



Blackstone Hazard Mitigation Plan



Town of Blackstone municipal complex, flood control berm, and Blackstone River (CMRPC photo)

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Town of Blackstone, Massachusetts

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1.0 INTRODUCTION

1.1 Disaster Mitigation Plan

Congress enacted the Disaster Mitigation Act of 2000 (DMA 2000) on October 10, 2000. Also known as the Stafford Act Amendments, the bill was signed into law by President Clinton on October 30, 2000, creating Public Law 106-390. The law established a national program for pre-disaster mitigation and streamlined the federal administration of disaster relief. Specific rules on the implementation of DMA 2000 were published in the Federal Register in February 2002 and required that all communities must have a Hazard Mitigation Plan in place in order to qualify for future federal disaster mitigation grants following a Presidential disaster declaration. The Hazard Mitigation Plan emphasizes measures that can be taken to reduce or prevent future disaster damages caused by natural hazards. In the context of natural hazard planning, Pre-Disaster Mitigation refers to any action that permanently reduces or eliminates long-term risks to human life and property.

1.2 Plan Purpose

New England weather is renowned for its mercurial and dramatic nature. Late summer hurricanes, major winter blizzards, and summer droughts are all part of climactic atmosphere in Central Massachusetts. These occur frequently enough to be familiar scenes to residents of Blackstone. The intersection of these natural hazards with the built environment can transition these routine events into classified natural disasters. Since many towns historically developed along waterways as a corridor for transportation and power, they have evolved into riverine floodplains. The historical development pattern of Central Massachusetts makes the likelihood of a devastating impact of a natural disaster more likely.

This plan identifies the natural hazards facing the Town of Blackstone, assesses the vulnerabilities of the area's critical facilities, infrastructure, residents, and businesses, and presents recommendations on how to mitigate the negative effects of typical natural hazards.

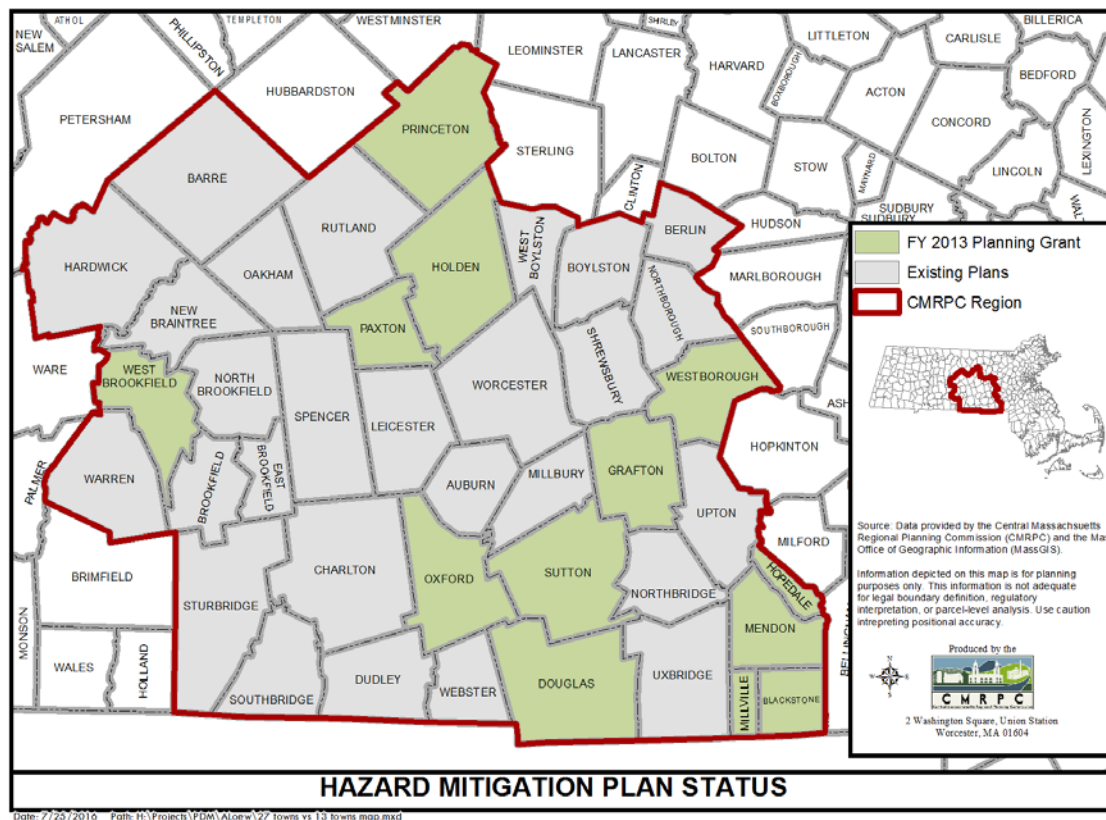
This effort has drawn from the knowledge of local municipal officials and residents, and the recommendations presented are intended to be realistic and effective steps for mitigating natural hazards. Implementation of these actions will translate into savings – fewer lives lost, less property destroyed, and less disruption to essential services.

2.0 PLANNING PROCESS

This Plan is funded through a Fiscal Year 2013 Pre-Disaster Mitigation grant to CMRPC from the Federal Emergency Management Agency (FEMA) through the Massachusetts Emergency Management Agency (MEMA). Aside from Blackstone, twelve other communities are

participating in this round of planning: Douglas, Grafton, Holden, Hopedale, Mendon, Millville, Oxford, Paxton, Princeton, Sutton, West Brookfield, and Westborough.

Figure 1



The planning process in each community was composed of two distinct but related phases – data collection and technical review, and public input and planning. Identification of natural hazards impacting participating communities was accomplished through review of available information from various sources. These included federal and state reports and datasets, existing plans, and in some cases engineering documents. An assessment of risks and vulnerabilities was performed primarily using geographic information systems (GIS) to identify the infrastructure (critical facilities, public buildings, roads, homes, businesses, etc.) at the highest risk for being damaged by hazards, particularly flooding. Local knowledge as imparted by town officials, staff, emergency management volunteers and others was a critical element of this phase.

The second phase of the process was focused on outreach, public participation and input, and planning. This phase was critical to ensuring awareness of the planning process among a wide range of local officials, coordinating plan elements with other sectors of the community, and providing opportunities for public comment and input from a representative base of residents and other stakeholders in each community. Through this engagement, CMRPC was better able to

gauge community priorities for mitigation and to understand local resources and existing policies and procedures. With this information in hand, the planning team was able to develop an informed and community-specific list of mitigation strategies for each participating town.

In Blackstone, a planning team of local staff and volunteers led by Fire Chief and EMD Michael Sweeney met three times to discuss hazard areas, critical infrastructure and other assets, and plan priorities and strategies: November 27, 2014, December 18, 2014, and April 20, 2016. Participants included Michael Sweeney, Fire Chief and EMD; Daniel Keyes, Town Administrator; Ross Atstupenas, Police Chief; James Sullivan, DPW; and Bill Walsh, Code Enforcement. Between meetings and during development of the draft and final plans, information and comments were shared among the local team and CMRPC. CMRPC held a public regional forum for the thirteen participating towns on November 5, 2015 to discuss the overall planning effort and to highlight best practices in mitigation efforts and policies for use by individual communities. Fire Chief Sweeney represented Blackstone at the forum. Also in late 2015, a public survey to gauge residents' concerns about (and experiences with) hazards was distributed on the Town's website. Four residents participated, offering opinions on hazards and vulnerabilities, preferred means of emergency communication, and priorities and suggestions for future mitigation action. Survey responses were discussed by the planning team at its April 2016 meeting and helped inform development and prioritization of mitigation strategies.

As planning activities progressed, a public presentation was made by CMRPC at the July 26, 2016 meeting of the Blackstone Board of Selectmen to provide a summary of key aspects of the draft Plan report then being finalized. The presentation was televised on the local cable access channel and the opportunity for public comment was emphasized. Materials and notes from the presentation and subsequent public discussion are included in the appendix. A full draft Plan was provided to the Town for distribution and made available online at CMRPC's website for public comment for two weeks starting on November 7, 2016. No substantive public comments were received. In addition, the final draft Plan was distributed to officials in all neighboring communities for review and input regarding shared hazards. Again, no comments were received.

The final draft Plan was submitted to MEMA for review on November 7, 2016 and was then relayed to FEMA for federal review. After receipt of FEMA's approval on January 19, 2017, a presentation of the final plan was made by CMRPC at the January 24, 2017 meeting of the Board of Selectmen. At the meeting, the plan was formally adopted by vote of the Board.

The Blackstone Planning Board is the primary Town agency responsible for regulating development in town. Feedback to the Planning Board was ensured through the participation of the Town Administrator on the local hazard planning team. In addition, CMRPC, the State-designated regional planning authority for Blackstone, works with all agencies that regulate development in its region, including the municipal entities listed above and state agencies, such

as Department of Conservation and Recreation and MassDOT. This regular involvement ensured that during the development of the Blackstone Hazard Mitigation Plan, the operational policies and any mitigation strategies or identified hazards from these entities were incorporated.

See Appendix C for additional documentation of local stakeholder and public participation in the planning process.

3.0 REGIONAL AND COMMUNITY PROFILE

The Central Massachusetts Regional Planning Commission (CMPRC) region occupies roughly 1,000 square miles in the southern two-thirds of Worcester County, Massachusetts. The area surrounds the City of Worcester, which is the second-largest city in Massachusetts and New England, with a population of 182,511 as of the 2014 American Community Survey (five-year estimate). Nearly 563,000 people live in the CMRPC Region, of whom 9,055 reside in Blackstone.

The CMRPC area is framed on the west by the Central Massachusetts uplands, on the south by Rhode Island and Connecticut, on the east by the Boston metropolitan area, and on the north by the Montachusett region in northern Worcester County. The forty-community region has been divided for planning purposes into six sub-regions, determined by shared characteristics and roadway corridors. Blackstone is located in the Southeast sub-region consisting of eleven towns lying within the Blackstone River watershed, including: Blackstone, Douglas, Grafton, Hopedale, Mendon, Millbury, Millville, Northbridge, Sutton, Upton, and Uxbridge.

Massachusetts has a humid continental climate, with maritime influences increasing from northwest to southeast. The Blackstone area, as represented by National Weather Service data collected from 2000 through 2016 in nearby Worcester, sees monthly mean temperatures ranging from 24.4 degrees in January to 71 in July. Precipitation is relatively high at 49.15 inches annually, including 78 inches of snowfall. With a temperate climate and a location some 25 miles from the Atlantic coast, Blackstone and its neighboring communities are subject to a variety of severe weather, including hurricanes, nor'easters, thunderstorms, and blizzards. All of these are discussed more fully in Chapter 4.

The Town of Blackstone, Massachusetts was incorporated in 1845 and for many decades was an industrial center. It is located some 20 miles south of the City of Worcester and 20 miles north of Providence, RI and is now largely a bedroom community. Highway access to both major cities is available via Route 146, accessible in nearby Millville. Blackstone lies within the Blackstone River valley. It is bordered by Mendon on the north, Millville on the west, Bellingham to the east, and Woonsocket, RI to the south. Blackstone has a total area of 11.2 square miles and a population of 9,055 (2014 American Community Survey).

Blackstone is a demographically stable community with its population essentially unchanged since a 1990s boom. The number of residents has grown from 8,023 in the 1990 US Census to 8,804 in 2000 to the currently (2014) estimated 9,055. According to the CMRPC's Long Range Transportation Plan, Mobility 2040, the town is expected to experience low population growth over the next 25 years. Blackstone is a largely white community, with some 93.4% of residents identifying within that group. Latinos or Hispanics of all races are the largest minority group, at 4.5%. The age breakdown is broadly similar to Massachusetts state splits, with children under 19 (24.9%) and seniors 65 or over (11.4%) fairly close to the state rates of 24.4% and 14.4% respectively. Median age is 42.8, somewhat above the state median of 39.3.

At \$72,699, median household annual income is slightly above the state (\$67,846) and Worcester County (\$65,453) medians. Poverty is low at 5.1%, or less than half the state and county rates (both 11.6%). Housing costs are moderate, with a median owner-occupied home valued at \$263,500, compared to \$329,900 for Massachusetts and \$255,600 for the county. Nearly 88% of occupied homes are detached or semi-detached single family houses; the remainder is multi-unit structures. At 7.9%, vacancies are below the state (9.9%) and county (8.5%) numbers. Homes are slightly newer than in the broader region, with 27.4% built before 1940, compared to nearly 34% for Massachusetts and almost 31% for Worcester County.

4.0 NATURAL HAZARD IDENTIFICATION AND ANALYSIS

The following section includes a summary of disasters that have affected or could affect Blackstone. Historical research, discussions with local officials and emergency management personnel, available hazard mapping and other weather-related databases were used to develop this list. The most significant identified hazards are the following:

- Flooding
- Severe Snowstorms / Ice storms/ Nor'easters
- Hurricanes
- Severe Thunderstorms / Wind / Tornadoes
- Wildfires / Brushfires
- Earthquakes
- Dam failure
- Drought
- Extreme Temperatures
- Other hazards

4.1 Overview of Hazards and Impacts

This section examines the hazards in the Massachusetts State Hazard Mitigation Plan which are identified as likely to affect Blackstone. The analysis is organized into the following sections: Hazard Description, Location, Extent, Previous Occurrences, Probability of Future Events, Impact, and Vulnerability. A description of each of these analysis categories is provided below.

Hazard Description

The natural hazards identified for Blackstone are: Flooding, Severe snowstorms / Ice storms / Nor'easters, Hurricanes, Severe thunderstorms / Wind / Tornadoes, Wildfire / Brushfire, Earthquakes, Dam failure, and Drought. Many of these hazards result in similar impacts to a community. For example, hurricanes, tornadoes and severe snowstorms may cause wind-related damage.

Location

Location refers to the geographic areas within the planning area that are affected by the hazard. Some hazards affect the entire planning area universally, while others apply to a specific portion, such as a floodplain or area that is susceptible to wild fires. Classifications are based on the area that would potentially be affected by the hazard, on the following scale:

Table 1

Percentage of Town Impacted by Natural Hazard	
Land Area Affected by Occurrence	Percentage of Town Impacted
Large	More than 50% of the town affected
Medium	10 to 50% of the town affected
Small	Less than 10% of the town affected

Extent

Extent describes the strength or magnitude of a hazard. Where appropriate, extent is described using an established scientific scale or measurement system. Other descriptions of extent include water depth, wind speed, and duration.

Previous Occurrences

Previous hazard events that have occurred are described. Depending on the nature of the hazard, events listed may have occurred on a local, state-wide, or regional level.

Probability of Future Events

The likelihood of a future event for each natural hazard was classified according to the following scale:

Table 2

Frequency of Occurrence and Annual Probability of Given Natural Hazard	
Frequency of Occurrence	Probability of Future Events
Very High	70-100% probability in the next year
High	40-70% probability in the next year
Moderate	10-40% probability in the next year
Low	1-10% probability in the next year
Very Low	Less than 1% probability in the next year

Impact

Impact refers to the effect that a hazard may have on the people and property in the community, based on the assessment of extent described above. Impacts are classified according to the following scale:

Table 3

Impacts, Magnitude of Multiple Impacts of Given Natural Hazard	
Impacts	Magnitude of Multiple Impacts
Catastrophic	Multiple deaths and injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of facilities for 30 days or more.
Critical	Multiple injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 week.
Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 day.
Minor	Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of facilities.

Vulnerability

Based on the above metrics, a hazard index rating was determined for each hazard. The hazard index ratings are based on a scale of 1 through 5 as follows:

- 1 – Highest risk
- 2 – High risk
- 3 – Medium risk
- 4 – Low risk
- 5 – Lowest risk

The ranking is qualitative and is based, in part, on local knowledge of past experiences with each type of hazard. The size and impacts of a natural hazard can be unpredictable. However; many of the mitigation strategies currently in place and many of those proposed for implementation can be applied to the expected natural hazards, regardless of their unpredictability.

