TOWN OF CHARLEMONT, MA HAZARD MITIGATION PLAN UPDATE

JULY 2022

Town of Charlemont
157 Main Street
Charlemont, MA 01339

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July 2022

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157 Main Street

Charlemont, MA 01339

Phone: 413-339-4335

https://charlemont-ma.us

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Acknowledgements

The Town of Charlemont would like to thank the following people for supporting the development of this plan. This group was considered the Hazard Mitigation Planning Committee throughout the planning process.

- Dennis Annear, Emergency Management Director, and Fire Chief
- Jared Bellows, Police Chief
- Gordon Hathaway, Highway Superintendent
- Dana Johnson, Charlemont Ambulance
- Thorne Palmer, Sewer Department
- Sarah Reynolds, Administrator
- Marguerite Willis, Select Board Chair

E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))

Local Adoption Resolution

TOWN OF CHARLEMONT, MASSACHUSETTS
SELECT BOARD
A RESOLUTION ADOPTING THE
TOWN OF CHARLEMONT, MA HAZARD MITIGATION PLAN UPDATE

WHEREAS, the Town of Charlemont established a Hazard Mitigation Planning Committee to prepare the TOWN OF CHARLEMONT, MA HAZARD MITIGATION PLAN UPDATE and

WHEREAS, the Town of Charlemont participated in the development of the TOWN OF CHARLEMONT, MA HAZARD MITIGATION PLAN UPDATE;

and WHEREAS, the Town of Charlemont, MA contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Charlemont, and

WHEREAS, a duly noticed public meeting was held by the Charlemont Select Board on _________ for the public and municipality to review prior to consideration of this resolution; and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Charlemont Select Board formally approves and adopts the TOWN OF CHARLEMONT, MA HAZARD MITIGATION PLAN UPDATE**,** in accordance with M.G.L. c. 40.

ADOPTED AND SIGNED by the Charlemont Select Board on this______ __________, 2022.

____
Dan Girard

____
Marguerite Willis

____
Valentine Reid

Record of Changes

This Town of Charlemont, MA Hazard Mitigation Plan Update will be reviewed and approved on a biannual basis by the HMPC and following any major disasters. All updates and revisions to the plan will be tracked and recorded in the following table. This process will ensure the most recent version of the plan is disseminated and implemented by the Town.

Table 1. Summary of Changes.

Date of Change	Entered By	Summary of Changes

Chapter 1. Introduction

The Federal Emergency Management Agency (FEMA) defines mitigation as "the effort to reduce loss of life and property by lessening the impact of disasters. Mitigation is taking actions now – before the next disaster – to reduce human and financial consequences later (analyzing risk, reducing risk, insuring against risk.)"[1]

"The purpose of mitigation planning is to identify policies and actions that can be implemented over the long term to reduce risk and future losses. Mitigation plans form the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. The planning process is as important as the plan itself. It creates a framework for risk-based decision making to reduce damages to lives, property, and the economy from future disasters."[2]

"Disaster Mitigation Act (DMA) 2000 (Public Law 106-390)[3] provides the legal basis for FEMA mitigation planning requirements for State, local and Indian Tribal governments as a condition of mitigation grant assistance. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by repealing the previous mitigation planning provisions and replacing them with a new set of requirements that emphasize the need for State, local, and Indian Tribal entities to closely coordinate mitigation planning and implementation efforts."[4]

The Town of Charlemont, Massachusetts created this plan as part of an ongoing effort to reduce the negative impacts and costs from damages associated with natural hazards, such as nor'easters, floods, and hurricanes. This plan meets the requirements of the Disaster Mitigation Act 2000. More importantly, the plan was created to reduce loss of life, land, and property due to natural hazards that affect the Town of Charlemont. It is difficult to predict when natural hazards will impact the planning area, but it is accurate to say that they will. By implementing the mitigation actions listed in this plan, the impact of natural hazards will be lessened.

Local Mitigation Plans must be updated at least once every five years to remain eligible for FEMA hazard mitigation project grants. A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within five (5) years to continue to be eligible for mitigation project grants.

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[1] What is Mitigation? (2014). Federal Emergency Management Agency. Retrieved January 2014 from http://www.fema.gov/what-mitigation

[2] Multi-Hazard Mitigation Planning. (2014). Federal Emergency Management Agency. Retrieved January 2014 from http://www.fema.gov/multi-hazard-mitigation-planning

[3] Disaster Mitigation Act of 2000, Pub. L. 106-390, as amended

[4] Disaster Mitigation Act of 2000. (2014). Federal Emergency Management Agency. Retrieved January 2014 from http://www.fema.gov/media-library/assets/documents/4596?id=1935

Purpose of the Plan

The purpose of the Local Hazard Mitigation Plan is to provide the Town of Charlemont with a comprehensive examination of all natural hazards affecting the area, as well as a framework for informed decision-making regarding the selection of cost-effective mitigation actions. When implemented, these mitigation actions will reduce the Town's risk and vulnerability to natural hazards. FEMA supports local mitigation planning to achieve the following:

- Foster partnerships among all levels of government.
- Develop and strengthen non-governmental and private partnerships.
- Promote more disaster-resilient and sustainable communities.
- Reduce the costs associated with disaster response and recovery by promoting mitigation activities.[5]

This plan is a result of a collaborative effort between the Town of Charlemont and the surrounding communities. Throughout the development of the plan, the Hazard Mitigation Planning Committee (HMPC) consulted the public and key stakeholders for input regarding identified goals, mitigation actions, risk assessment, and mitigation implementation strategy. A sample of key stakeholders who participated, included the Franklin Regional Council of Governments (FRCOG), the Massachusetts Emergency Management Agency (MEMA), the Massachusetts Department of Conservation and Recreation (DCR), and FEMA. Inclusion of underserved and socially vulnerable populations was a priority of the HMPC.

Guiding Principles for Plan Development

The HMPC adhered to the following guiding principles in the plan's development.[6]

- Plan and invest for the future.
- Collaborate and engage early.
- Integrate community planning.

Identified Hazards

The HMPC identified the following list of hazards to profile. They are shown in order of climate change interaction for consistency with the State Hazard Mitigation and Climate Adaptation Plan.

[5] Federal Emergency Management Agency. (April 19, 2022). Local Mitigation Planning Policy Guide, p.3.

[6] Federal Emergency Management Agency. (April 19, 2022). Local Mitigation Planning Policy Guide, p.13.

Table 2. Hazards Considered.

Primary Climate Change Interactions	Hazards
Changes in Precipitation	Flooding *(including dam failures, ice jams, etc.)* Drought Landslide
Rising Temperatures	Average/Extreme Temperatures Wildfires *(including brushfires)* Infectious Disease Invasive Species
Extreme Weather	Hurricanes/Tropical Storms Severe Winter Storm/Nor'easter Tornadoes Other Severe Weather *(including thunderstorms, microbursts, etc.)*
Non-Climate Influenced Hazards	Earthquake
Technological / Human Caused Hazards	Hazardous Materials

Mitigation Strategy

C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))

The hazard mitigation strategy is the culmination of work presented in the planning area profile, risk assessment, and capability assessment. It is also the result of multiple meetings and sustained public outreach. The HMPC developed one mission statement and three goal statements shown below. The goals from the 2014 Town of Charlemont Local Multi-Hazard Mitigation Plan were revised to develop this current list. Information about the goal development process is in Chapter 6: Mitigation Strategy. These goals are considered "broad policy-type statements"[7] that represent the long-term vision for mitigating risk to natural hazards in the Town of Charlemont.

[7] Federal Emergency Management Agency. (2013). *Local Mitigation Planning Handbook,* p. 6.

Mission Statement

- Reduce or eliminate risk to people, property, and infrastructure from natural hazards and climate change.

Public Engagement

- Increase citizen awareness of how to mitigate risks posed by climate change and natural hazards.

Capacity Building

- Increase the Town's capacity for mitigating risk by investing in regional collaboration, employee education, project implementation and the integration of hazard mitigation and climate adaptation strategies into local plans and policies.

Infrastructure and Critical Facilities

- Protect critical facilities and infrastructure from the impacts of natural hazards and climate change.

Figure 1. Goal Statements.

Plan Update and Changes

This section details some of the changes incorporated into this plan based on development, status of mitigation actions, and current Town priorities. Details regarding critical facilities and land use may be found in Chapter 4: Risk Assessment. Details regarding land use and capabilities may be found in Chapter 5: Capability Assessment. This plan serves as a total revision and update to the 2014 Town of Charlemont Local Multi-Hazard Mitigation Plan.

Changes in Development and Vulnerability

D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))

The plan was revised to reflect changes in development as further described in Chapter 2. The critical facility list was amended and reflects the new generator at the Town Hall and broadband infrastructure. Adding a stable internet connection will make a substantial difference to the ability of the Town collaborate with outside agencies. Businesses in Town that cater to summer tourists continue to grow. Berkshire East purchased Zoar Outdoor and added a campground. Simultaneously, vacancies have increased at storefronts in Town. Charlemont has experienced very little residential development. During a Hazard Mitigation Planning Committee meeting and at a Public Meeting it was mentioned that there is a need for affordable housing and limited space to build outside of the floodplain. Development that has occurred has not increased or decreased the community's vulnerability since the previous plan was approved.

The Town of Charlemont does not have a Town Planner. Planning responsibilities are shared by the Town Administrator who identifies opportunities, and the Planning Board that grants special permits for residence new construction, renovations, and additions, if required by the Building Inspector. Special permits are also required for all new businesses, change of use or any new commercial construction. The Conservation Commission gets involved with planning by administering the state's wetland regulations. The Town also works with the Franklin County Regional Council of Governments regarding development in the region. The Town of Charlemont works to remain consistent with state agency guidelines such as those from the Department of Conservation and Recreation and MassDOT.

Additional information regarding development, such as population changes and land use may be found in Chapter 2: Planning Area Profile. Additional information regarding vulnerability is included in Chapter 4: Risk Assessment. Finally, the HMPC did amend hazard mitigation actions to mitigate risk based on current and future development patterns.

Progress in Mitigation Efforts

D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))

Chapter 6: Mitigation Strategy details the previously identified mitigation actions from the 2014 Town of Charlemont Local Multi-Hazard Mitigation Plan and their status in 2022. Each of these actions is listed as completed, in progress, or delayed. A description of the status is given. The HMPC used this information to determine if the actions should now be considered capabilities of the Town or if they should move forward into this new plan. The current mitigation action list represents present and future needs for the Town of Charlemont.

Changes in Priority Since 2014

D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))

The biggest change in priority since the 2014 Town of Charlemont Local Multi-Hazard Mitigation Plan is how the Town understands the current and potential impacts of climate change. Charlemont completed a Municipal Vulnerability Preparedness (MVP) plan in 2018 which identified climate change impacts and key climate change adaptation actions the Town can take for improved resiliency. The goal statements were revised to include climate change and a mission statement was developed. In addition, the priorities from the previous plan and the MVP plan of public engagement, capacity building, and infrastructure and critical facilities were developed into goal statements. Mitigation actions supporting each of these goal statements were developed.

The other significant change in priority was due to the Covid-19 Pandemic. The Core Team added Infectious Disease to the list of hazards reviewed. Like communities nationwide the Covid-19 Pandemic impacted local government function and citizen expectations. This plan was created through virtual meetings to avoid the spread of disease. The mitigation actions created include consideration of infectious disease risk and mitigation, primarily through citizen education and increased local government capacity.

The priority that has not changed since 2014, is the Town's priority to mitigate flood risk. This is seen in the MVP actions identified in 2018 and carries into the mitigation actions for this 2022 plan.

Hazard Mitigation Plan Integration Since Previous Plan

The previous Hazard Mitigation Plan was integrated into the Town's MVP plan. This is the most significant instance of plan integration. Covered in the MVP plan and then integrated into the planning process for this plan was invasive species.

Authority and Assurances

The Town of Charlemont will continue to comply with all applicable Federal laws and regulations during the periods for which it receives grant funding, in compliance with 44 CFR 201.6. It will amend its plan whenever necessary to reflect changes in Town, State or Federal laws and regulations, as required in 44 CFR 201.6.

The HMPC recognizes the following FEMA publications:

- Local Mitigation Planning Policy Guide (April 2022, Effective April 2023)
- Local Mitigation Planning Handbook (March 2013)
- Local Mitigation Plan Review Guide (October 2011)
- Demonstrating Good Practices Within Local Hazard Mitigation Plans (January 2017, FEMA Region 1)

Plan Adoption

The Town of Charlemont will adopt the Plan when it has received "Approved-Pending Adoption" status from the FEMA. The Certificate of Adoption is included on page five.

Document Overview

Below is a summary of the Town of Charlemont, MA Hazard Mitigation Plan Update chapters, including appendices. The planning process closely adhered to FEMA guidelines and to the intent of those guidelines.

Chapter 2: Planning Area Profile
The Planning Area Profile chapter describes the Town of Charlemont completely, including history, population, government, and infrastructure.

Chapter 3: Planning Process
The Planning Process chapter documents the methodology and approach of the hazard mitigation planning process. The chapter summarizes the HMPC meetings and the public outreach process (including public meetings). This chapter guides the reader through the process of generating this plan and reflects its open and inclusive public involvement process.

Chapter 4: Risk Assessment
The Risk Assessment identifies the natural hazard risks to the Town of Charlemont and its citizens. The risk assessment looks at current and future vulnerabilities based on land use development including structures and infrastructure. Included in this chapter is a list of critical facilities identified by the HMPC.

Chapter 5: Capability Assessment
The Capability Assessment looks at the Town's ability to mitigate risk prior to and following disaster. This chapter is structured around the following four categories: planning and regulatory, administrative, and technical, financial, and education and outreach. The chapter concludes with information regarding the National Flood Insurance Program and a list of specific opportunities to expand and improve on the Town's capabilities to reduce current and future hazard risks.

Chapter 6: Mitigation Strategy

This chapter provides a blueprint for reducing losses identified in the Risk Assessment. The chapter presents the hazard mitigation goals and identifies mitigation actions in order of priority. Each mitigation action includes essential details, such as Town lead, potential funding sources, and implementation timeframe.

Chapter 7: Plan Implementation and Maintenance

The Plan Implementation and Maintenance establishes a system and mechanism for periodically monitoring, evaluating, and updating the Town of Charlemont Hazard Mitigation Plan Update. It also includes a plan for continuing public outreach and monitoring the implementation of the identified mitigation actions.

Appendices

The Appendices includes documentation regarding the planning process, the list of mitigation actions, and the Hazus Report.

Chapter 2: Planning Area Profile

Charlemont is located at the foot of the Berkshire Hills between the towns of Greenfield and North Adams. The Mohawk Trail, a regional corridor for Native Americans, cuts through the town. European settlement of the town began in 1740. Farming dominated the town's economy, although the power of the Deerfield River was used for mill operations. The town's population reportedly grew significantly during the Federal Period, with the development of two commercial village centers, Charlemont Center and East Charlemont.

During the end of the 19th and beginning of the 20th centuries, mining operations became important in Charlemont. Small manufacturers and commercial enterprises also prospered during this time. The town was serviced by the Troy and Greenfield Railroad beginning in 1868 and the Hoosac Tunnel was opened in 1875.

Over the past fifty years, the town's economy has shifted from agriculture and industry to tourism and recreation, due mostly to the construction of Route 2. Second homeowners, drawn by the abundant natural beauty of the town, are reportedly a growing presence. Skiing, whitewater rafting, and other outdoor activities are complemented by the lodging and restaurant industries.

According to the previous edition of this plan which cites the 2005 MassGIS Land Use Data, the total land area of Charlemont is approximately 16,859 acres with roughly 84% of town classified as forested. Agricultural uses (cropland, pasture, orchard, and nursery) make up approximately 1,254 acres or 7.4% of the total land in town. Residential use makes up approximately 549 acres (3.3%).

Charlemont had a resident population of 1,358 in the 2000 census, 1,266 according to the 2010 Census, and 1,185 according to the 2020 Census; this represents a continued modest decrease over 20 years. There are 644 housing units in the town, and 490 households. Because the population is below 5,000, census "quickfacts" for Charlemont are not yet published; additional data is forthcoming in the next year.

Development Trends

According to the previous version of this plan, the predominant land use change in the Town of Charlemont since the 1970s has been the conversion of forest to residential development along existing roads. The locations of the new residential development are spread throughout town with an atypical concentration in East Charlemont off Hawk Hill and Deer Run Lane. Since 2000, new construction in town has been rare, and usually happens along Legate Hill Road, which is the densest area in town outside of the village center. Charlemont has one zoning district that covers the entire town. Minimum lot size for all developments is 45,000 square feet, or larger depending on the site conditions or specifics of the project.

A significant change in Charlemont since the 1970s is the increase in active recreational uses in the town. Tourism has become the dominant driver of the town's economy. When the previous edition of this plan was adopted, it was unclear how the changing local economy will impact town wide population in the future. The plan explained that as baby boomers age, Charlemont may become an attractive location for retirees wishing to live in a scenic setting that also offers a wide array of cultural and recreational opportunities; and those new industries that are less tied to specific locations may find Charlemont an attractive location that offers a high quality of life to its employees.

The previous edition of this plan hypothesized that if recreational tourism related to the Deerfield River and other natural and cultural amenities in the region grows, the increased influx of tourists could lead to demand for more businesses in town that support tourism. Interestingly, recreational land uses have increased moderately, with Zoar Outdoor Whitewater Rafting acquired by Berkshire East in the last few years and new entries into the market such as Great Outdoors Tubing and Hyytinin Hollow Tubing. A new campground is located of Zoar Road. Berkshire East has become a four-season recreational center and includes a campground. Additionally, Berkshire East may develop a new hotel building in the town. These changes in development are not necessarily located in areas with exceptional risk, but they will increasingly burden the Town's emergency services.

According to the MVP Resiliency Plan, 41% of the Town's total acreage is under some level of protection, but the vast majority of these properties are only temporarily protected under the Chapter 61 tax exemption program. Just 12% of the Town's land area is permanently protected from development, consisting primarily of the Mohawk Trail State Forest owned by the MA DCR. Despite these potential challenges, the Town does not believe that excessive development is imminent. Instead, the Town's administration is concerned that suitable developable land is not available for the affordable housing needs of an ageing population. The Town reports that locations are needed for supporting future elderly housing. Care will be taken to ensure that new development is not sited in areas of risk.

Environmental Justice Populations

According to the Massachusetts Environmental Justice (EJ) Viewer, one census block in Charlemont is an EJ tract: Block Group 1, Census Tract 401; Criteria: Income, with income 62% of the Massachusetts median. Overall, Charlemont has a median household income of $62,794, which is significantly lower than the State median. Charlemont does not have any EJ populations based on race or language barriers.

Water and Sewer Service

The Town of Charlemont does not have a town wide municipal water supply. Private wells serve most residences and businesses. The Department of Environmental Protection identifies 19 public water systems in the Town of Charlemont, one of which is a community system and two of which are nontransient noncommunity public water supply systems.

The Town has a wastewater treatment facility that serves approximately 450 people in Charlemont Center. It is a recirculating sand filter facility with a design capacity of 50,000 gallons per day. The wastewater treatment facility composts its sludge and discharges its effluent to the Deerfield River. The Charlemont Sewer District is not designed to accommodate uses that would require an extension of its collection system or its storage and filtration capacity. The ordinance authorizing designation of the District does not allow for its boundaries to expand and there is not enough land surrounding the wastewater treatment facility to allow for an expansion of the holding tanks or sand filters. However, the district is designed to allow for limited increases in wastewater treatment needs for existing uses.

Critical Facilities

The previous edition of the Charlemont plan noted that "a community's critical facilities include important municipal structures (i.e., town hall), emergency service structures (i.e., municipal public safety complex, shelters, and medical centers), and locations of populations that may need special assistance (i.e., nursing homes, day cares, schools, prisons) and major employers or other areas where there is a dense concentration of people." The number and nature of critical facilities in a community can differ greatly from one jurisdiction to another, and usually includes both public and private facilities. Each community needs to determine the relative importance of the publicly and privately owned facilities that deliver vital services, provide important functions, and protect special populations.

Local Mitigation Planning Handbook (FEMA, 2013) explains that *"Critical facilities are structures and institutions necessary for a community's response to and recovery from emergencies. Critical facilities must continue to operate during and following a disaster to reduce the severity of impacts and accelerate recovery. When identifying vulnerabilities, it is important to consider both the structural integrity and content value of critical facilities and the effects of interrupting their services to the community."*

To develop its initial list, the previous edition of the plan repeated a list of critical facilities from the "Charlemont Comprehensive Emergency Management Plan" (2010), choosing to identify public venues, special institutions, critical infrastructure, and two designated shelters. At the time, the Greenfield Community College was also identified as a shared shelter facility, but the Town noted (1) that it did not have formal agreements with the college to use the facility as a shelter, and (2) the only access from Charlemont to the school is along Route 2, which could become impassable during a flood, dam failure, or wildfire. Therefore, the college has been discontinued as a listed critical facility for Charlemont.

The MVP Resiliency Plan (2018) does not directly address critical facilities in the same way as the HMP. A few are mentioned in the context of recommendations, either by name or implied:

- Workshop participants identified the Fire Department facility as the first priority for reconstruction or replacement, as the current facility is the oldest of the structures in the floodplain, it is located at the lowest elevation, it is not able to accommodate regularly sized modern fire trucks and would require expensive upgrades.
- Top recommendation: Conduct feasibility study for relocation and/or flood proofing of key Town buildings in the floodplain.
- Execute a Memorandum of Agreement (MOA) with the Federated Church to provide food and sheltering services to all Town residents, especially vulnerable populations, during emergencies. Formalizing this relationship will be especially important as the Church undergoes a change in leadership in the coming year.
- Work with AT&T to upgrade existing cell towers and identify locations to add new ones as needed to provide cell phone coverage to the entire Town.
- Seek funding for off-site storage of important Town documents stored in critical facilities.
- Execute an MOA with the bus company serving the public schools to provide buses and drivers in an emergency.
- Execute MOAs with local businesses that have buses (e.g., Academy at Charlemont, Crab Apple Whitewater) to provide buses and drivers in an emergency.
- Execute a MOA with the Academy at Charlemont to provide buses for transportation and short-term sheltering services during an emergency.
- Regional emergency preparedness planners should identify an alternative site for and EOC to be located outside of the floodplain.
- Local institutions ("The Academy at Charlemont, Crab Apple Whitewater, Zoar Outdoors, Berkshire East") could potentially provide short-term sheltering and/or bus service in the event of an emergency.

In summary, a current list of the critical facilities in Charlemont is provided below as Table XX. This list was obtained from the previous edition of the hazard mitigation plan and the MVP-funded CRB plan; and edited through a review by the local planning team from March through June 2022. The Town elected to include its new broadband system as a critical facility, but a specific geographic location has not been listed given the nature of the infrastructure.

Table 3. Critical Facilities.

Facility	Address*	Listed in Prior Plan?	In MVP CRB?	Standby Power?	Use or Comment
Charlemont DPW	12 Factory Road	Y			
Charlemont Police Station	12 Factory Road	Y			
Charlemont Fire Department	Factory Road	Y	Y	Y	
Charlemont Town Hall (EOC)	157 Main Street	Y		Y	
Mohawk Trail Regional High School	26 Ashfield Road, Greenfield	Y			Regional shelter
Charlemont Sewer Plant	20 Factory Road				
School Bus Company	635 Mohawk Trail, Shelburne Falls		Y		This is the nearest school bus facility
Heath School	18 Jacobs Road, Heath		Y		Potential future critical facility
Hawlemont Regional Elementary School	10 School Street	Y			Shelter
Charlemont Academy	1359 Rte 2	Y	Y		
Berkshire East Ski Area	66 Thunder Mountain Road	Y	Y		
Charlemont Fairgrounds	Park Street	Y			Staging Area
Charlemont Federated Church	175 Main Street	Y	Y		Served as backup Shelter During T.S. Irene
Country Aire Campground	1753 Rte 2	Y			
Crab Apple Whitewater Rafting	2056 Rte 2	Y	Y		
Mohawk Park Family Campground	559 Tea Street	Y			
Mohawk Trail State Forest	Cold River Road	Y			

Facility	Address*	Listed in Prior Plan?	In MVP CRB?	Standby Power?	Use or Comment
Zoar Outdoor Whitewater Rafting (owned by Berkshire East)	7 Main Street	Y	Y		
Great Outdoors Tubing	78 Main Street				
Hyytinin Hollow Tubing	7 Tea Street Extension				
Propane Sales and Distribution					
Zoar Road Bridge	Zoar Road	Y			Helicopter Landing Site
Hawlemont School – *see comment to the right; this is not a repeat*	10 School Street	Y			Helicopter Landing Site
Levitt Cemetery	Burrington Road	Y			Helicopter Landing Site
Cell/Mobile Towers	66 Thunder Mountain Road		Y		
Town broadband system					

*All in Charlemont unless noted

Sources:

- Previous HMP
- MVP Resiliency Plan
- Local Committee Member Direct Input to Excel File
- Local Committee Member Meeting

One distinctive characteristic of the Town's critical facility list is that it includes several private recreational facilities associated with skiing and with Deerfield River. These were listed in the previous plan and in the MVP Resiliency Plan. These key facilities maintain a significant presence in the community, with high seasonal populations (winter for skiing and summer for river uses), unique emergency response needs, and the ability to shelter or transport large quantities of people. The MVP Resiliency Plan notes that "Zoar Outdoor, Crab Apple Whitewater Inc., and the Academy at Charlemont have buses and other resources that could potentially be useful in an emergency if the Town enters into formal agreements."

Overall, future hazard mitigation assistance requests from the Town of Charlemont may involve benefits to the unique set of community and essentially facilities, underscoring the importance of classifying them as critical facilities.

Flooding on the Deerfield River during Tropical Storm Irene reached the Hawlemont School and the Fire Station, which was being used as an Emergency Operations Center (EOC). The EOC was moved to the Town Hall, while evacuees seeking shelter were temporarily housed in the Charlemont Federated Church in the village center, though for a time it looked like flood waters might force the shelter to be moved to even higher ground. These vulnerabilities are addressed further in the Risk Assessment.

Critical Transportation Infrastructure

According to the previous edition of this plan, a total of 66 miles of roads are located in Charlemont. The major arteries running through Charlemont are Route 2 and Route 8A, which connect Charlemont with nearby towns and urban centers. On the town's southeast corner, Route 112 links Charlemont to the Town of Buckland. The closest access to I-91, Franklin County's major north/south route, is in Greenfield. About sixteen miles (24%) of Charlemont's roads are gravel.

