas 16 & 17 -	Complete CAM011 sewer	ALREADY	

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	Hazard	Area that will benefit	Mitigation	Total Votes	Of Total Votes, # that were First Priority
		Irving, Bryant, Crescent, Carver, Sacramento streets	separation and stormwater management program	PRIORITY	
72	Flood	City-wide	Complete Fresh Pond NE Sector Landscape Project	ALREADY FUNDED	
144 & 42	Multi-Hazard	City-wide	Investigate potential hazardous releases due to any/all natural hazard	17	2
32	Extreme Cold	City-wide	Pursue a more aggressive program to replace older water mains.	15	3
115	Multi-Hazard	City-wide	To have an emergency and evacuation plan that spells out what various entities do, such as MBTA, etc., so that all are aware. Include in the Plan options for residents that do not own a car.	15	1
123	Multi-Hazard	City-wide	Develop comprehensive communications plan. Plan must include communication with non-English speakers	15	1
44	Flood	City-wide	Assess risks to infrastructure including electric, gas, & steam distribution & MBTA subway system.	14	0
118	Multi-Hazard	City-wide	Have a power-loss plan for major power outages.	14	1
113	Multi-Hazard	City-wide	To have an MOU between cities, universities, etc., that provides shared access to various resources such as buses, personnel, etc.	13	1
117	Multi-Hazard	City-wide	Study vulnerability of utilities to hazards.	12	0
116	Multi-Hazard	City-wide	Ensure that public rights of way are properly maintained and accessible so that essential services and deliveries can continue.	10	2
35	Extreme Heat	City-wide	Provide a facility for parents to bring infants during a heat emergency.	9	1
111	Multi-Hazard	City-wide	Improved communications between City Departments and between universities and the City.	9	1
114	Multi-	City-wide	Provide opportunities for	9	0

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	Hazard	Area that will benefit	Mitigation	Total Votes	Of Total Votes, # that were First Priority
	Hazard		"knowledge exchanges" between city agencies and private interests, such as the universities on issues relating to hazards.		
53	Flood	City-wide	Establish funding program for residential structural improvements/flood proofing.	8	0
66	Flood	City-wide	Maintain, protect, & exercise connection between City's water system & MWRA to ensure operability during emergencies.	8	0
138	Winter Storms	City-wide	Locate critical shut-off's for gas, electricity, etc. so they can be located under snow.	8	0
22	Dams	City-wide	Identify measures to adapt dams to withstand the storm surge of a major hurricane.	7	0
30	Earthquake	City-wide	Determine vulnerability of roadways and utilities in the high susceptibility area.	7	0
34	Extreme Heat	City-wide	Provide a generator at the cool shelter or provide a back-up shelter.	7	0
119	Multi-Hazard	City-wide	Ensure that public facilities have back up generators and that staff are trained on how to use and maintain the generators.	7	0
120	Multi-Hazard	City-wide	Ensure that generators are located in areas protected from hazards.	7	0
122	Multi-Hazard	City-wide	Improved response time by private utilities, especially electrical due to the hazard that live wires causes.	7	0
61	Flood	City-wide	Completion of SCADA & encourage other departments to use, including CWD.	6	0
132	Winter Storms	City-wide	Develop a staffing plan for sustained winter events.	6	0
10	Climate Change	City-wide	Improve energy efficiency of buildings and facilities.	5	0
17	Climate	City-wide	Encourage the purchase	5	0