Table 4

Hazard Identification and Analysis Worksheet for Blackstone				
Type of Hazard	Location of Occurrence	Probability of Future Events	Impact	Hazard Risk Index Rating
Flooding	Small	Low	Minor	2
Severe Snowstorms / Ice Storms/ Nor'easter	Large	Very High	Limited	2
Severe Thunderstorms /	Small	Moderate	Minor	2
Winds /	Small	Moderate	Limited	2
Tornadoes	Small	Very Low	Limited	4
Hurricanes	Large	Low	Limited	3
Wildfire / Brushfire	Small	Moderate	Minor	4
Earthquakes	Large	Very Low	Minor	5
Dam Failure	Small	Very Low	Limited	3
Drought	Large	Very Low	Minor	4
Extreme Temperatures	Large	Moderate	Limited	4

Based on Massachusetts State Hazard Mitigation Plan, 2013; modified to reflect conditions in Blackstone

4.2 Flooding

Hazard Description

Flooding was the most pressing hazard identified by local officials in Blackstone. Flooding is generally caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms. Global climate change has the potential to exacerbate these issues over time with the potential for more severe and frequent storm and rainfall events. There are several different types of flood hazards –

from stormwater inundation and poor drainage infrastructure to riverine flooding and storm surges to dam failures. The most extensive damage would result from dam failure. However, the most frequent flood threat is due to riverine and stormwater flooding.

Location

Flooding and flood-prone areas in Blackstone are closely associated to the course of the Blackstone River and associated tributaries, canals and impoundments. According to a GIS analysis performed by CMRPC, there are 45 parcels in Blackstone that are susceptible to 100-year floods, with 40 of them containing structures. Much of Blackstone is a slightly elevated rolling plateau, away from rivers and ponds – as a result, the location of this hazard is relatively “small”. Map 2 in Appendix A illustrates the FEMA FIRM 100-year flood zones in town, as well as locally-identified flooding areas. See below for discussion of previous flood occurrences and their locations.

Extent

The average annual precipitation for Blackstone and surrounding areas in central Massachusetts has been 45 to 50 inches during the past several years.

Water levels in Blackstone's rivers, streams, and wetlands rise and fall seasonally and during high rainfall events. High water levels are typical in spring, due to snowmelt and ground thaw. This is the period when flood hazards are normally expected. Low water levels occur in summer due to high evaporation and plant uptake (transpiration). At any time, heavy rainfall may create conditions that raise water levels in rivers and streams above bank full stage, which then overflow adjacent lands.

Based on past records and the knowledge and experience of members of the Blackstone Hazard Mitigation team and residents, the extent of the impact of localized flooding would be "minor".

Previous Occurrences

In addition to the floodplains mapped by FEMA for the 100-year and 500-year flood, Blackstone often experiences minor flooding at isolated locations due to problem culverts/bridges, past construction in inappropriate areas, or other drainage problems. Also see section 4.4 for discussion of flooding associated with hurricanes/tropical storms. The following specific flooding locations were identified by the local team based on knowledge of past flood events:

- Saint Paul Street/Rivers Edge Road/Farnum Street/Canal Street area (Blackstone River just above 100 year flood zone; impacts Town Hall/Public Safety/Senior Center building)
- South side of Main Street from appx. 1st Avenue to Blackstone Street (Blackstone River, Fox Brook); Public Library is across the street
- Elm Street (at Mill River)
- Farm Street (at Hop Brook)
- Blackstone Street (at Hop Brook)
- Lakeshore Drive (at Quick Stream, just below Lake Hiawatha Dam)
- Mendon Street (at Fox Brook, just below Crain's Pond Dam)
- Rathbun Street in 600s area (low area with poor drainage; includes Fire Station #2, the town's EOC)
- Main Street between Federal Street and Castle Hill Way (low area with poor drainage possibly due to runoff from new subdivision road; adjacent to 100 year flood zone)

In addition to the locations listed here (and mapped in Appendix A, Map 2), there are many areas with no record of previous flood incidents that could be affected in the future by heavy rain and runoff.

In recent years, there have been 7 loss claims in Blackstone made by FEMA NFIP participants, totaling \$12,381. At this time, Blackstone has no repetitive loss structures. As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of \$1,000 or more in any given 10-year period since 1978. For more information on repetitive losses see www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet.

Probability of Future Events

Based upon previous data, there is "low" probability of localized flooding occurring in Blackstone in a given year.

Impact

The Town faces a "minor" impact, with less than 10% of total town area likely to be affected by a flooding event.

Utilizing the GIS analysis noted above, the total value of the structures on the 45 parcels that are susceptible to a 100-year flood is approximately \$4,404,200.

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The HAZUS software was used to model potential damages

to the community from a 10,000 cubic feet per second (cfs) flood event, which would be greater than either a 100-year or 500-year flood event.

Table 5

Estimated Damage from Flood	
	10,000 cfs flood event
Building Characteristics	
Estimated total number of buildings	3,103
Estimated total building replacement value (2010 \$)	\$ 905,909,000
Building Damages	
# of buildings sustaining minor damage (1-10%)	138
# of buildings sustaining moderate damage (11-40%)	302
# of buildings sustaining severe damage (41-50%)	26
# of buildings destroyed	33
Population Needs	
# of households displaced	1,121
# of people seeking public shelter	2,847
Debris	
Building debris generated (tons)	8,243
# of truckloads to clear building debris	330
Value of Damages	
Total property damage (buildings and content)	\$ 134,510,000
Total losses due to business interruption	\$ 860,000

Though there is only one recorded instance of a flood event of this size (Tropical Storm Diane, 1955), this model was included in order to present a reasonable “worst case scenario” that would help planners and emergency personnel evaluate the impacts of flooding that might be more likely in the future, as we enter into a period of more intense and frequent storms. For more information on the HAZUS-MH software, go to <http://www.fema.gov/hazus-software>.

Vulnerability

Based on this analysis, Blackstone faces a hazard index rating of “2 - high risk” from flooding, though it is likely at the low end of this category within a national context.

Conditions in Blackstone demonstrate somewhat greater vulnerability to flooding than in most other Central Massachusetts communities. Previous NFIP claims are slightly higher than in most

nearby towns with similar populations and levels of development, a relatively large number of parcels with structures are located within the 100 year flood zone, and HAZUS simulations show that roughly 30% of Blackstone households would be displaced in a very rare flooding event along the lines of 1955's Tropical Storm Diane, despite the installation of limited flood control berms since that time. The local planning team notes the following concerns:

- The Town Hall/Public Safety/Senior Center complex sees recurrent basement and access road flooding when the Blackstone River is high and during long-duration rain events; floods have previously damaged Fire Department apparatus, Town records, and the backup power generator located behind the building; in severe flooding this area reportedly becomes an "island," impeding emergency vehicle operations. Recently, stormwater BMPs such as a bioretention area, pervious pavement, and tree plantings were implemented here but the overall flood vulnerability remains notable.
- Fire Station #2, the EOC, is also located in a flood-prone area due to locally poor drainage
- The relatively new Public Library abuts Fox Brook and the site is partly within a FEMA flood zone
- Evacuation routes Main Street, Blackstone Street and Elm Street are have seen regular flooding in some places. Mendon Street (a secondary route) is also subject to flooding.
- Pump stations for drinking water wells 2 and 7 are adjacent to flooding areas
- Extreme rainfall associated with Tropical Storm Diane in 1955 placed most of the town and village centers along the Blackstone River underwater

If evacuation routes and critical facilities such as those listed above are flooded, emergency response operations, regular town operations, and/or evacuations could be hampered.

4.3 Severe Snowstorms / Ice Storms / Nor'easters

Hazard Description

Severe winter storms can pose a significant risk to property and human life. Severe snowstorms and ice storms can involve rain, freezing rain, ice, snow, cold temperatures and wind. Heavy snowfall and extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines and hypothermia. A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain.

Location

The entire Town of Blackstone is susceptible to severe snowstorms, which means the location of occurrence is “large.” Because these storms occur regionally, they would impact the entire community.

Extent

The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004) characterizes and ranks high-impact Northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus NESIS gives an indication of a storm's societal impacts.

NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The aerial distribution of snowfall and population information are combined in an equation that calculates a NESIS score which varies from around one for smaller storms to over ten for extreme storms. The raw score is then converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers.

Table 6

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

Source: <http://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis>

Previous Occurrences

Based on data available from the National Oceanic and Atmospheric Administration, there are 58 high-impact snowstorms since 1958 that have affected the Northeast Corridor. Of these, 28

storms resulted in snowfalls in Blackstone of appx. 10 inches or more. These storms are listed in the table below:

Table 7

Winter Storms Producing over 10 Inches of Snow in Blackstone, 1958-2015			
Date	NESIS Value	NESIS Category	NESIS Classification
2/8/2015	1.32	1	Notable
1/29/2015	5.42	3	Major
1/25/2015	2.62	2	Significant
3/4/2013	3.05	2	Significant
2/7/2013	4.35	3	Major
1/26/2011	2.17	1	Notable
1/9/2011	5.31	3	Major
12/24/2010	4.92	3	Major
2/23/2010	5.46	3	Major
12/18/2009	3.99	2	Significant
3/15/2007	2.54	2	Significant
2/12/2006	4.10	3	Major
1/21/2005	6.80	4	Crippling
2/15/2003	7.50	4	Crippling
3/31/1997	2.29	1	Notable
2/8/1994	5.39	3	Major
3/12/1993	13.2	5	Extreme
2/10/1983	6.25	4	Crippling
4/6/1982	3.35	2	Significant
2/5/1978	5.78	3	Major
1/19/1978	6.53	4	Crippling
2/18/1972	4.77	3	Major
2/22/1969	4.29	3	Major
2/8/1969	3.51	2	Significant
2/5/1967	3.50	2	Significant
2/2/1961	7.06	4	Crippling
1/18/1961	4.04	3	Major
12/11/1960	4.53	3	Major
3/2/1960	8.77	4	Crippling
2/14/1958	6.25	4	Crippling

Source: <http://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis>

Probability of Future Events

Based upon the availability of records for Worcester County, the likelihood that a severe snow storm will affect Blackstone is “very high” (greater than 70 percent in any given year).

Research on climate change indicates that there is great potential for stronger, more frequent storms as the global temperature increases. The Massachusetts State Climate Change Adaptation Report has additional information about the impact of climate change and can be accessed at www.mass.gov/eea/air-water-climate-change/climate-change/.

Impact

The Town faces a “limited” impact or less than 10 percent of total property damaged, from snowstorms.

The weight from multiple snowfall events can test the load ratings of building roofs and potentially cause significant damage. Multiple freeze-thaw cycles can also create large amounts of ice and make for even heavier roof loads.

Other impacts from snowstorms and ice storms include:

- Disrupted power and phone service
- Unsafe roadways and increased traffic accidents
- Infrastructure and other property are also at risk from severe winter storms and the associated flooding that can occur following heavy snow melt.
- Tree damage and fallen branches that cause utility line damage and roadway blockages
- Damage to telecommunications structures
- Reduced ability of emergency officials to respond promptly to medical emergencies or fires

Vulnerability

Based on the above assessment, Blackstone has a hazard index rating of “2 — high risk” from snowstorms and ice storms. The local team notes that several of the local schools were damaged during recent winters with heavy snow loads, requiring more than \$1 million in repairs. Damage occurred at the Blackstone-Millville Regional High School and Kennedy Elementary/Maloney Elementary (co-located schools). The local team also notes that the Town Hall/Public Safety/Senior Center building has a flat roof and has needed shoveling off during snowy winters, including 2015, to prevent collapse and protect pedestrians.

Utilizing the Town's median home value of \$263,500 (American Community Survey, 2014 5-year estimate), combined with the total value of all property, \$852,550,754 (Massachusetts Department of Revenue, 2016), and an estimated 5 percent of damage to 10 percent of residential structures, approximately \$4,262,754 worth of damage could occur from a severe snowstorm. This is a rough estimate and likely reflects a worst-case scenario. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

4.4 Hurricanes

Hazard Description

Hurricanes are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. The primary damaging forces associated with these storms are high-level sustained winds and heavy precipitation. Hurricanes are violent rainstorms with strong winds that can reach speeds of up to 200 miles per hour and which generate large amounts of precipitation. Hurricanes generally occur between June and November and can result in flooding and wind damage to structures and above-ground utilities.

Location

Because of the hazard's regional nature, all of Blackstone is at risk from hurricanes, meaning the location of occurrence is "large." Ridgetops are more susceptible to wind damage. Areas susceptible to flooding are also likely to be affected by heavy rainfall.

Extent

As an incipient hurricane develops, barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. Hurricane intensity is further classified by the Saffir-Simpson Hurricane Wind Scale, which rates hurricane wind intensity on a scale of 1 to 5, with 5 being the most intense.

Table 8

Saffir-Simpson Scale	
Category	Maximum Sustained Wind Speed (MPH)
1	74–95
2	96–110
3	111–129
4	130–156
5	157 +

Source: National Hurricane Center, 2012

Previous Occurrences

Hurricanes that have affected the region in which Blackstone is located are shown in the following table:

Table 9

Major Hurricanes and Tropical Storms Affecting the region		
Hurricane/Storm Name	Year	Saffir/Simpson Category (when reached MA)
Great Hurricane of 1938	1938	3
Great Atlantic Hurricane	1944	1
Hurricane Dog	1950	Unclear
Carol	1954	3
Edna	1954	1
Diane	1955	Tropical Storm
Donna	1960	Unclear, 1 or 2
Belle	1976	Minor Storm
Gloria	1985	1
Bob	1991	2
Floyd	1999	Tropical Storm
Irene	2011	Tropical Storm
Sandy	2012	“Super Storm”

Source: National Oceanic and Atmospheric Administration

Members of the local planning team note that major storms of the 1930s and 1950s resulted in damaging Blackstone River flooding. Tropical Storm Diane (1955) in particular was destructive, resulting in several feet of floodwater across Blackstone Village, the town center. USGS Circular #377 reports that 18,800 cfs flowed through the Blackstone River in Blackstone during that storm, which followed only days after heavy rains from Tropical Storm Connie.

Probability of Future Events

Blackstone's location in central Massachusetts approximately 25 miles inland reduces the risk of extremely high winds that are associated with hurricanes, although it can still experience some high wind events. Based upon past occurrences, it is reasonable to say that there is a “low” probability (1 percent to 10 percent in any given year) of hurricanes in Blackstone. Climate change is projected to result in more severe weather, including increased occurrence of hurricanes and tropical storms. Because of this, the occurrence of hurricanes will increase in the future.

Impact

A description of the damages that could occur due to a hurricane is described by the Saffir-Simpson scale, as shown below:

Table 10

Hurricane Damage Classifications			
Storm Category	Damage Level	Description of Damages	Wind Speed (MPH)
1	MINIMAL	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage. An example of a Category 1 hurricane is Hurricane Dolly (2008).	74-95
	Very dangerous winds will produce some damage		
2	MODERATE	Some roofing material, door, and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected moorings may break their moorings. An example of a Category 2 hurricane is Hurricane Francis in 2004.	96-110
	Extremely dangerous winds will cause extensive damage		
3	EXTENSIVE	Some structural damage to small residences and utility buildings, with a minor amount of curtain wall failures.	111-129

	Devastating damage will occur	Mobile homes are destroyed. Flooding near the coast destroys smaller structures, with larger structures damaged by floating debris. Terrain may be flooded well inland. An example of a Category 3 hurricane is Hurricane Ivan (2004).	
4	EXTREME	More extensive curtain wall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland. An example of a Category 4 hurricane is Hurricane Charley (2004).	130-156
	Catastrophic damage will occur		
5	CATASTROPHIC	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required. An example of a Category 5 hurricane is Hurricane Andrew (1992).	157+
	Catastrophic damage will occur		

The Town faces a “limited” impact from hurricanes, with 10 percent or less of Blackstone affected. However, it should be noted that the impact area would most likely include the most developed portions of town, along the Blackstone River and its larger local tributaries.

Vulnerability

Based on the above analysis, Blackstone has a hazard index rating of “3 – medium risk” from hurricanes. The local team notes that the site of the current Town Hall/Public Safety/Senior Center building (built in the late 1960s) was underwater during Tropical Storm Diane, suggesting that critical items located in the basement (including the generator, archives and fire apparatus parking) are vulnerable to extreme storms. Other critical facilities such as Fire Station #2/EOC (in an area susceptible to minor flooding), evacuation routes such as Main Street, Blackstone Street and Elm Street and low-lying water pump stations (esp. #2 and #7) would also be vulnerable to tropical storms. The local team noted some concern about potential roof damage from severe wind at Fire Station #3, which was built by volunteers in the 1960s to an undetermined structural standard. The Fire Department plans to seek 2017 Town Meeting funds to strengthen, expand and improve the facility.

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The HAZUS software was used to model potential damages to the community from a 100-year and 500-year hurricane event; storms that are 1% and .02% likely to happen in a given year, and roughly equivalent to a Category 2 and Category 4

hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the Town, bringing the strongest winds and greatest damage potential.