Route 2 is the most critical transportation corridor accessible to the general population. The railroad is a critical transportation corridor for movement of specific goods and services. These routes must remain resilient to enable the Town to function during and after natural disasters such as floods. The MVP Resiliency Plan for the town noted that "transport of hazardous materials on the railroad brings potential for derailments, spills, and fires threatening the Town's main evacuation route (Route 2)" and "Trucks speeding down the hill on Route 2 into Town cause accidents that can result in the release of hazardous materials, damage to the electrical infrastructure, etc." While these are not challenges that are unique only to Charlemont, the capacity to address these challenges is limited by the lack of other options for transportation. The MVP plan also notes that "Many bridges throughout town are in need of repairs. Culverts throughout town may not be large enough to pass high flows resulting from more frequent and intense storms."

Dams

According to information from the MA DCR Office of Dam Safety, no dams are located within Charlemont. The Charlemont Comprehensive Emergency Management (CEM) Plan also confirms there are no dams in Charlemont. However, the upstream dams on the Deerfield River owned by TransCanada and licensed by FERC are a significant concern to the Town. These include the Somerset Dam, the Harriman Dam, and the Sherman Dam, all of which are classified as High Hazard Dams. The Fife Brook Dam and the Bear Swamp Upper Reservoir, owned by Brookfield Power, are also High Hazard dams. These will be addressed further in the Risk Assessment.

Historic and Cultural Resources

Charlemont Village is listed on the National Register of Historic Places. The district, located on Main Street in the center of town, is comprised of 500 acres with 87 buildings. This designation does not provide any protective measures for the historic resources, but designated sites may qualify for federal and state funding if damaged during a natural or manmade hazard. Flooding of the Deerfield River during Tropical Storm Irene on August 27 and 28, 2011 caused damage to some structures in downtown Charlemont, though the village was largely spared from damage.

The Town's Master Plan (2003) notes that the Charlemont fairgrounds have been the site of many cultural events in Charlemont since the 1850s. The fairgrounds are located to the north of the village center, along Route 8A. The center and the surrounding hills can be seen from portions of the fairgrounds, making the fairgrounds an important tourist destination within walking distance of the village center. For many years the fairgrounds were the site of the annual Deerfield Valley Agricultural Society fairs.

Chapter 3. Planning Process

The planning process was developed in full compliance with the current planning requirements of the Federal Emergency Management Agency (FEMA) per the following rules and regulations:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), as amended by the Disaster Mitigation Act of 2000
- Code of Federal Regulations – Title 44, Chapter 1, Part 201 (§201.6: Local Mitigation Plans)
- Federal Emergency Management Agency Local Mitigation Plan Review Guide (dated October 1, 2011)

The Federal Emergency Management Agency's recently released; Local Mitigation Planning Policy Guide (Released April 19, 2022, Effective April 19, 2023) was considered but all requirements may not be included. In addition, the plan was prepared with the suggestions found in the Demonstrating Good Practices Within Local Hazard Mitigation Plans, FEMA Region 1, January 2017.

A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))

A priority through the planning process was equity, which FEMA defines as the "consistent and systematic fair, just and impartial treatment for all individuals." This was a central theme through the planning process and effort was made to develop an inclusive planning process. The whole community (individuals, communities, private and nonprofit sectors, faith-based organizations, and all levels of government) were given an opportunity to participate.

The planning process for this updated mitigation plan began in March 2022 and concluded in August 2022 (this does not include the months of plan review and adoption). The Town developed a Municipal Vulnerability Preparedness (MVP) Program summary of findings in 2018. This planning effort contributed to the update of the mitigation plan. Below is a graphical display of the plan development timeline. The months with one check mark indicate a Hazard Mitigation Planning Committee (HMPC) meeting was held and the months with two check marks indicate that a public meeting was also held. The Town Administrator, facilitated all activities related to the mitigation plan update, including meeting logistics, data gathering, and public outreach.

Table 4. Planning Process Timeline.

Project Tasks	Feb 2022	Mar 2022	Apr 2022	May 2022	Jun 2022	Jul 2022	Aug 2022
1. Convene Hazard Mitigation Planning Committee		✓	✓✓	✓		✓✓	
2. Create/Update Hazard Profiles for Each Hazard							
3. Facility Inventory							
4. Vulnerability							
5. Mitigation Goals							
6. Actions							
7. Maintenance							
8. Public Review of Draft							
9. Review and Approval							

Hazard Mitigation Planning Committee

A Hazard Mitigation Planning Committee (HMPC) was formed to support the planning process. This team included Town employees. Key stakeholders, such as the Franklin Regional Council of Governments were invited to meetings but not considered a part of the HMPC. A list of HMPC members is shown below. The HMPC met four times on the following dates, March 1, 2022, April 12, 2022, May 25, 2022, and June 16, 2022. All the meetings were conducted via Zoom due to the Covid-19 Pandemic, however sometimes Town employees gathered at the town offices. A list of participants at each of these meetings is included in Appendix A.

- Dennis Annear, Emergency Management Director, and Fire Chief
- Jared Bellows, Police Chief
- Gordon Hathaway, Highway Superintendent
- Dana Johnson, Charlemont Ambulance
- Thorne Palmer, Sewer Department

- Sarah Reynolds, Administrator
- Marguerite Willis, Select Board Chair

A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))

The first HMPC meeting, **March 1, 2022**, was an opportunity for the Consulting Team to introduce the project and expectations for the HMPC. Sarah Reynolds was the only person representing the town in attendance. Jeffrey Zukowski, MEMA, Jamie Caplan, Jamie Caplan Consulting, and Bill Bohn, Sobis were also on the call. During this call, the consulting team discussed who else should be on the HMPC, how to conduct public engagement and how to include Environmental Justice Populations. It was decided the best way to include the public in the planning process is to host a meeting when the seniors meet for lunch on a Wednesday. Sarah Reynolds described some of the development that has taken place, such as Berkshire East purchasing Zoar Outdoor, moving the Emergency Operation Center to Town Hall, and adding a generator at the Town Hall. She also mentioned that Charlemont experiences fewer ice jams and fewer large snowstorms, however, high winds have increased, and they have experienced a microburst. She also mentioned how the Town of Hawley can be cut-off from Charlemont when disasters impact the main roadway. Ms. Reynolds agreed to adding the following hazards to the plan, drought, extreme temperatures, invasive species, and infectious disease and to organize all hazards according to Primary Climate Change Interaction for consistency with the Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

The second HMPC meeting, **April 12, 2022**, provided an opportunity for the majority of HMPC members to gather and discuss in detail the Town's capabilities to mitigate risk and the location of critical facilities. They also discussed outreach for the first public meeting and future meetings. In terms of critical facilities, the HMPC noted that the school is in an earthquake zone and that they felt an earthquake centered in Virginia. The Town reports no plans to update their Open Space or Master Plan. They also emphasized they are not a wealthy community and take on projects as funding and support is available. In terms of priorities, they reported affordable housing and elderly housing are needed. The Town's location, adjacent to the Deerfield River with steep slopes adjacent to the river, make building expensive and feasible land for building minimal, both increase costs. The Town has not experienced a significant amount of development over the last five years, although they have experienced a decline in population and an increase in vacant storefronts. During this meeting the consulting team presented draft goal statements which were approved by the HMPC. These are detailed in Chapter 6 Mitigation Strategy.

The third HMPC Meeting, **May 25, 2022**, gave the consulting team an opportunity to share results from the risk assessment and the capability assessment. It also was a time to confirm the revised goal statements and to discuss mitigation actions, especially those identified through the risk and capability assessments. The HMPC agreed that with only twelve National Flood Insurance policies in Town it would not make sense to participate in the Community Rating System. The group agreed on a system of prioritization for the mitigation actions and reviewed a draft list of actions based on the status of the sixty actions identified in the 2014 Hazard Mitigation Plan.

The final HMPC Meeting, **June 16, 2022**, provided an opportunity to review the final list of mitigation actions and their priority ranking. In addition, the HMPC discussed outreach for the final public meeting and for plan review. They made a final change to the list of goal statements by combining the concepts of investment and capacity building.

The HMPC also participated in two public meetings, one on **April 13, 2022**, and one on **June 29, 2022 as further described below**. These were hosted via Zoom. Finally, the HMPC reviewed the draft Town of Charlemont, MA Hazard Mitigation Plan Update prior to sending it to the Massachusetts Emergency Management Agency (MEMA) for their review in late July 2022.

Public Outreach

A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))

The Public Outreach Strategy was designed to involve the public in the mitigation planning process. The purpose of public outreach and stakeholder involvement was to:

- Generate public interest in mitigation planning
- Identify and accommodate special populations
- Solicit public input
- Engage local stakeholders
- Create opportunities for public and local stakeholders to be actively involved in the mitigation planning process

The public outreach strategy included two Public Meetings, and an opportunity for the public to review the draft plan. Both meetings were hosted virtually due to the Covid-19 pandemic. Each meeting included a PowerPoint presentation and plenty of opportunity for questions and discussion. In addition, Mentimeter was used to facilitate input from meeting participants. This has proven to be an effective tool when engaging people who may not be comfortable participating in a virtual meeting. The HMPC participated in each meeting.

The Town Administrator conducted outreach for each public meeting by posting a flyer (included in the Appendix) in “hot spots” around Town, including the Avery Store, Neighbors, and post office. Notices were also included in the Town Newsletter and posted on the Town Website (included in the Appendix). Flyers were sent via the Town’s electronic list serv. Berkshire East was personally invited to the meetings. Copies of outreach materials for each meeting are included in Appendix A.

The first public meeting occurred on **April 13, 2022**. It was held via Zoom, so an accurate list of participants was not gathered, however, six computer connections were made. The meeting asked participants a series of questions to engage them and help them to understand the process of developing a hazard mitigation plan. The questions are listed below.

1. Who lives and works in Charlemont?
2. What buildings and infrastructure do people rely on?
3. What weather related hazards may impact the people, buildings, and infrastructure identified?
4. What can be done to lessen the impact of these hazards on people, buildings, and infrastructure?

Answers included from Mentimeter are shown in the figures below.

Figure 2. Who lives and works in Charlemont?

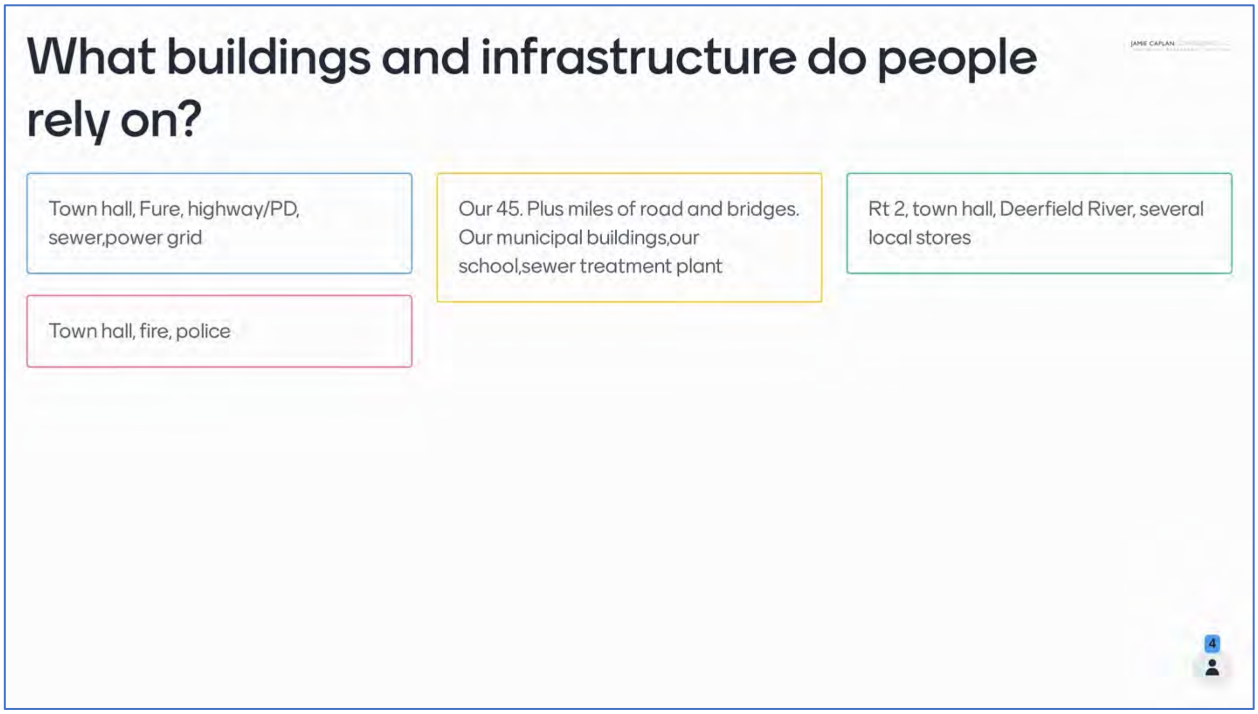

Figure 3. What buildings and infrastructure do people rely on?

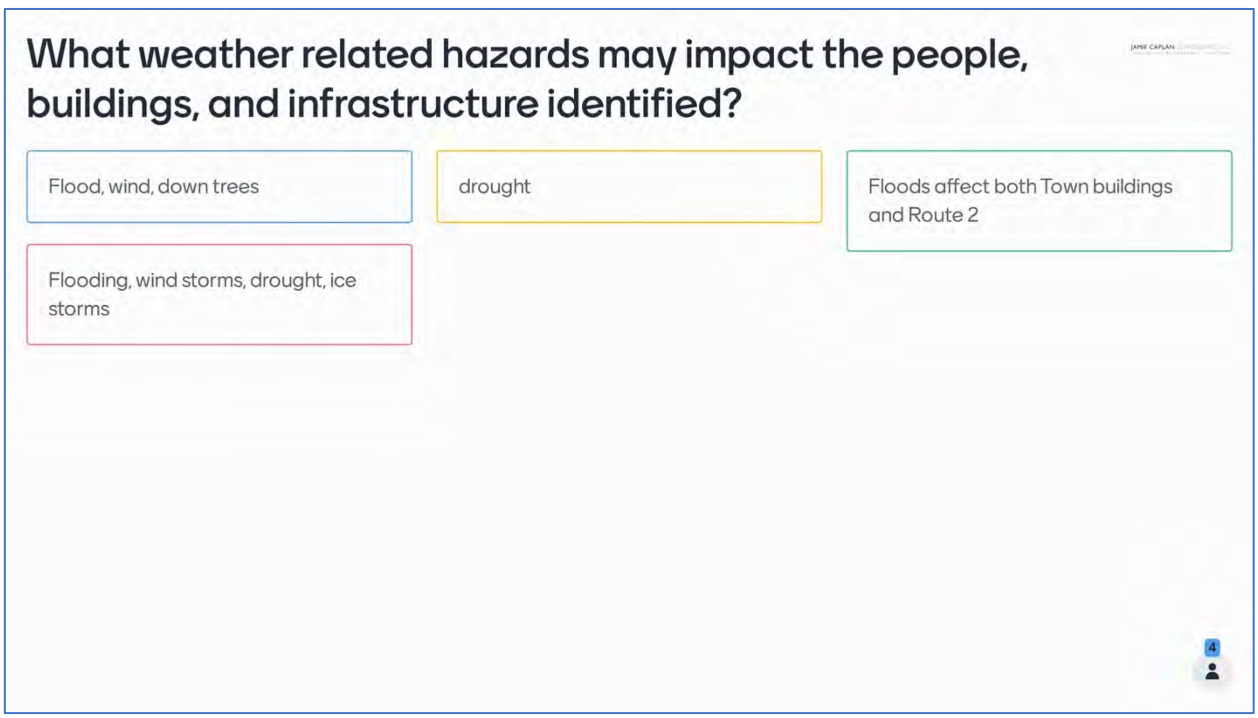

Figure 4. What weather related hazards may impact the people, buildings, and infrastructure identified?

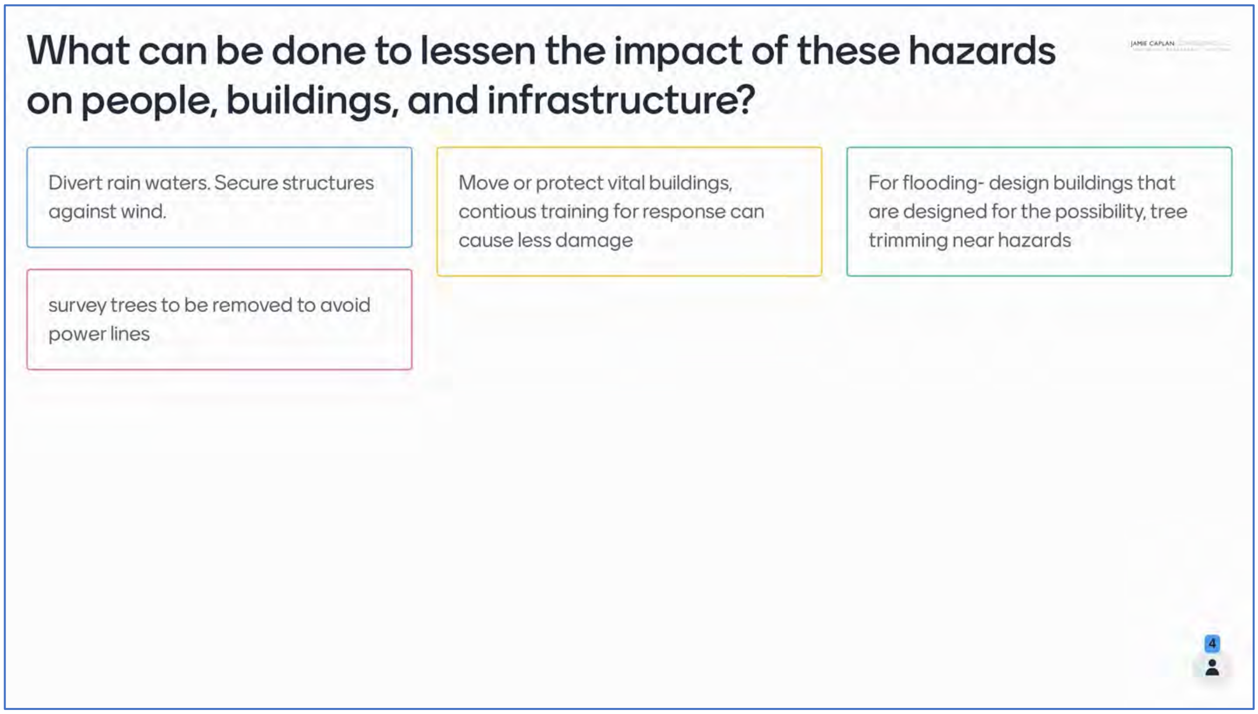

Figure 5. What can be done to lessen the impact of these hazards on people, buildings, and infrastructure?

Turn out at this initial public meeting was not significant so another meeting was held at the Senior Center on **April 14, 2022**. This was a well-attended in-person meeting. The same series of questions were asked, and their responses are below. Sarah Reynolds, Town Administrator facilitated this meeting and reported that participants were eager to describe how storms used to impact the Town and how perspectives have shifted in terms of what qualifies as an emergency today.

Who lives and works in our community?

- Lots of elderly fixed income residents
- Newer folks who work from home
- Lots of folks who commute

What buildings, organizations and infrastructure do these people rely on?

- Senior center
- Avery’s Store
- The church
- Fairgrounds
- School
- Post office

- Gas station
- Transfer station
- Their houses

What weather related hazards impact these?

- Power outages
- Snowstorms “the kind that snowed in your front door use to be a thing”
- Wind
- Ice
- Hurricanes
- They also talked about how when it used to hail, they got hail the size of balls much larger than the “quarter size hail we hear about now”

What can be done to lessen the impact of the hazards to protect people and property?

- Better communication- during Irene many of them felt cut off
- Could we get a broadcast system for the town in case the Dams ever do have an issue- no good way to warn people
- An evacuation plan for home bound residents
- Tree trimming
- Train Wrecks were also discussed here- people don’t know what is being hauled through could the town have a public evacuation plan that addresses this and is better known

The second public meeting was held on **June 29, 2022**. This meeting was held at 5:00 pm to try and attract more participants, the previous meeting was held during the workday. A few new people did participate in this meeting including the Secretary for all Town Boards except the Select Board and a couple of Select Board members. They reported that Town has limited ingress and egress points and how necessary it is to keep them open. They also mentioned how the Zoar Outdoor building was renovated to allow water to flow underneath it. They mentioned concern for floods, hurricanes, and wildfires and emphasized that hurricanes and extreme winds have gotten worse over the last several years.

Stakeholder Engagement

To give neighboring communities and regional agencies an opportunity to participate in the planning process, the HMPC sent personal invitations to their contacts in the adjacent communities of Hawley, Buckland, Rowe, Shelburne, Colrain, and Savoy. The Franklin Regional Council of Governments was invited to meetings and the Town Administrator sent them a copy of the draft plan for review. In addition, the HMPC made overtures to include private businesses and schools in the Town of Charlemont such as Berkshire East and the Academy at Charlemont.

The HMPC was aware of the need to engage multiple sectors of stakeholders including representatives of community lifelines. Community lifelines enable the continuous operation of critical government and business functions. The table below indicates how each sector was represented. The following list includes areas of expertise or sectors who have responsibility to mitigate risk or make land use decisions. Participants from these sectors were included to develop a shared understanding of risk and to build widespread support for "directing financial, technical and human resources toward natural hazard risk reduction."[8]

Sectors	Charlemont Representatives
Emergency Management	• Emergency Management Director and Fire Chief • Police Chief • Charlemont Ambulance • Highway Superintendent
Economic Development	• Town Administrator • Berkshire East • Crabapple is part of Capital Improvement Committee • Have a list of businesses, share information about plan to this group via email and announcements at Town Meeting
Land Use and Development	• Select Board • Town Administrator
Housing	• Town Administrator • Franklin Regional Council of Governments
Health and Social Services	• Seniors who meet every Wednesday at the Senior Center
Infrastructure	• Sewer District • Highway Superintendent

[8] Local Mitigation Planning Policy Guide, FP 206-21-0002, Released April 19, 2022, p. 17.

	• Franklin Regional Council of Governments
Natural and Cultural Resources	• Franklin Regional Council of Governments • Franklin Land Trust • Mohawk Trail, J. Healy is the Representative • Woodland Association

Review of Draft Plan

The Town made the draft plan available for public review beginning July 29, 2022. A press release announcing the availability to review the plan was sent and an announcement was posted in the Town Newsletter. A hard copy was available on the counter at the Town Hall and on the counter at the Post Office. Links to a digital version were posted to the Town's website (https://charlemont-ma.us). Invitations to review the plan were sent via email to all Town departments, and to key stakeholders such as adjacent towns, the FRCOG, and the Woodland Partnership. An announcement was made at the Selectboard Meeting on July 11, 2022. The public was encouraged to comment on the plan and to submit comments via email to the Town Administrator.

Insert how comments were incorporated into the plan

Chapter 4. Risk Assessment

Purpose

The risk assessment is organized to meet the Federal Emergency Management Agency's (FEMA's) local hazard mitigation planning regulations as found in C.F.R. 44 201.6 (Local Mitigation Plans) in addition to state requirements. FEMA requires the Town to include all possible natural hazard events, to assess vulnerability, and to estimate potential losses. Each hazard must be profiled to include a description of the hazard, historical occurrences, extent (or magnitude), location, and vulnerability. The hazards are identified and profiled in this chapter. This risk assessment then examines the vulnerability of current and future populations and structures (including critical facilities and infrastructure) to various natural hazards. The risk assessment provides a compilation of available information and data sets to the Town for comprehensive planning purposes. The risk assessment answers questions regarding hazard history, probability, frequency, and impact. These answers are then used to inform mitigation actions for the town. The ultimate purpose of this plan is to save lives and reduce property losses in future disasters.

Hazard Identification

The first step in the risk assessment was to revisit and evaluate the hazards identified for study and inclusion the Town's previous hazard mitigation plan. This was a key topic of discussion at the first Hazard Mitigation Planning Committee (HMPC) meeting, along with the consideration of any additional hazards to include in the updated risk assessment. While only natural hazards are required to be addressed by FEMA, other hazards such as technological and human-caused hazards may be included if they are of significant concern to the community and determined to be a mitigation priority.

In completing the updated hazard identification process, the HMPC considered the results of the Town's recent Municipal Vulnerability Preparedness (MVP) planning effort, as well as the 2018 State Hazard Mitigation and Adaptation Plan (SHMCAP).[9] As a result of this process all hazards from the 2016 plan remain included in this updated risk assessment, though some have been consolidated or renamed to be consistent with the SHMCAP. The top four natural hazards identified for the MVP effort are thoroughly covered in this assessment, which include flooding, severe winter storms, transport of hazardous materials, and wildfires and village firefighting. In addition, two new hazards have been identified and incorporated into the assessment, including Infectious Disease and Invasive Species. Infectious disease was added based on the local impacts of the Covid-19 pandemic as well as a growing concern for vector-borne diseases. Invasive species was added to reflect the concern for this becoming a more prevalent hazard with projected climate changes and so that the risk assessment is aligned with the SHMCAP.

With the addition of invasive species, all relevant hazards as identified in the SHMCAP were considered and addressed in this risk assessment for Charlemont. Due to the community's inland location, coastal

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[9] Massachusetts State Hazard Mitigation and Climate Adaptation Plan. 2018.

hazards identified in the SHMCAP are not included (such as sea level rise, coastal flooding, coastal erosion, and tsunami).

To better reflect the relationship between natural hazards and changing climate and weather patterns, each of the individual hazards identified for the updated risk assessment have been reorganized and categorized according to their primary interaction with climate change. These new categories are consistent with the SHMCAP and include the following:

- Changes in Precipitation
- Rising Temperatures
- Extreme Weather
- Non-Climate Influenced Hazards
- Technological and Human-Caused Hazards

Individual hazards are also grouped within each category according to their primary hazard (for example, all flooding-related hazards are listed under "Flooding" in the Changes in Precipitation category). This includes specific hazards as identified in the Town's previous plan as shown in *italics* in Table 35 below. This new classification for identified hazards was done for the plan update to consolidate and be consistent with the state's current hazard classification scheme per the SHMCAP.

Table 35 provides an abbreviated list of the 13 primary hazards included in the update risk assessment.

Table 5. Town of Charlemont's Hazards.

Primary Climate Change Interactions	Hazards
Changes in Precipitation	Flooding *(including dam failures, ice jams, etc.)* Drought Landslide
Rising Temperatures	Average/Extreme Temperatures Wildfires *(including brushfires)* Infectious Disease Invasive Species
Extreme Weather	Hurricanes/Tropical Storms Severe Winter Storm/Nor'easter Tornadoes Other Severe Weather *(including thunderstorms, microbursts, etc.)*
Non-Climate Influenced Hazards	Earthquake
Technological / Human Caused Hazards	Hazardous Materials

Hazard Profiles

B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))

B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))

B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))

The risk assessment for the Massachusetts SHMCAP describes the natural hazards that have the potential to impact the Commonwealth, providing the underlying narrative for this hazard profile for Charlemont. This section is organized by climate change interaction category, consistent with the SHMCAP. Because this section repeats information from the SHMCAP, some citations have been removed for brevity. The original citations can be found in the SHMCAP.