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	Hazard	Area that will benefit	Mitigation	Total Votes	Of Total Votes, # that were First Priority
	Change		of fleet and private vehicles with higher fuel economy. Use biodiesel for all City owned diesel vehicles and equipment. Utilize improved vehicle emission technology.		
28	Dams	City-wide	Need better communication so that City is aware of when DCR plans to raise and lower water levels at the Charles River Dam.	5	0
48	Flood	City-wide	Reduce impervious area through pavement replacement, green roofs, & the use of LID techniques	5	0
50	Flood	City-wide	Expand City catch basin cleaning & repairs with more equipment and more staff.	5	1
58	Flood	City-wide	Public education on post-flooding risks. E.g., mold issues, structural impacts due to dampness or flooding, etc.	5	0
76	Flood	City-wide	Hurricane surge zone modeling is based on topography. Need research based on actual drainage issues to see if surge zone is different than this model.	5	0
135	Winter Storms	City-wide	Improve snow-fighting equipment.	5	0
7	Climate Change	City-wide	Provide incentives for planting trees and creating additional green space.	4	0
21	Dams	City-wide	DCR should create a plan outlining the dam operations and potential impacts [due to security concerns, this information is not publicly available].	4	0
26	Dams	City-wide	Assess long term impacts to dams due to projected sea level rise per the CLIMB study and other studies and determine dam adaptations that may be warranted.	4	1
29	Earthquake	City-wide	Determine which buildings may be most vulnerable and conduct a structural assessment.	4	0

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	Hazard	Area that will benefit	Mitigation	Total Votes	Of Total Votes, # that were First Priority
63	Flood	Watershed Communities	Revise 1998 Emergency Action Plan to reflect recently-implemented mitigation measures. Update should include dam inundation study & evaluate feasibility of remote control system for gates.	4	0
126	Wind	City-wide	Create a debris management plan.	4	0
145	Multi-Hazard	City-wide	Drilling for communications	4	0
5 & 33	Climate Change / Extreme Heat	City-wide	Optimize building design and the use of vegetation to shade buildings and reduce the urban heat island effect.	3	1
27	Dams	City-wide	DCR should be provided additional resources for maintaining the dams.	3	0
31	Earthquake	City-wide	Encourage critical land uses in those located in high susceptible areas to ensure that equipment is protected from earth quakes.	3	0
38	Extreme Heat & Cold	City-wide	Develop a process to waive limitations on homeless shelters during a heat emergency.	3	0
39	Fire	City-wide	Make sure all public facilities have appropriate fire protection systems installed including sprinklers, when appropriate, including City Hall.	3	0
62	Flood	Watershed Communities	Conduct feasibility study for abandoned gatehouse on Trapelo Road on Lincoln & Waltham line. May be possible to use gatehouse to better control flooding & better address water quality issues.	3	0
74	Flood	City-wide	Project review should require an assessment of potential impacts during significant rain events.	3	0
77	Flood	Area # 12 - Walden Sq, Bellis Circle & Bolton St, Dudley & Clifton St & Pemberton/Yerxa	Study to confirm if Massachusetts Avenue bridge to Arlington is contributing to flooding issues.	3	0

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	Hazard	Area that will benefit	Mitigation	Total Votes	Of Total Votes, # that were First Priority
		Rd			
86	Flood	Area # 6 - East of Fresh Pond Pkwy	Structural upgrades for Tobin School (the generator is affected during floods).	3	0
97	Flood	Area # 15 - Porter Square	Alter pumping operations of flood water from MBTA facilities	3	0
124	Multi-Hazard	City-wide	Ensure that information is distributed to stakeholders of the various communities.	3	0
133	Winter Storms	City-wide	Explore feasibility of putting snow in the harbor.	3	1
134	Winter Storms	City-wide	Plan for oil delivery disruptions.	3	0
136	Winter Storms	City-wide	Better clearing of sidewalks and bridges (DCR). Encourage the use of transit by keeping sidewalks clear.	3	0
139	Winter Storms	City-wide	SCADA temperature controls in street (? – is this to track temperatures?)	3	0
140	Winter Storms	City-wide	Consider partnerships for snow melting technology and snow storage facilities/locations.	3	0
4	Climate Change	City-wide	Strengthen zoning incentives to include LEED in project review and PUD processes.	2	0
12	Climate Change	City-wide	Improve facilities for walking and cycling.	2	0
16	Climate Change	City-wide	Support greening of the regional electric grid through purchase of bundled renewable electricity and renewable energy certificates and local installation of renewable energy systems.	2	0
19	Climate Change	City-wide	Support environmentally preferable purchasing practices.	2	0
20	Climate Change	City-wide	Use computer imaging (such as GIS) to accurately determine current canopy cover, assess environmental benefits, and plan plantings.	2	0
37	Extreme Heat	City-wide	Money for more fans and air conditioners to provide	2	0