Table 11

Estimated Damages from Hurricanes		
	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	3,103	
Estimated total building replacement value (2010 \$)	\$ 905,909,000	
Building Damages		
# of buildings sustaining minor damage	135	629
# of buildings sustaining moderate damage	11	118
# of buildings sustaining severe damage	0	9
# of buildings destroyed	0	4
Population Needs		
# of households displaced	5	37
# of people seeking public shelter	1	7
Debris		
Building debris generated (tons)	497	2,304
Tree debris generated (tons)	3,672	9,020
# of truckloads to clear building debris	20	92
Value of Damages (thousands of dollars)		
Total property damage (buildings and content)	\$ 6,856.89	\$26,493.26
Total losses due to business interruption	\$ 286.76	\$1,998.82

Though there are no recorded instances of a hurricane equivalent to a 500-year storm passing through Massachusetts, this model was included in order to present a reasonable “worst case scenario” that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms. For more information on the HAZUS-MH software, go to www.fema.gov/hazus-software.

4.5 Severe Thunderstorms / Wind / Tornado

Hazard Description

A thunderstorm is a storm with lightning and thunder produced by a cumulonimbus cloud, usually producing gusty winds, heavy rain, and sometimes generating hail. Effective January 5,

2010, the NWS modified the hail size criterion to classify a thunderstorm as ‘severe’ when it produces damaging wind gusts in excess of 58 mph (50 knots), hail that is 1 inch in diameter or larger (quarter size), or a tornado (NWS, 2013).

Wind is air in motion relative to surface of the earth. For non-tropical events over land, the NWS issues a Wind Advisory (sustained winds of 31 to 39 mph for at least 1 hour or any gusts 46 to 57 mph) or a High Wind Warning (sustained winds 40+ mph or any gusts 58+ mph). For non-tropical events over water, the NWS issues a small craft advisory (sustained winds 25-33 knots), a gale warning (sustained winds 34-47 knots), a storm warning (sustained winds 48 to 63 knots), or a hurricane force wind warning (sustained winds 64+ knots). For tropical systems, the NWS issues a tropical storm warning for any areas (inland or coastal) that are expecting sustained winds from 39 to 73 mph. A hurricane warning is issued for any areas (inland or coastal) that are expecting sustained winds of 74 mph. Effects from high winds can include downed trees and/or power lines and damage to roofs, windows, etc. High winds can cause scattered power outages. High winds are also a hazard for the boating, shipping, and aviation industry sectors.

Tornadoes are swirling columns of air that typically form in the spring and summer during severe thunderstorm events. In a relatively short period of time and with little or no advance warning, a tornado can attain rotational wind speeds in excess of 250 miles per hour and can cause severe devastation along a path that ranges from a few dozen yards to over a mile in width. The path of a tornado may be hard to predict because they can stall or change direction abruptly. Within Massachusetts, tornadoes have occurred most frequently in the Connecticut River Valley and in western Worcester County, with Blackstone some 40 miles east of the zone of most frequent past occurrence. High wind speeds, hail, and debris generated by tornadoes can result in loss of life, downed trees and power lines, and damage to structures and other personal property (cars, etc...).

Location

As per the Massachusetts Hazard Mitigation Plan, the entire Town is at risk of high winds, severe thunderstorms, and tornadoes. The plan identifies Blackstone and its surrounding communities as having a moderate frequency of tornado occurrence within the Massachusetts context. However, the actual area affected by thunderstorms, wind, or tornadoes is “small,” with less than 10 percent of the Town generally affected by damage.

Extent

An average thunderstorm is 15 miles across and lasts 30 minutes; severe thunderstorms can be much larger and longer. Southern New England typically experiences 10 to 15 days per year with severe thunderstorms. Thunderstorms can cause hail, wind, and flooding.

Tornadoes are measured using the enhanced F-Scale, shown with the following categories and corresponding descriptions of damage:

Table 12

Enhanced Fujita Scale Levels and Descriptions of Damage			
EF-Scale Number	Intensity Phrase	3-Second Gust (MPH)	Type of Damage Done
EF0	Gale	65–85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
EF1	Moderate	86–110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
EF2	Significant	111–135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
EF3	Severe	136–165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
EF4	Devastating	166–200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.

Table 13 - Extent Scale for Hail

CONVERTING TRADITIONAL HAIL SIZE DESCRIPTIONS

Traditional object-to-size conversion for assessment and translation of severe hail reports. We encourage *measurement*, not estimation, of hail size.

HAIL SIZE (in.)	OBJECT ANALOG REPORTED
-----------------	------------------------

.50	Marble, moth ball
.75	Penny
.88	Nickel
1.00	Quarter
1.25	Half dollar
1.50	Walnut, ping pong
1.75	Golf ball
2.00	Hen egg
2.50	Tennis ball
2.75	Baseball
3.00	Tea cup
4.00	Grapefruit
4.50	Softball

Previous Occurrences

Because thunderstorms and wind affect the town regularly each year, there are not significant records available for these events. As per the Massachusetts Hazard Mitigation Plan, there are approximately 10 to 30 days of thunderstorm activity in the state each year.

In Worcester County, there have been a number of F1 tornadoes occurring sporadically over the years, and the local planning team recalls that a small tornado may have touched down in Blackstone very briefly about 20 years ago. A search for tornadoes rating 3 or above, or resulting in death/injury, or significant property damage, identifies the following events:

- In 1953, an F4 tornado struck Worcester. The event resulted in at least 90 fatalities, and more than 1,200 injured. There was extensive property damage. On the same date, an F3 tornado began in the Town of Sutton, ca. 5 miles NW of Blackstone.
- In 1981 an F3 tornado struck, resulting in just 3 injuries and very little reported property damage.
- In June 2011, an F3 tornado struck Massachusetts. Few deaths were reported, all in Hampden County.



Figure 2- Photo: MEMA 2011

No deaths were reported in Worcester County.



Figure 3 - Above: NASA released this image of part of the 39-mile-long tornado track through south-central Mass. The image was captured June 5, 2011 by Landsat 5 satellite.

Probability of Future Events

One measure of tornado activity is the tornado index value. It is calculated based on historical tornado events data using USA.com algorithms. It is an indicator of the relative tornado activity level in a region. A higher tornado index value means a higher chance of tornado events. Index values for Blackstone and its surroundings are shown below.

Table 14

Tornado Index Value	
Town of Blackstone	89.78
Worcester County	120.35
Massachusetts	87.60
United States	136.45

Source: www.usa.com/massachusetts-state-natural-disasters-extremes.htm

Based upon the available historical record, as well as Blackstone's location in a moderate-density cluster of tornado activity for Massachusetts, there is a “very low” probability (less than 1 percent chance in any given year) of a tornado affecting the town, and a moderate (10 percent to 40 percent chance in any given year) probability of a severe thunderstorm and/or high winds.

Impact

Overall, Blackstone faces a “minor” impact from severe thunderstorms, and a “limited” impact from severe winds, or tornados, with 10 percent or less of the Town likely to be affected.

As indicated as part of the Enhanced Fujita Scale Levels for tornados, the following impacts can result from a tornado:

- EF0 - Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
- EF1 - The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
- EF2 - Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
- EF3 - Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
- EF4 - Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.

Vulnerability

Based on the above assessment, Blackstone has a hazard index rating of “2- high risk” from severe thunderstorms and winds, and a “4 – low risk” from tornadoes.

The potential for locally catastrophic damage is a factor in any tornado, severe thunderstorm, or wind event. In Blackstone, a tornado that hit residential areas would leave much more damage than a tornado with a travel path that ran along the town’s uplands, where less settlement has occurred. Most buildings in the town have not been built to Zone 1, Design Wind Speed Codes. The first edition of the Massachusetts State Building Code went into effect on January 1, 1975, and 57.5% percent of the town’s 3,749 occupied housing units was constructed in 1979 or earlier (American Communities Survey, 2014 5-year estimate). Beyond private homes, the local team

noted some concern about potential roof damage from severe wind at Fire Station #3, which was built by volunteers in the 1960s to an undetermined structural standard (the Fire Department plans to seek 2017 Town Meeting funds to expand and improve the facility). Utility lines throughout town are also vulnerable, particularly where trees have not been trimmed recently.

Utilizing the Town's median home value of \$263,500 (American Community Survey, 2014 5-year estimate), combined with the total value of all property, \$852,550,754 (Massachusetts Dept. of Revenue, 2016), and an estimated 10 percent of damage to 5 percent of all structures, the estimated amount of damage from a tornado is \$4,262,754. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

4.6 Wildfires / Brush Fires

Hazard Description

Wildfires are typically larger fires, involving full-sized trees as well as meadows and scrublands. Brushfires are uncontrolled fires that occur in meadows and scrublands, but do not involve full-sized trees. Typical causes of brushfires and wildfires are lightning strikes, human carelessness, and arson.

FEMA has classifications for 3 different classes of wildfires:

- Surface fires are the most common type of wildfire, with the surface burning slowly along the floor of a forest, killing or damaging trees.
- Ground fires burn on or below the forest floor and are usually started by lightning
- Crown fires move quickly by jumping along the tops of trees. A crown fire may spread rapidly, especially under windy conditions.

Potential vulnerabilities to wildfires include damage to structures and other improvements, and impacts on natural resources. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases.

Location

Worcester County has approximately 645,000 acres of forested land, which accounts for 64% of total land area (Massachusetts Office of GIS, 2007). In Blackstone, an estimated 51.8% of the land is forested. While Blackstone is developed in a mostly middle density suburban pattern and few large uninterrupted tracts of forest are present, the substantial tree coverage does present

some risk for wildfires and brush fires. The total amount of town that would plausibly be affected by a wildfire is categorized as “small,” or less than 10 percent of the total area.

Central and southern Blackstone – the most densely developed parts of town – are served by a municipal water system drawn from groundwater wells listed in Chapter 5. Approximately 80% of water users – about 2,800 households and business – in town use the system. This system is also used for fire control. In the relatively undeveloped northern parts of town, fire protection is supplemented through two dry hydrant systems, located respectively on Lake Shore Drive (Lake Hiawatha) and at a pond at Wojcik's farm on Milk Street, just east of Mendon Street.

Extent

Wildfires can cause widespread damage. They can spread very rapidly, depending on local wind speeds and can be very difficult to get under control. Fires can last for several hours up to several days.

In Blackstone approximately 51.8% percent of the town's total land area is forested, and is therefore at risk of fire, but this forested area is generally scattered throughout the community, with developed areas, rivers and transportation corridors breaking up the forest. In drought conditions, a brushfire or wildfire would be a matter of concern. As noted in the next section describing previous occurrences of wildfire, there have not been any major wildfires recorded in Blackstone in recent decades. Based on historic data for 2001-2013, it is estimated that a brush fire might destroy 10 to 50 acres of forested area (Massachusetts Fire Incident Reporting System).

The overall extent of wildfires is shown in the table below:

Table 15 - Extent of Wildfires

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) Color Code: Green	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.

Rating	Basic Description	Detailed Description
<p>CLASS 2: Moderate Danger (M)</p> <p>Color Code: Blue</p>	<p>Fires start easily and spread at a moderate rate</p>	<p>Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.</p>
<p>CLASS 3: High Danger (H)</p> <p>Color Code: Yellow</p>	<p>Fires start easily and spread at a rapid rate</p>	<p>All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.</p>
<p>CLASS 4: Very High Danger (VH)</p> <p>Color Code: Orange</p>	<p>Fires start very easily and spread at a very fast rate</p>	<p>Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.</p>
<p>CLASS 5: Extreme (E)</p> <p>Color Code: Red</p>	<p>Fire situation is explosive and can result in extensive property damage</p>	<p>Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.</p>

Previous Occurrences

Blackstone has a mixed fire department with professional firefighters supported by on-call volunteers. There have not been any major forest fires in Blackstone in recent decades, but fires ranging from 5 to 25 acres have occurred in 2006, 2007 and 2013. During the period 2001-2013,

there were between 5 and 25 brush fires per year in town, with burned acreage ranging from essentially 0 to nearly 27 per year. More than 91 total acres of brush burned over that 12-year period (Massachusetts Fire Incident Reporting System). The map below illustrates statewide wildfires of all types from 2001-2009; during the period depicted, Blackstone experienced fewer than 50 wildfires and less than 100 total acres burned. Blackstone issues permits for controlled burning of yard waste.

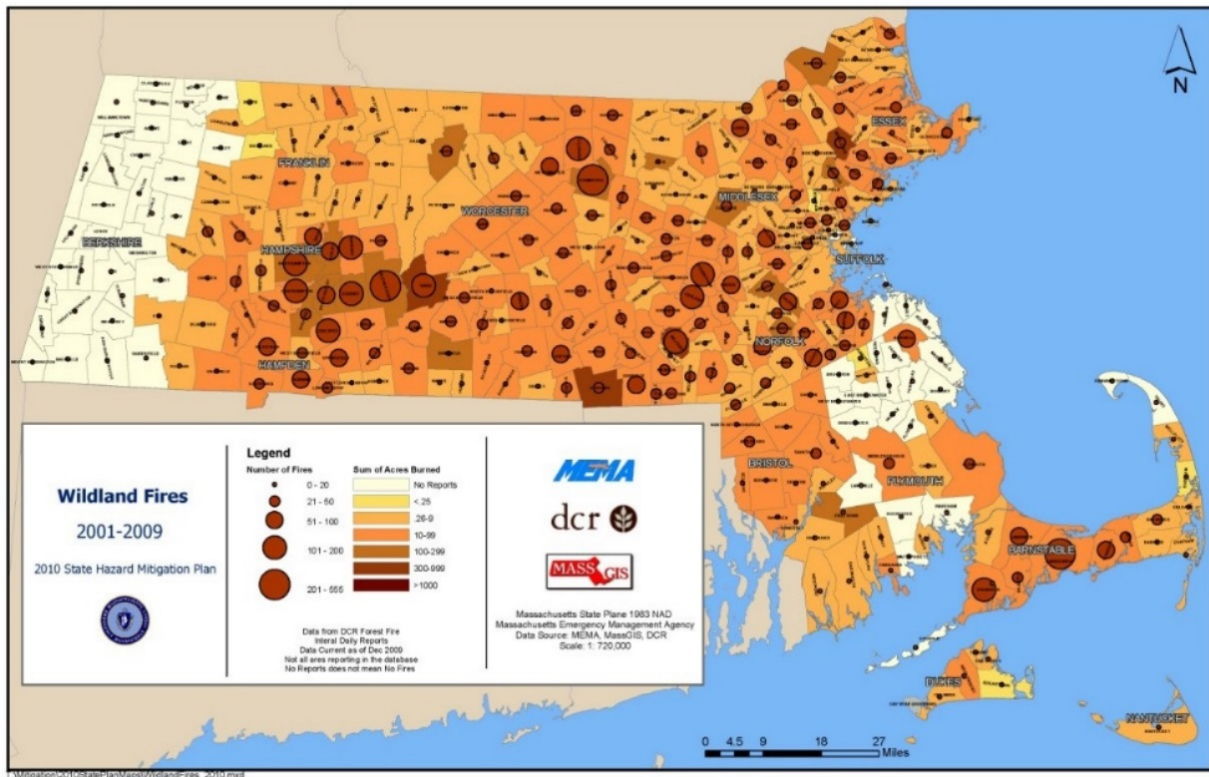


Figure 4 - Wildfires statewide from 2001-2009

Probability of Future Events

In accordance with the Massachusetts Hazard Mitigation Plan, the Blackstone Hazard Mitigation Team found it is difficult to predict the likelihood of wildfires in a probabilistic manner because the number of variables involved. However, based on regular previous occurrences of minor brush fires, the planning team determined the probability of future damaging wildfire events to be “moderate” (10 percent to 40 percent probability in the next year).

Climate scenarios project summer temperature increases between 2° C and 5° C and precipitation decreases of up to 15 percent. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide—the so-

called “fertilization effect”—could also contribute to more tree growth and thus more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown.

Climate change is also predicted to bring increased wind damage from major storms, as well as new types of pests to the region. Both increased wind and the introduction of new pests could potentially create more debris in wooded areas and result in a larger risk of fires.

Impact

While a large wildfire could in theory damage much of Blackstone, most forested areas are sparsely developed, meaning that wildfire-affected areas are not likely to cause damage to property. For this reason, the town faces a “minor” impact from wildfires, with little damage likely to occur. Damage is likely to be highest in areas outside of water coverage.

Both wildfires and brush fires can consume homes, other buildings and/or agricultural resources. The impact of wildfires and brush fires are as follows:

- Impact to benefits that people receive from the environment, such as food/water and the regulation of floods and drought
- Impact on local heritage, through the destruction of natural features
- Impact to the economy, due to damage to property and income from land following a wildfire
- Impact through the destruction of people and property

Vulnerability

Based on the above assessment, Blackstone has a hazard risk index of “4 – low risk” from wildfires. The local team did not identify any critical facilities or infrastructure that are particularly vulnerable to wildfires. Vulnerability is lowest in areas served by the Town's potable water system, higher in outlying areas close the two dry hydrant systems, and highest in other areas, primarily in the northernmost section of town.