Profiles have been developed for each identified hazard, organized by primary climate change interaction. Hazard profiles include the following sections: Hazard Description, Location, Previous Occurrences, Extent, Probability of Future Events, and Vulnerability Assessment; these are described below.

Table 6. Hazard Characterization

Category/Method	Definition
Description	Description of hazard, its characteristics, and potential effects.
Location	Describes geographic areas within the town that are affected by the hazard
Previous Occurrences	Provides information on the history of previous hazard events for the region, including their impacts on people and property.
Extent	Describes potential strength or magnitude of a hazard. Where possible, extent is described using established scales.
Probability of Future Events	Describes likelihood of future hazard occurrences in the town based on best available and climate-informed science
Vulnerability Assessment	Describes potential impact on the community, including estimated potential losses and the anticipated effects of climate change

To describe previous occurrences, this plan update highlights major events from history but *relies primarily on a ten-year lookback (2012 through 2021)* ending with the date of plan development (2022). This helps maintain a concise narrative. Where applicable, narratives about warning times (i.e., floods, heat advisories, and wildfires) are incorporated into the "Extent" subsections.

The vulnerability assessment characterizes how hazards have impacted and may impact the different aspects of the community. In the vulnerability assessment sub-sections, the magnitude and likelihood of a hazard event are evaluated, and impacts are quantified using hazard models. Some hazards, like earthquakes and winter storms, will impact the entire community while other hazards, like floods and landslides, impact specific locations in the community. The areas that could be impacted are defined as the community's exposure. The results of the vulnerability assessment are used to help identify mitigation measures the community may take to lessen the impact and better understand their benefits.

Primary Climate Change Interaction: Changes in Precipitation

Flooding Including Dam Failures and Ice Jams

Nationally, flooding causes more damage annually than any other severe weather event. Flooding in Massachusetts is often the direct result of frequent weather events such as coastal storms, nor'easters, tropical storms, hurricanes, heavy rains, and snowmelt. In an inland community such as Charlemont, flooding is the result of moderate precipitation over several days, intense precipitation over a short period, or melting snowpack. Increases in precipitation and extreme storm events will result in increased inland flooding. Common types of flooding are described below.

Description

Riverine Flooding: Riverine flooding often occurs after heavy rain. Areas of the state with high slopes and minimal soil cover (such as found in western Massachusetts) are particularly susceptible to flash flooding caused by rapid runoff that occurs in heavy precipitation events and in combination with spring snowmelt, which can contribute to riverine flooding. Frozen ground conditions can also contribute to low rainfall infiltration and high runoff events that may result in riverine flooding. Some of the worst riverine flooding in Massachusetts' history occurred as a result of strong nor'easters and tropical storms in which snowmelt was not a factor. Tropical storms can produce very high rainfall rates and volumes of rain that can generate high runoff when soil infiltration rates are exceeded.

Floodplains are the low, flat, and periodically flooded lands adjacent to rivers, lakes, and oceans. These areas are subject to geomorphic and hydrologic processes. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined. These areas form a complex physical and biological system that supports a variety of natural resources and flood storage.

Drainage-Related Flooding: Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and adjacent properties. They make use of a conveyance system that channels water away from a developed area to surrounding streams, bypassing natural processes of water infiltration into the ground, groundwater storage, and evapotranspiration. Flooding from overwhelmed drainage entails floods caused by increased water runoff due to development and drainage systems that are not capable of conveying high flows. Since drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding can occur more quickly and reach greater depths than if there were no urban development at all. In almost any community with some degree of development, basement, roadway, and infrastructure flooding can result in significant damage due to poor or insufficient stormwater drainage.

Ice Jam: An ice jam is an accumulation of ice that acts as a natural dam and restricts the flow of a body of water. A freeze-up jam usually occurs in early winter to midwinter during extremely cold weather when super-cooled water and ice formations extend to nearly the entire depth of the river channel. This type of jam can act as a dam and begin to back up the flowing water behind it. A breakup jam, forms as a result of the breakup of the ice cover at ice-out, causing large pieces of ice to move downstream, potentially piling up at culverts, around bridge abutments, and at curves in river channels. Breakup ice jams occur when warm temperatures and heavy rains cause rapid snowmelt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to a thickness great enough to raise the water level and cause flooding upstream of the obstruction.

Dam Overtopping: Dam overtopping is caused by floods that exceed the capacity of the dam, and it can occur as a result of inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors. Overtopping accounts for one-third of all dam failures in the U.S. The two primary types of dam failure are catastrophic failure (characterized by the sudden, rapid, and uncontrolled release of impounded water) and design failure (which occurs as a result of minor overflow events).

There are a number of ways in which climate change could alter the flow behavior of a river, causing conditions to deviate from what the dam was designed to handle. For example, more extreme precipitation events could increase the frequency of intentional discharges. Many other climate impacts, including shifts in seasonal and geographic rainfall patterns, could also cause the flow behavior of rivers to deviate from previous hydrographs. When flows are greater than expected, spillway overflow events (often referred to as "design failures") can occur. These overflows result in increased discharges downstream and increased flooding potential. Therefore, although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

Beaver Dams: Additional causes of flooding include beaver dams. Beaver dams obstruct the flow of water and cause water levels to rise. Significant downstream flooding can occur if beaver dams break. Alteration of the landscape by beavers is a natural process that creates habitat for shore birds, mammals, and rare amphibians. However, beaver ponds can flood structures, roads, and utilities, causing costly and potentially dangerous situations. Beaver activity can also pollute drinking water supplies. Mitigation measures suggested by Massachusetts Division of Fish and Wildlife (MassWildlife) and other agencies can help communities and homeowners deal with nature's master builders.

Until 1996, when a ballot initiative passed restricting the practice, Massachusetts residents were permitted to trap beavers. That change in policy caused a spike in the beaver population, which, in turn, led to a sharp increase in complaints about beaver activity and its effects. The law was modified in 2000 so that town Board of Health members could issue emergency trapping permission outside of the usual trapping season. State law makes it illegal for any person to disturb or tear open a beaver dam or beaver lodge without written permission from MassWildlife and the local Conservation Commission or Department of Environmental Protection. Permits are needed to disturb a beaver dam for any reason in Massachusetts. Even dams that cause flooding require permits to be breached.

Secondary Hazards: The most problematic secondary hazards for flooding are fluvial erosion, riverbank erosion, and landslides affecting infrastructure and other assets (e.g., agricultural fields) built within floodplains. Without the space required along river corridors for natural physical adjustment, such changes in rivers after flood events can be more harmful than the actual flooding. For instance, fluvial erosion attributed to Hurricane Irene caused an excess of $23 million in damages along the entirety of Route 2 in Massachusetts, including Charlemont. The impacts from these secondary hazards are especially prevalent in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging buildings, and structures closer to the river channel or cause them to fall in. Landslides can occur following flood events when high flows oversaturate soils on steep slopes, causing them to fail. These secondary hazards also affect infrastructure.

Roadways and bridges are impacted when floods undermine or wash out supporting structures. Dams may fail or be damaged, compounding the flood hazard for downstream communities. Failure of wastewater treatment plants from overflow or overtopping of hazardous material tanks and the dislodging of hazardous waste containers can occur during floods as well, releasing untreated wastewater or hazardous materials directly into storm sewers, rivers, or the ocean. Flooding can also impact public water supplies and the power grid in similar ways, through inundation and/or erosion.

Location

Heavy rainfall events occur regularly in Massachusetts. As a result, riverine flooding and drainage-related flooding affect the majority of the communities in the Commonwealth, including Charlemont. Dam failure has the potential to impact areas downstream of dams, including river corridors in Charlemont.

Previous Occurrences

The impacts of T.S. Irene of August 2011 were the last major flood event in Charlemont. According to the Town's previous edition of this plan, T.S. Irene brought heavy rain to the region, causing extensive and long-term damage to a number of Franklin County towns. According to the NWS, up to 9.9 inches of rain fell during the storm, though amounts varied significantly across Franklin County. Rivers, streams, and brooks throughout the county reached and surpassed flood levels. During T.S. Irene, the Deerfield River set a new flood record at 23.8 feet, greatly surpassing the previous record of 17.7 feet set in April of 1987. Rising water gathered debris that clogged culverts, roads and bridges were washed out, and homes and businesses were flooded, and in some cases washed downriver. Damage in Charlemont included:

- Hawlemont School, where the boiler room was flooded, and the property was covered with mud from the river.
- Indian Plaza building on Route 2 was inundated with water and mud from the river, causing the business to cancel all its scheduled events for the remainder of the year.
- Zoar Outdoor, located just west of the village center, suffered damage to a storage shed and some whitewater rafting equipment.
- Significant damage occurred along Route 2 towards the western border of town, where a seven-mile section was closed to traffic from the time of the storm until December 2011.
- In addition to Route 2, the Tower Road Bridge was closed, as well as several other sections of roadway in town.
- Rice Energy lost over 100 propane bottles.
- The filtration beds at the Charlemont Sewer District wastewater treatment facility were submerged under 4 feet of water, resulting in $900,000 in damages and the facility being off-line for 18 months after the storm.

After the storm, Franklin, Berkshire, Hampshire and Hampden Counties were declared a disaster area freeing up federal funds to assist towns with emergency work and road, bridge, and facility repairs.

As noted earlier, this plan update highlights major events from history but relies primarily on a ten-year lookback (2012 through 2021) ending with the date of plan development. From 2012 through 2021, none of the disaster declarations in Massachusetts that cover Franklin County were related to flood impacts. The NOAA Storm Events database (https://www.ncdc.noaa.gov/stormevents/) for Franklin County lists one flood event affecting Charlemont in that timeframe. On August 4, 2012, a "warm front moved north through southern New England producing scattered showers and thunderstorms across a very warm, humid environment. Route 2 was flooded with two feet of water. Firefighters trying to get to the Rowe Elementary School were delayed due to the flooding."

According to the previous edition of this plan, historical data from the U.S. Army Cold Regions Research and Engineering Laboratory show nine ice jams occurred along the Deerfield River between 1918 and 1959, with six of the jams in Charlemont. According to the previous edition of this plan, ice jams have occurred on the Deerfield River in recent years near the Crab Apple Whitewater Rafting company in East Charlemont but have not caused any damage.

Notwithstanding the relative quiet in the last ten years, flood risks have not decreased in Charlemont, and critical facilities remain at risk.

Although a specific event is not apparent, Rice Brook is causing flooding and erosion on private property in downtown Charlemont that may eventually threaten the Hawlemont School property, according to the previous edition of this plan. Flash flooding of the brook, and subsequent erosion of a hayfield on the private property, appeared to begin after extensive logging took place upstream, according to a resident. The largest impact occurred during Tropical Storm Irene, when a significant amount of land was gauged out by the brook. With each subsequent heavy rainfall, more land is eroded.

Extent

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) will be equaled or exceeded each year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the “100-year discharge” has a 1 percent chance of being equaled or exceeded in any given year. The “annual flood” is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The 1% annual chance flood is the standard used by most federal and state agencies. It is used by the National Flood Insurance Program (NFIP) to guide floodplain management and determine the need for flood insurance. The extent of flooding associated with a 1% annual probability of occurrence (the base flood or 100-year flood) is called the 100-year floodplain, which is used as the regulatory boundary by many agencies. Also referred to as the Special Flood Hazard Area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. The term “500-year flood” is the flood that has a 0.2% chance of being equaled or exceeded each year. Base flood elevations and the boundaries of the 1% annual chance (100-year) and the 0.2% annual chance (500-year) floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principal tools for identifying the extent and location of the flood hazard.

Both the 100-year and the 500-year floodplains are determined based on past events. As a result, the flood maps do not reflect projected changes in precipitation events.

Flooding in Massachusetts is forecast and classified by the NWS’s Northeast River Forecast Center as minor, moderate, or severe based upon the types of impacts that occur. Minor flooding is considered “disruptive” flooding that causes impacts such as road closures and flooding of recreational areas and farmland. Moderate flooding can involve land with structures becoming inundated. Major flooding is a widespread, life-threatening event. River forecasts are made at many locations in the state containing USGS river gauges with established flood elevations and levels that correspond to each of the degrees of flooding.

Due to the pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Flash flooding, which occurs when excessive water fills either normally dry creeks or riverbeds or dramatically increases the water surface elevation on currently flowing creeks and river, can be less predictable. However, potential hazard areas can be warned in advanced of potential flash-flooding danger. Flooding is more likely to occur due to a rainstorm when the soil is already wet and/or streams are already running high from recent previous rains. NOAA's Northeast River Forecast Center provides flood warnings for Massachusetts, relying on monitoring data from the USGS stream gauge network. Notice of potential flood conditions is generally available several days in advance. State agency staff also monitor river, weather, and forecast conditions throughout the year. Notification of potential flooding is shared among state agency staff, including the Massachusetts Emergency Management Agency (MEMA) and the Office of Dam Safety. The NWS provides briefings to state and local emergency managers and provides notifications to the public via traditional media and social networking platforms.

Dams are a special consideration within the Extent characterization for floods. Many dams in Massachusetts were built in the 19th Century without the benefit of modern engineering design and construction oversight. Dams can fail because of structural problems due to age and/or lack of proper maintenance. Dam failure can also be the result of structural damage caused by an earthquake or flooding brought on by severe storm events. The Massachusetts Department of Conservation and Recreation (DCR) 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). The DCR was also responsible for conducting dam inspections until 2002, when state law was changed to place the responsibility and cost of inspections on the owners of the dams. In accordance with the new regulations, which went into effect in 2005, dam owners must register, inspect, and maintain dams in good operating condition. The state has three hazard classifications for dams:

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

Owners of dams are required to hire a qualified engineer to inspect and report results using the following inspection schedule:

- High Hazard Potential dams – 2 years
- Significant Hazard Potential dams – 5 years
- Low Hazard Potential dams – 10 years

The time intervals represent the maximum time between inspections. More frequent inspections may be performed at the discretion of the state. Owners of High Hazard Potential dams and certain Significant Hazard Potential dams are also required to prepare, maintain and update Emergency Action Plans (EAPs). Dams and reservoirs licensed and subject to inspection by the Federal Energy Regulatory Commission (FERC) are excluded from the provisions of the state regulations provided that all FERC-approved periodic inspection reports are provided to the DCR. FERC inspections of high and significant hazard projects are conducted on a yearly basis. All other dams are subject to the regulations unless exempted in writing by DCR.

Probability of Future Events

The frequency of hazard events of disaster declaration proportions is defined by the number of federally declared disaster events for the Commonwealth over a specified period of time. The historical record indicates the Commonwealth has experienced 22 coastal and inland flood-related disaster declaration events from 1954 to 2017. In the northeast, precipitation has increased by 17% from the baseline level recorded in the period from 1901 to 1960 to present-day levels measured from 2011 to 2012. Therefore, based on these figures, the Commonwealth may experience a flood event of disaster declaration proportions approximately once every three years.

However, the frequency of flooding varies significantly based on watershed, riverine reach, and location along each reach. Additionally, it is important to note that floods of lesser magnitude occur at a much higher frequency. The SHMCAP notes that in the ten-year period 2007 to 2017, the NOAA Storm Events Database reports that there were 433 flood events in Massachusetts, which is an average of more than 43 floods per year. The Town of Charlemont should assume that the probability of future flood events is moderate to high.

According to information from the MA DCR Office of Dam Safety, no dams are located within Charlemont. The Charlemont Comprehensive Emergency Management (CEM) Plan also confirms there are no dams in Charlemont. Charlemont has not been impacted by a dam failure in recent history. However, the upstream dams on the Deerfield River owned by TransCanada and licensed by FERC are a significant concern to the Town. These include the Somerset Dam, the Harriman Dam, and the Sherman Dam, all of which are classified as High Hazard Dams. The Fife Brook Dam and the Bear Swamp Upper

Reservoir, owned by Brookfield Power, are also High Hazard dams. These will be addressed further in the vulnerability assessment. However, for the purpose of estimating the probability of future dam failure events, it is important to understand the rigorous reviews and regulations associated with FERC licensing. Failure of a FERC-licensed dam along the Deerfield River upstream of Charlemont is expected to have a very low probability.

Vulnerability Assessment

Exposure

In Charlemont, the 1% annual chance floodplain (100-year floodplain) covers about 815 acres, or approximately 5 percent of the town, including an estimated 22 acres of developed residential land. In addition to the 100- year floodplain, there are a number of streams in Charlemont with the potential to cause localized flooding. The Charlemont CEM Plan identifies the area within 200 feet of the Deerfield River as a flood prone area in town. Other key areas of concern that experience chronic flooding include the southern, flat section of Legate Hill Road, and sections of Route 2.

There are several critical facilities located in the 100-year floodplain shown in Table 7. A large flood could disrupt emergency services and utilities. Children in the Elementary School may need to be evacuated during an event. Visitors may be staying at one of the campgrounds located in the floodplain while the Mohawk Park Family Campground has recreational vehicles parked in the floodplain along the river.

Table 7. Critical Facilities in 100-Year Floodplain

Critical Facilities in 100-Year Floodplain	
Police Department	Department of Public Works
Fire Department	Sewer Plant
Hawlemont Regional Elementary School	Mohawk Park Family Campground
Crab Apple Whitewater Rafting	Country Aire Campground
Broadband Infrastructure	

There are over 200 other buildings in the floodplain in Charlemont. Table 8 shows the types of buildings exposed to the flood and their value. The number in parathesis shows the total number of buildings and building values for the Town.

Table 8. Buildings in 100-Year Floodplain

Building Type	**Number of Buildings (Total in Town)**	**Building Value (Total in Town)**
Single Family	57 (814)	$6,184,500 ($120,617,700)
Multi-Family	11 (110)	$2,117,100 ($24,506,700)
Commercial	7 (20)	$1,786,500 ($3,926,200)

Building Type	Number of Buildings (Total in Town)	Building Value (Total in Town)
Industrial	0 (1)	$0 ($110,300)
Multi-Use	112 (317)	$58,775,600 ($157,675,800)
Government	12 (26)	$1,091,700 ($2,864,300)
Educational	1 (3)	$5,268,400 ($6,025,000)
Religious	1 (9)	$267,100 ($1,856,500)
Total	**201 (1,300)**	**$75,490,900 ($317,582,500)**

The population exposed to the 100-year floodplain is shown in Table 9. The column in the left shows the population in and around the floodplain (wherever the Census Block overlapped with the floodplain boundary) while the column on the right shows the total population numbers for the Town. There is an older population exposed to the flood hazard.

Table 9. Population Exposed to 100-Year Floodplain (2020 U.S. Census)

Population in and Adjacent to Floodplain	Total Population
Population: 942	Population: 1,185
Households: 431	Households: 536
White: 888 (94.3%)	White: 1,076 (90.7%)
Black: 2 (0.3%)	Black: 2 (0.2%)
American Indian: 0 (0%)	American Indian: 3 (0.3%)
Asian: 4 (0.4%)	Asian: 9 (0.8%)
Other Race: 4 (0.4%)	Other Race: 11 (0.9%)
Two or More Races: 43 (4.6%)	Two or More Races: 84 (7.1%)
Hispanic or Latino: 15 (1.6%)	Hispanic or Latino: 36 (3.0%)
Population under 18: 139 (14.8%)	Population under 18: 186 (15.7%)
Population over 64: 438 (46.5%)	Population over 64: 542 (45.7%)
Annual Income < $30K/year: 115 (12.2%)	Annual Income < $30K/year: 143 (12.1%)
Population in EJ Zone: 373 (39.6%)	Population in EJ Zone: 547 (46.2%)

Although dams and their associated impoundments provide many benefits to a community, such as water supply, recreation, hydroelectric power generation, and flood control, 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 instantly released, oftentimes with catastrophic consequences as the water rushes in a torrent downstream flooding an area known 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.

For the flood hazard, the inundation areas identified in the high hazard dam Emergency Action Plan (EAP) were reviewed. The EAP identified inundation areas for both Sunny Day and Probably Maximum

Flood (PMF) conditions. Under both Sunny Day and PMF flooding scenarios, the village center in Charlemont would be completely inundated. Critical facilities that fall within the inundation area include the Hawlemont Regional Elementary School, the Charlemont Fire Station, Charlemont DPW and Police Station, Charlemont Wastewater Treatment Plant, Town Hall, and the Federated Church. Floodwaters would also reach a wide swath of land and structures south of the river, including the Berkshire East facilities at the base of the ski mountain. Route 2 and the railroad are both largely within the inundation area throughout the entire stretch of Charlemont. The Mohawk Park Campground is completely within the inundation area, as well as the whitewater rafting company Crab Apple Whitewater. Route 8A is inundated both south and north of the Deerfield River in the village center. Further east, the Charlemont Academy, one of the town's designated shelters, would also be inundated by floodwaters during either breach scenario.

Under PMF or Sunny Day conditions, flood waters from the breach would reach the western border of Charlemont (17 miles from the dam) in approximately 1 hour, with peak flooding occurring 1.6 hours after a breach. Water would reach the Route 8A bridge in the village center (22.3 miles from the dam) approximately 1.3 hours after a breach (slightly less time for a Sunny Day breach), with peak flooding occurring at 2.17 hours for both a PMF breach and Sunny Day breach. Table 10 shows the dams in Charlemont. There are additional significant and high hazard dams just outside Town Boundary which could impact the Town in the dam breach scenarios described above.

Table 10. Dams in Vicinity

Name	Ownership	Hazard Type
New England Power Co. #4 Dam	Private	High
J.A. Wells Upper Dam	Public (Town of Charlemont)	N/A
Cold River Swimming Pool Dam	Public (DCR)	N/A

The 100-year Floodplain (FEMA and USGS) with the Town's critical facilities is shown in Figure 6. Several of the critical facilities and other buildings are found in the 100-year floodplain.

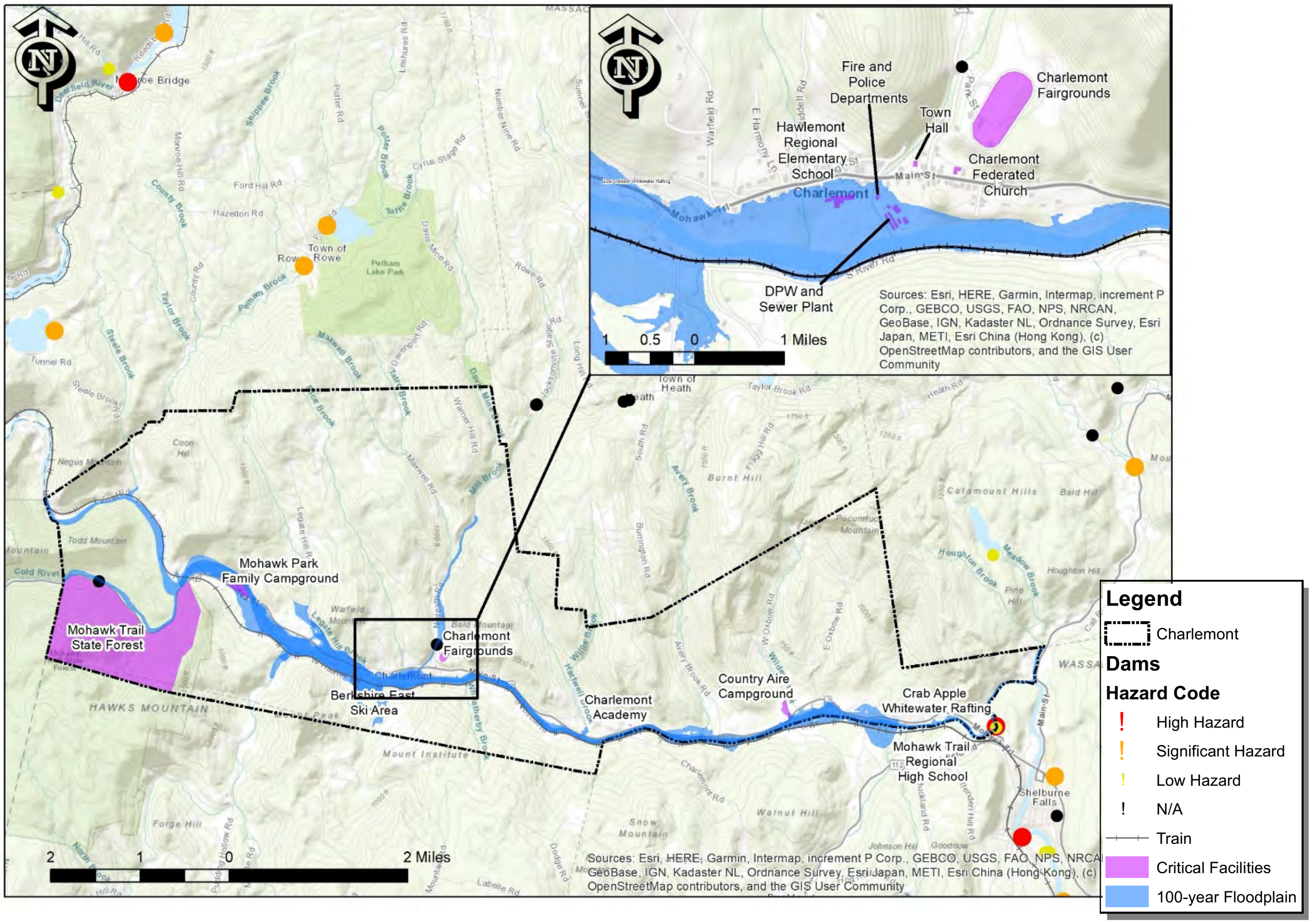


Figure 6. Charlemont Critical Facilities and 100-Year Floodplain

Built Environment Impacts

To identify built environment impacts to the Town, FEMA's risk assessment software, Hazus, was implemented. Building footprint data and parcel data was used to update the model while the latest floodplain was also integrated into the software. The economic loss results of the 100-year event are shown in Table 11. The Town's Average Annual Loss (AAL) is calculated to be $435,400.