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	Hazard	Area that will benefit	Mitigation	Total Votes	Of Total Votes, # that were First Priority
			to seniors.		
52	Flood	City-wide	Improved frequency of catch basin cleaning and repairs on DCR-owned parkways.	2	0
60	Flood	City-wide	Preserve flood plain storage, (as per Wetlands Protection Act)	2	0
65	Flood	Watershed Communities	Work to make project review standards for flooding & storm water used for projects in watershed communities to be consistent with City's standards.	2	0
67	Flood	Watershed Communities	Install back-up generators for gates (?) to complement manual control.	2	0
71	Flood	Watershed Communities	MassHighway reduce use of sand & salt in watershed. New pavement type in watershed requires more sand.	2	0
73	Flood	City-wide	Formalize the storm water regulations, which will include permeability standards & operation and maintenance requirements.	2	0
75	Flood	City-wide	Ensure that new buildings are more resilient from flooding, such as requiring elevation, flood-proofing, etc	2	0
79	Flood	Area # 12 - Walden Sq, Bellis Circle & Bolton St, Dudley & Clifton St & Pemberton/Yerxa Rd	Improve channel clearing in Alewife Brook	2	0
89	Flood	Areas # 1 & 4 - Golf Course, Fresh Pond Res, Blanchard Rd., Thingavilla St	Improve storm water management	2	0
92	Flood	Area # 7 - Adjacent to Little River	Study how the lowering of water levels before storms at Spot Pond, Spy Pond and Claypit Pond could address flooding	2	0
93	Flood	Area # 7 - Adjacent to Little River	Channel maintenance	2	0
103	Flood	Areas # 21-23 -	Improve Collection and	2	0

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	Hazard	Area that will benefit	Mitigation	Total Votes	Of Total Votes, # that were First Priority
		Grant & Bank Sts	conveyance system		
125	Multi-Hazard	City-wide	Work with private communications / telecommunications provides to assess vulnerability and upgrade infrastructure.	2	0
127	Wind	City-wide	Increased tree maintenance – more equipment and more personnel.	2	0
128	Wind	City-wide	Institute an inspection and tracking program for diseased tree.	2	0
129	Wind	City-wide	Create a brochure on preventative measures for construction sites which could be handed out to contractors and developers before they begin construction.	2	0
141	Winter Storms	City-wide	Investigate alternatives to road salt and calcium chloride. Explore de-icing and liquids.	2	0
1	Climate Change	City-wide	Foster mixed-use, transit oriented development.	1	0
9	Climate Change	City-wide	Reduce single-occupancy vehicle travel through regulatory measures.	1	0
14	Climate Change	City-wide	Reduce single-occupancy vehicle travel through public education campaigns.	1	0
18	Climate Change	City-wide	Reduce waste and expand recycling programs and household and business hazardous waste collection/options.	1	0
23	Dams	City-wide	Study if the operation of the Amelia Earhart dam affects water levels in the Mystic River and Alewife Brook [CDM has conducted two studies on this issue .	1	0
45	Flood	City-wide	Zoning should consider hurricane surge zones	1	0
51	Flood	City-wide	Other agencies & neighboring communities maintain their infrastructure.	1	0
55	Flood	City-wide	MBTA and MassHighway – Route 2, better control of water levels at Spy Pond and Spot Pond.	1	0
59	Flood	City-wide	Property owner education	1	0