Utilizing the Town’s median home value of \$263,500 (American Community Survey, 2014 5-year estimate), combined with the total value of all property, \$852,550,754 (Massachusetts Dept. of Revenue, 2016), and an estimated 5 percent of damage to 1 percent of all structures, the estimated amount of damage from a wildfire is \$462,275. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

4.7 Earthquakes

Hazard Description

An earthquake is a sudden, rapid shaking of the ground that is caused by the breaking and shifting of rock beneath the Earth's surface. Earthquakes can occur suddenly, without warning, at any time of the year. Ground shaking from earthquakes can rupture gas mains and disrupt other utility service, damage buildings, bridges and roads, and trigger other hazardous events such as avalanches, flash floods (dam failure) and fires. Un-reinforced masonry buildings, buildings with foundations that rest on filled land or unconsolidated, unstable soil, and mobile homes not tied to their foundations are at risk during an earthquake.

Location

Because of the regional nature of the hazard, the entire Town of Blackstone is susceptible to earthquakes. This makes the location of occurrence "large," or over 50 percent of the total area.

Extent

The magnitude of an earthquake is measured using the Richter Scale, which measures the energy of an earthquake by determining the size of the greatest vibrations recorded on the seismogram. On this scale, one step up in magnitude (from 5.0 to 6.0, for example) increases the energy more than 30 times.

Table 16

Richter Scale Magnitudes and Effects	
Magnitude	Effects
< 3.5	Generally not felt, but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.4 - 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 - 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 - 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or >	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

The intensity of an earthquake is measured using the Modified Mercalli Scale. This scale quantifies the effects of an earthquake on the Earth's surface, humans, objects of nature, and man-made structures on a scale of I through XII, with I denoting a weak earthquake and XII denoting an earthquake that causes almost complete destruction.

Table 17

Modified Mercalli Intensity Scale for and Effects			
Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs.	
II	Feeble	Some people feel it.	< 4.2
III	Slight	Felt by people resting; like a truck rumbling by.	
IV	Moderate	Felt by people walking.	
V	Slightly Strong	Sleepers awake; church bells ring.	< 4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves.	< 5.4
VII	Very Strong	Mild alarm; walls crack; plaster falls.	< 6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged.	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open.	< 6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread.	< 7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards.	< 8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves.	> 8.1

Source: US Federal Emergency Management Agency

Previous Occurrences

Although New England has not experienced a damaging earthquake since 1755, seismologists state that a serious earthquake occurrence is possible. There are five seismological faults in Massachusetts, but there is no discernible pattern of previous earthquakes along these fault lines. Earthquakes occur without warning and may be followed by aftershocks. Most older buildings and infrastructure were constructed without specific earthquake resistant design features.

The most recent notable (Magnitude or Intensity 4 or greater) earthquakes to affect Massachusetts since 1900 are shown in the table below:

Table 18

Notable Earthquakes in Massachusetts 1900 – 2007

Location	Date	Magnitude	MMI
Nantucket, MA	October 25, 1965	4.7	5.0
Cape Anne, MA	January 7, 1925	4.0	5.0
Wareham, MA	April 25, 1924	4.0	5.0
Newbury, MA	June 10, 1951	4.0	5.0

Source: Northeast States Emergency Consortium website, <http://nsec.org/massachusetts-earthquakes/>

Additionally, a table showing historic incidences of earthquakes for the six New England states are shown in the table below:

Table 19

New England States Record of Historic Earthquakes		
State	Years of Record	Number of Earthquakes
Connecticut	1668 - 2007	137
Maine	1766 - 2007	544
Massachusetts	1668 - 2007	355
New Hampshire	1638 - 2007	360
Rhode Island	1776 - 2007	38
Vermont	1843 - 2007	73
New York	1840 - 2007	755
<i>Total Number of Earthquakes within the New England states between 1638 and 2007 is 2262.</i>		

Source: Northeast States Emergency Consortium website, <http://nsec.org/massachusetts-earthquakes/>

Probability of Future Events

One measure of earthquake activity is the Earthquake Index Value. It is calculated based on historical earthquake events data using USA.com algorithms. It is an indicator of the earthquake activity level in a region. A higher earthquake index value means a higher chance of earthquake events. Data was used for Worcester County to determine the Earthquake Index Value as shown in the table below:

Table 20

Earthquake Index for Worcester County	
Worcester County	0.34
Massachusetts	0.70
United States	1.81

Source: *USA.com*

The local Hazard Mitigation Team reports that no earthquakes have been felt in Blackstone. Based upon existing records, there is a “very low” frequency (less than 1 percent probability in any given year) of a damaging earthquake.

Impact

Massachusetts introduced earthquake design requirements into their building code in 1975 and improved building code for seismic reasons in the 1980s. However, these specifications apply only to new buildings or to extensively-modified existing buildings. Buildings, bridges, water supply lines, electrical power lines and facilities built before the 1980s may not have been designed to withstand the forces of an earthquake. The first edition of the Massachusetts State Building Code went into effect on January 1, 1975, and 57.5% percent of the town’s 3,749 occupied housing units was constructed in 1979 or earlier (American Communities Survey, 2014 5-year estimate). The seismic standards were upgraded with the 1997 revision of the State Building Code. Despite its older housing stock, Blackstone faces a “minor” impact from earthquakes, with little damage likely to occur due to the extreme rarity of damaging events.

Vulnerability

Based on the above analysis, Blackstone has a hazard index rating of “5- lowest risk” from earthquakes. HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic center of the study area. For the purposes of this plan, a magnitude 5.0 earthquake was selected for analysis. Historically, major earthquakes are rare in New England, although a magnitude 5 event occurred in 1963.

Table 21 - Estimated Damages from an Earthquake

	Magnitude 5.0
Building Characteristics	
Estimated total number of buildings	3,103
Estimated total building replacement value (2010 \$)	\$ 905,909,000
Building Damage	
# of buildings sustaining slight damage	871
# of buildings sustaining moderate damage	410
# of buildings sustaining extensive damage	89
# of buildings completely damaged	17

	Magnitude 5.0
Population Needs	
# of households displaced	99
# of people seeking public shelter	54
Debris	
Building debris generated (tons)	13,000
# of truckloads to clear debris (@ 25 tons/truck)	520
Value of Damages (dollars)	
Total property damage	\$82,200,000
Total losses due to business interruption	\$8,100,000

For more information on the HAZUS-MH software, go to www.fema.gov/hazus-software.

The planning team did not note any local critical infrastructure or facilities that would be of particular vulnerability to earthquakes aside from the two aging Providence & Worcester railroad bridges over the Blackstone River.

4.8 Dam Failure

Hazard Description

Dams and their associated impoundments provide many benefits to a community, such as water supply, recreation, hydroelectric power generation, and flood control. However, they also pose a potential risk to lives and property. Dam failure is not a common occurrence, but dams do represent a potentially disastrous hazard. When a dam fails, the potential energy of the stored water behind the dam is released rapidly. Most dam failures occur when floodwaters above overtop and erode the material components of the dam. Often dam breaches lead to catastrophic consequences as the water rushes in a torrent downstream flooding an area engineers refer to as an “inundation area.” The number of casualties and the amount of property damage will depend upon the timing of the warning provided to downstream residents, the number of people living or working in the inundation area, and the number of structures in the inundation area.

Many dams in Massachusetts were built during the 19th century without the benefit of modern engineering design and construction oversight. Dams of this age can fail because of structural problems due to age and/or lack of proper maintenance, as well as from structural damage caused by an earthquake or flooding.

The Massachusetts Department of Conservation and Recreation Office of Dam Safety is the agency responsible for regulating dams in the state (M.G.L. Chapter 253, Section 44 and the implementing regulations 302 CMR 10.00). To be regulated, these dams are in excess of 6 feet in height (regardless of storage capacity) and have more than 15 acre-feet of storage capacity (regardless of height). Dam safety regulations enacted in 2005 transferred significant responsibilities for dams from the Commonwealth of Massachusetts to dam owners, including the responsibility to conduct dam inspections.

Location

According to the Massachusetts Office of Dam Safety, there are 10 reported dams in Blackstone, of which 0 are High Hazard and 1 is a Significant Hazard. Of some note is the Lake Hiawatha Dam, Town-owned, which was on the state's 2011 list of 100 dams needing substantial investments in maintenance and/or operations; these concerns were substantially addressed using funds from a state earmark, and the dam is no longer considered in poor condition. In addition to the dams in town, the Harris Pond Dam (High Hazard, RI00073) in neighboring Woonsocket, RI lies immediately along the town/state boundary, creating Harris Pond upstream from the dam. The pond itself is almost completely within Blackstone. Fortunately for Blackstone, impacts from a failure event would take place almost completely in Rhode Island. A former iteration of this dam failed due to embankment collapse during Tropical Storm Diane in 1955, according to the Association of State Dam Safety Officials' inventory of failures and near-failures. Blackstone dams are listed below and are mapped in Appendix A.

Table 22

National ID	Dam Name	Owner Type	Hazard Potential	Notes
MA00096	Stone Diversion Dam	Private	Low Hazard	aka Rolling Dam; Historic
MA01164	Blackstone River Dam at Canal Street	Town of Blackstone	Low Hazard	
MA01167	Lake Hiawatha Dam	Town of Blackstone	Significant Hazard	On state's 2011 list of dams requiring substantial repair; repairs made
MA02741	Canal Headgate Dam	Private	Low Hazard	
MA02742	Mill Pond Dam	Private	Low Hazard	
MA02743	Crain's Pond Dam	Private	N/A	
MA02744	Fish Pond Dam	Private	N/A	
MA02745	Fox Brook Dam	Private	N/A	Historic
MA02746	Old Ice Pond #1 Dam	Private	N/A	
MA02748	Walsh's Pond Dam	Town of Blackstone	N/A	

Inundation areas for these dams cover less than 10% of the town, or a “small” portion of its area.

Extent

Often dam or levee breaches lead to catastrophic consequences as the water ultimately rushes in a torrent downstream flooding an area engineers refer to as an “inundation area.” The number of casualties and the amount of property damage will depend upon the timing of the warning provided to downstream residents, the number of people living or working in the inundation area, and the number of structures in the inundation area.

Dams in Massachusetts are assessed according to their risk to life and property. The state has three hazard classifications for dams:

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

Previous Occurrences

To date, there has been one dam failure in Blackstone, as noted by the local team. In the 1960s, a historic low stone dam on the Mill River just upstream from Summer Street failed due to damage from severe winter icing, draining its mill pond and causing minor downstream damage. In addition, the Harris Pond Dam on the Mill River on the border with Woonsocket, RI failed during Tropical Storm Diane in 1955. Harris Pond is located almost entirely in Blackstone, though the dam is in Rhode Island.

Probability of Future Events

There has been one reported dam failure event in town in the 150-plus years that dams have been present, and one failure near the town line in neighboring Woonsocket, RI. Concerns about the Lake Hiawatha Dam's condition have been substantially resolved. Probability for future failure events is therefore “very low” with less than 1 percent chance of a dam failing in any given year.

Impact

The Town faces a “limited” impact from failure of dams with, with 10 to 25 percent of the affected area likely to see damage.

It is not possible to estimate the property loss impacts of dam failure quantitatively given the large number of variables involved in failure events. Qualitatively, losses from failure of an individual dam could be significant but would be geographically limited to portions of the dam’s inundation zone.

Vulnerability

In accordance with the Massachusetts Hazard Mitigation Plan, a quantitative vulnerability analysis could not be completed to estimate potential losses from a dam failure event. Based on a mostly qualitative assessment, Blackstone has a hazard index rating of “3 – medium” from dam failure. While the historic Harris Pond Dam collapse on the Blackstone River in next door Woonsocket, RI during Tropical Storm Diane and the 1960s Summer Street mill pond dam collapse from ice damage are quite unlikely to be repeated, they do indicate that there is local exposure to very extreme events that can result in failures. In addition, while the state's primary concerns with conditions at the Lake Hiawatha Dam have been addressed, it remains a Significant Hazard dam, presenting some continued risk to residences and to the replaced Harris Pond Dam downstream. A failure at the Lake Hiawatha Dam would also impact Elm Street, a designated evacuation route.

4.9 Drought

Hazard Description

Drought is a normal, recurrent feature of climate. It occurs almost everywhere, although its features vary from region to region. In the most general sense, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector. Reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat are a few examples of the direct impacts of drought. Of course, these impacts can have far-reaching effects throughout the region and even the country.

Location

Because of this hazard’s regional nature, a drought would likely impact the entire community, meaning the location of occurrence is “large” or over 50 percent of the town.

Extent

The severity of a drought would determine the scale of the event. Roughly 80% of Blackstone residents and businesses are served by municipal water, with the remainder utilizing private well water. The water service area is centered on the densely populated former mill villages along the Blackstone River and in newer residential areas in the central part of town, with more recent expansions into the northern area. The US Drought Monitor also records information on historical drought occurrence. Unfortunately, data are only available at the state level. The US Drought Monitor categorizes drought on a D0-D4 scale as shown below.

Table 23

U.S. Drought Monitor		
Classification	Category	Description
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies

Source: US Drought Monitor, <http://droughtmonitor.unl.edu/>.

Previous Occurrences

In Massachusetts, six major droughts have occurred statewide since 1930, though the Blackstone area has been spared the most severe impacts in each case according to USGS Water Supply Paper for Massachusetts #2375. These historic major droughts range in severity and in length, lasting from three to eight years. In many of these droughts, water-supply systems around the state were found to be inadequate. Water was piped in to urban areas, and water-supply systems were modified to permit withdrawals at lower water levels. The following table displays peak drought severity since 2000, from the US Drought Monitor:

Table 24

Annual Drought Status	
Year	Maximum Severity
2000	No drought
2001	D2 conditions in 21% of the state
2002	D2 conditions in 100% of the state
2003	No drought
2004	D0 conditions in 48% of the state
2005	D1 conditions in 7% of the state
2006	D0 conditions in 98% of the state
2007	D1 conditions in 71% of the state
2008	D0 conditions in 69% of the state
2009	D0 conditions in 45% of the state
2010	D1 conditions in 27% of the state
2011	D0 conditions in 0.01% of the state
2012	D2 conditions in 51% of the state
2013	D1 conditions in 60% of the state
2014	D1 conditions in 54% of the state
2015	D1 conditions in 58% of the state
2016 (to Oct. 31)	D3 conditions in 52% of the state

Source: US Drought Monitor

During this year's drought, the DPW has enacted a total outdoor watering ban from late July to help preserve aquifer levels. A handful of residences using shallow private wells have run dry.

Probability of Future Events

In Blackstone, as in the rest of the state, extreme and exceptional droughts occur at a “very low” probability (1 to 10 percent in the next year). Based on past events and current criteria outlined in the Massachusetts Drought Management Plan, it appears that central Massachusetts may be slightly more vulnerable than parts of eastern Massachusetts to severe drought conditions. However, many factors, such as water supply sources, population, economic factors (i.e., agriculture based economy), and infrastructure, may affect the severity and length of a drought event. When evaluating the region’s risk for drought on a national level, utilizing a measure called the Palmer Drought Severity Index from the National Drought Mitigation Center at the University of Nebraska, Massachusetts is historically in the lowest percentile for severity and risk of drought.

As with all communities in normally precipitation-rich Massachusetts, Blackstone is unlikely to be adversely affected by anything other than a major, extended drought. While such a drought would require water saving measures to be implemented, foreseeable damage to structures or loss of life resulting from the hazard would likely be very limited, with modest increased risk of damaging forest or brush fires.