Table 11. Building Loss for the 100-Year Flood Scenario

Loss Type	**Residential ($Million)**	**Commercial ($Million)**	**Other Occupancy ($Million)**	**Total ($Million)**
Building Loss	5.24	1.41	1.01	**7.66**
Content Loss	2.37	3.07	3.78	**9.22**

Loss Type	Residential ($Million)	Commercial ($Million)	Other Occupancy ($Million)	Total ($Million)
Business Inventory Loss	0.00	0.06	.06	**0.12**
Business Income Loss	0.09	2.08	0.67	**2.84**
Business Relocation Loss	0.87	0.15	0.43	**1.45**
Rental Income Loss	0.40	0.11	0.02	**0.53**
Wage Loss	0.21	2.05	19.46	**21.72**
Total	**9.17**	**8.93**	**25.43**	**43.54**

Population Impacts

The Town should be aware that senior and low-income segments of Charlemont's population may be more vulnerable to hazard events due to a number of factors. Senior and low-income populations may be physically or financially unable to react and respond to a hazard event and require additional assistance. Access to information about the hazard event may be lacking, as well as access to transportation in the case of an evacuation. The location and construction quality of housing can also pose a significant risk. Table 9 shows the number of senior and low-income residents in Charlemont. The town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence

Using the Hazus software, the 100-year flood scenario results showed that there would be about 50 displaced households and up to 5 people seeking shelter.

Environment Impacts

One of the major environmental impacts of a major flood would be the potential release of hazardous materials. Rail cars running along the Deerfield River containing hazardous materials including:

- Hydrocyanic Acid
- Hydrochloric Acid
- Chlorine
- Caustic soda
- Methanol
- Sodium chlorate
- Liquified Petroleum Gas (LPG)
- Sulfuric acid

Other sources of hazmat found in the floodplain include the Wastewater Treatment Plant (Chlorine) and Charlemont DPW (diesel, gasoline, salt, and sand).

Droughts

Droughts are typically defined as periods of deficient precipitation. How this deficiency is experienced can depend on factors such as land use change, the existence of dams, and water supply withdrawals or diversions. Droughts can vary widely in duration, severity, and local impact.

Description

The National Drought Mitigation Center references five common definitions of drought:

- Meteorological drought is a measure of departure of precipitation from normal.
- Hydrological drought is related to the effects of precipitation shortfalls on stream flows and on reservoir and groundwater levels.
- Agricultural drought links various characteristics of meteorological and hydrological drought to agricultural impacts and occurs when there is not enough water available for a particular crop to grow at a particular time.
- Socioeconomic drought is associated with the supply and demand of economic goods with elements of meteorological, hydrological, and agricultural drought.
- Ecological drought is an episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability and impacts ecosystem services.

Drought conditions can cause a shortage of water for human consumption and reduce local firefighting capabilities. Public water suppliers may struggle to meet system demands while maintaining adequate pressure for fire suppression and meeting water quality standards. The Massachusetts DEP requires all PWSs to maintain an emergency preparedness plan.

Private well owners can be vulnerable to droughts. With declining groundwater levels, well owners may experience dry wells or sediment in their water due to the more intense pumping required to pull water from the bedrock or overburden aquifer. Wells may also develop a concentration of pollutants, which may include nitrates and heavy metals depending on local geology.

The loss of clean water for consumption and for sanitation may be a significant impact depending on the affected population's ability to quickly drill a deeper or a new well or to relocate to unaffected areas. During a drought, dry soil and the increased prevalence of wildfires can increase the amount of irritants (such as pollen or smoke) in the air. Reduced air quality can have widespread deleterious health impacts, but is particularly significant to the health of individuals with pre-existing respiratory health conditions like asthma (CDC).

Lowered water levels can result in direct environmental health impacts, as the concentration of contaminants in swimmable bodies of water will increase when less water is present. Harmful algal blooms may occur, closing recreational areas.

One primary hazard in this plan that is commonly associated with drought is wildfire. A prolonged lack of precipitation dries out soil and vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. A drought may increase the probability of a wildfire occurring.

Location

Parts of Massachusetts can experience significantly different weather patterns due to topography, distance from coastal influence, as well as a combination of regional, national, and global weather patterns. As a result, the Massachusetts Drought Management Plan (DMP) assesses drought conditions in six regions: Western, Connecticut River Valley, Central, Northeast, Southeast, and Cape and Islands. A regional approach allows customization of drought actions and conservation measures to address particular situations in each region; and allows for the determination of a drought on a watershed basis. Droughts have the potential to impact the entirety of Charlemont.

Previous Occurrences

The Commonwealth of Massachusetts has never received a Presidential Disaster Declaration for a drought-related disaster. However, several substantial droughts have occurred over the past 100 years. Massachusetts experienced its most significant drought on record in the 1960s. The severity and duration of the drought caused significant impacts on both water supplies and agriculture.

Although short or relatively minor droughts occurred over the next 50 years, the next long-term event began in March 2015, when Massachusetts began experiencing widespread abnormally dry conditions. In July 2016, based on a recommendation from the Drought Management Task Force (DMTF), the Secretary of EOEEA declared a Drought Watch for Central and Northeast Massachusetts and a Drought Advisory for Southeast Massachusetts and the Connecticut River Valley. Drought warnings were issued in five out of six drought regions of the state. Many experts stated that this drought was the worst in more than 50 years. DMTF declared an end to the drought in May 2017 with a return to wetter-than-normal conditions.

USDA declares agricultural disasters as needed for a variety of hazards. Information can be found at https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index. The events related to droughts in Franklin County are listed below.

Year	Event	Event Begin Dates
2020	Drought	5/26/2020, 6/1/2020, 8/18/2020, 9/29/2020

Year	Event	Event Begin Dates
2018	Drought	7/15/2018, 7/17/2018
2016	Drought	4/26/2016
2016	Drought, wildfire, excessive heat, high winds, insects	7/5/2016
2015	Drought	2/1/2015

Figure 7. Drought History.

The drought of 2020 was the so-called "flashy drought" that impacted southern New England. Flashy droughts are described below.

USDA payments to Massachusetts agricultural sectors for drought impacts associated with the event of 2015-2017 originated from the livestock forage program; the emergency assistance for livestock, bees, and fish; the emergency conservation program; and the non-insured assistance program. A figure for Charlemont was not available.

The severity of a drought depends on the degree of moisture deficiency, duration, spatial extent and location relative to resources or assets. The drought of the 1960s is the drought of record because duration, spatial extent, moisture deficiency, and impact all contributed to historic levels. The severity of the 2016-2017 drought is due to impacts on natural resources (record low stream flows and groundwater levels), many water supplies, farms, and agriculture and to the swift onset of the drought.

Extent

Drought is defined by a combined look at several indices as detailed in the Massachusetts DMP (EOEEA and MEMA, 2013). The indices are:

- SPI for 3-, 6-, and 12-month time periods
- Precipitation as a percent of normal (or historic average) for 2-, 3-, 6-, and 12-month time periods
- Crop Moisture Index
- Keetch-Byram Drought Index
- Groundwater levels
- Stream flow
- Reservoir levels

These indices are analyzed on a monthly basis to generate hydrological conditions report and used to determine the onset, severity, and end of droughts. Five levels of increasing drought severity are defined in the DMP: *Normal, Advisory, Watch, Warning,* and *Emergency*. The drought levels are associated with actions outlined in the DMP. Recommendations of drought levels are made by the DMTF to the Secretary of the EOEEA, who then declares the drought level for each region of the state.

Other entities may measure drought conditions by these or other criteria more relevant to their operations. For example, water utilities may calculate the days of supply remaining. Farmers may assess soil moisture and calculate the water deficit for specific plants to determine irrigation needs or decide to change their crop based on the deficit or harvest early for non-irrigated crops.

The five drought levels in the 2013 DMP provide a basic framework for taking actions to assess, communicate, and respond to drought conditions. Under the “Normal” condition, data are routinely collected, assessed, and distributed. When drought conditions are identified, the four drought levels escalate moving to heightened action, which may include increased data collection and assessment, interagency communication, public education and messaging, recommendations for water conservation measures, and a state of emergency issued by the Governor. At the “Emergency” level, mandatory water conservation measures may be enacted. These regionally declared drought levels and associated state actions are intended to communicate and provide guidance to the public and stakeholders across industries to enable them to respond early and effectively and to reduce impacts. Individual public water suppliers may have their own drought management plan, drought levels, and associated actions, which they may follow at all levels except at the Emergency level when mandatory actions may be required.

Droughts develop over long periods of time relative to other hazards. However, flashy droughts are changing these norms (AMS, 2017). Flashy droughts may develop quickly or quickly intensify a developing or existing drought. The 2016-2017 drought is an example. Dry conditions from late 2015 lingered through the winter, with scattered groundwater levels reporting below normal and less than normal snowpack heading into spring 2016. Impacts were first seen in March 2016 in stream flows, groundwater levels, and reservoirs showing the long-term deficit. Then, as precipitation dramatically dropped below normal from June through September 2016, the entire state experienced record low stream flows and groundwater levels.

NOAA and others are advancing the science of early warning for droughts similar to the early warnings for floods and earthquakes to better project flash droughts. Based on projected climate change, the distributions of precipitation events will continue to become more extreme, with periods of minimal rain alternating with extreme rain events. Therefore, developing ways to project and adapt to flash droughts may be critical for sectors such as agriculture and water supply.

The Massachusetts Water Resources Commission publishes the hydrologic condition report monthly, which includes the seven drought indices and the National Climate Prediction Center’s U.S. Monthly and Seasonal Drought Outlooks. The National Drought Mitigation Center produces a weekly Drought Monitor map. In accordance with the DMP, drought declarations are made on a monthly basis.

Probability of Future Events

Using data collected since 1850, the probability of the precipitation index of the DMP exceeding the threshold at each drought level was calculated. On a monthly basis over the 162-year period of record from 1850 to 2012, there is a 2% chance of being in a drought warning level.

Table 12. Frequency of Drought Events Exceeding the Precipitation Index of the DMP.

Level	Frequency Since 1850	Probability in Any Given Month
Emergency	5 occurrences	1% chance
Warning	5 occurrences	2% chance
Watch	46 occurrences	8% chance
Source: EOEEA and MEMA		

The likely range of consecutive dry days per year is projected to increase by up to nearly 20 days per year in 2090, compared to the annual statewide baseline of approximately 16 days per year from 1971 to 2001. Table 4-16 indicates the projected number of consecutive dry days according to the "high" and "low" limits of the Northeast Climate Adaptation Science Center (NE CASC) data.

Table 13. Projected Continuous Dry Days by Planning Year.

Planning Year	2030	2050	2070	2100
Projected Range of Consecutive Dry Days	16.44-17.94	16.34-18.64	15.94-18.94	16.34-19.64
Source: resilient MA, 2018				

These projections suggest that the average time between rain events is likely to remain fairly constant; however, individual drought events could still increase in frequency and severity.

Vulnerability Assessment

Droughts can affect agriculture, water supply, aquatic ecology, wildlife, and plant life.

Exposure

Drought is a gradual phenomenon, and its condition occurs naturally in a broad geographic area. The entire Town would be exposed to drought conditions.

Built Environment Impacts

Major water users are more susceptible to drought, and these include water utilities, farmers using irrigated agriculture, mining operations, and some commercial users.

Population Impacts

Populations considered most vulnerable to drought impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard. Homeowners with a shallow well could also be more vulnerable to a drought. Table 9 summarizes the senior and low-income populations in Charlemont. It should be noted that there may be overlap within the two categories, so that the total number of persons exposed may be lower than what is shown in the table. However, the Town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

Socioeconomic impacts of the drought may also include anxiety and depression about economic impact, health problems associated with poor water quality, fewer recreational activities, higher incidents of heat stroke, and even loss of human life.

Environment Impacts

Some agriculture found in Franklin County may be more susceptible to drought. Typically, agriculture with a small or immature root system is more susceptible. Farmers not incorporating rotational grazing, deep-rooted legumes into pastures, warm-season perennial, and annual grasses into grazing system, and utilizing commodities (brewer's grain, corn gluten, and soybean hulls) to extend pastures and stock are more at risk to drought.

Drought also amplifies the risk of loss of biodiversity and affects animal and plant species. Economic impacts include reductions of income to farmers, and higher food and lumber prices. Drought can shrink the food supplies of animals and plants dependent on water and damage their habitats. Sometimes the environmental damage caused by a drought is temporary, and other times it is irreversible.

The insured losses for Franklin County were identified to be $774,106 over 22 years (USDA) for an AAL of $35,187. Droughts in 2010 and 2016 resulted in more than $400K in losses mostly to apples, corn, and potatoes. Instead of using a population index to identify the Town losses from the County losses, a land index was developed, Charlemont Land/Franklin County Land = 0.036. This results in a Charlemont loss of $27,868.

Landslides

The term "landslide" includes a wide range of ground movements such as rock falls, deep failure of slopes, and shallow debris flows. The most common types of landslides in Massachusetts include translational debris slides, rotational slides, and debris flows. Most of these events are caused by a combination of unfavorable geologic conditions (silty clay or clay layers contained in glaciomarine, glaciolacustrine, or thick till deposits), steep slopes, and/or excessive wetness leading to excess pore pressures in the subsurface.

Description

Historical landslide data for the Commonwealth suggests that most landslides are preceded by higher-than-normal precipitation, followed by a single, high-intensity rainfall of several inches or more (Mabee and Duncan, 2013). This precipitation can cause slopes to become saturated. Landslides associated with slope saturation occur predominantly in areas with steep slopes underlain by glacial till or bedrock. Bedrock is relatively impermeable relative to the unconsolidated material that overlies it. Similarly, glacial till is less permeable than the soil that forms above it. Thus, there is a permeability contrast between the overlying soil and the underlying, and less permeable, unweathered till and/or bedrock. Water accumulates on this less permeable layer, increasing the pore pressure at the interface, leading to a failure or slide.

Occasionally, landslides occur as a result of geologic conditions and/or slope saturation. Adverse geologic conditions exist wherever there are lacustrine or marine clays, as clays have relatively low strength. These clays often formed in the deepest parts of the glacial lakes that existed in Massachusetts following the last glaciation. These lakes include Bascom, Hitchcock, Nashua, Sudbury, Concord, and Merrimack, among many other unnamed glacial lakes. When oversteepened or exposed in excavations, these vulnerable areas often produce classic rotational landslides.

Landslides can also be caused by external forces, including both undercutting (due to flooding or wave action) and construction. Undercutting of slopes during flooding or coastal storm events is a major cause of property damage. Streams and waves erode the base of the slopes, causing them to oversteepen and eventually collapse.

Location

In 2013, the Massachusetts Geological Survey and University of Massachusetts Amherst published a Slope Stability Map of Massachusetts. This project, funded by the FEMA Hazard Mitigation Grant Program, was designed to provide statewide mapping and identification of landslide hazards that can be used for community level planning as well as prioritizing high-risk areas for mitigation. The maps produced from this project should be viewed as a first-order approximation of potential landslide hazards across the state.

The Slope Stability Map categorizes areas of Massachusetts into stability zones, and the categorization is correlated to the probability of instability in each zone. The probability of instability metric indicates how likely each area is to be unstable, based on the parameters used in the analysis. According to the map, these unstable areas are located throughout the Commonwealth. However, the highest prevalence of unstable slopes is generally found in the western portion of the Commonwealth, including the area around Mount Greylock and the nearby portion of the Deerfield River, the U.S. Highway 20 corridor near Chester, as well as the main branches of the Westfield River. Landslide risk is therefore assumed present throughout Charlemont.

Previous Occurrences

Nationwide, landslides constitute a major geologic hazard because they are widespread, occur in all 50 states and cause approximately $1 billion to $2 billion in damages and more than 25 fatalities on average each year. In Massachusetts, landslides tend to be more isolated in size and pose threats to highways and structures that support fisheries, tourism, and general transportation.

Landslides commonly occur shortly after other major natural disasters, such as earthquakes and floods, which can exacerbate relief and reconstruction efforts. Many landslide events may have occurred in remote areas, causing their existence or impact to go unnoticed. Expanded development and other land uses may contribute to the increased number of landslide incidences and/or the increased number of reported events in the recent record.

T.S. Irene caused landslides in western Massachusetts and specifically in Charlemont. Mabee (2012) published the work entitled "Geomorphic Effects of Tropical Storm Irene on Western Massachusetts: Landslides and Fluvial Erosion along the Deerfield and Cold Rivers, Charlemont and Savoy" which is referenced extensively in the SHMCAP. This report and associated mapping describe a 5.8-mile section of Route 2 in Charlemont and Florida that was undermined and collapsed due to the floods associated with T.S. Irene. The reported cost of temporary repairs was $33.5 million.

According to the previous edition of this plan, minor landslides have occurred in Charlemont along Route 8A near the intersection with South River Road due to poor drainage. There is also a regular problem along Route 8A North near the town line, where the slope adjacent to the road often falls into the road. Additionally West Oxbow Road subsided approximately two feet due to saturation of the soil during Tropical Storm Irene. The road has reportedly been repaired.

Extent

Variables that contribute to the extent of potential landslide activity in any particular area include soil properties, topographic position and slope, and historical incidence. Predicting a landslide is difficult, even under ideal conditions. As a result, estimations of the potential severity of landslides are informed by previous occurrences as well as an examination of landslide susceptibility. Information about previous landslides, such as the information and images from landslides after T.S. Irene can provide insight as to both where landslides may occur and what types of damage may result. It is important to note, however, that landslide susceptibility identifies only areas potentially affected and does not imply a time frame when a landslide might occur. The distribution of susceptibility across the Commonwealth is depicted on the Slope Stability Map, with areas of higher slope instability considered to also be more susceptible to the landslide hazard.

Characterizing the warning time before landslides can be challenging. Mass movements can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material, and water content. Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine the areas that are at risk during general time periods. Assessing the geology, vegetation, and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis and respond after the event has occurred. Generally accepted warning signs for landslide activity include the following:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements, or sidewalks
- Soil moving away from foundations
- Ancillary structures, such as decks and patios, tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken waterlines and other underground utilities
- Leaning telephone poles, trees, retaining walls, or fences
- Offset fence lines
- Sunken or down dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels even though rain is still falling or has just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together

Probability of Future Events

The probability of future occurrences is defined by the number of events over a specified period of time. The SHMCAP notes that from 1996 to 2012, eight noteworthy events triggered one or more slides in the Commonwealth. However, because many landslides are minor and occur unobserved in remote areas, the true number of landslide events is probably higher. The SHMCAP estimated that about 30 or more landslide events occurred in the period between 1986 and 2006. This roughly equates to one to three landslide events each year in Massachusetts.

Vulnerability Assessment

Exposure

While landslides are rare, their impacts can be devastating, including loss of property, disruption to infrastructure, and injury and death. Continued development, particularly on steep slopes or unstable soils, increases the chances that landslides will be a danger. Other associated concerns are debris management issues including debris removal and identification of disposal sites.

To help identify potential landslide areas for the Town, the slope stability index developed by the Massachusetts Geological Survey was used. The unstable and moderately unstable regions were queried out of the data and overlaid with the critical facilities and other buildings. Table 14 shows the critical facilities found in the moderately unstable area. It should be noted that none of the buildings were found in the moderately unstable areas, but parts of the campgrounds, fairground, and park were identified in these areas. There were no critical facilities found in the unstable areas.

Table 14. Critical Facilities in Moderately Unstable Area

Critical Facilities in Unstable Areas	
Foolhardy Hill Campground (Some Areas Unstable)	Charlemont Fairgrounds (Some Areas Moderately Unstable)
Mohawk Park Family Campground (Some Areas Moderately Unstable)	Mohawk Trail State Forest (Some Areas Moderately Unstable)

The other building data was overlaid with the unstable and moderately unstable areas. Table 15 shows the result of this analysis. No buildings were found in the unstable area. Forty-nine buildings, mostly single-family homes, were found in the moderately unstable area. There were four mobile homes found in these areas and they are usually very susceptible to landslides.

Table 15. Buildings in Moderately Unstable Area

Building Type	Number of Buildings (Total in Town)	Building Value (Total in Town)
Single-Family	39 (814)	$5,356,200 ($120,617,700)
Mobile Home	4 (51)	$376,900 (5,714,400)
Multi-Use	3 (317)	$627,200 ($157,675,800)
Government	3 (26)	$535,800 ($2,864,300)
Total	**49**	**$6,896,100**

Nearly all the Census Blocks including those that have been identified as environmental justice concerns contain moderately unstable areas.

Figure 8 shows the landslide susceptibility map for the Town. The red and pink areas are more susceptible to landslides.

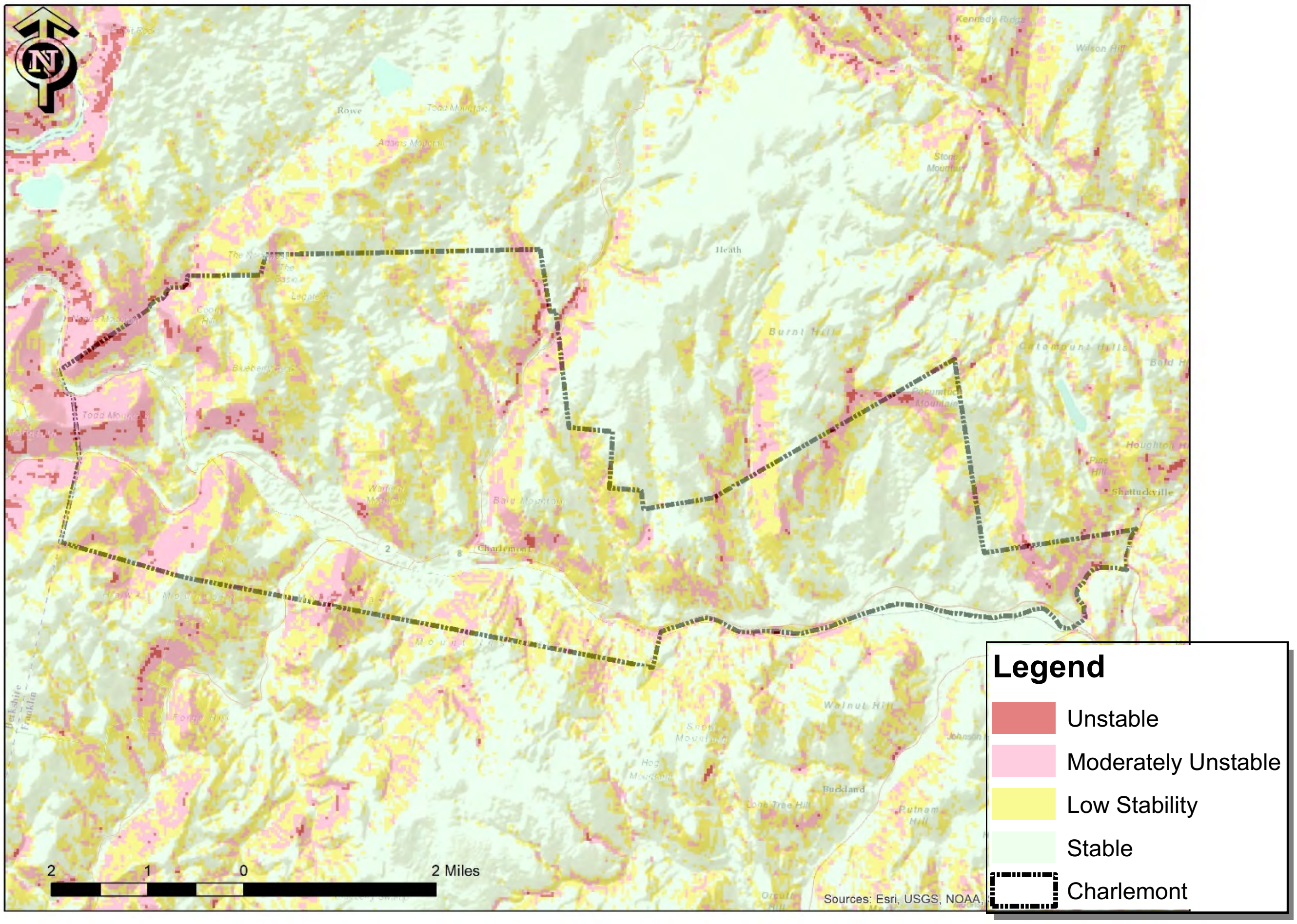


Figure 8. Landslide Susceptibility Map

Built Environment Impacts

Historic data for landslide events indicate that between 1993 and 2022, no landslide events were recorded in Charlemont. Still, there is a likelihood even if it's slight. Reviewing the buildings at higher risk, they are fairly spread out across the Town making an event damaging more than one property unlikely. We'll assume a total loss for a building due to a 100-year landslide event. The average value of a building in the moderately susceptible zone is $140,737. This would result in an AAL of $1,407.

Population Impacts

Populations considered most vulnerable to landslide impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 9 summarizes the senior and low income populations in Charlemont. The town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

Environment Impacts

There are unstable and moderately unstable areas uphill from the train tracks. Rail runs along the Deerfield River and sometimes contains hazardous materials including:

- Hydrocyanic Acid
- Hydrochloric Acid
- Chlorine
- Caustic soda
- Methanol
- Sodium chlorate
- Liquified Petroleum Gas (LPG)
- Sulfuric acid

Primary Climate Change Interaction: Changing Temperatures

Extreme Temperatures

There is no universal definition for extreme temperatures. The term is relative to the usual weather in the region based on climatic averages. According to the SHMCAP, extreme heat for Massachusetts is usually defined as a period of three or more consecutive days above 90 degrees Fahrenheit (°F), but more generally as a prolonged period of excessively hot weather which may be accompanied by high humidity. Extreme cold is also considered relative to the normal climatic lows in a region. Extreme cold temperatures are characterized by the ambient air temperature dropping to approximately 0°F or below. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.

Description

Extreme cold is a dangerous situation that can result in health emergencies for susceptible or vulnerable people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat. Extreme cold events are events when temperatures drop well below normal in an area. When winter temperatures drop significantly below normal, staying warm and safe can become a challenge. Extremely cold temperatures often accompany a winter storm, which may also cause power failures and icy roads. During cold months, carbon monoxide may be high in some areas because the colder weather makes it difficult for car emission control systems to operate effectively, and temperature inversions can trap the resulting pollutants closer to the ground.

Likewise, extreme heat is a dangerous situation that can result in health emergencies for susceptible and vulnerable people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without adequate cooling.

A heat wave is defined as 3 or more days of temperatures of 90°F or above. A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population. Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. According to the SHMCAP, more than 9,000 Americans have died from heat-related ailments (EPA, 2016) since the 1970s.

Heat impacts can be particularly significant in urban areas. Buildings, roads, and other infrastructure replace open land and vegetation. Dark-colored asphalt and roofs also absorb more of the sun's energy. These changes cause urban areas to become warmer than the surrounding areas. This forms "islands" of higher temperatures, often referred to as "heat islands." Even in a rural town like Charlemont, heat island impacts can develop along developed transportation corridors. Heat islands can affect communities by increasing peak energy demand during the summer, air conditioning costs, air pollution and GHG emissions, heat-related illness and death, and water quality degradation (EPA).