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	Hazard	Area that will benefit	Mitigation	Total Votes	Of Total Votes, # that were First Priority
			tied to renovations.		
64	Flood	Watershed Communities	Assess potential for hazardous materials to be released during flooding.	1	0
70	Flood	Watershed Communities	More CWD staff trained on data collection equipment.	1	0
80	Flood	Area #3 - Aberdeen & Homer	Conduct analysis of CAM 005	1	0
85	Flood	Area # 6 - East of Fresh Pond Pkwy	Flood proof affected buildings.	1	0
88	Flood	Area #5 - Between Concord Ave. & New St rotaries	Monitor discharges near Danehy Park.	1	0
91	Flood	Area # 7 - Adjacent to Little River	Determine if operations of Amelia Earhart Dam affect water levels of Alewife Brook.	1	0
94	Flood	Area # 7 - Adjacent to Little River	Separate storm water sewers (City and Somerville)	1	0
99	Flood	Area #26 - School, Pine, Cherry Streets, Windsor	Complete CAM017 Sewer Separation and Stormwater Management	1	0
104	Flood	Areas # 21-23 - Mt. Auburn near Plympton St	Complete CAM011 sewer separation and stormwater management program	1	0
108	Mosquito-borne disease	City-wide	New catch basins should not retain water for extended periods of time.	1	0
121	Multi-Hazard	City-wide	Provide live wire information to the public.	1	0
131	Wind	City-wide	Provide funding for property owners to practice preventative tree maintenance on private property.	1	0
137	Winter Storms	City-wide	Provide GPS in snow plows.	1	0
2	Climate Change	City-wide	Provide developers, citizens, and City staff with information to assist them in applying LEED standards.	0	0
3	Climate Change	City-wide	Develop green standards for City-owned properties.	0	0
6	Climate Change	City-wide	Conduct open space review during the permitting process for development projects to incorporate open space	0	0

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	Hazard	Area that will benefit	Mitigation	Total Votes	Of Total Votes, # that were First Priority
			into project design.		
8	Climate Change	City-wide	Create small-scale public gathering places with well-adapted vegetation.	0	0
11	Climate Change	City-wide	Expand the use of district steam.	0	0
13	Climate Change	City-wide	Expand the City's recycling drop off center	0	0
15	Climate Change	City-wide	Increase public education on the benefits and proper care of trees	0	0
24	Dams	City-wide	Determine if the Watertown Square Dam has/could have flooding impacts on Cambridge.	0	0
25	Dams	City-wide	Determine potential impacts to Cambridge from Upper Mystic Lake Dam	0	0
36	Extreme Heat	City-wide	More staffing for senior center.	0	0
40	Flood	City-wide	Complete the conceptual model for the remaining CSO separation.	0	0
41	Flood	City-wide	Further studies of causes of flooding	0	0
56	Flood	City-wide	Belmont – fully separate combined sewers.	0	0
68	Flood	Watershed Communities	Work more closely with watershed communities on flood control issues, including public education.	0	0
69	Flood	Watershed Communities	More staff time to work at more coordinated efforts with watershed communities.	0	0
78	Flood	Area # 12 - Walden Sq, Bellis Circle & Bolton St, Dudley & Clifton St & Pemberton/Yerxa Rd	Over next 5 years, plan for additional CSO separation in this area, along with storm water management.	0	0
81	Flood	Area #3 - Aberdeen & Homer	Examine structural measures to protect affected buildings from flooding. This includes roughly 20 buildings (apartment buildings and single-family houses).	0	0
82	Flood	Area #3 - Aberdeen & Homer	Do nothing	0	0
83	Flood	Area # 6 - East of Fresh Pond Pkwy	Implement new zoning regulations	0	0

POTENTIAL HAZARD MITIGATIION MEASURES				Voting Results from May 2, 2006 Meeting	
ID #	**Hazard**	**Area that will benefit**	**Mitigation**	**Total Votes**	**Of Total Votes, # that were First Priority**
95	Flood	Area # 7 - Adjacent to Little River	Acquire flood plain properties.	0	0
109	Mosquito-borne disease	City-wide	Provide more education to residents to reduce water containers.	0	0
110	Mosquito-borne disease	City-wide	Augment existing efforts to treat catch basins with larvicide.	0	0
130	Wind	City-wide	Develop a text communication mechanism to alert contractors to high wind warnings.	0	0
142	Winter Storms	City-wide	Relieve snow build up on roofs – how? City properties?	0	0
143	Winter Storms	City-wide	Educate homeowners about snow load hazards.	0	0

[This page intentionally left blank]

Appendix G
Documentation of Plan Adoption by Cambridge City Council

[to be provided after adoption]