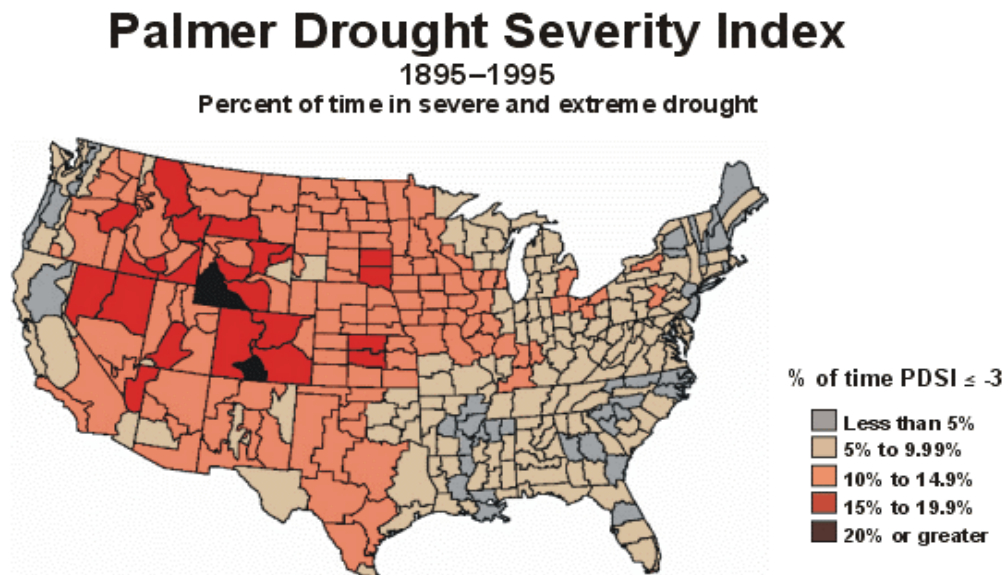


Figure 5

Impact

The impact of droughts is categorized by the U.S. Drought Monitor include:

- Slowing or loss of crops and pastures
- Water shortages or restrictions
- Minor to significant damage to crops, pastures;
- Low water levels in streams, reservoirs, or wells

Impacts in Blackstone may vary among customers of the Town water systems and private well users. As mentioned above, some residential wells ran dry this summer, while customers within the Town's water service area were able to maintain service. So while the impact of a drought can be assessed as "minor" overall, with very little damage to people or property likely to occur, impacts may be higher in parts of town that are not located within the Town's water service area.

Vulnerability

Based on the above assessment, Blackstone has a hazard index rating of “4 – low risk” from drought. Minimal or no loss of property, or damage to people or property is expected due to this hazard. Vulnerability is higher in areas outside the municipal water service area.

4.10 Extreme Temperatures

Hazard Description

As per the Massachusetts Hazard Mitigation Plan, extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat. There is no universal definition for extreme temperatures, with the term relative to local weather conditions. For Massachusetts, extreme temperatures can be defined as those that are far outside the normal ranges. The average temperatures for Massachusetts are:

- Winter (Dec-Feb) Average = 27.51°F
- Summer (Jun-Aug) Average = 68.15°F

Criteria for issuing alerts for Massachusetts are provided on National Weather Service web pages at www.weather.gov/box/criteria.

Location

Extreme temperatures can be expected to be fairly uniform across Blackstone during a given weather event, due to the town’s lack of extreme elevations, urban areas, and coastal areas. Therefore this hazard is of “large” geographic coverage.

Extent

As per the Massachusetts Hazard Mitigation Plan, the extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. The chart shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops. In Massachusetts, a wind chill warning is issued by the NWS Taunton Forecast Office when the Wind Chill Temperature Index, based on sustained wind, is –25°F or lower for at least three hours.

Extreme temperatures would affect the whole community.

Wind Chills

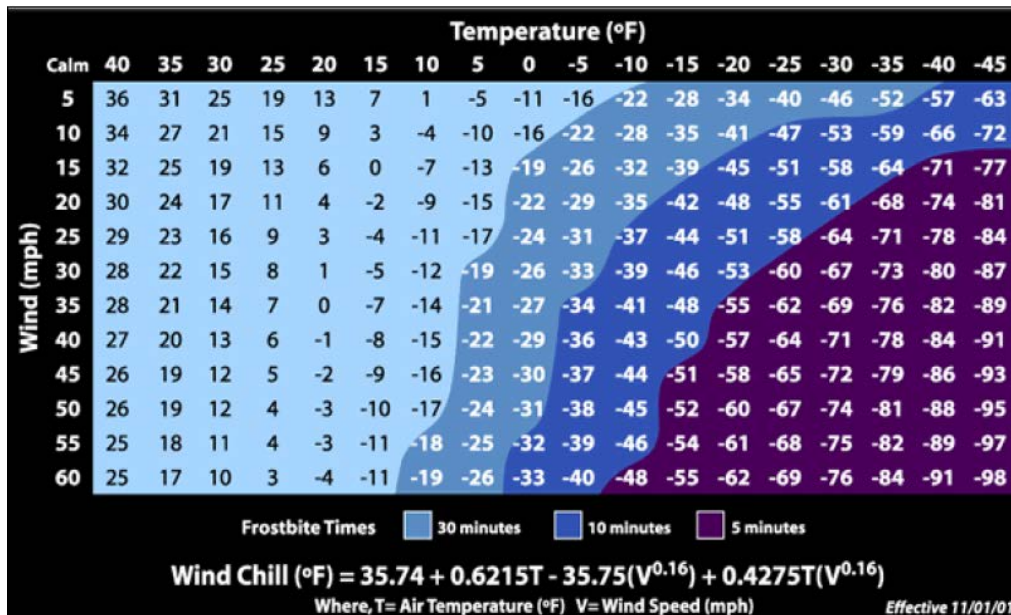


Figure 6

For extremely hot temperatures, the heat index scale is used, which combines relative humidity with actual air temperature to determine the risk to humans. The NWS issues a Heat Advisory when the Heat Index is forecast to reach 100-104 degrees F for 2 or more hours. The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105+ degrees F for 2 or more hours. The following chart indicates the relationship between heat index and relative humidity:

Heat Index

Table 25

Relative Humidity (%)		80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
	40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
	45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
	50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
	55	81	84	86	89	93	97	101	106	112	117	124	130	137			
	60	82	84	88	91	95	100	105	110	116	123	129	137				
	65	82	85	89	93	98	103	108	114	121	128	136					
	70	83	86	90	95	100	105	112	119	126	134						
	75	84	88	92	97	103	109	116	124	132							
	80	84	89	94	100	106	113	121	129								
	85	85	90	96	102	110	117	126	135								
	90	86	91	98	105	113	122	131									
	95	86	93	100	108	117	127										
	100	87	95	103	112	121	132										
Category		Heat Index		Health Hazards													
Extreme Danger		130 °F – Higher		Heat Stroke or Sunstroke is likely with continued exposure.													
Danger		105 °F – 129 °F		Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.													
Extreme Caution		90 °F – 105 °F		Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.													
Caution		80 °F – 90 °F		Fatigue possible with prolonged exposure and/or physical activity.													

Previous Occurrences

The following are some of the lowest temperatures recorded in parts of Massachusetts for the period from 1895 to present (Source: NOAA, www.ncdc.noaa.gov). Blackstone's temperature range is intermediate between Boston (at similar elevation) and Worcester (shares inland location).

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

The following are some of the highest temperatures recorded for the period from 1895 to present (also NOAA):

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

Probability of Future Events

The probability of future extreme heat and extreme cold is considered to be "moderate," or between 10 and 40 percent in the next year.

Impact

The impact of extreme heat or cold in Blackstone is considered to be "limited," with no property damage and very limited effect on humans. Extreme temperatures are of some concern for the local Hazard Mitigation Team due to health threats to the very young and very old.

Vulnerability

Blackstone's vulnerability from extreme heat and cold is considered to be, "4 - Low Risk."

4.11 Other Hazards

In addition to the hazards identified in previous sections, the Hazard Mitigation Team reviewed the other hazards listed in the Massachusetts Hazard Mitigation Plan: coastal hazards, atmospheric hazards, ice jams, coastal erosion, sea level rise, nor'easters, and tsunamis. It was determined that these hazards are either irrelevant to Blackstone due to the town's location, or in the case of nor'easters, that the hazard is already included within another hazard described above (severe winter storms).

One other hazard that can affect Blackstone is landslides. Landslides occur in all U.S. states and territories. In a landslide, masses of rock, earth, or debris move down a slope. Landslides may be small or large, slow or rapid. They are generally activated by:

- storms
- earthquakes
- volcanic eruptions
- fires
- alternate freezing or thawing
- steepening of slopes by natural erosion or by human modification

Debris and mud flows are rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, during heavy rainfall or rapid snowmelt,

changing the earth into a flowing river of mud or “slurry.” They can flow rapidly, striking with little or no warning at avalanche speeds. They also can travel several miles from their source, growing in size as they pick up trees, boulders, cars, and other materials.

There are no documented previous occurrences of significant landslides in Blackstone. The town is relatively flat and most of its rivers are slow moving, frequently dammed and/or lined with riprap, which can minimize landslide risk. Roadways are not generally built close to river channels, reducing undercutting risk from stormwater-induced bank erosion. High slope terrain (defined as 15 to 25% grade) covers 196 acres, or only 2.7% of the town; very high slopes (higher than 25% grade) cover only 9 acres, far below 1% of the town’s area. Little development is present in these areas. Should a landslide occur in the future, the type and degree of impacts would be highly localized. Vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures, though our data review and the local planning team noted no specific concerns. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Blackstone.

Blackstone, like nearly all communities in the CMRPC region, is categorized in the Massachusetts Natural Hazard Mitigation Plan as a low incidence/low susceptibility area for landslide hazards based on review of past occurrences. Landslides are therefore considered low frequency events that may occur once in 50 to 100 years (a 1% to 2% chance of occurring per year).

4.12 Impacts of Climate Change on Hazards

Over the next several decades, climate change can be expected to exacerbate many of the hazards described previously in this chapter. This section identifies the impacts that a changing climate may have on Blackstone’s hazard risk profile going forward. Sources for this section include:

- Northeast Climate Impacts Assessment (NECIA) (2007)
- Massachusetts Climate Change Adaptation Report (2011)
- Massachusetts Multi-Hazard Mitigation Plan (2013)

Expected Changes

The NECIA and state Climate Change Adaptation Report offer Massachusetts state-level predictions for temperature and precipitation for upcoming decades, which show dramatic increases in both measures:

Table 26

Category	Current (1961-1990 avg.)	Predicted Change 2040-2069	Predicted Change 2070-2099
Average Annual Temperature (°F)	46°	50° to 51°	51° to 56°
Average Winter Temperature (°F)	23°	25.5° to 27°	31° to 35°
Average Summer Temperature (°F)	68°	69.5° to 71.5°	74° to 82°
Days over 90 °F	5 to 20 days	-	30 to 60 days
Days over 100 °F	0 to 2 days	-	3 to 28 days
Annual Precipitation	41 inches	43 to 44 inches	44 to 47 inches
Winter Precipitation	8 inches	8.5 to 9 inches	9 to 10.4 inches
Summer Precipitation	11 inches	10.9 to 10.7 inches	10.9 to 11 inches

Flooding

A warming climate is expected to lead to higher precipitation. The Massachusetts Multi-Hazard Mitigation Plan estimates that precipitation will increase 6 to 14% by mid-century, with an increased frequency of floods meeting current 10-year flood levels. Much of the winter precipitation increase is projected to be in the form of rain rather than snow, which may actually reduce peak spring flooding but could lead to more frequent winter runoff events. Overall, the frequency of flooding events and their impacts on people and property can be expected to increase over time, largely in locations that are already of flood concern. Public health may be impacted through increased mosquito populations, which depend on the availability of standing water.

Severe Snowstorms/Ice Storms/Nor'easters

The Massachusetts Multi-Hazard Mitigation Plan estimates that as the climate warms, winter snowfall will be reduced and will generally fall later in the winter season. The Climate Change Adaptation Report predicts that snowfall events will decline over time from around 5 per month during winter to 1 – 3, but that the frequency of the strongest winter storms may actually increase until winter average temperatures warm above the freezing point late in the century. Overall, the risk from winter storms to people and property can be expected to decline.

Hurricanes

The Massachusetts Multi-Hazard Mitigation Plan notes that there is still a great deal of uncertainty about the impacts of climate change on hurricanes and tropical storms, but that the limited evidence available indicates that stronger storms (Category 4 and 5) are becoming more frequent. Overall, the risk from hurricanes and their associated flooding can be expected to

increase.

Severe Thunderstorms/Wind/Tornado

Evidence shows that severe weather including thunderstorms, damaging wind and tornados is already increasing as temperatures rise. The Massachusetts Multi-Hazard Mitigation Plan notes that smaller storm events are becoming less frequent, while more severe storms are becoming more common. Overall, the risk from severe storms can be expected to increase.

Wildfire/Brush Fire

The Massachusetts Multi-Hazard Mitigation Plan projects summer rainfall to decrease as much as 15% in the next decades. In combination with higher temperatures and winds, this drop in precipitation would contribute to additional fire risk. Forest response to increased atmospheric carbon dioxide – the so-called fertilization effect – could also contribute to more tree growth and thus provide more fuel for wildfires. Climate change may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods. Reduced stream flows and pond depths may also impact the number and quality of access points for rural firefighting, which is of particular concern to communities like Blackstone where part of the town's area is not covered by municipal water service. Overall, the risk from wildfires to people and property can be expected to increase.

Earthquake

Climate change is not expected to significantly impact the risk from earthquakes. The state Multi-Hazard Mitigation Plan notes that there may be additional earthquake risk in conjunction with other hazards such as higher rainfall (which can contribute to soil liquefaction during earthquakes), but that research is not yet mature. At this time, overall risk from earthquake to people and property can be expected to stay around the same as the current risk level.

Dam Failure

The Massachusetts Multi-Hazard Mitigation Plan does not note major concerns about catastrophic dam failure due to climate change. It does, however, mention that increased heavy rainfall events may lead to more frequent dam design failures, in which spillways overflow due to flow rates exceeding design capacity. This type of failure may have a secondary result of increased riverine flooding below dams. Overall, the risk from dam failure to people and property can be expected to stay around the same as the current risk level.

Drought

While the projections noted above show overall increases in precipitation going forward, summer rainfall is actually expected to decline slightly as the climate warms, raising the risk of seasonal droughts. According to the Massachusetts Multi-Hazard Mitigation Plan, droughts are expected to increase in frequency, severity and length. The Massachusetts Climate Change Adaptation Report finds that by the end of the century, under a high carbon emissions scenario, the occurrence of droughts lasting one to three months could go up by as much as 75% over existing conditions. Secondary to drought, wildfire risk can be expected to rise. Overall, the risk from drought to people and property can be expected to increase.

Extreme Temperatures

According to records of the US Historical Climatology Network, average temperatures have increased about 0.2 degrees C (0.5°F) per decade since 1970. These higher average temperatures have primarily been the result of warmer winters (December through March), during which there has been an increase of 1.3°F per decade since 1970. In addition to average temperature increases, the number of extremely hot and record heat days has also increased: the number of days with temperatures of 90°F and higher throughout the Northeast has doubled during the past 45 years. As noted in the table elsewhere in this section, the number of days exceeding 90 degrees is expected to surge several times over, presenting a health risk to young children, the elderly, and to persons with various health conditions. Overall, the risk from extreme temperatures to people and property can be expected to increase.

5.0 CRITICAL FACILITIES & VULNERABLE POPULATIONS

A Critical Facility is defined as a building, structure, or location which:

- Is vital to the hazard response effort.
- Maintains an existing level of protection from hazards for the community.
- Would create a secondary disaster if a hazard were to impact it.

5.1 Critical Facilities in Blackstone

The Critical Facilities List for the Town of Blackstone has been identified utilizing several sources, and the knowledge and expertise of the team:

- Comprehensive Emergency Management Plan
- MassGIS data

- Critical infrastructure mapping undertaken by CMRPC under contract with the Central Region Homeland Security Advisory Council, which is charged by the Executive Office of Public Safety and Security to administer and coordinate the State Homeland Security Grant for central Massachusetts.

Blackstone's Hazard Mitigation Team has broken up this list of facilities into four categories:

- Emergency Response Facilities needed in the event of a disaster
- Non-Emergency Response Facilities that have been identified by the Team as non-essential. These are not required in an emergency response event, but are considered essential for the everyday Town operations
- Dams
- Facilities/Populations that the Team wishes to protect in the event of a disaster

Critical infrastructure and facilities are mapped in Appendix A.

Category 1 – Emergency Response Facilities

The Town has identified the Emergency Response Facilities and Services as the highest priority in regards to protection from natural and man-made hazards.

1. Police Department

Town Hall/Public Safety/Senior Center 15 Saint Paul Street

This shared facility has a backup power generator located in rear of building. It is the location of the Police HQ as well as Fire Station #1. It is located adjacent to the FEMA flood zone on the Blackstone River. The basement is regularly flooded in long-duration rainstorms (causing damage to fire apparatus and Town archives) and historically the site has been flooded by the nearby Blackstone. The generator is also vulnerable to flooding, which has been a problem during past power failures (most recently 2011). The flat roof has to be shoveled off in major snow events (such as 2015's blizzards) due to concerns about snow loads and risks from falling snow/ice to nearby pedestrians.