Many conditions associated with heat waves or more severe events (including high temperatures, low precipitation, strong sunlight and low wind speeds) contribute to a worsening of air quality in several ways. High temperatures can increase the production of ozone from volatile organic compounds and other aerosols. Weather patterns that bring high temperatures can also transport particulate matter air pollutants from other areas of the continent. Additionally, atmospheric inversions and low wind speeds allow polluted air to remain in one location for a prolonged period of time (UCI, 2017).

Location

According to the NOAA, Massachusetts is made up of three climate divisions: Western, Central, and Coastal. Average annual temperatures vary slightly over the divisions, with annual average temperatures of around 46°F in the Western division (area labeled "1" in the figure), 49°F in the Central division (area labeled "2" in the figure) and 50°F in the Coastal division (area labeled "3" in the figure). Charlemont is located in the Western division. Because extreme temperature events occur more frequently and vary more in the inland regions where temperatures are not moderated by the ocean, Charlemont is believed at risk.

Previous Occurrences

<u>Extreme Cold</u>: The SHMCAP notes that since 1994, there have been 33 cold weather events within the Commonwealth, ranging from Cold/Wind Chill to Extreme Cold/Wind Chill events.

<u>Extreme Heat</u>: The SHMCAP notes that according to the NOAA's Storm Events Database (accessed in March 2018 for that planning process) there have been 43 warm weather events (ranging from Record Warmth/Heat to Excessive Heat events) since 1995. The most current event in the database occurred in July 2013. Excessive heat results from a combination of temperatures well above normal and high

humidity. Whenever the heat index values meet or exceed locally or regionally established heat or excessive heat warning thresholds, an event is reported in the database.

In 2012, Massachusetts temperatures broke 27 heat records. Most of these records were broken between June 20 and June 22, 2012, during the first major heat wave of the summer to hit Massachusetts and the East Coast. In July 2013, a long period of hot and humid weather occurred throughout New England. One fatality occurred on July 6, when a postal worker collapsed as the Heat Index reached 100°F.

The NOAA Storm Events database (https://www.ncdc.noaa.gov/stormevents/) for Franklin County does not list any extreme heat events for Charlemont in the timeframe 2012-2021. This could reflect a lack of extreme heat reporting in Franklin County. Cold events are typically reported with winter storms, and will be described in the winter storm section of this chapter.

USDA declares agricultural disasters as needed for a variety of hazards. Information can be found at https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index. The events related to extreme temperatures in Franklin County are listed below.

Year	Event	Event Begin Dates
2019	Extreme cold, temperature fluctuations	12/1/2018
2019	Excessive rain, below normal temps.	4/1/2019
2016	Frost/freeze	2/14/2016
2016	Drought, wildfire, excessive heat, high winds, insects	7/5/2016
2016	Frost/freeze, unseasonably warm temps.	2/1/2016
2014	Cold, frost/freeze	12/1/2013
2013	Extreme heat, excessive humidity	5/8/2013

Figure 9. Agricultural Disasters.

Extent

Extreme Cold: The extent (severity or magnitude) of extreme cold temperatures is generally measured through the Wind Chill Temperature Index. Wind Chill Temperature is the temperature that people and animals feel when they are outside, and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body loses heat at a faster rate, causing the skin's temperature to drop. The NWS issues a Wind Chill Advisory if the Wind Chill Index is forecast to dip to –

15°F to – 24°F for at least 3 hours, based on sustained winds (not gusts). The NWS issues a Wind Chill Warning if the Wind Chill Index is forecast to fall to –25°F or colder for at least 3 hours. On November 1, 2001, the NWS implemented a Wind Chill Temperature Index designed to more accurately calculate how cold air feels on human skin. Figure 4-42 shows the Wind Chill Temperature Index.

Extreme Heat: The NWS issues a Heat Advisory when the NWS Heat Index is forecast to reach 100 to 104°F for 2 or more hours. The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105°F or higher for 2 or more hours. The NWS Heat Index is based both on temperature and relative humidity and describes a temperature equivalent to what a person would feel at a baseline humidity level. It is scaled to the ability of a person to lose heat to their environment. The relationship between these variables and the levels at which the NWS considers various health hazards to become relevant are shown in Figure 4-43. It is important to know that the heat index values are devised for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can increase the risk of heat-related impacts.

Probability of Future Events

The SHMCAP notes that Massachusetts averaged 2.4 declared cold weather events and 0.8 extreme cold weather events annually between January 2013 and October 2017. The year 2015 was a particularly notable one, with seven cold weather events, including three extreme cold/wind chill events, as compared to no cold weather events in 2012 and one in 2013. The SHMCAP notes that an average of between four and five heat waves occur annually in Massachusetts.

There are a number of climatic phenomena that determine the number of extreme weather events in a specific year. However, there are significant long-term trends in the frequency of extreme hot and cold events. In the last decade, U.S. daily record high temperatures have occurred twice as often as record lows (as compared to a nearly 1:1 ratio in the 1950s). Models suggest that this ratio could climb to 20:1 by midcentury, if GHG emissions are not significantly reduced (C2ES, n.d.).

The NE CASC data support the trends of an increased frequency of extreme hot weather events and a decreased frequency of extreme cold weather events. High, low, and average temperatures in Massachusetts are all likely to increase significantly over the next century as a result of climate change. The graphics below (from resilient MA, 2018) show the projected annual days with maximum temperature above 90 degrees and projected annual days with minimum temperature below 32 degrees.

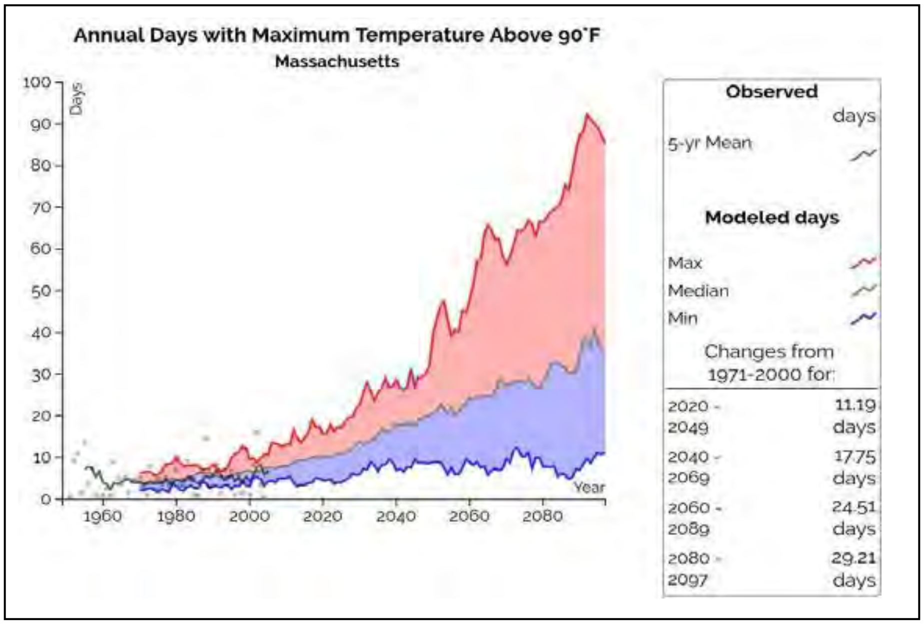


Figure 10. Annual Days with Temps above 90⁰.

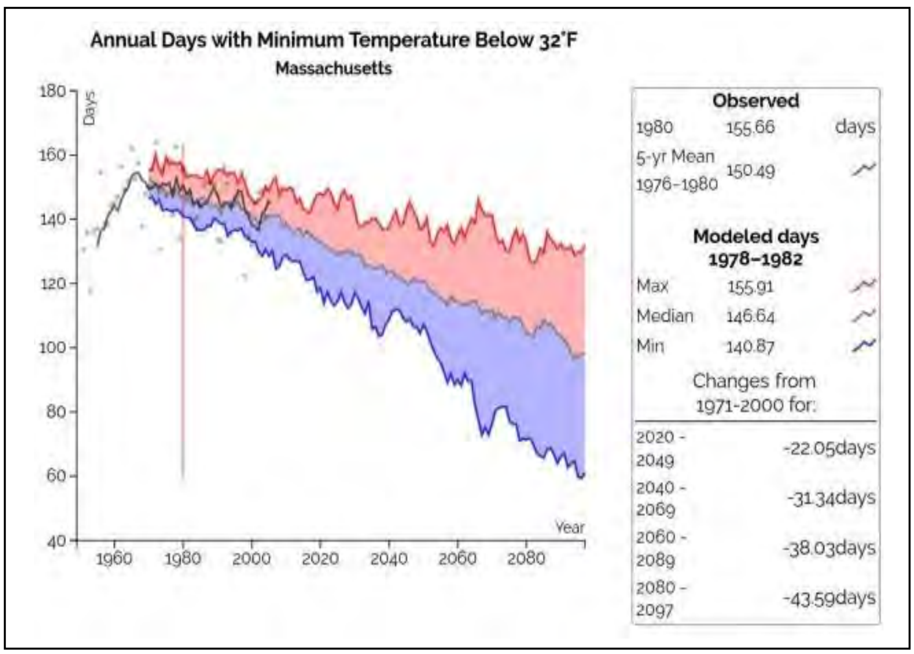


Figure 11. Annual Days with Low Temps.

Vulnerability Assessment

Exposure

Extreme temperatures are not a hazard with a defined geographic boundary. The entire Town should be considered exposed to the hazard. Excessive heat can occur at any time during the year but is most dangerous during the summer between June and August when average temperatures are at their highest.

Built Environment Impacts

The impact of excessive heat is most prevalent in urban areas, where the Town lacks a tree canopy. Secondary impacts of excessive heat are severe strain on the electrical power system and potential brownouts or blackouts. Extreme heat can have a negative impact on transportation. Highways and roads are damaged by excessive heat as asphalt roads soften and concrete roads expand and can buckle, crack, or shatter. Moreover, concrete has been known to "explode," lifting chunks of concrete and putting those nearby at serious risk. Stress is also placed on automobile cooling systems, diesel trucks, and railroad locomotives which lead to an increase in mechanical failures. Steel rails are at risk of overheating and warping which can lead to train derailments.

Extreme cold weather poses a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperatures drop and stay low, increased demand for heating places a strain on the heating system, which can lead to temporary outages. These outages can impact operations throughout the campus, which can result in interruptions and delays in services. Broken pipes may cause flooding in buildings, causing property damage and loss of utility service. Some of the secondary effects presented by extreme/excessive cold include dangerous conditions to livestock and pets.

Population Impacts

Extreme cold events are predicted to decrease in the future, while extreme heat days, as well as average temperatures are projected to increase. The projected increase in extreme heat and heat waves is the source of one of the key health concerns related to climate change. Prolonged exposure to high temperatures can cause heat-related illnesses, such as heat cramps, heat exhaustion, heat stroke, and death. Heat exhaustion is the most common heat-related illness and if untreated, it may progress to heat stroke. People who perform manual labor, particularly those who work outdoors, are at increased risk for heat-related illnesses. Prolonged heat exposure and the poor air quality and high humidity that often accompany heat waves can also exacerbate pre-existing conditions, including respiratory illnesses, cardiovascular disease, and mental illnesses.

The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life threatening. Body temperatures that are too low affect the brain, making it difficult for the victim to think clearly or move well. This makes hypothermia particularly dangerous for those suffering from it, as they may not understand what is happening to them or what to do about it. Hypothermia is most likely at very cold temperatures but can occur at higher temperatures (above 40 degrees Fahrenheit) if the person exposed is also wet from rain, sweat, or submersion. Warning signs of hypothermia include shivering, exhaustion, confusion, fumbling hands, memory loss, slurred speech, or drowsiness. In infants, symptoms include bright red, cold skin and very low energy. A person with hypothermia should receive medical attention as soon as possible, as delays in medical treatment may result in death.

Older adults are often at elevated risk due to a high prevalence of pre-existing and chronic conditions. In Franklin 11.9% of the population is over age 65. People who live in older housing stock and in housing without air conditioning have increased vulnerability to heat-related illnesses. Power failures are more likely to occur during heat waves, affecting the ability of residents to remain cool during extreme heat. Individuals with pre-existing conditions and those who require electric medical equipment may be at increased risk during a power outage. Heat impacts are more likely to be felt by residents without air conditioning, by those who work outdoors, and those with underlying health conditions.

Extreme heat can pose severe and life-threatening problems for people. According to the NWS, it is one of the leading weather-related killers in the United States, resulting in hundreds of fatalities each year and even more heat-related illnesses. Extreme heat has a special impact on the most vulnerable segments of the population - the elderly, young children and infants, impoverished individuals, and persons who are in poor health. The high-risk population groups with specific physical, social, and economic factors that make them vulnerable include:

- Older persons (age > 65)
- Infants (age < 1)
- Homeless population
- Very low- and low-income persons
- People who are socially isolated
- People with mobility restrictions or mental impairments
- People taking certain medications (e.g., for high blood pressure, depression, insomnia)
- People engaged in vigorous outdoor exercise or work or those under the influence of drugs or alcohol.

Environment Impacts

- County insured agricultural losses: $37,043 from 2000 to 2021. (USDA)
- Average annualized drought loss ~$1,700/year
- 2018 resulted in $28K of losses
- Crops most impacted were apples and other (non-specified)

In the agriculture community, livestock, such as rabbits, poultry, pigs, and cows are severely impacted by heat waves. Ill-timed high temperatures inhibit crop yields and wheat, corn, and other yields can all be significantly reduced by extreme high temperatures at key development stages.

The insured losses caused by extreme temperatures for Franklin County were identified to be $37,043 over 22 years (USDA) for an AAL of $1,684. Extreme temperatures in 2018 resulted in more than $28K in losses mostly to apples and non-specified crops. Instead of using a population index to identify the Town losses from the County losses, a land index was developed, Charlemont Land/Franklin County Land = 0.036. This results in a Charlemont loss of $61.

Wildfires

A wildfire can be defined as any non-structure fire that occurs in vegetative wildland that contains grass, shrub, leaf litter, and forested tree fuels. Wildfires in Massachusetts are caused by natural events, human activity, or prescribed fire. Wildfires often begin unnoticed but spread quickly, igniting brush, trees, and potentially homes.

Description

The wildfire season in Massachusetts usually begins in late March and typically culminates in early June, corresponding with the driest live fuel moisture periods of the year. April is historically the month in which wildfire risk is the highest. Drought, snowpack level, and local weather conditions can impact the length of the fire season.

According to FEMA, there are three different classes of wildland fires: surface fires, ground fires and crown fires. The most common type of wildland fire is a surface fire that burns slowly along the floor of a forest, killing or damaging trees. A ground fire burns on or below the forest floor and is 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.

According to the National Fire Protection Agency, several elements (known as the fire tetrahedron) must be present in order to have any type of fire:

- Fuel: Without fuel, a fire will stop. Fuel can be removed naturally (when the fire has consumed all burnable fuel) or manually by mechanically or chemically removing fuel from the fire. In structure fires, removal of fuel is not typically a viable method of fire suppression. Fuel separation is important in wildfire suppression and is the basis for controlling prescribed burns and suppressing other wildfires. The type of fuel present in an area can help determine overall susceptibility to wildfires. According to the Forest Encyclopedia Network, four types of fuel are present in wildfires:

    - Ground Fuels: organic soils, forest floor duff, stumps, dead roots, buried fuels
    - Surface Fuels: the litter layer, downed woody materials, dead and live plants to 2 meters tall
    - Ladder Fuels: vine and draped foliage fuels
    - Canopy Fuels: tree crowns

- Heat: Without sufficient heat, a fire cannot begin or continue. Heat can be removed through the application of a substance, such as water, powder, or certain gases, that reduces the amount of heat available to the fire. Scraping embers from a burning structure also removes the heat source.
- Oxygen: Without oxygen, a fire cannot begin or continue. In most wildland fires, this is commonly the most abundant element of the fire triangle and is therefore not a major factor in suppressing wildfires.
- Uninhibited Chain Reaction: The chain reaction is the feedback of heat to the fuel to produce the gaseous fuel used in the flame. In other words, the chain reaction provides the sustained heat necessary to maintain the fire. Fire suppression techniques, such as dry chemical extinguishers, break up the uninhibited chain reaction of combustion to stop a fire.

Location

According to the SHMCAP, the ecosystems that are most susceptible to the wildfire hazard are pitch pine, scrub oak, and oak forests, as these areas contain the most flammable vegetative fuels. Other portions of the Commonwealth are also susceptible to wildfire, particularly at the urban-wildland interface.

Due to its rural, forested characteristics and linear patterns of development, the entirety of Charlemont is believed at risk of wildfires. Indeed, the MVP-funded resiliency plan for Charlemont notes that "The Town of Charlemont is particularly vulnerable to wildfires and brush fires, given that 84 percent of land in Town is wooded. Also, some State-owned land, like that in Mohawk Trail State Forest, is hard to get to, especially given the lack of maintenance on State-owned roads. In addition, the village center is vulnerable to fast-moving fires that could have the potential to adversely impact key Town infrastructure and many homes of town residents."

Previous Occurrences

Several notable wildfires have occurred in Massachusetts history, although none has ever resulted in a FEMA disaster declaration. Smaller fires such as brush fires are somewhat easier to characterize. According to statewide data sets (https://www.mass.gov/service-details/fire-data-and-statistics), the number of brush fire events per year from 2012 through 2019 ranged from about 3,000 in 2019 to almost 8,000 in the drought year of 2016.

Year	Total # of Events	Injuries/deaths (civilians and fire service)	Losses
2019	2,974	12/0	$136,357

2018	3,253	1/5	$493,145
2017	4,206	20/0	$215,156
2016	7,834	40/0	$1,526,654
2015	6,962	35/0	$323,211
2014	4,627	25/0	$209,857
2013	4,968	31/3	$297,854
2012	5,857	38/0	$705,457

Figure 12. Brush Fire Statistics.

In Charlemont, fire event counts back to 2012 were as follows:

Year	Total Outdoor Fires	Total Fire Events	Reported Losses
2019	0	0	--
2018	0	0	--
2017	2	5	--
2016	5	7	--
2015	8	16	--
2014	2	3	$3,000
2013	2	8	--
2012	0	1	--

Figure 13. Charlemont Fire Events.

According to the previous edition of this plan, the Charlemont Fire Department reported a total of 15 brush fires between 2004 and 2010. A comparison of this figure with the above table generally shows that brush fire frequency has either not changed significantly, or increased slightly during the drought of 2015-2017 before dropping in 2018-2019.

Extent

Unfragmented and heavily forested areas of the state are vulnerable to wildfires, particularly during droughts. The greatest potential for significant damage to life and property from fire exists in areas designated as wildland-urban interface areas. A wildland-urban interface area defines the conditions where highly flammable vegetation is adjacent to developed areas.

Fires can be classified by physical parameters such as their fireline intensity, or Byram's intensity, which is the rate of energy per unit length of the fire front (BTU [British thermal unit] per foot of fireline per second) (NPS, n.d.). Wildfires are also measured by their behavior, including total heat release during burnout of fuels (BTU per square foot) and whether they are crown-, ground-, or surface-burning fires. Following a fire event, the severity of the fire can be measured by the extent of mortality and survival of plant and animal life aboveground and belowground and by the loss of organic matter (NPS, n.d.).

The National Wildfire Coordinating Group defines seven classes of wildfires:

- Class A: 0.25 acre or less
- Class B: more than 0.25 acre, but less than 10 acres
- Class C: 10 acres or more, but less than 100 acres
- Class D: 100 acres or more, but less than 300 acres
- Class E: 300 acres or more, but less than 1,000 acres
- Class F: 1,000 acres or more, but less than 5,000 acres
- Class G: 5,000 acres or more

Early detection of wildfires is a key part of the overall efforts of the Massachusetts Bureau of Fire Control. Early detection is achieved by trained Bureau observers who staff the statewide network of 42 operating fire towers. During periods of high fire danger, the Bureau conducts county-based fire patrols in forested areas. These patrols assist cities and towns in prevention efforts and allow for the quick deployment of mobile equipment for suppression of fires during their initial stage. If a fire breaks out and spreads rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

Probability of Future Events

It is difficult to predict the likelihood of wildfires in a probabilistic manner because a number of factors affect fire potential and because some conditions (e.g., ongoing land use development patterns, location, and fuel sources) exert changing pressure on the wildland-urban interface zone. However, based on the frequency of past occurrences, the Town should anticipate at least one wildfire or brush fire each year.

Conducting public outreach and education about forest management to reduce fire hazards was another of the highest priority recommendations identified by participants in the MVP process. Best practices that might be encouraged include maintaining logging/fire roads in forested areas and cleaning up dead trees resulting from invasive pests and drought conditions that could serve as fuel in a wildfire.

Vulnerability Assessment

While wildland fires have not been a significant problem in Charlemont, there is always a possibility that changing land use patterns and weather conditions will increase a community's vulnerability. For example, drought conditions can make forests and other open, vegetated areas more vulnerable to ignition. Once the fire starts, it will burn hotter and be harder to extinguish.

Exposure

To help identify potential wildfire areas for the Town, the U.S. Forest Service's Wildfire Risk to Communities spatial data was downloaded. This data was developed in 2020 using the vegetation and wildland fuels from the LANDFIRE 2014 model with the burn probability coming from the Forest Service Fire Simulation System (FSim). To create a product with a finer resolution, the data was upsampled to the native 30m resolution of the LANDFIRE fuel and vegetation data spreading the values of the modeled burn probability into developed areas represented in LANDFIRE fuels as non-burnable. The areas with a .02% and .01% probability of burning were identified and overlaid with the critical facilities and other buildings. Table 16 shows the critical facilities found in the .01% area. No critical facilities were found in the .02% area.

Table 16. Critical Facilities in 0.01% Wildfire Areas

Critical Facilities in Unstable Areas	
Foolhardy Hill Campground (Some Areas Unstable)	Charlemont Fairgrounds (Some Areas Moderately Unstable)
Mohawk Park Family Campground (Some Areas Moderately Unstable)	Mohawk Trail State Forest (Some Areas Moderately Unstable)

The other building data was overlaid with the .02% areas. Table 17 shows the result of this analysis. Six buildings, all single-family homes, were found in area with a .02% probability.

Table 17. Buildings in 0.02% Annual Chance Area

Building Type	**Number of Buildings (Total in Town)**	**Building Value (Total in Town)**
Single Family	6 (814)	$1,598,600 ($120,617,700)

The population exposed to the 0.02% probability area is shown in Table 18. The column in the left shows the population in and around the 0.02% probability wildfire area (wherever the Census Block overlapped with the wildfire area) while the column on the right shows the total population numbers for the Town. There is an older population exposed to the wildfire hazard and a high percent of the EJ community.

Table 18. Population Exposed to 0.02% Annual Chance Wildfire (2020 U.S. Census)

Population in and Adjacent to 0.02% Wildfire Area	Total Population
Population: 367	Population: 1,185
Households: 174	Households: 536
White: 343 (93.5%)	White: 1,076 (90.7%)
Black: 0 (0%)	Black: 2 (0.2%)
American Indian: 0 (0%)	American Indian: 3 (0.3%)
Asian: 2 (0.5%)	Asian: 9 (0.8%)
Other Race: 1 (0.3%)	Other Race: 11 (0.9%)
Two or More Races: 21 (5.7%)	Two or More Races: 84 (7.1%)
Hispanic or Latino: 6 (1.6%)	Hispanic or Latino: 36 (3.0%)
Population under 18: 43 (11.7%)	Population under 18: 186 (15.7%)
Population over 64: 174 (47.4%)	Population over 64: 542 (45.7%)
Annual Income < $30K/year: 115 (31.3%)	Annual Income < $30K/year: 143 (12.1%)
Population in EJ Zone: 237 (64.6%)	Population in EJ Zone: 547 (46.2%)

Figure 14 shows the burn probability map from the USFS overlaid on the Town.

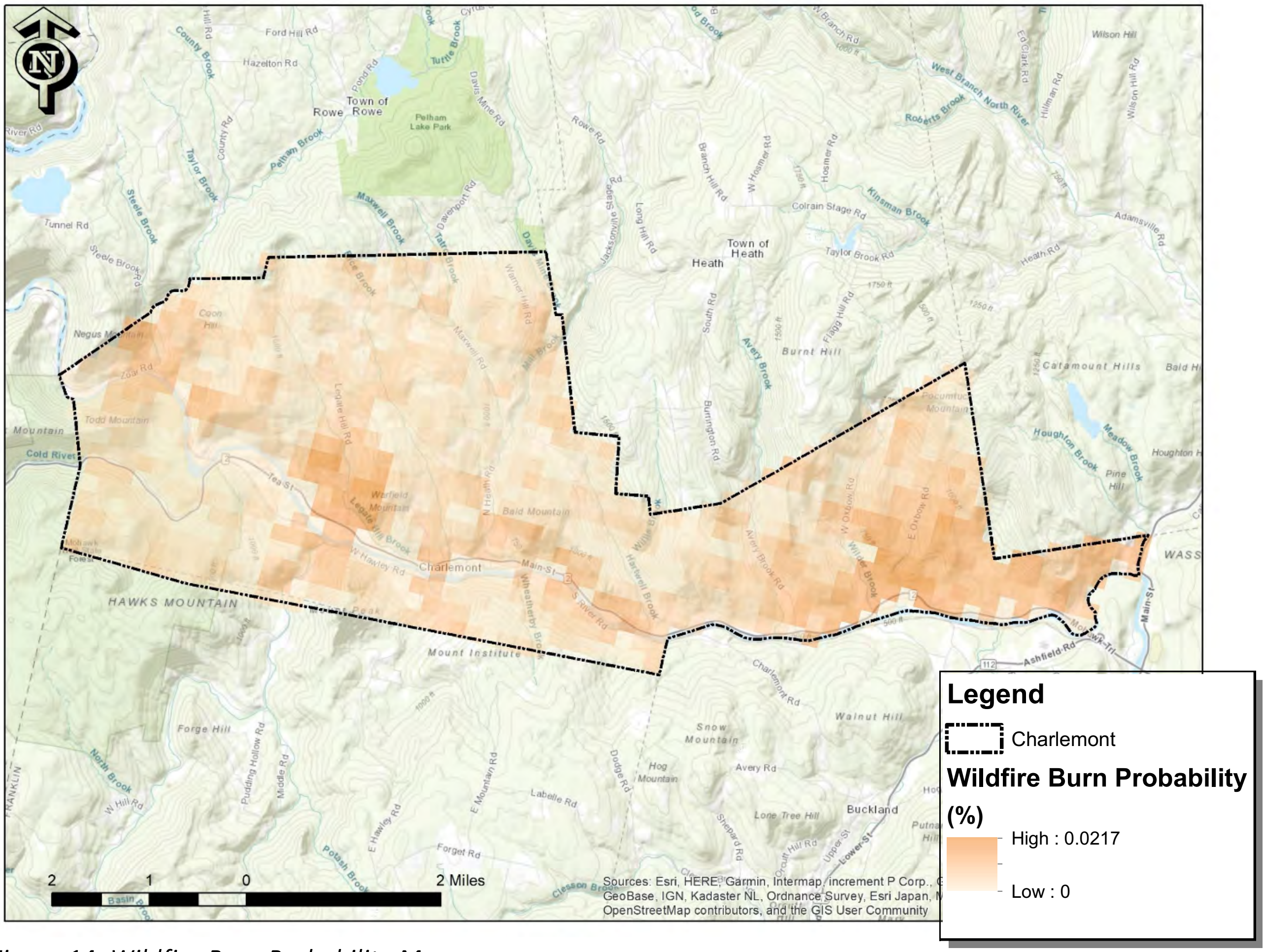


Figure 14. Wildfire Burn Probability Map

Built Environment Impacts

A major out-of-control wildfire can damage property, utilities and forested land; create smoke that can cause breathing problems; and injure or kill people. Other associated concerns are debris management issues including debris removal and identification of disposal sites.