2. Fire Department

Town Hall/Public Safety/Senior Center	15 Saint Paul Street
Fire Station #2/EOC	666 Rathbun Street
Fire Station #3	132 Elm Street
Dry hydrant system	Lake Shore Drive (Lake Hiawatha)
Dry hydrant system	Milk Street (Wojcik's farm pond)

Station #1 is located in the Town Hall complex and is manned 24/7. The other stations are manned as needed. Station #2 – the Town's EOC – is located in a low-lying area with poor drainage, which can hinder access for vehicles. Stations #2 and #3 have experienced power outages from major storms, most recently 2011, and #3 is thought to be vulnerable to roof damage from extreme winds. Station #2 is now being equipped with a generator funded through FEMA's EMPG program. The Fire Department will seek Town Meeting funds in 2017 to expand/improve station #3, which would include roof improvements and add a generator. A small, portable manual-start generator is currently in place there to provide very limited backup power.

3. Communications Facilities

Town Hall/Public Safety/Senior Center	15 Saint Paul Street
Fire Station #2/EOC	666 Rathbun Street
Repeater	128 Blackstone Street (at water tank)

A generator funded by FEMA's EMPG program was recently installed at the repeater site. See police/fire sections above for information on the other sites.

4. Department of Public Works

DPW offices/garage	53-55 Elm Street
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There is no generator at this facility – the Town is currently looking for funds to install one. The facility is close to but not within the 100 year flood zone.

5. Primary Evacuation Routes

Main Street (Route 122)
Lincoln Street/Summer Street/Winter Street
Elm Street (southern end)
Blackstone Street
Federal Street

Main Street, Blackstone Street and Elm Street are all located partly in FEMA flood zones and have seen past flooding. Secondary routes include Mendon Street and Elm Street (northern end). Mendon Street is partly within a FEMA flood zone.

Category 2 – Non Emergency Response Facilities

The Town has identified these facilities as non-emergency facilities; however, they are

considered essential for everyday Town operations.

1. Water Supply

Well/pump #2	11 Summer Street
Well/pumps #4-5-5a	Elm Street (parcels 18-1, 18-6)
Well/pump #7	Park Street (parcel 17-39)
Well/pump #8	56 Glenside Drive
Storage tank (1 million gallons)	Blackstone Street (near #315)
Storage tank (500,000 gallons)	128 Blackstone Street
Storage tank (560,000 gallons)	Lincoln Street (parcel 12-33 at Millville line)
Storage tank (1.3 million gallons)	45 Bellingham Road
Corrosion control facility	53-55 Elm Street

All wells/pump stations are located in areas that are potentially subject to flooding; the local team regards the pump stations at wells 2 and 7 as the most likely to be damaged in an extreme event. Wells 2, 4 and 7 lack generators. Well 9 is now under construction near Well 8. Roughly 80% of water users utilize the town system.

2. Sewer System

Sewage lift station	53-55 Elm Street (at corrosion station)
Sewage lift station	Mill Street
Sewage lift station	Main Street
Sewage lift station	Staples Lane
Sewage lift station	760 Rathbun Street
Sewage lift station	Montcalm Avenue
Sewage lift station	Elmwood Avenue
Sewage lift station	Edgewater Drive
Sewage lift station	Quickstream Street
Sewage lift station	666 Rathbun Street (Fire Station #3)
Sewage lift station	Elm Street (near Mill River)
Sewage lift station	175 Lincoln Street (at High School)
Sewage lift station	Alice Avenue (at Housing Authority)

Blackstone's sanitary sewage is treated at a regional facility operated by the City of Woonsocket, RI. All stations are equipped with generators except the Edgewater Drive station, which can be powered by a mobile generator if needed. Most stations are near flood zones but none have seen substantial damage in past floods. The sewer system covers the more developed parts of town, primarily in the southern area near the

Blackstone River. Roughly 35% of all households use the town system – the rest are on septic.

3. Other Town Facilities

Public Library	86 Main Street
Town Hall/Public Safety/Senior Center	15 Saint Paul Street
Primary shelter (@ Middle School	35 Federal Street
Secondary shelter (@ High School)	175 Lincoln Street

The library is located within the FEMA 500 year flood zone associated with Fox Brook just upstream from its confluence with the Blackstone, and is immediately adjacent to the 100 year zone. See schools section below for more information on those facilities.

4. Other Utilities/Facilities

Algonquin natural gas pipeline	NW corner of town
Providence & Worcester RR	along Blackstone River
ANP Blackstone natural gas powerplant	204 Elm Street
Kimball Sand Company sand/gravel mine	202 Elm Street

The P&W route is elevated above the 100 year flood zone but aging bridge structures over the Blackstone River may be at risk from very extreme riverine flooding or from earthquakes. During very heavy rain events runoff from the Kimball Sand facility reportedly increases turbidity and sometimes causes minor siltation in the nearby Mill River, but the local team notes that there have not been noticeable impacts to the flood hazard level in that area. The ANP powerplant is adjacent to the 100 year flood zone at Fish Pond/Mill River but it is elevated well above the waterways and is not considered vulnerable.

Category 3 – Dams

A list of dams is provided in section 4.8.

Category 4 – Facilities/Populations to Protect

1. Special Needs Population/Elderly Housing/Assisted Living

Foxbrook Manor (Blackstone HA)	15 Foxbrook Manor (aka Austin Street)
Early Village (Blackstone HA)	Alice Avenue (off Blackstone Street)
Blackstone Nursing and Rehabilitation	8 Butler Street
DuCharme Estates	25 Federal Street

Oak Ledge Terrace

29 Federal Street

Both Housing Authority complexes have experienced power failures during past storms (most recently 2011) and lack backup generators.

2. Schools/Daycares

(Please note: The EMD has a list of current daycare facilities but these can change locations and addresses frequently, so this list should be revisited periodically.)

Blackstone-Millville Regional High School	175 Lincoln Street
Hartnett Regional Middle School	35 Federal Street
Maloney Elementary School	200 Lincoln Street
Kennedy Elementary School	200 Lincoln Street
Battaglia (home daycare)	138 Blackstone Street
Bouchard (home daycare)	4 Susan Drive
Curboy (home daycare)	5 Rivers Edge Drive
Girard (home daycare)	10 Quickstream Street
Hart (home daycare)	21 Bellingham Road
Boys & Girls Club (afterschool programs)	115 Canal Street

The high school and the elementary schools sustained roof damage during winter storms in 2013, requiring more than \$1 million in repairs. The middle school is the primary shelter, while the high school is the secondary shelter. Both have backup generators and are intended to shelter residents of both Blackstone and Millville as part of the regional school district arrangement. The elementary schools are also equipped with generators.

3. Historic Buildings/Sites

According to the Massachusetts Cultural Resources Information System (MACRIS) online database accessed in October 2016, there are 27 Areas, 429 Buildings, 15 Burial Grounds, 5 Objects, and 44 Structures listed for Blackstone. Two dams listed as critical infrastructure are also listed in MACRIS; see table in chapter 4, section 4.8.

4. Employment Centers

Based on data obtained from the Massachusetts Executive Office of Labor and Workforce Development (EOLWD), the following table shows the largest employers in Blackstone:

Table 27

Largest Employers in Blackstone - October 2016		
Company	Location	No. of Employees
Augustine F Maloney Elementary	Lincoln St	100-249
AF Maloney Elementary	Lincoln St	50-99
Blackstone Millville Middle	Federal St	50-99
Blackstone Town Municipal Ctr	Saint Paul St	50-99
Blackstone-Millville Jr High	Lincoln St	50-99
John F Kennedy Elementary Schl	Lincoln St	50-99
Kalaoun Hatem	Bridge St	50-99
Park'n Shop	Main St	50-99
Tellstone Garage Inc	Mendon St	50-99
Blackstone Nursing Home	Butler St	20-49

Source: EOLWD at http://lmi2.detma.org/lmi/Largest_employer_index.asp

5. Environmental Justice and Vulnerable Populations

The US Environmental Protection Agency defines Environmental Justice (EJ) as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Within the context of natural hazards and their mitigation, potential EJ concerns may arise from income-related factors, discrimination (overt or institutional), cultural isolation and barriers, language isolation, lack of transportation access, and disability (especially among the elderly).

In 2015, as part of its Mobility 2040 long range transportation plan, CMRPC identified disproportionate concentrations of EJ and other vulnerable populations at the US Census block group level throughout Central Massachusetts. Thresholds used in this identification process included various metrics from the 2010 Census and 2013 American Community Survey:

- Lower income households (median income below \$50,259/year); or

- Minority residents (20.3% or more of population); or
- Hispanic or Latino residents (14.0% or more of population); or
- Language isolated households (9.45% or more of population); or
- Zero vehicle households (12.75% or more of population); or
- Households with persons 75+ years of age (18.8% or more of population); or

In Blackstone, one block group in the Millerville neighborhood (in the southeastern corner of town) was identified as an EJ area due to its relatively low household income. As of the 2014 American Community Survey, median household income in this block group is estimated at \$32,191, compared to Blackstone's town-wide median of \$72,699 and Worcester County's median of \$65,453. Because median income in this area is well below regional and local norms and suggests that some residents may lack the economic wherewithal to fully prepare for or recover from a disaster, it is recommended that outreach and education efforts include extra emphasis to reach residents of Millerville, and that mitigation efforts in this area be prioritized when appropriate. The location of this EJ area is shown in Map 1 in Appendix A.

More information regarding the identification of Environmental Justice and Vulnerable populations in the Central Massachusetts region can be found online at www.cmrpc.org/mobility2040.

6.0 EXISTING PROTECTION

The Town of Blackstone currently makes use of many available locally-controlled tools to mitigate the consequences of natural hazards: zoning regulations, planning, and physical improvements. The Town does not participate in any federal programs such as StormReady certification or Firewise community certification, but it has CodeRED/enhanced 911 and plans to research the utility of other public awareness and education programs as a result of this planning process.

Blackstone has many of the no-cost or low-cost hazard mitigation capabilities in place. Land use zoning, subdivision regulations and an array of specific policies and regulations that include hazard mitigation best practices, such as limitations on development in wetlands, stormwater management, tree maintenance, etc.... Blackstone also has appropriate staff dedicated to hazard mitigation-related work for a community of its size, including a Town Administrator, an Emergency Management Commission and Director, a professionally run Department of Public Works, a Building Commissioner, and a Tree Warden. Blackstone has several relevant plans in place, including a Comprehensive Emergency Management Plan, a Capital Improvement Plan, and a NPDES MS4 permit action plan. These capabilities are deployed for hazard mitigation, as appropriate. The Town also has very committed and dedicated volunteers who serve on Boards,

Commissions and Committees and in other volunteer positions. The Town has opted in to fire protection mutual aid agreements through MEMA. Blackstone is also an active member community of the Central Massachusetts Regional Planning Commission (CMRPC) and can take advantage of no cost local technical assistance as needed provided by the professional planning staff at CMRPC.

The table below describes existing mitigation protections in Blackstone. It includes a brief description of each activity as well as a subjective evaluation of its effectiveness and of any need for modifications.

6.1 Existing Protection Matrix

Table 28

Existing Measure	Description	Action	Effectiveness & Recommendations
Participation in National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas. Also, communities participating in the NFIP have adopted and enforce ordinances, bylaws and regulations that meet or exceed FEMA requirements to reduce the risk of flooding.	Blackstone monitors building activity within the flood plain to ensure compliance with provisions of state building code.	Effective There are no repetitive loss properties in Blackstone. It should seek to further limit development in the 100-year flood zones. It should work to score in the Community Rating System (CRS) under NFIP to enable its residents to obtain lower flood insurance rates. Blackstone should educate its residents about NFIP.
Floodplain Zoning District bylaw	Requires all development to be in compliance with state building code requirements for construction in floodplains	Blackstone regulates development in FEMA mapped floodplains as part of its zoning bylaw, as Chapter 123, Section 19.	Effective Blackstone should investigate adoption of a floodplain-specific bylaw that more comprehensively regulates development and activity within floodplains and adjacent areas.
Stormwater Management policy and regulations	Planning Board or Conservation Commission reviews projects for consistency with MA DEP standards. This helps ensure adequate on site retention and recharge and reduces the burden on the NPDES MS4 permitted stormwater system.	Blackstone enacted a Stormwater Management and Land Disturbance Bylaw in 2011, which is included as Chapter 110 in the Town's General Bylaws.	Very effective No changes recommended; however, Blackstone should evaluate participation in the Central Mass Stormwater Coalition.

Existing Measure	Description	Action	Effectiveness & Recommendations
Local Open Space and Recreation Plan	Local plan identifying significant natural resources and identifying mechanisms to ensure their protection. Following Mass. Department of Conservation and Recreation guidance for development of OSRPs, this document does not focus on specific hazards.	Blackstone's Open Space and Recreation Plan was issued in 2001 and is now expired.	Somewhat effective Plan is expired as of 2006. Blackstone should prepare plan update as per Mass. DCR guidance. Where allowable, it should use the update to integrate hazard mitigation activities and recommendations.
NPDES MS4 Compliance Program	Upgrade of municipal sewer systems and system inputs to reduce or eliminate CSOs and illicit connections to comply with NPDES requirements	Blackstone is implementing a program to ensure compliance with NPDES requirements. Recent actions include installation of LID infrastructure at the Town Hall (bioretention area, pervious pavement, plantings), stormwater bylaw updates, public outreach, GPS mapping, capital improvements (recently on Milk Street), and inspections for illicit connections. Appx. 1/3 rd of the town is on municipal sanitary sewer.	Very effective No changes recommended

Existing Measure	Description	Action	Effectiveness & Recommendations
Local wetlands protection bylaw and regulations	Local bylaws building upon the State's Wetlands Protection Act and Regulations. These add regulatory oversight provisions for development within the jurisdictional buffer zone, adding increased attention to alteration of wetlands and the opportunity to preserve capacity and quality.	Blackstone adopted a wetlands protection bylaw (general bylaws, Chapter 119) in 1986 to protect wetlands and related waterways throughout town in accordance with Mass. regulations.	Very effective No changes recommended
Drainage system cleaning and preventive maintenance	Plan to keep municipal drainage facilities (storm drains, culverts, etc.) in good order	Blackstone performs street sweeping and catch basin cleaning from April to November.	Effective Blackstone should continue its public education program for residents on storm drain clearance and other best practices
Tree Trimming	Maintain vegetation to reduce likelihood of damaging debris from storm events	Blackstone conducts roadside mowing from April-November to remove juvenile trees. Tree trimming (take-downs and clearing dead branches) takes place as needed.	Effective Blackstone should work with its electrical utility to coordinate a more systematic tree trimming program

Existing Measure	Description	Action	Effectiveness & Recommendations
Drainage maintenance, replacement and upgrade	Maintain existing culverts and drains through regular maintenance and (in some cases) beaver controls; replace/expand culverts where needed to allow for adequate stormwater flow.	The Town generally maintains and replaces problem culverts and other infrastructure when needed and as funding allows. Recent activities include Town Hall area LID drainage improvements, Milk Street drainage replacement, and storm drain/manhole repair/maintenance work on Woodcrest Lane, Saint Paul Street, Spruce Street and Blackstone Street. Historically, the Town also installed flood protection berms, walls and riprap in vulnerable parts of the village centers after Tropical Storm Diane.	Somewhat effective Current efforts are piecemeal and are limited by lack of resources and systematic approach. Blackstone should develop a prioritized inventory of problem culverts/drains for use in seeking external financial support. Planning must comply with 2014 Mass. Wetlands Protection Act update; culverts may not simply be replaced in-kind.
CodeRED system	Emergency warning system that sends voicemail/text/email alerts to residents (text/email alerts are optional).	Town Emergency Management officials are able to alert residents when information is received that a natural or man-made disaster is impending.	Effective Blackstone should consider NWS StormReady certification and adoption of StormReady emergency notification practices to supplement CodeRED.
Generator program	Install emergency backup power generators at key Town facilities to enable continued operations during and after natural and man-made disasters.	In the past year, generators have been obtained through FEMA's EMPG program for the Blackstone Street emergency communications repeater site and for fire station #2. These supplement generators already in place at the Town Hall/Public Safety building and at the public schools, which serve as shelters.	Effective Continue to pursue resources to install generators at key facilities to include fire station #3 and the DPW garage.

7.0 MITIGATION STRATEGY

The Blackstone hazard mitigation planning team developed a list of mitigation strategies (both new and previously identified by local officials) and prioritized them using the criteria described below. This list of factors is broadly derived from FEMA's STAPLE+E feasibility criteria.

7.1 Impact

The team's consideration of each strategy included an analysis of the mitigation impact each can provide, regardless of cost, political support, funding availability, and other constraints. The intent of this step is to separately evaluate the theoretical potential benefit of each strategy to answer the question: if cost were no object, what strategies have the most benefit? Factors considered in this analysis include the number of hazards each strategy helps mitigate (more hazards equals higher impact), the estimated benefit of the strategy in reducing loss of life and property (more benefit equals higher impact) based on the relevant hazard(s) as assessed in Chapter 4, and the geographic extent of each strategy's benefits (other factors being equal, a larger area equals higher impact).