No property damage, injuries or deaths have been recorded for the reported brushfires in Charlemont between 2004 and 2022. Using the wildfire probabilities and building values, a loss estimate was produced for the 0.02% scenario. The losses are shown in Table 19 and the AAL will be $480.

Table 19. Building Loss for a 0.02% Annual Chance Scenario

Loss Type	**Residential ($Million)**	**Commercial ($Million)**	**Other Occupancy ($Million)**	**Total ($Million)**
Building Loss	$1.6	$0	$0	**$1.6**
Content Loss	$0.8	$0	$0	**$0.8**
Total	**$2.4**	**$0**	**$0**	**$2.4**

Population Impacts

Populations considered most vulnerable to wildfire impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 18 summarizes the senior and low-income populations in Charlemont. The town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

Environment Impacts

Many of the natural features in the Town are susceptible to wildfire including the trees, agriculture, livestock, and parks. Agriculture not directly burned by the fire can suffer from smoke taint.

Infectious Diseases

The SHMCAP does not address infectious diseases as a profiled hazard. While major disease outbreaks are uncommon, public health emergencies can become standalone disasters that compound the threat of other natural hazards and exceed local and state capacity. Precedent for federal assistance due to public health emergencies has been set including West Nile Virus (2000), a mosquito-borne disease, for which a federal emergency declaration was made in New York and New Jersey; and the COVID-19 pandemic, which resulted in a major disaster declaration in all states, territories, and the District of Columbia. Given that COVID-19 has resulted in excessive public expenditures and resulted in a disaster declaration, and considering heightened concerns about tick and mosquito-borne illnesses, this plan addresses infectious diseases.

Description

Public health risks, such as those presented by infectious diseases and vector-borne illnesses, are present within every community. An infectious disease is one that is caused by micro-organisms, such as bacteria, viruses, and parasites. A vector-borne illness is an infectious disease that is transmitted to humans by blood-feeding arthropods, including ticks, mosquitoes, and fleas, or in some cases by mammals (e.g., rabies). Infectious diseases cause illness, suffering and even death, and place an enormous financial burden on society.

Most infectious diseases are caused by pathogens that can be spread, directly or indirectly, from person to person. Such diseases may be seasonal (seasonal influenza) or result, in the case of new diseases, result in a global pandemic. Infectious disease dynamics depend on a range of factors, including land use, human behavior, climate, efficacy of healthcare services, population dynamics of vectors, population dynamics of intermediate hosts and the evolution of the pathogens themselves. Many of these diseases require continuous monitoring, as they present seasonal threats to the general population.

A communicable disease is an illness caused by an infectious agent or its toxic products that develops when the agent or its product is transmitted from an infected person, animal, or arthropod to a susceptible host. Infectious agents include viruses, bacteria, fungi, parasites, or aberrant proteins called prions. The infectious agent might spread by one of several mechanisms, including contact with the infected individual or his or her bodily fluids, contact with contaminated items or a vector, or contact with droplets or aerosols. An infection, which is the actual spread of the infectious agent or its toxic product, is not synonymous with disease because an infection may not lead to the development of clinical signs or symptoms.

Influenza (flu) spreads mainly from person to person by droplets from the nose or throat that are released when an infected person coughs or sneezes. It happens every year and is more common in the fall and winter. An estimated 19 million influenza illnesses occur in the United States each year. People at highest risk for flu-related complications include children younger than 5 years (especially those younger than 2 years old), adults 65 years of age and older, pregnant women, and people who have certain medical conditions such as asthma, heart disease, chronic lung disease, kidney disease, or weakened immune systems due to disease or medication.

In Massachusetts, state public health officials rely on local boards of health, healthcare providers, laboratories, and other public health personnel to report the occurrence of notifiable diseases as required by law. An epidemic emerges when an infectious disease occurs suddenly in numbers that are more than normal expectancy. Infectious disease outbreaks put a strain on the healthcare system and may cause continuity issues for local businesses. These outbreak incidents are a danger to emergency responders, healthcare providers, schools, and the public. This can include influenza (e.g., H1N1), pertussis, West Nile virus, and many other diseases. A pandemic is an epidemic that has spread over a large area, that is, it is prevalent throughout an entire country, continent, or the whole world.

On March 11, 2020, the World Health Organization (WHO) officially declared the Coronavirus disease 2019 (COVID-19) outbreak a pandemic due to the global spread and severity of the disease. COVID-19 is a respiratory illness that can spread from person to person. COVID-19 is a highly contagious, viral upper respiratory illness that was first detected in China in late 2019. The virus quickly spread throughout the world and has resulted in a global pandemic ongoing at the time of this plan. COVID-19 symptoms include cough, difficulty breathing, fever, muscle pain, and loss of taste or smell. Severe cases may result in death, especially in individuals over the age of 65 or with underlying medical conditions, such as diabetes, lung disease, asthma, obesity, or those who are immunocompromised. COVID-19 spreads from person to person through respiratory droplets in the air or on surfaces.

Location

The entire Commonwealth of Massachusetts and Town of Charlemont are considered at risk to the infectious diseases addressed in this chapter.

Previous Occurrences

Pandemic influenza episodes that were considered to be global outbreaks spread were observed in 1918, 1957, 1968, and in 2009 with the novel H1N1 strain. The 2009 H1N1 outbreak, though not considered a serious threat, still affected some residents in Massachusetts with nearly 2,000 confirmed cases and 33 deaths. The great influenza epidemic of 1918 killed millions worldwide and would likely cause hundreds to thousands of deaths in Massachusetts should a similar outbreak occur today. It is anticipated that a more serious strain of the usual flu will occur some year and that vaccines might not be ready in time to combat rapid spread.

The most significant recent occurrence of infectious disease for Charlemont is that of COVID-19. Approximately 2 million cases and 21,000 deaths have been reported in Massachusetts. As of the end of June 2022, approximately 12,200 cases and 150 deaths were reported for Franklin County. The federal designation for the Massachusetts Covid-19 Pandemic is DR-4496-MA, with incident period January 20, 2020, and continuing. The Major Disaster Declaration was issued March 27, 2020.

Vector-borne diseases continue to pose a significant threat to communities across Massachusetts. Blacklegged (deer) ticks and dog ticks are found throughout Massachusetts and may spread different diseases. The most common tick-borne diseases in Massachusetts are Lyme Disease, Babesiosis, and Anaplasmosis. Other diseases that are rare, but still occur, are Tularemia, Rocky Mountain spotted fever, Borrelia miyamotoi, and Powassan virus. Tickborne figures for Franklin County are available at https://www.mass.gov/lists/monthly-tick-borne-disease-reports; a summary for the last three calendar years is provided below.

Table 20. Tickborne Statistics.

Year	Emergency Department Visits	Number of Tick-Borne Disease Visits	Rate (per 10,000) of Tick-borne Disease Visits
2021	32,684	61	18.66

Year	Emergency Department Visits	Number of Tick-Borne Disease Visits	Rate (per 10,000) of Tick-borne Disease Visits
2020	27,635	37	13.39
2019	31,801	48	15.09

Mosquito-borne diseases are also a seasonal threat. West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE or "Triple E") are viruses that occur in Massachusetts and can cause illness ranging from a mild fever to more serious disease like encephalitis or meningitis. Other diseases spread by mosquitoes may affect people when traveling in other regions of the world such as Zika virus, Dengue fever, and Chikungunya.

Extent

Well-established scales for characterizing total impacts of infectious diseases are not present for applied uses such as a hazard mitigation plan. Nevertheless, commonly accepted methods are in place for characterizing active transmission, such as color scales (yellow, orange, red). Future editions of this plan will provide updates to measures of extent. Johns Hopkins continues to provide a very comprehensive dashboard of information for all regions of the U.S. including Massachusetts. County-level data can also be accessed (https://coronavirus.jhu.edu/region/us/massachusetts).

Probability of Future Events

Probability of infectious disease in the planning area is extremely variable. Many public health risks occur seasonally and are ongoing, such as the common cold and influenza. Major disease outbreaks such as the current COVID-19 pandemic are much less common but can last for long periods. Based on the information available regarding occurrences of greatest concern, the infectious disease hazard has been assigned a probability of likely for the foreseeable future.

The COVID-19 pandemic has the potential to continue to some degree over the next several years, even as vaccines continue to be developed are distributed. The Town of Charlemont is continually updating community mitigation measures and guidance in close consultation with Massachusetts Department of Public Health and based on new information from the CDC.

The effects of climate change will result in an increase in the probability and/or frequency of some infectious diseases. Those infectious diseases that are currently present in Massachusetts and which may be exacerbated by climate change are already exhibiting increased prevalence in New England. For example, with both temperature and precipitation expected to increase in Massachusetts, West Nile Virus mosquito vector activity will likely increase, as well as the vector's period of activity. Similarly, between 1964 and 2010, counts of Eastern Equine Encephalitis (EEE) have continued to rise in New England, though they remain constant in the southeastern states.

The United States is already seeing a significant increase in vector-borne infectious diseases. According to the CDC, the number of reported disease cases from mosquito, tick, and flea bites tripled from 2004 to 2016, and mosquito-borne disease epidemics are happening more frequently. Annual cases of Lyme disease have increased over the last decade, and with shrinking winters, the potential for infection through tick bite continues to grow. Given increasing trends for global travel, several other diseases not typically observed in Massachusetts could continue to make their way back to the state through infected travelers. COVID-19 is the most recent and severe example of this threat. Another example is the Zika virus, transmitted from infected mosquitoes to humans, which received international attention during an outbreak in 2015 and persists today.

Vulnerability Assessment

Exposure

The risk associated with communicable disease in the region has not been formally quantified, due to the difficulty in predicting specific occurrences, and the lack of complete data on impacts. However, the potential risk and impact of communicable diseases is often presumed to be very high in the chaos that follows natural disasters (WHO, 2006).

Natural disasters, particularly meteorological and geological events such as hurricanes, floods, and earthquakes, can bring about serious health consequences. These disasters can affect vector breeding sites and vector-borne disease transmission. In a flood hazard area, initial flooding may wash away existing mosquito breeding sites, but standing water caused by heavy rainfall or overflow of rivers can create new breeding sites. This can result (with typically some weeks delay) in an increase of the vector population and potential for disease transmission, depending on the local mosquito vector species and its preferred habitat. The crowding of infected and susceptible hosts, a weakened public health infrastructure and interruptions of ongoing control programs are all risk factors for vector-borne disease transmission.

The major causes of communicable disease from natural disasters can be categorized into four areas: Infections due to contaminated food and water, respiratory infections, vector, and insect borne diseases, and infections due to wounds and injuries. The most common causes of morbidity and mortality in this situation are diarrheal disease and acute respiratory infections.

- Waterborne diseases: Diarrheal disease outbreaks can arise subsequent to drinking water contamination and have been reported after flooding and related movement. Hepatitis A and E have fecal-oral transmission in areas with poor water sanitation.
- Diseases associated with crowding: Acute respiratory infections are the main cause of morbidity and mortality among unsettled people and are seen predominantly in children less than 5 years old.

- Vector-borne diseases: The most common vector-borne diseases are carried by mosquitoes and ticks and include Lyme Disease, Rocky Mountain Spotted Fever, West Nile Virus, and Eastern equine encephalitis. Environmental changes after disaster could increase vector breeding sites and proliferation of disease vectors.
- Infections due to wounds and injuries: The potentially significant threats to persons suffering a wound are tetanus, staphylococci, and streptococci.

Built Environment Impacts

All human-occupied critical facilities are assumed to be at risk of contamination from a communicable disease. If facilities supporting emergency response lost their functionality because of contamination, delays in emergency services could result. Additionally, with a significant human disease outbreak, resources of health care systems such as ambulance services, hospitals, and medical clinics could quickly become overwhelmed. In most cases, critical infrastructure would not be affected by communicable disease. Scenarios that would affect infrastructure include the contamination of the water supplies and diseases that require special provisions in the treatment of wastewater. Should an epidemic necessitate quarantine or incapacitate a significant portion of the population, support of and physical repairs to infrastructure may be delayed, and services may be disrupted for a time due to limitations in getting affected employees to work.

Population Impacts

High death counts during a natural disaster (either human or animal) can indicate an increased risk of outbreaks associated with the size, health status, and living conditions of the population displaced by the natural disaster. Crowding, inadequate water and sanitation, and poor access to health services, often characteristic of sudden population displacement, increase the risk of communicable disease transmission.

Populations that are vulnerable to communicable diseases include the economically disadvantaged, racial and ethnic minorities, the uninsured, low-income children, the elderly, the homeless, and those with other chronic health conditions, including severe mental illness. It may also include rural residents, who often encounter barriers to accessing healthcare services, transportations, or the internet.

Environment Impacts

Infectious diseases can also impact livestock and other animals. Some of the most common communicable diseases include Eastern Equine Encephalitis, Equine Herpes Virus, West Nile Virus, and Avian Influenza. While Zoonotic diseases (those transmissible between humans and animals or via an animal vector) are also a concern for the region, those events are best addressed in a pandemic or contagious disease plan rather than this hazard mitigation plan.

Invasive Species

According to the SHMCAP, invasive species are defined as non-native species that cause or are likely to cause harm to ecosystems, economies, and/or public health (NISC 2006). The focus of this section is on invasive terrestrial plants, as this is the most studied and managed typed of invasive; information for invasive aquatic flora and fauna (including marine species) is also provided when relevant.

Description

The Massachusetts Invasive Plant Advisory Group (MIPAG), a collaborative representing organizations and professionals concerned with the conservation of the Massachusetts landscape, is charged by EOEEA to provide recommendations to the Commonwealth to manage invasive species. MIPAG defines invasive plants as "non-native species that have spread into native or minimally managed plant systems in Massachusetts, causing economic or environmental harm by developing self- sustaining populations and becoming dominant and/or disruptive to those systems." These species have biological traits that provide them with competitive advantages over native species, particularly because in a new habitat they are not restricted by the biological controls of their native habitat. As a result, these invasive species can monopolize natural communities, displacing many native species and causing widespread economic and environmental damage.

MIPAG recognized 69 plant species as "Invasive," "Likely Invasive," or "Potentially Invasive." The criteria for an “Invasive” species are listed below; the other assigned categories are associated with lower scores on the criteria checklist. The criteria for invasive animal species are less well-defined, but many of the same characteristics (including a non-Massachusetts origin and the ability to out-compete native species) are similar. To be considered “Invasive” by MIPAG, a plant species must meet the following criteria:

- Be nonindigenous to Massachusetts.
- Have the biologic potential for rapid and widespread dispersion and establishment in minimally managed habitats.
- Have the biologic potential for dispersing over spatial gaps away from the site of introduction.
- Have the biologic potential for existing in high numbers away from intensively managed artificial habitats.
- Be naturalized in Massachusetts (persists without cultivation in Massachusetts).
- Be widespread in Massachusetts or at least common in a region or habitat in the state.
- Have many occurrences of numerous individuals in Massachusetts that have high numbers of individuals forming dense stands in minimally managed habitats.
- Be able to outcompete other species in the same natural plant community.

- Have the potential for rapid growth, for high seed or propagule production and dissemination, and for establishment in natural plant communities.

Some examples of invasive insect species include:

- Nantucket Pine Tip Moth (native pest) is a moth with heads, bodies, and appendages covered with gray scales with mottled rusty-red markings. Larvae causes damage to young trees (up to five years old) by feeding inside growing shoots, buds, and conelets. The preferred host is the loblolly pine.
- Bark Beetles (native pest) include more than 600 species of beetles which serve in important ecological roles in small numbers where they live in dead, weakened, and dying host conifer trees.
- Forest Tent Caterpillar (native pest) has the biggest footprint of any indigenous tent caterpillar in North America (Furniss and Carolin 1977) and is a major defoliator of a variety of deciduous hardwood trees. The caterpillars spin silken mats on the trunks and large branches of trees where they molt and feed. Forest Tent Caterpillars can reach outbreak proportions causing massive defoliation of host trees and becoming a nuisance to people
- Pine Reproduction Weevils (native pest) is a very dark, elongate, oval insect up to 1/2 inch long with indistinct to distinct gray or pale orange spots of scales on the wings and thorax. They feed at night on the conifer seedlings or near the tips of branches of larger plants. Females lay their eggs on the roots of these trees. The weevils breed in all species of pines, hemlocks, junipers, spruces, firs, and cedars.
- Hardwood Borers (native pest) usually attack hardwoods experiencing some kind of stress although the clear-wing moths attack healthy trees. These insects attack the tree year after year and may eventually weaken it enough that it is prone to wind breakage. Some borers develop in the root system damaging young trees.
- Hemlock Wooly and Balsam Wooly Adelgid (non-native pest) is a very small, invasive, aphid-like insect that attacks North American hemlocks (Hemlock Wooly) and firs (Balsam Wooly). They can be identified by the white woolly masses that form on the underside of branches at the base of the tree's needles. They stay at this location for the rest of their lives. Their feeding disrupts the flow of nutrients to the tree twigs and needles leading to a decline in tree health and mortality in 4 to 10 years.
- Gypsy Moth (non-native pest) is an insect which feeds on a large variety of tree leaves from oak, maple, apple, crabapple, hickory, basswood, aspen, willow, birch, pine, spruce, hemlock, and others. It does prefer oak tree leaves, however. Periodically, large populations can cause defoliation damaging and killing trees they are feeding on.
- Spotted Lanternfly (non-native pest) is an invasive insect first detected in the U.S. in 2014. It feeds on a variety of fruit, ornamental, and wood trees and could seriously impact the grape, orchard, and logging industries.

Location

The damage rendered by invasive species is significant. Experts estimate that about 3 million acres within the U.S. are lost each year to invasive plants (Pulling Together, 1997, from Mass.gov “Invasive Plant Facts”). The massive scope of this hazard means that the entire Commonwealth experiences impacts from these species. Furthermore, the ability of invasive species to travel distances (either via natural mechanisms or accidental human interference) allows these species to propagate rapidly over a large geographic area. Similarly, in open freshwater and marine ecosystems, invasive species can quickly spread once introduced, as there are generally no physical barriers to prevent establishment, outside of physiological tolerances, and multiple opportunities for transport to new locations (by boats, for example). The entire geographic area of Charlemont is believed at risk for invasive species propagation.

Previous Occurrences

Invasive species do not represent a singular event but rather an ongoing or emerging problem, so it is difficult to measure the frequency of occurrences. Invasives of current concern to forest health (https://www.mass.gov/service-details/current-forest-health-threats) in Franklin County are Gypsy Moth, Hemlock Woolly Adelgid, Southern Pine Beetle, Emerald Ash Borer, and White Pine Needlecast.

The annual budget to address invasive species in Massachusetts has fluctuated over time but, in general, appears to have decreased. This likely implies a lack of resources rather than a decrease in risk. The following figures are from https://budget.digital.mass.gov/summary/fy22/enacted/energy-and-environmental-affairs/environmental-affairs/20000100.

Table 21. Invasive Species Annual Budget.

FY Year	Budget
2022	$277,838
2021	$146,348
2020	$4,150,000
2019	$3,831,135
2018	$4,347,000
2017	$6,046,870

The Town's MVP-funded resiliency report only lightly addresses invasive species. The document notes that "Best practices that might be encouraged include… cleaning up dead trees resulting from invasive pests and drought conditions that could serve as fuel in a wildfire." Specific invasive species were not listed or described in the document.

Extent

The MIPAG has developed a list of Early Detection plant species according to an established set of criteria that includes MIPAG classification as an *invasive, likely invasive,* or *potentially invasive* ecological threat and one of these three criteria: *limited prevalence in Massachusetts, partial containment potential,* or *public health threat.* The Early Detection table includes the documented distribution of a species by county.

Once established, invasive species often escape notice for years or decades. Introduced species that initially escaped many decades ago are only now being recognized as invasives. Because these species can occur anywhere (on public or private property), new invasive species often escape notice until they are widespread, and eradication is impractical. As a result, early and coordinated action between public and private landholders is critical to preventing widespread damage from an invasive species.

Probability of Future Events

The USDA Animal and Plant Health Inspection Service (APHIS) manages the Plant Protection and Quarantine (PPQ) Program which safeguards U.S. agriculture and natural resources from the introduction, establishment, and spread of plant pests and noxious weeds. PPQ is the lead federal agency for plant health emergencies and works closely with federal, state, and local agencies; universities; industries; and private entities in developing and implementing science-based framework designed to protect against invasive pests and diseases.

Massachusetts has a variety of laws and regulations in place that attempt to mitigate the impacts of these species. The Department of Agricultural Resources (DAR) maintains a list of prohibited plants for the state, which includes federally noxious weeds as well as invasive plants recommended by MIPAG and approved for listing by DAR. Species on the DAR list are regulated with prohibitions on importation, propagation, purchase, and sale in the Commonwealth. Additionally, the Massachusetts Wetlands Protection Act (310 CMR 10.00) includes language requiring all activities covered by the Act to account for, and take steps to prevent, the introduction or propagation of invasive species.

In 2000, Massachusetts passed an Aquatic Invasive Species Management Plan, making the Commonwealth eligible for federal funds to support and implement the plan through the federal Aquatic Nuisance Prevention and Control Act. MassDEP and CZM are part of the Northeast Aquatic Nuisance Species Panel, which was established under the federal Aquatic Nuisance Species Task Force. This panel allows managers and researchers to exchange information and coordinate efforts on the management of aquatic invasive species. The Commonwealth also has several resources pertaining to terrestrial invasive species, such as the Massachusetts Introduced Pest Outreach Project, although a strategic management plan has not yet been prepared for these species. All of these efforts are aimed at reducing the probability of future occurrences.

Notwithstanding the above efforts, the presence of invasive species is ongoing, and it is difficult to quantify the future frequency of these occurrences. Increased rates of global trade and travel have created many new pathways for the dispersion of exotic species. As a result, the frequency with which these threats have been introduced has increased significantly. Increased international trade in ornamental plants is particularly concerning because many of the invasive plants species in the U.S. were originally imported as ornamentals. Furthermore, they are expected to be an increasing problem due to a changing climate and projected increases in non-native plant and animal infestations. For this reason and based on the fact invasive species are already an ongoing issue for the region, this hazard has been assigned a probability of highly likely.

Vulnerability Assessment

Exposure

The entire Town has the potential to be exposed to invasive pests. Climate change will make the area more attractive to pests who have not been found there traditionally.

Built Environment Impacts

Although the built environment is not as susceptible to pests as the natural environment, it can help spread the invasive species. This includes trains and vehicles that could move the species from one location to another. Additionally, the campground may have recreational vehicles carrying invasive species.

Population Impacts

The direct population impacts are minimal. However, the indirect impacts could destroy livelihoods.

Environment Impacts

Most of the natural features in the Town have some susceptible pests including the trees and orchards, forested areas, agriculture, and parks. Trees that have been damaged by other events such as fire, wind, flooding, and animal browsing are more susceptible to diseases and pests. Certain species of trees are more susceptible based on the need of the damaging organism.

The insured losses caused by invasive insects for Franklin County were identified to be $23,628 over 22 years (USDA) for an AAL of $1,074. Insect damage in 2018 resulted in more than $13K in losses mostly to apples, corn, and potatoes. Instead of using a population index to identify the Town losses from the County losses, a land index was developed, Charlemont Land/Franklin County Land = 0.036. This results in a Charlemont loss of $39.

Primary Climate Change Interaction: Extreme Weather Events

Hurricanes and Tropical Storms

Flooding in Massachusetts is often the direct result of tropical storms and hurricanes. These powerful storms can also cause significant widespread damage due to high winds.

Description

Tropical cyclones (tropical depressions, tropical storms, and hurricanes) that affect New England form over the warm, moist waters of the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. Tropical systems customarily come from a southerly direction and when they accelerate up the East Coast of the U.S., most take on a distinct appearance that is different from a typical hurricane. Although rain is often limited in the areas south and east of the track of the storm, these areas can incur the worst winds and storm surge. Dangerous flooding occurs most often to the north and west of the track of the storm. An additional threat associated with a tropical system making landfall is the possibility of tornado generation. Tornadoes would generally occur in the outer bands to the north and east of the storm, a few hours to as much as 15 hours prior to landfall.

The official hurricane season runs from June 1 to November 30. In New England, these storms are most likely to occur in August, September, and the first half of October. The SHMCAP notes that this is due in large part to the fact that it takes a considerable amount of time for the waters south of Long Island to warm to the temperature necessary to sustain the storms this far north. Also, as the region progresses into the fall months, the upper-level jet stream steering winds might flow from the Great Lakes southward to the Gulf States and then back northward up the eastern seaboard. This pattern is conducive for capturing a tropical system over the Bahamas and accelerating it northward.

Location

Tropical storms and hurricanes can affect the entirely of Massachusetts, including the geographic extent of Charlemont.

Previous Occurrences

The SHMCAP notes that hurricanes and tropical storms occur somewhat regularly in Massachusetts. The impacts of T.S. Irene of August 2011 were the last major flood event in Charlemont. These flood impacts were described earlier in this chapter.

As noted elsewhere, this plan update relies primarily on a ten-year lookback (2012 through 2021) ending with the date of plan development. During that ten-year period, only one declared disaster in Massachusetts (SuperStorm Sandy of October 2012) was associated with a tropical system, and the impacts to western Massachusetts were minimal.