- **High Impact** – actions that help mitigate several hazards, substantially reduce loss of life and property (including critical facilities and infrastructure), and/or aid a relatively large portion of the community
- **Medium Impact** – actions that help mitigate multiple hazards, somewhat reduce loss of life and property (including critical facilities and infrastructure), and/or aid a sizeable portion of the community
- **Low Impact** – actions that help mitigate a single hazard, lead to little or no reduction in loss of life and property (including critical facilities and infrastructure), and/or aid a highly localized area

7.2 Priority

Following the ranking of each strategy for its mitigation impact, real world considerations were brought back into the analysis to inform the priority ranking process. Factors considered in this step include costs and cost effectiveness (including eligibility and suitability for outside funding), timing, political and public support, and local administrative burden.

Costs and cost effectiveness – in order to maximize the effect of mitigation efforts using limited funds, priority is given to low-cost strategies. For example, regular tree maintenance is a relatively low-cost operational strategy that can significantly reduce the length of time of power

outages during a winter storm. Strategies that have clear and viable potential funding streams, such as FEMA's Hazard Mitigation Grant Program (HMGP), are also given higher priority.

Time required for completion - Projects that are faster to implement, either due to short work duration, current or near-term availability of funds, and/or ease of permitting or other regulatory procedures, are given higher priority.

Political and public support - Strategies that have demonstrated political and/or public support through positive involvement by the public or prioritization in previous regional and local plans and initiatives that were locally initiated or adopted are given higher priority.

Administrative burden – Strategies that are realistically within the administrative capacity of the town and its available support network (CMRPC, mutual aid fire district, etc...) are prioritized. Considerations include grant application requirements, grant administrative requirements (including audit requirements), procurement, and staff time to oversee projects.

- **High Priority** – strategies that have obvious mitigation impacts that clearly justify their costs and to a large degree can be funded, can be completed in a timely fashion, can be administered effectively, and are locally supported
- **Medium Priority** – strategies that have some clear mitigation impacts that generally justify their costs and generally can be funded, can be completed in a timely fashion, can be administered effectively, and are locally supported
- **Low Priority** – strategies that have relatively low mitigation impacts that do not necessarily justify their costs and that may have difficulty being funded, completed in a timely fashion, administered effectively, and locally supported

7.3 Estimated Cost

Each implementation strategy is provided with a rough cost estimate based on available third-party or internal estimates and past experience with similar projects. Each includes hard costs (construction and materials), soft costs (engineering design, permitting, etc...), and where appropriate Town staff time (valued at appx. \$25/hour for grant applications, administration, etc...). Projects that already have secured funding are noted. Detailed and current estimates were not generally available, so costs are summarized within the following ranges:

- **Low** – less than \$50,000
- **Medium** – between \$50,000 – \$100,000
- **High** – over \$100,000

7.4 Timeline

Each strategy is provided with an estimated length of time it will take for implementation. Where funding has been secured for a project, a specific future date is provided for when completion is expected. However, most projects do not currently have funding and thus it is difficult to know exactly when they will be completed. For these projects, an estimate is provided for the amount of time it will take to complete the project once funding becomes available. Strategies are grouped by 1-2 year timeframe, 3-5 year timeframe, 5+ year timeframe, and ongoing items.

7.5 Strategy Types

Mitigation strategies were broken into four broad categories to facilitate local implementation discussions, especially regarding budget considerations and roles/responsibilities:

Structure and Infrastructure Projects - Construct “bricks & mortar” infrastructure and building improvements in order to eliminate or reduce hazard threats, or to mitigate the impacts of hazards. Examples include drainage system improvement, dam repair, and generator installation. Structure and infrastructure improvements tend to have the greatest level of support at the local level, but are highly constrained by funding limits.

Preparedness, Coordination and Response Actions - Ensure that a framework exists to facilitate and coordinate the administration, enforcement and collaboration activities described in this plan. Integrate disaster prevention/mitigation and preparedness into every relevant aspect of town operations, including Police, Fire, EMD, EMS, DPW, Planning Board, Conservation Commission and Board of Selectmen; coordinate with neighboring communities where appropriate. Recommendations in this category tend toward standardizing and memorializing generally-practiced activities.

Education and Awareness Programs - Integrate education and outreach into the community to raise awareness of overall or hazard-specific risk and generate support for individual or community-wide efforts to reduce risk.

Awareness and education seek to affect broad patterns of behavior, essentially altering a culture. Awareness-building activity tends to have a fairly slow effect, although in the end it can provide extraordinary benefits with relatively little cash outlay.

Local Plans and Regulations - Review and propose updates to local bylaws, ordinances and regulations to protect vulnerable resources and prevent further risk to those resources. Formally adopt these updates into the local regulatory framework. Review the effectiveness

of past mitigation projects, programs procedures and policies. Incorporate mitigation planning into master plans, open space plans, capital improvement plans, facility plans, etc...

Planning and regulatory activity tends to provide extraordinary benefits with relatively little cash outlay. However, in smaller communities where planning activities are largely the purview of volunteers, outside assistance from the state or regional levels may be required to maximize its benefits. Political support may be difficult to achieve for some planning and regulatory measures, especially those that place new constraints on land use.

In addition to describing action items in each of these categories, for each strategy we also identify what hazard(s) it is intended to address, as described in Chapter 4 of this plan. Each strategy also identifies the lead organization who serves as the primary point of contact for coordinating efforts associated with that item, and identifies potential funding sources for implementation. See Chapter 8 for more information on potential funding.

Town of Blackstone Mitigation Strategies

OVERALL GOAL: Facilitate activity within Blackstone that reduces the loss, and risk of loss, to persons and property

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
A. Structure & Infrastructure Strategies								
	Continued drainage improvements at Saint Paul Street/Rivers Edge Road/Farnum Street/Canal Street near Town Hall/Public Safety/Senior Center building; area is just above Blackstone River 100 year flood zone and sees recurrent basement flooding in heavy/long rain events	FL, SS, ST, HU	DPW, Building Commissioner	Local, Federal Grants (HMGP/PDM), State Grants (Various)	High	High	More information required; likely High	3-5 Years
	Drainage improvements at Main Street on mostly south side from appx. 1 st Avenue to Blackstone Street; area is partly within 100 and 500 year flood zones and sees recurrent flooding in heavy/long rain events; includes Public Library on Fox Brook	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Medium	High	More information required; likely High	3-5 Years
	Evaluate structural conditions and implement long-term solutions for buildings that have previously seen roof damage from	SS	Building Commissioner, Schools, MSBA	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Medium	Medium	More information required	3-5 Years

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
	winter storms, including Town Hall/Public Safety/Senior Center building, regional High School, and elementary schools							
	Culvert/bridge upgrade on Elm Street at Mill River; within 100 year flood zone and area floods during storms when river exceeds capacity under roadway; evacuation route impacted	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM, TIP), State Grants (Various)	Medium	High	More information required	1-2 Years
	Culvert/bridge upgrade on Farm Street at Hop Brook; within 100 year flood zone and area floods during storms when river exceeds capacity under roadway	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM, TIP), State Grants (Various)	Medium	Medium	More information required	1-2 Years
	Culvert/bridge upgrade on Blackstone Street at Hop Brook; within 100 year flood zone and area floods during storms when river exceeds capacity under roadway; evacuation route impacted	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM, TIP), State Grants (Various)	Medium	High	More information required	1-2 Years
	Culvert/raceway upgrade on Lakeshore Drive at Quick Stream at the outlet of the Lake Hiawatha Dam; near 100 year flood zone	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM, TIP), State Grants (Various)	Medium	Medium	More information required	3-5 Years

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
	and wetland and area floods when dam is at maximum release							
	Culvert upgrade on Mendon Street at Fox Brook below Crain's Pond Dam; within 100 year flood zone and area floods during storms when river exceeds capacity under roadway; secondary evacuation route impacted	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM, TIP), State Grants (Various)	Medium	Medium	More information required	1-2 Years
	Identify and address drainage problem in 600s area of Rathbun Street in area of Fire Station #2/EOC; low area sees mostly roadway flooding; adjacent area of Bellingham is in 500 year flood zone; within EJ area	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Medium	Medium	More information required	3-5 Years
	Identify and address roadway flooding problem on Main Street between Federal Street and Castle Hill Way; low area may also be impacted by runoff from upgradient subdivision; adjacent to 100 year flood zone	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Low	Low	More information required	1-2 Years
	Tree trimming needed throughout town to protect utility wires;	SS, ST, HU	National Grid, Tree Warden,	Utility (National Grid), Local, Private (property	High	High	More information required	Ongoing

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
	coordinate with utility to implement systematic approach		Private property owners	owners)				
	Evaluate feasibility and possibly implement a permanent water system connection between Blackstone and neighboring Bellingham to provide resilience in drought (currently hydrants can be connected to share limited water)	DR	DPW, Town of Bellingham	Local, State Grants (Various)	Medium	Low	More information required; likely High	3-5 Years
	Install/improve generators at critical public facilities where needed, including the DPW garage, Fire Station #3 and the Housing Authority's Fox Brook Manor complex; also evaluate feasibility of obtaining a mobile generator to serve multiple public facilities	All	Building Commissioner, DPW, Housing Authority	Local, Federal Grants (HMGP/PDM), State Grants (Various)	High	Medium	High	5+ Years
	Continue to monitor conditions at the Town-owned Lake Hiawatha Dam (Significant Hazard) to ensure compliance with state mandate on structural conditions.	DF	DPW	Local, State Grants (Dam & Seawall)	High	Low	Low	Ongoing

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
B. Preparedness, Coordination & Response Action Strategies								
	Continue to participate in National Flood Insurance Program (NFIP) (or other) training offered by the State and/or FEMA that addresses flood hazard planning and management	FL, SS, ST, HU	DPW, Planning	Local	High	High	Low	Ongoing
	Investigate Community Rating System (CRS) benefits and requirements and decide whether to participate	FL, SS, ST, HU	DPW, Planning	Local	Low	Low	Low	1-2 Years
	Road information coordination and planning for snow removal	SS	DPW; MassDOT; Mass State Police; CMRPC	Local, Federal Grants (HMGP/PDM), State Grants (Various), Private Contracts	High	High	Low	Ongoing
	Evacuation Plan updates; where possible, ensure that routes are outside of hazard areas	All	Local Emergency Management, DPW, CMRPC, MassDOT	Local, Federal Grants (Homeland Security via MEMA and CRHSAC)	High	High	Low	Update underway Fall 2016 (update every 5 Years)
	Improve vegetation and debris management along P&W Railroad rights-of-way; recurrent brush fires reported near tracks in neighboring towns	DR, WF	P&W Railroad, Fire, DPW	Private (P&W Railroad)	High	High	Low	Ongoing
	Investigate/join the Central Massachusetts Stormwater Coalition to	FL, SS, ST, HU	DPW, Conservation Commission,	State Grants	Medium	Medium	Low	1-2 Years

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
	aid in public outreach and funding of drainage improvements		Planning					
C. Education & Awareness Strategies								
	Provide information to residents and businesses on water conservation through reduction in use, low-impact landscaping and other low-cost measures (in part to conserve water for firefighting)	DR, WF	DPW, Conservation, Fire	Local	High	Medium	Low	Ongoing
	Provide information to residents and businesses on generator safety and sump pump usage; Blackstone has seen generator safety problems during past floods when power was lost and homeowners switched to generator power for pumps	FL, SS, ST, HU	Fire, DPW	Local, Federal Grants (AFG FP&S)	High	Medium	Low	1-2 Years, then ongoing
	Continue/restart education program begun under NPDES MS4 permit to supplement pollution prevention effort with storm drain safety/clearance and related topics	FL, SS, ST, HU	DPW	Local	High	Medium	Low	1-2 Years, then ongoing
D. Local Plan & Regulation Strategies								
	During next municipal facilities or capital improvement planning process; review options	All	Building Commissioner, Planning, Fire, Police	Local	Medium	High	More information required	1-2 Years

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
	for relocating departments (esp. public safety departments) away from current Town Hall/Public Safety/Senior Center building, which floods regularly and is adjacent to 100-year flood zone							
	In tandem with water conservation outreach listed above, conduct enhanced enforcement of water usage restrictions (in part to conserve water for firefighting)	DR, WF	DPW, Conservation, Fire	Local	High	Medium	Low	Ongoing
	Update Open Space and Recreation Plan (expired) to include mitigation goals	All	Planning, Parks	Local, CMRPC	High	Medium	Medium/High	1-2 Years to complete
	Review and update local plans and development review processes (planning, zoning, stormwater management, conservation, etc.) to ensure new construction will not be affected by hazards	All	All Town Departments	Local	Medium	High	Low	Ongoing
	Monitor implementation of Hazard Mitigation Plan	All	All Town Departments	Local	High	High	Low	Ongoing

'Hazards Addressed' abbreviations:

DF	Dam Failure	DR	Drought
EQ	Earthquake	FL	Flooding
HU	Hurricane	OT	Other
SS	Severe Snowstorm/Ice storm/Nor'easter	ST	Severe Thunderstorm/Wind/Tornado
WF	Wildfire/Brushfire	XT	Extreme Temperatures

8. PLAN ADOPTION, IMPLEMENTATION, AND MAINTENANCE

8.1 Plan Adoption

A public meeting was held on July 26, 2016 as part of the Board of Selectmen's meeting in order detail the planning process to date and to solicit comments and feedback from the public on the draft Blackstone Hazard Mitigation Plan then being developed. The draft plan was provided to the Town for distribution and posted on CMRPC's website from November 7, 2016 for public review and input. The Plan was then submitted to the Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA) for their review. Upon receiving conditional approval of the plan by FEMA, the final plan was presented to the Blackstone Board of Selectmen and adopted on January 24, 2017.

8.2 Plan Implementation

The implementation of this plan began upon its formal adoption by the Board of Selectmen and approval by MEMA and FEMA. Those Town departments and boards responsible for ensuring the development of policies, ordinance revisions, and programs as described in Sections 5 and 6 of this plan will be notified of their responsibilities immediately following approval. The Hazard Mitigation Team will oversee the implementation of the plan.

Incorporation with Other Planning Documents

Existing plans, studies, reports and municipal documents were incorporated throughout the planning process. This included a review and incorporation of significant information from the following key documents:

- ***Comprehensive Emergency Management Plan*** (particularly the Critical Infrastructure Section) – the Critical Infrastructure section was used to help identify infrastructure components in Town that have been identified as crucial to the function of the Town; this resource was also used to identify potentially vulnerable populations and potential emergency response shortcomings.
- ***Open Space and Recreation Plan*** – this Plan was used to identify the natural context within which mitigation planning would take place. This proved useful insofar as it identified water bodies, rivers, streams, and population trends. This was incorporated to ensure that the Town's mitigation efforts would be sensitive to the surrounding environment. It should be noted that this plan has expired and needs to be updated.

- ***General and Zoning Bylaws*** – Bylaws were reviewed to identify those actions that the town is already taking that are reducing the potential impacts of a natural hazard (i.e. floodplain regulations) to avoid duplicating existing successful efforts.
- ***Massachusetts State Hazard Mitigation Plan (2013)*** - This plan was used to ensure that the town's HMP was consistent with the State's Plan.

After this plan has been approved by both FEMA and the local government, links to the plan will be emailed to all Town staff, boards, and committees, with a reminder to review the plan periodically and work to incorporate its contents, especially the action plan, into other planning processes and documents. In addition, during annual monitoring meetings for the Hazard Mitigation Plan implementation process, the Hazard Mitigation Team will review whether any of these plans are in the process of being updated. If so, the Hazard Mitigation Team will remind people working on these plans, policies, etc., of the Hazard Mitigation plan, and urge them to incorporate the Hazard Mitigation plan into their efforts. The Hazard Mitigation Team will also review current Town programs and policies to ensure that they are consistent with the mitigation strategies described in this plan. The Hazard Mitigation Plan will also be incorporated into updates of the Comprehensive Emergency Management Plan.

8.3 Plan Monitoring and Evaluation

The Town's Emergency Management Director will call meetings of all responsible parties to review plan progress as needed, based on occurrence of hazard events. The public will be notified of these meetings in advance through a posting of the agenda at Town Hall. Responsible parties identified for specific mitigation actions will be asked to submit their reports in advance of the meeting.