The NOAA Storm Events database (https://www.ncdc.noaa.gov/stormevents/) for Franklin County lists several high wind and flood events for the period 2012-2021, but none are associated with a tropical system. Nevertheless, Charlemont narrowly missed a variety of impacts from a sustained series of tropical and post-tropical storm systems that impacted Massachusetts in 2021. These storms occurred in July, August, and September 2021 as follows:

- T.S. Elsa - July 9, 2021
- T.S. Fred - August 19, 2021
- T.S. Henri - August 22-23, 2021
- T.D. Ida - September 1, 2021

The Town of Charlemont suffered only minor precipitation and minimal impacts from these events. The recorded precipitation associated with Henri was about 1.5” according to WWLP; and the recorded precipitation associated with Ida ranged from 1.5” to 2.2” according to NBCBoston. The rainfall from storms Elsa and Fred was minimal. However, other locations in Massachusetts experienced higher rainfall totals and experienced moderate flooding, especially from storm Ida.

Extent

Hurricanes are measured according to the Saffir-Simpson scale, which categorizes or rates hurricanes from 1 (minimal) to 5 (catastrophic) based on their intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, inherently leaving out any measure of precipitation and flooding.

Saffir-Simpson Hurricane Wind Scale

	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	**Damaging winds will produce some damage:** Well-constructed framed homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallow-rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	**Very strong, damaging winds will cause widespread damage:** Well-constructed framed homes could sustain major roof and siding damage. Many shallow-rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph 96-112 kt 178-208 km/h	**Dangerous winds will cause extensive damage:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph 113-136 kt 209-251 km/h	**Extremely dangerous winds will cause devastating damage:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: National Hurricane Center, NOAA

Figure 15. Saffir-Simpson Hurricane Wind Scale.

Tropical storms and tropical depressions, while generally less dangerous than hurricanes, can be deadly. The winds of tropical depressions and tropical storms are usually not the greatest threat; rather, the rains, flooding, and severe weather associated with the tropical storms are what customarily cause more significant problems. Additionally, serious power outages can also be associated with these types of events. After Hurricane Irene passed through the region as a tropical storm in late August 2011, many areas of the Commonwealth were without power for more than 5 days. T.S. Isaias of August 2020 caused significant and widespread outages immediately south of the Massachusetts border in northern Connecticut.

The NWS issues a hurricane warning when sustained winds of 74 mph or higher are expected in a specified area in association with a tropical, subtropical, or post-tropical cyclone. A warning is issued 36 hours in advance of the anticipated onset of tropical-storm-force winds. A hurricane watch is announced when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. A watch is issued 48 hours in advance of the anticipated onset of tropical-storm-force winds (NWS, 2013).

Probability of Future Events

The SHMCAP notes that Massachusetts experiences an average of one storm every other year or 0.5 storms per year. Storms severe enough to receive FEMA disaster declarations are far more rare, occurring every 9 years on average. According to NOAA, a Category 1 hurricane can be expected to make landfall in/near southern New England once every 17 years. A Category 2 hurricane could be expected to make landfall once every 39 years, and a Category 3 hurricane has a calculated return period of 68 to 70 years.

Some researchers have suggested that the intensity of tropical cyclones has increased over the last 40 years, with some believing that there is a connection between this increase in intensity and climate change. While most climate simulations agree that greenhouse warming enhances the frequency and intensity of tropical storms, models of the climate system are still limited by resolution and computational ability. However, given the past history of major storms and the possibility of increased frequency and intensity of tropical storms due to climate change, it is prudent to expect that there will be hurricanes impacting Charlemont in the future that may be of greater frequency and intensity than in the past.

Vulnerability Assessment

Exposure

High winds and heavy rain and/or hail associated with hurricanes and tropical storms can cause damage to utilities, structures, roads, trees (potentially causing vehicle accidents) and injuries and death. Other associated concerns are debris management issues including debris removal and identification of disposal sites. All assets in Charlemont should be considered exposed to high winds. Figure 16 shows the 500-year windspeeds identified in the ASCE 7-98 publication while shows the 1000-year windspeeds.

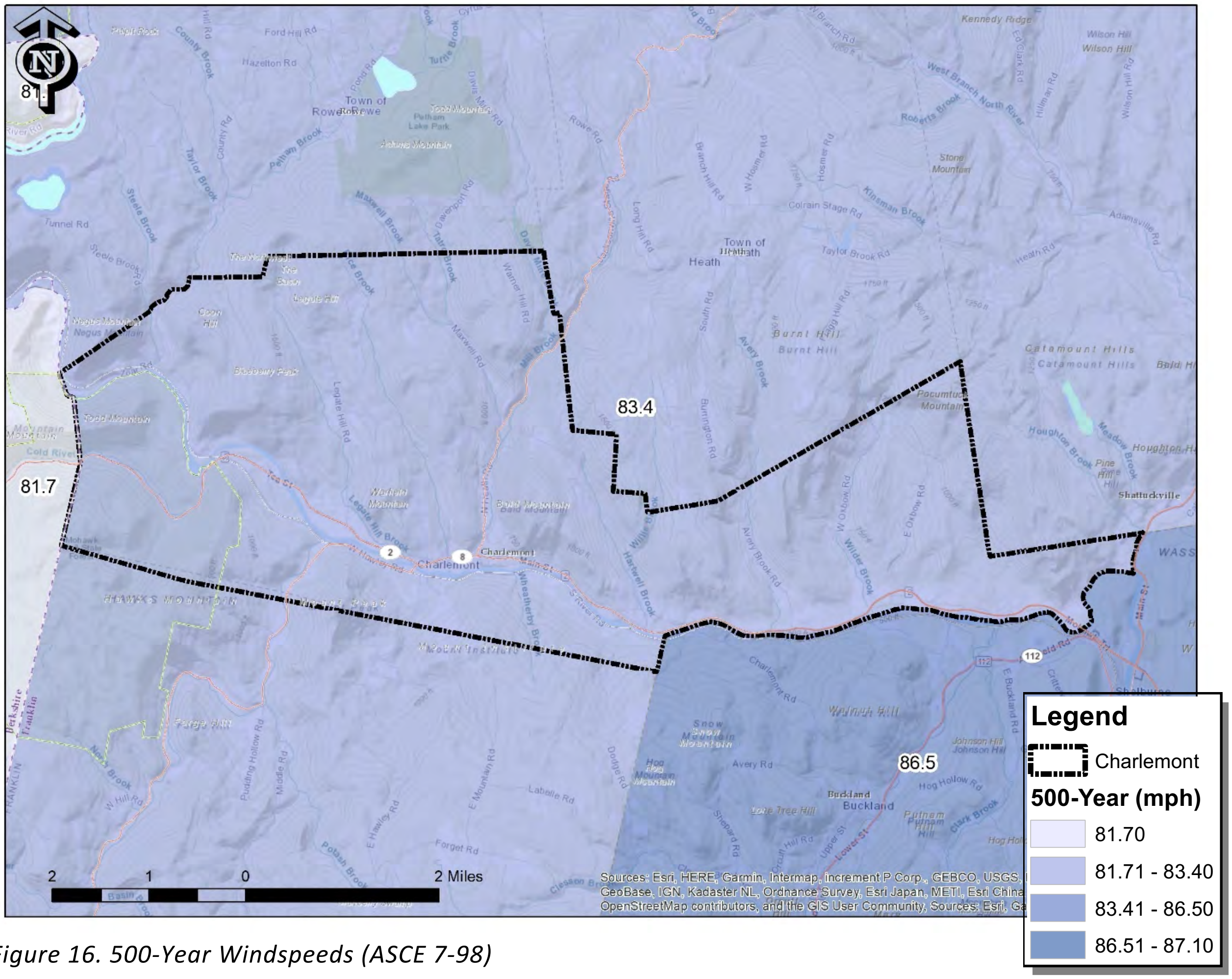


Figure 16. 500-Year Windspeeds (ASCE 7-98)

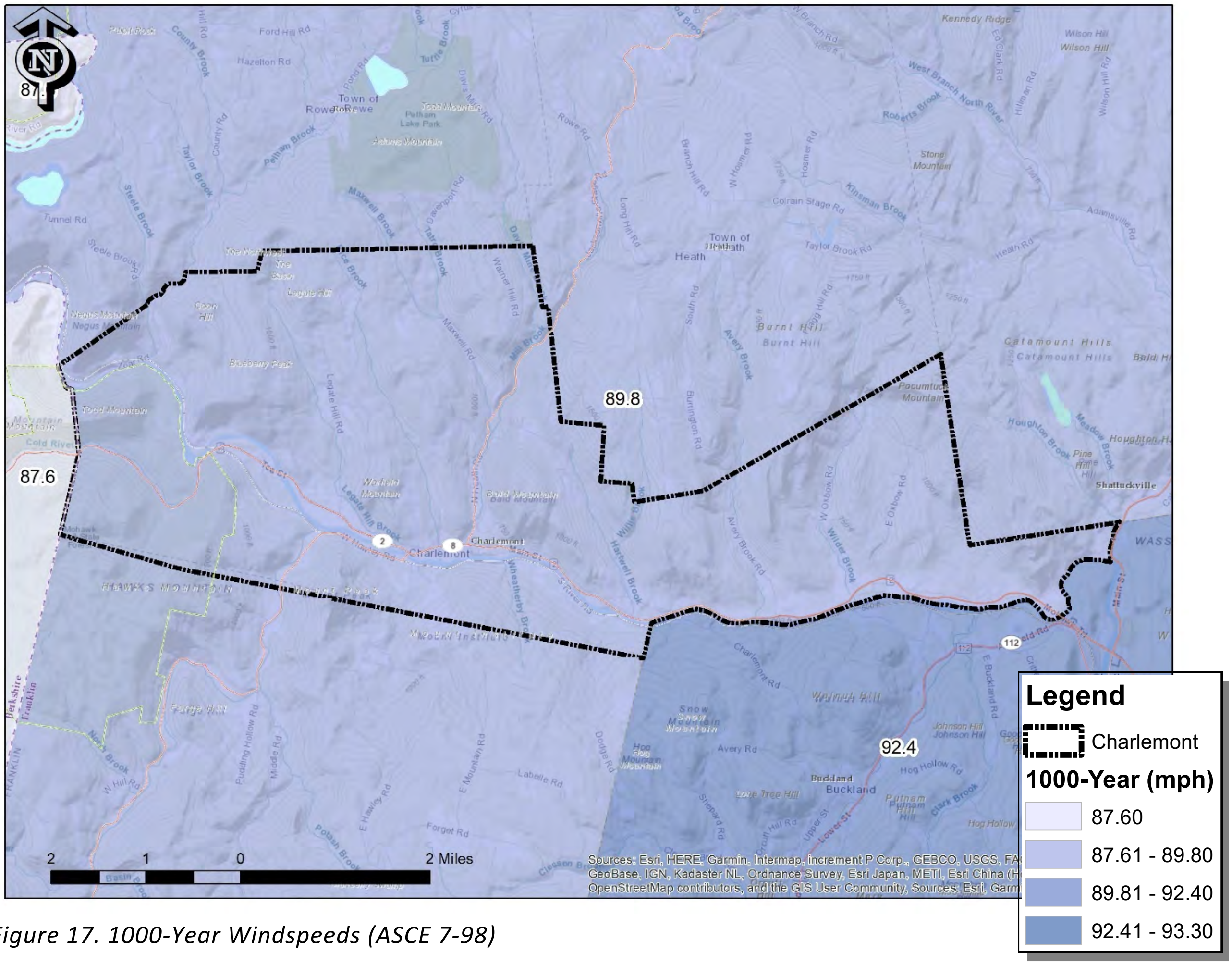


Figure 17. 1000-Year Windspeeds (ASCE 7-98)

Built Environment Impacts

To identify built environment impacts to the Town, FEMA's risk assessment software, Hazus, was implemented. Building footprint data and parcel data was used to update the model. The economic loss results of the 500-year event are shown in Table 22 while the results for the 1000-year event are shown in Table 23. The Town's Average Annual Loss (AAL) is calculated to be $36,017.

Table 22. Building Loss for a 500-Year Scenario

Loss Type	Residential ($Million)	Commercial ($Million)	Other Occupancy ($Million)	Total ($Million)
Building Loss	2.540	0.020	0.018	**2.578**
Content Loss	1.225	0.000	0.002	**1.227**
Business Inventory Loss	0.000	0.000	0.000	**0.000**
Business Income Loss	0.000	0.000	0.000	**0.000**
Business Relocation Loss	0.074	0.000	0.001	**0.075**
Rental Income Loss	0.028	0.000	0.000	**0.028**
Wage Loss	0.000	0.000	0.000	**0.000**
Total	**3.867**	**0.020**	**0.021**	**3.908**

Table 23. Building Loss for a 1000-Year Scenario

Loss Type	Residential ($Million)	Commercial ($Million)	Other Occupancy ($Million)	Total ($Million)
Building Loss	3.930	0.041	0.042	**4.013**
Content Loss	1.746	0.003	0.007	**1.756**
Business Inventory Loss	0.000	0.000	0.001	**0.001**
Business Income Loss	0.000	0.000	0.000	**0.000**
Business Relocation Loss	0.092	0.001	0.001	**0.094**
Rental Income Loss	0.045	0.000	0.000	**0.045**
Wage Loss	0.000	0.000	0.000	**0.000**
Total	**5.813**	**0.045**	**0.051**	**5.909**

The average annual loss is $36,017.

Population Impacts

Populations considered most vulnerable to hurricane and tropical storm impacts in Charlemont are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. For high windspeeds, it's important to maintain the building envelope during the event. If a window or door fails, damage to the structure will be much greater. Table 9 summarizes the senior and low-income populations in Charlemont. It should be noted that there may be overlap within the two categories, so that the total number of persons exposed may be lower than what is shown in the table. However, the town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

Hazus predicts that there will be no displaced households from the high windspeeds alone. However, if the rainfall leads to flooding, families may be displaced (see flood section).

Environment Impacts

Hurricanes can cause damage to agriculture, campgrounds, and parks. Campgrounds and parks may be out of service until trees are removed. Hurricane Bob in 1991 caused $500,000 in crop damage to Franklin County.

Severe Winter Storms

Severe winter storms include ice storms, nor'easters, heavy snow, blowing snow, and other extreme forms of winter precipitation. These are often accompanied by very low temperatures which were previously addressed.

Description

Blizzard: A blizzard is a winter snowstorm with sustained or frequent wind gusts to 35 mph or more, accompanied by blowing snow that reduces visibility to or below a quarter of a mile (NWS, 2018). These conditions must be the predominant condition over a 3-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of the definition. However, the hazard created by the combination of snow, wind, and low visibility increases significantly with temperatures below 20ºF. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near zero.

Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions due to the blowing snow. Blowing snow is wind-driven snow that reduces visibility to 6 miles or less, causing significant drifting. Blowing snow may be snow that is falling and/or loose snow on the ground picked up by the wind.

Ice Storms: Ice storm conditions are defined by liquid rain falling and freezing on contact with cold objects, creating ice buildups of one-fourth of an inch or more. These can cause severe damage to vegetation, utilities, and structures. An ice storm warning, which is now included in the criteria for a winter storm warning, is issued when a half inch or more of accretion of freezing rain is expected. This may lead to dangerous walking or driving conditions and the pulling down of power lines and trees. Ice pellets are another form of freezing precipitation, formed when snowflakes melt into raindrops as they pass through a thin layer of warmer air. The raindrops then refreeze into particles of ice when they fall into a layer of subfreezing air near the surface of the earth. Finally, sleet occurs when raindrops fall into subfreezing air thick enough that the raindrops refreeze into ice before hitting the ground. The difference between sleet and hail is that sleet is a wintertime phenomenon whereas hail falls from convective clouds (usually thunderstorms), often during the warm spring and summer months.

<u>Nor'easters</u>: A nor'easter is a storm that occurs along the East Coast of North America. A nor'easter is characterized by a large counterclockwise wind circulation around a low-pressure center that often results in heavy snow, high winds, and rain. A nor'easter gets its name from its continuously strong northeasterly winds blowing in from the ocean ahead of the storm and over the coastal areas. Nor'easters are among winter's most ferocious storms. These winter weather events are notorious for producing heavy snow, rain, and oversized waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. These storms occur most often in late fall and early winter. The storm radius is often as much as 100 miles, and nor'easters often sit stationary for several days, affecting multiple tide cycles and causing extended heavy precipitation. Sustained wind speeds of 20 to 40 mph are common during a nor'easter, with short-term wind speeds gusting up to 50 to 60 mph.

Location

Although the entire Commonwealth may be considered at risk to the hazard of severe winter storms, higher snow accumulations appear to be prevalent at higher elevations in Western and Central Massachusetts, and along the coast where snowfall can be enhanced by additional ocean moisture. Ice storms occur most frequently in the higher-elevation portions of Western and Central Massachusetts. Overall, winter storms can affect the entirely of Massachusetts, including the geographic extent of Charlemont.

Previous Occurrences

Winter storms occur somewhat regularly in Massachusetts. Although four of the disasters declared in Massachusetts from 2012 through 2021 were associated with winter storms, only one of the four covered Franklin County and therefore Charlemont:

- Massachusetts Severe Winter Storm, Snowstorm, and Flooding (DR-4110-MA)
    - Incident Period: February 8, 2013 - February 9, 2013
    - Major Disaster Declaration declared on April 19, 2013
    - *PA for entire state, **including Franklin County***

- Massachusetts Severe Winter Storm, Snowstorm, and Flooding (DR-4214-MA)
    - Incident Period: January 26, 2015 - January 28, 2015
    - Major Disaster Declaration declared on April 13, 2015
    - *PA for Worcester County and eastward*

- Massachusetts Severe Winter Storm and Snowstorm (DR-4379-MA)
    - Incident Period: March 13, 2018 - March 14, 2018
    - Major Disaster Declaration declared on July 19, 2018
    - *PA for Worcester, Middlesex, Suffolk, Norfolk, Essex Counties*

- Massachusetts Severe Winter Storm and Flooding (DR-4372-MA)
    - Incident Period: March 2, 2018 - March 3, 2018
    - Major Disaster Declaration declared on June 25, 2018
    - *PA for Norfolk, Essex, Bristol, Plymouth, Cape and Islands*

The PA assistance reimbursement for the Town of Charlemont associated with the winter storm of 2013 (DR-4110-MA) was a modest $18,000 against a total cost of approximately $24,000, indicating that the even was not significant for Charlemont.

The NOAA Storm Events database (https://www.ncdc.noaa.gov/stormevents/) for Franklin County lists three winter storm events for the period 2012-2021:

- 11/26/14 – Heavy Snow: A strong coastal storm moved up the east coast and over Nantucket bringing a heavy wet snow to much of the area. This resulted in tree damage and scattered power outages across the region. Ten to 16 inches of snow fell across western Franklin County. The heavy wet snow brought down trees and wires in Conway, Colrain, Shelburne, and Charlemont. Damage of $35,000 was reported for the region.
- 11/26/18 – Heavy Snow: A low pressure system over the mid-Atlantic region strengthened as it moved across southern New England. A foot of snow fell in northwesternmost part of Franklin County with 6 to 10 inches elsewhere in the immediate east slopes of the Berkshires. An amateur radio observer reported 10 inches Charlemont. The weight of the heavy snow caused trees and wires to be downed. At 705 AM on the 27th, wires were down on Rowe Road in Charlemont. Damage up to $7,000 was reported for the region.
- 1/16/21 – Heavy Snow: Low pressure in the Ohio Valley spawned a secondary low-pressure system off the mid-Atlantic coast, which moved northward into northern New England. In the highest terrain of western Franklin and Hampshire Counties, it was cold enough for 6 to 10 inches of snow. The heavy, wet snow downed some trees and wires in Franklin County. In

Charlemont at 1018 AM, a tree and wires were down on West Oxbow Road due to the weight of the wet snow. Damage up to $1,900 was reported.

USDA declares agricultural disasters as needed for a variety of hazards. Information can be found at https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index. The events related to winter storms in Franklin County are listed below.

Table 24. Agricultural Disaster Declarations from Winter Storms.

Year	Event	Event Begin Dates
2019	Extreme cold, temperature fluctuations	12/1/2018
2016	Frost/freeze	2/14/2016
2016	Frost/freeze, unseasonably warm temps.	2/1/2016
2014	Cold, frost/freeze	12/1/2013

Extent

Snowfall is a component of multiple hazards, including nor'easters and severe winter storms. Two scores, the *Regional Snowfall Index (RSI) and the NESIS*, are described in this section.

Since 2005, the RSI has become the descriptor of choice for measuring winter events that impact the eastern two-thirds of the U.S. The RSI ranks snowstorm impacts on a scale system from 1 to 5 as depicted in Table 4-64. The RSI is similar to the Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes, except that it includes an additional variable: population. The RSI is based on the spatial extent of the storm, the amount of snowfall, and population (NOAA, n.d.).

The RSI is a regional index. Each of the six climate regions (identified by the NOAA National Centers for Environmental Information) in the eastern two-thirds of the nation has a separate index. The RSI incorporated region-specific parameters and thresholds for calculating the index. The RSI is important because, with it, a storm event and its societal impacts can be assessed within the context of a region's historical events. Snowfall thresholds in Massachusetts (in the Northeast region) are 4, 10, 20, and 30 inches of snowfall, while thresholds in the Southeast U.S. are 2, 5, 10, and 15 inches.

Category	RSI Value	Event Description
1	1 to 3	Notable
2	3 to 6	Significant
3	6 to 10	Major
4	10 to 18	Crippling
5	18+	Extreme

Table 25. RSI Values.

Source: NOAA

Prior to the use of the RSI, the Northeast Snowfall Impact Scale, developed by Paul Kocin of The Weather Channel and Louis Uccellini of the NWS, was used to characterize, and rank high- impact northeast snowstorms with large areas of 10-inch snowfall accumulations and greater. In contrast to the RSI, which is a regional index, NESIS is a quasi-national index that is calibrated to Northeast snowstorms. NESIS has five categories.

Meteorologists can often predict the likelihood of a severe storm or nor'easter. This can give several days of warning time. The NOAA's NWS monitors potential events and provides extensive forecasts and information several days in advance of a winter storm to help the state to prepare for the incident.

Probability of Future Events

The SHMCAP notes that Massachusetts experiences high-impact snowstorms at approximately the rate of one per year, although there is significant interannual variability in the frequency and severity of winter storms. The Town of Charlemont should assume that winter storms are likely, even if the impacts of climate change will shift the timing to a shorter winter season. Heavy wet snowfall may be more common in the future.

Vulnerability Assessment

Severe winter storms can pose a significant risk to property and human life because the rain, freezing rain, ice, snow, cold temperatures and wind associated with these storms can disrupt utility service, phone service and make roadways extremely hazardous. Severe winter storms can be deceptive killers. The types of deaths that can occur as a result of a severe winter storm include: traffic accidents on icy or snow-covered roads, heart attacks while shoveling snow, and hypothermia from prolonged exposure to cold temperatures. Infrastructure and other property are also at risk from severe winter storms and the associated flooding that can occur following heavy snow melt. Power and telephone lines, trees, and telecommunications structures can be damaged by ice, wind, snow, and falling trees and tree limbs. Icy road conditions or roads blocked by fallen trees may make it difficult to respond promptly to medical emergencies or fires. Prolonged, extremely cold temperatures can also cause inadequately insulated potable water lines and fire sprinkler pipes to rupture and disrupt the delivery of drinking water and cause extensive property damage.

Exposure

Heavy snowfall coupled with low temperatures often results in increases in traffic accidents; disruptions in transportation, commerce, government, and education; utility outages due to falling trees, branches, and other objects; personal injuries associated with slippery surfaces and freezing temperatures; and numerous other problems. Specific damages associated with severe winter storm (snow) events include:

- Injuries and fatalities associated with accidents, low temperatures, power loss, falling objects and accidents associated with frozen and slippery surfaces and snow accumulation
- Increases in the frequency and impact of traffic accidents, resulting in personal injuries
- Ice-related damage to trees, building and infrastructure inventory, and utilities (power lines, bridges, substations, etc.)
- Roads damaged through freeze and thaw processes
- Stress on the local shelters and emergency response infrastructure
- Lost productivity that occurs when people cannot go to work, school, or stores due to inclement conditions

The entire Town should be considered exposed to the severe winter storm hazard.

Built Environment Impacts

The entire built environment of Charlemont is vulnerable to a severe winter storm. New England's climate offers no immunity to the potential damaging effects of severe winter storms. Some minimum damage is anticipated annually, with potential extensive damage occurring about once every 10 years.

Since Hazus doesn't support severe winter storms and there aren't other readily available severe winter storm models, historical data will be used to determine potential losses and probabilities. From 1996 until 2022, there was $22.956M in property damage to Franklin County. This equates to an AAL of $850,222. To make this more relevant to the Town itself, the population of Charlemont (1,185) was divided by the population of Franklin County (71,029) to create a population index (0.0167). That index is then multiplied by the county's AAL to get $14,199, the Town's AAL.

Population Impacts

As discussed above, some traffic accidents associated with storm events include injuries and in limited cases, deaths. However, the number of injuries and deaths reported for accidents is generally low. Populations considered most vulnerable to severe winter storm impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 9 summarizes the senior and low-income populations in Charlemont. It should be noted that there may be overlap within the two categories, so that the total number of persons exposed may be lower than what is shown in the table. However, the town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

Environment Impacts

Severe winter storms can cause damage to agriculture, campgrounds, and parks. Campgrounds and parks may be out of service until roads are cleared and trees are removed. Tree farms can be also damaged from extreme winter events.

Tornadoes

Tornadoes are a relatively infrequent occurrence but can be very destructive when they occur. While small tornadoes in outlying areas cause little to no damage, larger tornadoes in populated sections of Massachusetts have historically caused significant damage, injury, and death through the destruction of trees, buildings, vehicles, and power lines.

Description

A tornado is a narrow rotating column of air that extends from the base of a cumulonimbus cloud to the ground. The observable aspect of a tornado is the rotating column of water droplets, dust, and debris caught in the column. Tornadoes are the most violent of all atmospheric storms.

Tornadoes can form from individual cells within severe thunderstorm squall lines. They can also form from an isolated supercell thunderstorm. They can be spawned by tropical cyclones or the remnants thereof, and weak tornadoes can even occur from little more than a rain shower if air is converging and spinning upward.

Most tornadoes occur in the late afternoon and evening hours, when the heating is the greatest. The most common months for tornadoes to occur are June, July, and August, although the Great Barrington tornado (1995) occurred in May.

A tornadic waterspout is a rapidly rotating column of air extending from the cloud base (typically a cumulonimbus thunderstorm) to a water surface, such as a bay or the ocean. They can be formed in the same way as regular tornadoes, or can form on a clear day with the right amount of instability and wind shear. Tornadic waterspouts can have wind speeds of 60 to 100 mph, but since they do not move very far, they can often be navigated around. They can become a threat to land if they drift onshore.