Meetings will involve evaluation and assessment of the plan, regarding its effectiveness at achieving the plan's goals and stated purpose. The following questions will serve as the criteria that are used to evaluate the plan:

Plan Mission and Goal

- Is the Plan's stated goal and mission still accurate and up to date, reflecting any changes to local hazard mitigation activities?
- Are there any changes or improvements that can be made to the goal and mission?

Hazard Identification and Risk Assessment

- Have there been any new occurrences of hazard events since the plan was last reviewed? If so, these hazards should be incorporated into the Hazard Identification and Risk Assessment.

- Have any new occurrences of hazards varied from previous occurrences in terms of their extent or impact? If so, the stated impact, extent, probability of future occurrence, or overall assessment of risk and vulnerability should be edited to reflect these changes.
- Is there any new data available from local, state, or Federal sources about the impact of previous hazard events, or any new data for the probability of future occurrences? If so, this information should be incorporated into the plan.

Existing Mitigation Strategies

- Are the current strategies effectively mitigating the effect of any recent hazard events?
- Has there been any damage to property since the plan was last reviewed?
- How could the existing mitigation strategies be improved upon to reduce the impact from recent occurrences of hazards? If there are improvements, these should be incorporated into the plan.

Proposed Mitigation Strategies

- What progress has been accomplished for each of the previously identified proposed mitigation strategies?
- How have any recently completed mitigation strategies affected the Town's vulnerability and impact from hazards that have occurred since the strategy was completed?
- Should the criteria for prioritizing the proposed mitigation strategies be altered in any way?
- Should the priority given to individual mitigation strategies be changed, based on any recent changes to financial and staffing resources, or recent hazard events?

Review of the Plan and Integration with Other Planning Documents

- Is the current process for reviewing the Hazard Mitigation Plan effective? Could it be improved?
- Are there any Town plans in the process of being updated that should have the content of this Hazard Mitigation Plan incorporated into them?
- How can the current Hazard Mitigation Plan be better integrated with other Town planning tools and operational procedures, including the zoning bylaw, the Comprehensive Emergency Management Plan, and the Capital Improvement Plan?

Following these discussions, it is anticipated that the planning team may decide to reassign the roles and responsibilities for implementing mitigation strategies to different Town departments and/or revise the goals and objectives contained in the plan. The team will review and update the Hazard Mitigation Plan every five years.

Public participation will be a critical component of the Hazard Mitigation Plan maintenance process. The Hazard Mitigation Team will hold all meetings in accordance with Massachusetts

open meeting laws and the public invited to attend. The public will be notified of any changes to the Plan via the meeting notices board at Town Hall, and copies of the revised Plan will be made available to the public at Town Hall.

8.4 Potential Federal and State Funding Sources

Federal Funding Sources

The FEMA web pages identify a number of funding opportunities. Please refer to <https://www.fema.gov/grants>. Some programs are described briefly below:

Hazard Mitigation Assistance

The HMA grant programs provide funding opportunities for pre- and post-disaster mitigation. While the statutory origins of the programs differ, all share the common goal of reducing the risk of loss of life and property due to Natural Hazards. Brief descriptions of the HMA grant programs can be found below. For more information on the individual programs, or to see information related to a specific Fiscal Year, please click on one of the program links.

Hazard Mitigation Grant Program (HMGP)

HMGP assists in implementing long-term hazard mitigation measures following Presidential disaster declarations. Funding is available to implement projects in accordance with State, Tribal, and local priorities. Please refer to: <http://www.fema.gov/hazard-mitigation-grant-program> for additional information.

HMGP funds may be used to fund projects that will reduce or eliminate the losses from future disasters. Projects must provide a long-term solution to a problem, for example, elevation of a home to reduce the risk of flood damages as opposed to buying sandbags and pumps to fight the flood. In addition, a project's potential savings must be more than the cost of implementing the project. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. Examples of projects include, but are not limited to:

- Acquisition of real property for willing sellers and demolition or relocation of buildings to convert the property to open space use
- Retrofitting structures and facilities to minimize damages from high winds, earthquake, flood, wildfire, or other natural hazards
- Elevation of flood prone structures
- Development and initial implementation of vegetative management programs
- Minor flood control projects that do not duplicate the flood prevention activities of other Federal agencies
- Localized flood control projects, such as certain ring levees and floodwall systems, that are

designed specifically to protect critical facilities

- Post-disaster building code related activities that support building code officials during the reconstruction process

Pre-Disaster Mitigation Grant Program (PDM)

The PDM Program, authorized by Section 203 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, is designed to assist States, U.S. Territories, Federally-recognized tribes, and local communities in implementing a sustained pre-disaster natural hazard mitigation program. The goal is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding in future disasters. This program awards planning and project grants and provides opportunities for raising public awareness about reducing future losses before disaster strikes. Please refer to <http://www.fema.gov/pre-disaster-mitigation-grant-program> for additional information.

Flood Mitigation Assistance (FMA)

Flood Mitigation Assistance (FMA) provides funds on an annual basis so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program. Please refer to the FMA website: <http://www.fema.gov/flood-mitigation-assistance-grant-program>.

Three types of FMA grants are available to States and communities:

- **Planning Grants** to prepare Flood Mitigation Plans. Only NFIP-participating communities with approved Flood Mitigation Plans can apply for FMA Project grants
- **Project Grants** to implement measures to reduce flood losses, such as elevation, acquisition, or relocation of NFIP-insured structures. States are encouraged to prioritize FMA funds for applications that include repetitive loss properties; these include structures with 2 or more losses each with a claim of at least \$1,000 within any ten-year period since 1978.
- **Technical Assistance Grants** for the State to help administer the FMA program and activities. Up to ten percent (10%) of Project grants may be awarded to States for Technical Assistance Grants

Repetitive Flood Claims (RFC)

The Repetitive Flood Claims (RFC) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al). Please refer to: <https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet>

RFC provides funds on an annual basis to reduce the risk of flood damage to individual properties insured under the NFIP that have had one or more claim payments for flood damages. RFC provides up to 100% federal funding for projects in communities that meet the reduced

capacity requirements.

Severe Repetitive Loss (SRL)

The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004, which amended the National Flood Insurance Act of 1968 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP). Please refer to: <https://www.fema.gov/media-library/resources-documents/collections/14>

SRL provides funds on an annual basis to reduce the risk of flood damage to residential structures insured under the NFIP that are qualified as severe repetitive loss structures. SRL provides up to 90% federal funding for eligible projects.

Definition: The definition of severe repetitive loss as applied to this program was established in section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- a) That has at least four NFIP claim payments (including building and contents) over \$5,000 each, and the cumulative amount of such claims payments exceeds \$20,000; or
- b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart.

Purpose: To reduce or eliminate claims under the NFIP through project activities that will result in the greatest savings to the National Flood Insurance Fund (NFIF).

Federal / Non-Federal cost share: 75/25%; up to 90% Federal cost-share funding for projects approved in States, Territories, and Federally-recognized Indian tribes with FEMA-approved Standard or Enhanced Mitigation Plans or Indian tribal plans that include a strategy for mitigating existing and future SRL properties.

Disaster Assistance

Disaster assistance is money or direct assistance to individuals, families and businesses in an area whose property has been damaged or destroyed and whose losses are not covered by insurance. It is meant to help with critical expenses that cannot be covered in other ways. This assistance is not intended to restore damaged property to its condition before the

disaster. While some housing assistance funds are available through our Individuals and Households Program, most disaster assistance from the Federal government is in the form of loans administered by the Small Business Administration.

Disaster Assistance Available from FEMA

In the event of a Declaration of Disaster, assistance from FEMA is grouped in 3 categories:

- A. Housing Needs
- B. Other than Housing Needs
- C. Additional Services

A. Housing Needs

- **Temporary Housing** (a place to live for a limited period of time): Money is available to rent a different place to live, or a government provided housing unit when rental properties are not available.
- **Repair**: Money is available to homeowners to repair damage from the disaster to their primary residence that is not covered by insurance. The goal is to make the damaged home safe, sanitary, and functional.
- **Replacement**: Money is available to homeowners to replace their home destroyed in the disaster that is not covered by insurance. The goal is to help the homeowner with the cost of replacing their destroyed home.
- **Permanent Housing Construction**: Direct assistance or money for the construction of a home. This type of help occurs only in insular areas or remote locations specified by FEMA, where no other type of housing assistance is possible.

B. Other than Housing Needs

Money is available for necessary expenses and serious needs caused by the disaster, including:

- Disaster-related medical and dental costs.
- Disaster-related funeral and burial cost.
- Clothing; household items (room furnishings, appliances); tools (specialized or protective clothing and equipment) required for your job; necessary educational materials (computers, school books, supplies)
- Fuels for primary heat source (heating oil, gas).
- Clean-up items (wet/dry vacuum, dehumidifier).
- Disaster damaged vehicle.
- Moving and storage expenses related to the disaster (moving and storing property to avoid additional disaster damage while disaster-related repairs are being made to the home).

- Other necessary expenses or serious needs as determined by FEMA.
- Other expenses that are authorized by law.

C. Additional Services

- Crisis Counseling
- Disaster Unemployment Assistance
- Legal Services
- Special Tax Considerations

Assistance to Firefighters Grants

The FEMA Assistance to Firefighters Grants (AFG) program provides funds to equip and train emergency personnel to recognized standards, enhance operations efficiencies, foster interoperability, and support community resilience. Under AFG, funds may be available for equipment, vehicles and/or training that can be used to mitigate and/or respond to wildfire-related hazards. AFG also has a Fire Prevention and Safety (FPS) component which funds public outreach programs and prevention activities, which can emphasize wildfire mitigation. Please refer to: <https://www.fema.gov/welcome-assistance-firefighters-grant-program>.

Disaster Loans Available from the Small Business Administration

The U.S. Small Business Administration (SBA) can make federally subsidized loans to repair or replace homes, personal property or businesses that sustained damages not covered by insurance. The Small Business Administration can provide three types of disaster loans to qualified homeowners and businesses:

- home disaster loans to homeowners and renters to repair or replace disaster- related damages to home or personal property (please refer to: <https://www.sba.gov/loans-grants/see-what-sba-offers/sba-loan-programs/disaster-loans/types-disaster-loans/home-and-personal-property-loans>)
- business physical disaster loans to business owners to repair or replace disaster- damaged property, including inventory, and supplies (please refer to: <https://www.sba.gov/loans-grants/see-what-sba-offers/sba-loan-programs/disaster-loans/types-disaster-loans/business-physical-disaster-loans>); and
- economic injury disaster loans, which provide capital to small businesses and to small agricultural cooperatives to assist them through the disaster recovery period (please refer to: <https://www.sba.gov/loans-grants/see-what-sba-offers/sba-loan-programs/disaster-loans/types-disaster-loans/economic-injury-disaster-loans>).

For many individuals the SBA disaster loan program is the primary form of disaster assistance.

Disaster Assistance from Other Organizations and Entities

DisasterAssistance.gov is a secure, user-friendly U.S. Government web portal that consolidates disaster assistance information in one place. If you need assistance following a presidentially declared disaster— which has been designated for individual assistance— you can now go to DisasterAssistance.gov to register online. Local resource information to help keep citizens safe during an emergency is also available. Currently, 17 U.S. Government agencies, which sponsor almost 60 forms of assistance, contribute to the portal.

DisasterAssistance.gov speeds the application process by feeding common data to multiple online applications. Application information is shared only with those agencies you identify and is protected by the highest levels of security. DisasterAssistance.gov will continue to expand to include forms of assistance available at the federal, state, tribal, regional and local levels, with a projected completion date of 2014. Through www.DisasterAssistance.gov you have the ability to:

- Determine the number and forms of assistance you may be eligible to receive by answering a brief series of questions or start the individual assistance registration process immediately
- Apply for FEMA assistance and be referred to the Small Business Administration for loans through online applications
- Choose to have your Social Security benefits directed to a new address
- Access your federal student loan account information
- Receive referral information on forms of assistance that do not yet have online applications
- Access a call center in the event you do not have Internet access to ensure you can still register for assistance
- Check the progress and status of your applications online.
- Identify resources and services for individuals, families and businesses needing disaster assistance during all phases of an emergency situation
- Identify resources to help locate family members and pets
- Access assistance from the Department of State if you are affected by a disaster while traveling abroad
- Find information on disaster preparedness and response

Federal Funding Summary Table

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

Table 29

Program	Type of Assistance	Availability	Managing Agency	Funding Source
National Flood Insurance Program (NFIP)	Pre-Disaster Insurance	Any time (pre & post disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA

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

For a list of additional potential funding sources, please refer also to Table 17-7 on Pages 545-8 of the 2013 State Hazard Mitigation Plan:

<http://www.mass.gov/eopss/docs/mema/resources/plans/state-hazard-mitigation-plan/massachusetts-state-hazard-mitigation-plan.pdf>.

State Funding Sources

The Commonwealth of Massachusetts provides matching FEMA assistance. This means that, following Presidential disaster declarations, the state may contribute a portion of the 25% non-federal share for federal Infrastructure Support funds. Since 1991, the state has contributed nearly \$20 million to match FEMA's funding following declared Presidential disasters. Other State funding sources include the following:

Special Appropriations and Legislative Earmarks

Although there is no separate state disaster relief fund in Massachusetts, the state legislature may enact special appropriations for those communities sustaining damages following a natural disaster that are not large enough for a Presidential disaster declaration. Since 1991, Massachusetts has issued 20 major disaster declarations. Additionally, individual legislators may seek specific project funding for projects through the legislative budgeting and appropriations process.

State Revolving Fund

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

Chapter 90 Funds

This statewide program reimburses communities for roadway projects, such as resurfacing and related work and other work incidental to the above such as preliminary engineering including State Aid/Consultant Design Agreements, right-of-way acquisition, shoulders, side road approaches, landscaping and tree planting, roadside drainage, structures (including bridges), sidewalks, traffic control and service facilities, street lighting (excluding operating costs), and for such other purposes as the Department may specifically authorize. Maintaining and upgrading critical infrastructure and evacuation routes is an important component of hazard mitigation.

Community Development Block Grant (CDBG)

CDBG remains the principal source of revenue for communities to use in identifying solutions to address physical, economic, and social deterioration in lower-income neighborhoods and communities. While primarily a housing and community development program administered through the Executive Office of Housing and Community Development (EOHCD), the program can also fund the rehabilitation of municipal buildings such as town halls, which in many cases, also serve as Emergency Operations Centers for their communities.

State Land Acquisition & Conservation Program

Through the Massachusetts Executive Office of Energy and Environmental Affairs, this annual program purchases private property for open space, wetland protection and floodplain preservation purposes. For instance, in 1998, the state set an ambitious goal of protecting 200,000 acres of open space in the Commonwealth by 2010. In August 2001, less than three years later, the state announced that the Commonwealth and its land protection partners had reached the halfway mark in achieving that goal - 100,000 acres. Updated information may be found on the website of the Executive Office of Energy and Environmental Affairs Open Space Protection program at <http://www.mass.gov/envir/openspace/default.htm>.

Dams & Levees Program

EEA funds projects for the repair and removal of dams, levees, seawalls, and other forms of inland and coastal flood control. In FY 2016, the maximum award for any one application was \$1,000,000 for dams and levees and \$3,000,000 for seawalls and other coastal foreshore protection. A minimum financial match of 25% of total funds requested is required. For additional information, please refer to <http://www.mass.gov/eea/waste-mgmt-recycling/water-resources/preserving-water-resources/water-laws-and-policies/water-laws/draft-regs-re-dam-and-sea-wall-repair-or-removal-fund.html>.

Major Flood Control Projects

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

Flood Control Dams

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

Flood Hazard Management Program Staff Funding

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

MassWorks Infrastructure Program

The MassWorks Infrastructure Program provides a one-stop shop for municipalities and other eligible public entities seeking public infrastructure funding to support economic development and job creation. Although not specific to natural hazards per se, these infrastructure enhancements under MassWorks could also address identified needs for hazard mitigation. The MassWorks Infrastructure Program is administered by the Executive Office of Housing and Economic Development, in cooperation with the Department of Transportation and Executive Office for Administration & Finance. Please refer to <http://www.mass.gov/hed/economic/eohed/pro/infrastructure/massworks/> for additional information.

Weatherization Assistance Program

The Weatherization Assistance Program is funded each year by the U.S. Department of Energy's Office of Energy Efficiency & Renewable. The extent of services to be provided depends on

available funding. The program is intended to help low-income homeowners and renters lower their energy cost and reduce the potential impact from severe weather events. Weatherization service agencies throughout Massachusetts run the Weatherization Assistance Program. Please refer to <http://energy.gov/eere/wipo/weatherization-assistance-program> for additional information.

APPENDICES

- A. Maps**
- B. Public Survey Results**
- C. Planning Team & Public Meetings**
- D. Certificate of Adoption**
- E. Glossary**