Location

The U.S. experiences an average of 1,253 tornadoes per year, more than any other country (NOAA, n.d.). Because Massachusetts experiences fewer tornadoes than other parts of the country, residents may be less prepared to react to a tornado. The SHMCAP notes that the area at greatest risk for a tornado touchdown runs from central to northeastern Massachusetts. Specifically, tornados have occurred most frequently in Worcester County and in communities west of Worcester. Nevertheless, tornadoes can affect the entirely of Massachusetts, including the geographic extent of Charlemont.

Previous Occurrences

According to the SHMCAP, the most destructive tornado in New England history was the Worcester tornado of June 9, 1953. The F4 tornado hit at about 3:30 p.m. The funnel quickly intensified, carving a 46-mile path of death and destruction as it moved through seven towns. The twister tore through Barre, Rutland, Holden, Worcester, Shrewsbury, Westborough, and Southborough. It killed 90 people and left approximately 1,200 people injured. The National Storm Prediction Center has ranked this as one of the deadliest tornadoes in the nation's history. With wind speeds between 200 to 260 mph, the force of the tornado carried debris miles away and into the Atlantic Ocean.

According to the previous edition of this plan, three tornadoes have been reported in Franklin County since 1995: in the towns of Heath (1997), Charlemont (an F1 in 1997), and Wendell (2006). The July 2006 tornado in Wendell was rated F2 (Strong) on the Fujita Scale with winds estimated near 155 mph.

Table 26. Tornado Damages.

Date	Location	Injuries	Fatalities	Property Damage
7/3/1997	Heath	0	0	$ 50,000
7/3/1997	Charlemont	0	0	$ 50,000
7/11/2006	Wendell	0	0	$ 200,000

A storm on June 1, 2011, resulted in three tornadoes touching down in Hampden County. The strongest, an EF3 tornado, resulted in four deaths, 200 injuries, and $227,600,000 in property damage. This tornado first touched down in Westfield and continued a 39-mile path through West Springfield, Springfield, Wilbraham, Monson, Brimfield, and Sturbridge.

The NOAA Storm Events database (https://www.ncdc.noaa.gov/stormevents/) for Franklin County lists a variety of severe storms from 2012 through 2021, but none were caused by or associated with tornadoes.

Extent

The NWS rates tornadoes using the Enhanced Fujita scale (EF scale), which does not directly measure wind speed but rather the amount of damage created. This scale derives 3-second gusts estimated at the point of damage based on the assignment of 1 out of 8 degrees of damage to a range of different structure types. These estimates vary with height and exposure. This method is considerably more sophisticated than the original Fujita scale, and it allows surveyors to create more precise assessments of tornado severity.

Scale	Wind speed mph	Wind speed km/h	Relative frequency	Potential damage	
EF0	65–85	105–137	53.5%	Minor damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.	
EF1	86–110	138–178	31.6%	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.	
EF2	111–135	179–218	10.7%	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.	
EF3	136–165	219–266	3.4%	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.	
EF4	166–200	267–322	0.7%	Extreme damage to near-total destruction. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.	
EF5	>200	>322	<0.1%	Massive Damage. Strong frame houses leveled off foundations and swept away; steel-reinforced concrete structures critically damaged; high-rise buildings have severe structural deformation. Incredible phenomena will occur.	

Figure 18. Enhanced Fujita Scale.

Source: Linn County EMA and reprinted from SHMCAP

Tornado watches and warnings are issued by the local NWS office. A tornado watch is released when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly that little, if any, advance warning is possible.

Probability of Future Events

According to the SHMCAP, the Commonwealth experienced 171 tornadoes from 1950 to 2017, or an average annual occurrence of 2.6 tornado events per year. In the last 20 years, the average frequency of these events has been 1.7 events per year (NOAA, 2018). Massachusetts experienced an average of 1.4 tornadoes per 10,000 square feet annually between 1991 and 2010, less than half of the national average of 3.5 tornadoes per 10,000 square feet per year (NOAA, n.d.). As highlighted in the National Climate Assessment, tornado activity in the U.S. has become more variable, and increasingly so in the last two decades. While the number of days per year that tornadoes occur has decreased, the number of tornadoes on these days has increased. Climate models show projections that the frequency and intensity of severe thunderstorms (which include tornadoes, hail, and winds) will increase (USGCRP, 2017).

Vulnerability Assessment

High wind speeds, hail, and debris generated by tornados can result in loss of life, downed trees and power lines, and damage to structures and other personal property (cars, etc.).

Exposure

High winds, heavy rain, lightning and/or hail associated with tornados, thunderstorms and microbursts can cause damage to utilities, structures, roads, trees (potentially causing vehicle accidents) and injuries and death. The entire Town should be considered exposed to the tornado hazard.

Built Environment Impacts

Since Hazus doesn't support tornadoes and there aren't other readily available tornado models, historical data will be used to determine potential losses and probabilities. From 1954 until 2022, there was $1.146M in property damage to Franklin County. This equates to an AAL of $16,609. To make this more relevant to the Town itself, the population of Charlemont (1,185) was divided by the population of Franklin County (71,029) to create a population index (0.0167). That index is then multiplied by the county's AAL to get $277, the Town's AAL.

Population Impacts

Populations considered most vulnerable to tornado impacts in Charlemont are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 9 summarizes the senior and low-income populations in Charlemont. It should be noted that there may be overlap within the two categories, so that the total number of persons exposed may be lower than what is shown in the table. However, the town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

Environment Impacts

Tornadoes can cause damage to agriculture, campgrounds, and parks. Campgrounds and parks may be out of service until trees are removed.

Other Severe Weather

Several frequent natural hazards in Massachusetts – particularly strong winds and extreme precipitation events – occur outside of notable storm events. This section discusses the nature and impacts of these hazards, as well as ways in which they are likely to respond to climate change.

Description

Thunderstorms: A thunderstorm is a storm originating in a cumulonimbus cloud. Cumulonimbus clouds produce lightning, which locally heats the air to 50,000 degrees Celsius, which in turn produces an audible shock wave known as thunder. Frequently during thunderstorm events, heavy rain and gusty winds are present. Less frequently, hail is present, which can become very large in size. Tornadoes can also be generated during these events. An average thunderstorm is 15 miles across and lasts 30 minutes, but severe thunderstorms can be much larger and longer.

Three basic components are required for a thunderstorm to form: moisture, rising unstable air, and a lifting mechanism. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise, it will continue to rise as long as it weighs less and stays warmer than the air around it. As the warm surface air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool, releasing the heat, and the vapor condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice, and some of it turns into water droplets. Both have electrical charges. When a sufficient charge builds up, the energy is discharged in a bolt of lightning, which causes the sound waves we hear as thunder.

Downbursts: A downburst is a severe localized wind blasting down from a thunderstorm. They are more common than tornadoes. Depending on the size and location of downburst events, the destruction to property may be significant. Downbursts fall into two categories:

- Microbursts affect an area less than 2.5 miles in diameter, last 5 to 15 minutes, and can cause damaging winds up to 168 mph.
- Macrobursts affect an area at least 2.5 miles in diameter, last 5 to 30 minutes, and can cause damaging winds up to 134 mph.

An organized, fast-moving line of microbursts traveling across large areas is known as a "derecho." These occasionally occur in Massachusetts. Downburst activity is, on occasion, mistaken for tornado activity. Both storms have very damaging winds (downburst wind speeds can exceed 165 mph) and are very loud. These "straight line" winds are distinguishable from tornadic activity by the pattern of destruction and debris such that the best way to determine the damage source is to fly over the area.

Hail: Hailstones are chunks of ice that grow as updrafts in thunderstorms keep them in the atmosphere. Most hailstones are smaller in diameter than a dime, but stones weighing more than 1.5 pounds have been recorded. NOAA has estimates of the velocity of falling hail ranging from 9 meters per second (m/s) (20 mph) for a 1-centimeter (cm)-diameter hailstone to 48 m/s (107 mph) for an 8 cm, 0.7 kilogram stone.

<u>Lightning</u>: Lightning is a discharge of electricity that occurs between the positive and negative charges within the atmosphere or between the atmosphere and the ground. According to NOAA, the creation of lightning during a storm is a complicated process that is not fully understood. In the initial stages of development, air acts as an insulator between the positive and negative charges. However, when the potential between the positive and negative charges becomes too great, a discharge of electricity (lightning) occurs. In-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom. Cloud-to-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom of a second cloud. Cloud-to-ground lightning is the most dangerous. In summertime, most cloud-to-ground lightning occurs between the negative charges near the bottom of the cloud and positive charges on the ground.

Location

High wind events, thunderstorms, lightning, and hail can affect the entirely of Massachusetts, including the geographic extent of Charlemont.

Previous Occurrences

The NOAA Storm Events database (https://www.ncdc.noaa.gov/stormevents/) for Franklin County lists a variety of severe storms from 2012 through 2021. The individual damage figures for these events appear nominal but given the frequency of events occurring, the overall losses from severe storms are striking.

- 9/18/12 – Strong Wind: A strong cold front moved through southern New England, resulting in a line of thunderstorms that produced strong to severe winds. In addition, a strong low-level jet produced gusty strong to high winds with the front. Wires were downed on Labelle Road and a tree and wires were downed on Maxwell Road, both in Charlemont. Damage of $10,000 was reported.
- 3/1/16 – Strong Wind: A cold front combined with an upper-level disturbance to produce strong to damaging winds across portions of southern New England. A pole snapped and wires were downed on Laurel Lane in Charlemont. Damage of $10,000 was reported.
- 6/19/17 – Thunderstorm Wind: A cold front approaching from New York produced numerous showers and thunderstorms that produced strong wind gusts and heavy downpours. Several trees were down on wires on State Route 8A North in Charlemont. Damage of $8,000 was reported.
- 6/30/17 – Thunderstorm Wind: A weak disturbance moving through the atmosphere combined with a warm and humid air mass to generate showers and thunderstorms over Western Massachusetts. In Charlemont, a tree was down on state route 2 near the Savoy Mountain State Forest, partially blocking the road. Damage of $1,500 was reported.
- 8/2/17 – Hail: A mid-level disturbance moved across Southern New England, tapping very moist and unstable air to create showers and thunderstorms. Some showers and storms produced heavy downpours and strong wind gusts. One-inch diameter hail fell in Hawley, close to Charlemont, and was reported to be covering the ground.

- 7/27/18 – Thunderstorm Wind: A front remained stalled over Southern New England. Showers and a few thunderstorms developed in this environment. Trees and wires were reported down on Avery Brook Road in Charlemont. Damage of $7,000 was reported.
- 2/25/19 – Strong Wind: A storm moving north through the Great Lakes redeveloped along the Mid Atlantic coast on the 24th, then moved up the coast past Southern New England. This coastal storm brought damaging west-northwest winds to Massachusetts. Various reports included: tree and wires were down on North River Road in Charlemont; a tree and wires down on State Route 2 in Charlemont; several trees and wires down on Harris Mountain Road in Charlemont; multiple trees were down on wires on State Route 2 in Charlemont. Damage of $20,000 was reported.

USDA declares agricultural disasters as needed for a variety of hazards. Information can be found at https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index. The two events related to severe winds in Franklin County are listed below.

Table 27. Agricultural Disasters from Wind Events.

Year	Event	Event Begin Dates
2016	Drought, wildfire, excessive heat, high winds, insects	7/5/2016
2012	High Winds, excessive rains	8/10/2012

Extent

The strength of thunderstorms is typically measured in terms of its effects, namely the speed of the wind, the presence of significant lightning, and the size of hail. High winds are defined by the NWS as sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer, or gusts of 50 knots (58 mph) or greater for any duration (NCDC, 2018). A thunderstorm is classified 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).

Probability of Future Events

According to the NWS, an average of 100,000 thunderstorms per year occur in the United States. The SHMCAP notes that over the ten-year period between January 1, 2008, and December 31, 2017, a total of 435 high wind events occurred in Massachusetts on 124 days, and an annual average of 43.5 events occurred per year. This is consistent with the figure from the SHMCAP that thunderstorms typically occur on 20 to 30 days each year in Massachusetts, which is a subset of the 43.5 high wind event days.

NOAA reports that there are 10 downburst reports for every tornado report in the United States. This implies that there are approximately 10,000 downbursts reported in the United States each year and further implies that downbursts occur in approximately 10% of all thunderstorms in the United States annually. This figure suggests that downbursts are a relatively uncommon yet persistent hazard.

An average of 33 people per year died from lightning strikes in the United States from 2004 to 2013. Most lightning deaths and injuries occur outdoors, with 45% of lightning casualties occurring in open fields and ballparks, 23% under trees, and 14% involving water activities. The SHMCAP notes that 8 fatalities and 145 injuries have occurred in Massachusetts as a result of lightning events between 1993 and 2017 (NCDC, 2017).

According to NOAA's National Weather Service, hail caused two deaths and an average of 27 injuries per year in the United States from 2004 to 2013.

Climate models show projections that the frequency and intensity of severe thunderstorms (which include tornadoes, hail, and winds) will increase (USGCRP, 2017).

Vulnerability Assessment

Severe thunderstorms and microbursts and their associated wind, hail and lightning effects – can cause severe damage.

Exposure

The entire built environment of Charlemont is vulnerable to the high winds and/or flooding from a thunderstorm or microburst.

Built Environment Impacts

Severe thunderstorms, and their associated hail and lightning events, brought about significant property wreckage in Franklin County in previous years. Thunderstorms with associated wind damage, caused an average annual property loss of $50,761 or $3.401M over 67 years to Franklin County. Using the population index, the Charlemont AAL is $848.

Population Impacts

Some traffic accidents associated with storm events include injuries and deaths. However, the number of injuries and deaths reported for accidents is generally low. Populations considered most vulnerable to tornado, microburst and thunderstorm impacts in Charlemont are identified based on a number of factors including their physical and financial ability to react or respond during a hazard. Table 9 summarizes the senior and low-income populations in Charlemont. It should be noted that there may be overlap within the two categories, so that the total number of persons exposed may be lower than what is shown in the table. However, the town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

Environment Impacts

Thunderstorms and microbursts can cause damage to agriculture, campgrounds, and parks. Campgrounds and parks may be out of service until trees are removed. Severe thunderstorms have caused $1.25M in damage to agriculture to Franklin County over the last 67 years.

Non Climate-Induced Hazards

Earthquakes

An earthquake is the vibration of the Earth's surface that follows a release of energy in the Earth's crust. New England experiences intraplate earthquakes because it is located within the interior of the North American plate. Although damaging earthquakes are rare in Massachusetts, low-magnitude earthquakes occur regularly in the state.

Description

An earthquake is a sudden rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Earthquakes can cause buildings and bridges to collapse; disrupt gas, electric, and telephone lines; and often cause landslides, flash floods, fires, avalanches, and tsunamis. Earthquakes can occur at any time without warning.

The underground point of origin of an earthquake is called its focus; the point on the surface directly above the focus is the epicenter. Earthquakes are described based on their magnitude and intensity as explained below under *Extent*.

New England's earthquakes appear to be the result of the cracking of the crustal rocks due to compression as the North American Plate is being very slowly squeezed by the global plate movements. As a result, New England epicenters do not follow the major mapped faults of the region, nor are they confined to particular geologic structures or terrains. Because earthquakes have been detected all over New England, seismologists suspect that a strong earthquake could be centered anywhere in the region. Furthermore, the mapped geologic faults of New England currently do not provide any indications detailing specific locations where strong earthquakes are most likely to be centered.

In addition to earthquakes occurring within the Commonwealth, earthquakes in other parts of New England can impact widespread areas. Large earthquakes in Canada, which is more seismically active than New England, can affect buildings Massachusetts. This is due in part to the fact that earthquakes in the eastern U.S. are felt over a larger area than those in the western U.S. The difference between seismic shaking in the East versus the West is primarily due to the geologic structure and rock properties that allow seismic waves to travel farther without weakening (USGS, 2012).

In some places in New England, including locations in Massachusetts, small earthquakes seem to occur with some regularity. For example, since 1985 there has been a small earthquake approximately every

2.5 years within a few miles of Littleton. It is not clear why some localities experience such clustering of earthquakes, but clusters may indicate locations where there is an increased likelihood of future earthquake activity.

Location

Given the above discussion, the potential exists for earthquakes to be felt anywhere in Charlemont, or to occur within Charlemont.

Previous Occurrences

To determine whether earthquakes have occurred recently near or in Charlemont, all events listed by Weston Observatory were reviewed for western Massachusetts and southern Vermont for a five-year lookback. Listed earthquakes above magnitude 2.0 include:

- 12/21/18 – 3 mk WSW of Gardner, 2.1/2.1 [Mn*/Mc**]
- 8/21/19 – 2 km SSE of Wareham, 1.7/2.4
- 12/3/19 – 4 km SSE of Plymouth, 1.6/2.2
- 11/8/20 – 11 mk SW of New Bedford, 3.8/3.4
- 11/22/20 – 12 km WSW of New Bedford, 1.7/2.6

*Mn is the Nuttli Magnitude (see *Extent* below)
**Mc is the Coda Duration Magnitude (see *Extent* below)

These are very minor earthquakes.

On June 22, 2010, a magnitude 5.8 earthquake in Canada could be felt in Franklin County. No damage was reported, but residents stated they felt the quake and were un- nerved by the experience. On August 23, 2011, an earthquake measuring 5.8 on the Richter scale centered in Virginia was felt throughout the northeast, prompting the evacuation of a number of multi-story buildings in the Franklin County region, but causing no property damage or personal injury.

Extent

Magnitude is an estimate of the relative size or strength of an earthquake and is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of earthquake waves recorded on instruments that have a common calibration. The magnitude of an earthquake is thus represented by a single instrumentally determined value recorded by a seismograph, which records the varying amplitude of ground oscillations.

The Richter scale was developed in 1935 and was used exclusively until the 1970s. It set the magnitude of an earthquake based on the logarithm of the amplitude of recorded waves. Being logarithmic, each whole number increase in magnitude represents a tenfold increase in measured strength. Earthquakes with a magnitude of about 2.0 or less are usually called "microearthquakes" and are generally only recorded locally. Earthquakes with magnitudes of 4.5 or greater are strong enough to be recorded by seismographs all over the world.

As more seismograph stations were installed around the world following the 1930s, it became apparent that the method developed by Richter was valid only for certain frequency and distance ranges, particularly in the southwestern United States. New magnitude scales that are an extension of Richter's original idea were developed for other areas. In particular, the Moment magnitude scale (Mw) was developed in the 1970s to replace the Richter scale and has been in official use by the USGS since 2002.

According to USGS, these multiple methods are used to estimate the magnitude of an earthquake because no single method is capable of accurately estimating the size of all earthquakes. Some magnitude types are calculated to provide a consistent comparison to past earthquakes, and these scales are calibrated to the original Richter scale. However, differences in magnitude of up to 0.5 can be calculated for the same earthquake through different techniques. In general, Moment magnitude provides an estimate of earthquake size that is valid over the complete range of magnitudes and so is commonly used today.

Although Moment magnitude is the most common measure of earthquake size for medium and larger earthquakes, the USGS does not calculate Mw for earthquakes with a magnitude of less than 3.5 which is the more common situation for Massachusetts. Localized Richter scales or other scales are used to calculate magnitudes for smaller earthquakes.

Regionally, the Weston Observatory utilizes two scales to track the magnitude of earthquakes. These include the Nuttli magnitude (Mn) for North America east of the Rocky Mountains and is more appropriate for the relatively harder continental crust in Connecticut compared to California. Weston Observatory also utilizes the Coda Duration magnitude (Mc), which is based on the duration of shaking at a particular station. The advantages of the Coda Duration magnitude is that this method can quickly estimate the magnitude before the exact location of the earthquake is known.

The effect of an earthquake on the earth's surface is called the intensity. The Modified Mercalli Intensity Scale consists of a series of key responses such as people awakening, movement of furniture, damage to chimneys, and total destruction. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It is an arbitrary ranking based on observed effects.

Table 28. Modified Mercalli Intensity Scale.

Modified Mercalli Intensity	Description
I	Not felt except by a very few under especially favorable conditions
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck. Duration estimated.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes and windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry), structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage total. Lines of sight and level are distorted. Objects thrown in the air.

Source: USGS

A comparison of Richter magnitude to typical Modified Mercalli intensity is presented below.

Table 29. Comparison of Richter Scale and MMI.

Moment Magnitude	Typical Maximum Modified Mercalli Intensity
1.0 to 3.0	I
3.0 to 3.9	II to III
4.0 to 4.9	IV to V
5.0 to 5.9	VI to VII
6.0 to 6.9	VII to IX
7.0 and above	VIII or higher

Source: USGS

Probability of Future Events

Earthquake location and magnitude probabilities are exceptionally difficult to predict in Massachusetts. Minor earthquakes are relatively common in New England, but damaging earthquakes are not. Therefore, USGS instead characterizes the probability of ground acceleration rather than estimating a probability of magnitude. The Seismic Hazard Map for the state of Massachusetts (USGS) shows a peak ground acceleration of 8% to 10% of gravity in western Franklin County having a 2% probability of being exceeded in 50 years.

Vulnerability Assessment

Exposure

A major earthquake could cause severe damage to Charlemont buildings, including older structures that were built before a 1975 law requiring new buildings to withstand earthquakes. Other associated concerns are debris management issues including debris removal and identification of disposal sites.

Built Environment Impacts

Historic data for earthquake events indicate that between 1991 and 2022, no major (<5.0 magnitude) earthquakes were recorded in Franklin County during this period, causing no damage to property. The entire built environment of Charlemont is vulnerable to earthquakes. Older, unreinforced masonry buildings are very susceptible to earthquakes.

To identify built environment impacts to the Town, FEMA's risk assessment software, Hazus, was implemented. Building footprint data and parcel data was used to update the model. The economic loss results of the 1500-year event are shown in Table 30 while the results for the 2500-year event are shown in Table 31. The Town's Average Annual Loss (AAL) is modeled to be $4,000.

Table 30. Building Loss for a 1500-Year Scenario

Loss Type	Residential ($Million)	Commercial ($Million)	Other Occupancy ($Million)	Total ($Million)
Building Loss	0.814	0.152	0.139	**1.105**
Content Loss	0.174	0.052	0.058	**0.284**
Business Inventory Loss	0.000	0.001	0.006	**0.007**
Business Income Loss	0.006	0.058	0.002	**0.066**
Business Relocation Loss	0.082	0.033	0.021	**0.136**
Rental Income Loss	0.043	0.027	0.003	**0.073**
Wage Loss	0.014	0.057	0.012	**0.083**
Total	**1.133**	**0.380**	**0.241**	**1.754**

Table 31. Building Loss for a 2500-Year Scenario

Loss Type	Residential ($Million)	Commercial ($Million)	Other Occupancy ($Million)	Total ($Million)
Building Loss	1.517	0.274	0.254	**2.045**
Content Loss	0.369	0.108	0.118	**0.595**
Business Inventory Loss	0.000	0.002	0.013	**0.015**
Business Income Loss	0.010	0.095	0.004	**0.109**
Business Relocation Loss	0.143	0.053	0.035	**0.231**
Rental Income Loss	0.073	0.001	0.046	**0.120**
Wage Loss	0.024	0.093	0.019	**0.136**
Total	**2.136**	**0.626**	**0.489**	**3.251**

Population Impacts

Populations considered most vulnerable to earthquake impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Table 9 summarizes the senior and low-income populations in Charlemont. It should be noted that there may be overlap within the two categories, so that the total number of persons exposed may be lower than what is shown in the table. However, the Town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

Hazus was used to model injuries and fatalities for the 1500- and 2500-year events. For the 1500-year event, there are few minor injuries not requiring medical attention. For the 2500-year event some minor injuries not requiring medical attention and a few injuries requiring a paramedic.

Environment Impacts

The environment may be impacted by cascading impacts from the earthquake, such as a train derailment caused by track damage, landslide, or dam breach. This could result in a hazardous material release.

Technological / Human Caused Hazards

Hazardous Materials

Unlike most of the preceding hazard profile content, the narrative for hazard materials is not taken from the SHMCAP. Instead, the previous edition of the Town's hazard mitigation plan provides a more appropriate set of information for addressing risks in Charlemont.

A hazardous material is any solid, liquid, or gas that can harm people, other living organisms, property, or the environment. Chemical manufacturers, distributors and vendors are sources of hazardous materials, as are hazardous materials waste sites and many users, including service stations and medical facilities. Spills or releases can occur during production, storage, transportation, use, or disposal. Most incidents occur at fixed facilities; however, spills are also common along railroads, highways, pipelines, and waterways.

Most non-natural or manmade hazards fall into two general categories: intentional acts and accidental events, although these categories can overlap. Some of the hazards included in these two categories, as defined by MEMA, consist of intentional acts such as explosive devices, biological and radiological agents, arson and cyberterrorism and accidental events such as nuclear hazards, invasive species, infrastructure failure, industrial and transportation accidents. Accidental events can arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials. For the purpose of the previous edition of the Town's hazard mitigation plan, the Town's input focused on non-natural hazards that are of an accidental nature. These include industrial transportation accidents and industrial accidents in a fixed facility.

Description

Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products are shipped daily on the nation's highways, railroads, waterways, and pipelines. Chemical manufacturers are one source of hazardous materials, but there are many others, including service stations, hospitals, and hazardous materials waste sites. Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in plants.

A release may occur at a fixed facility or in transit. Communities with a large industrial base may be more inclined to experience a hazardous materials release due to the number of facilities such materials in their manufacturing process. Communities with several major roadways may be at a greater risk due to the number and frequency of trucks transporting hazardous materials passing through.

Location

The Franklin County transportation systems include mainly road and rail. Accessible and efficient freight transportation plays a vital function in the economy of the region. Most freight and goods being transported to and from Franklin County are by truck; however, a significant amount of freight that moves through the county is being hauled over the three main rail lines. The major trucking corridors in Franklin County are Interstate 91 running north/south, and Route 2 running east/west. These two highways also represent the busiest travel corridors in the region for non-commercial traffic. Safe and efficient transportation routes for trucks to and through the region are important to the region's economy and to the safety of its citizens. Therefore*, the location of industrial transportation accidents is along major road and rail lines.* On the other hand, the *location of industrial accidents in a fixed facility is in the vicinity of those facilities.*

Previous Occurrences

<u>Industrial Accidents – Transportation</u>: According to the Franklin County Hazardous Material Emergency Plan (HMEP), approximately 13 to 15 trucks per hour traveling through the region contain hazardous materials. This data is from 2011-2012 but believed relevant to current risks. While most of these vehicles are on Interstate 91, approximately 2 trucks per hour travel on Route 2, and 0 to 1 trucks per hour travel along Route 8A, which are both main roads in Charlemont. The Charlemont CEM Plan lists Routes 2 and 8A as hazardous transportation routes in town. According to the HMEP, the following hazardous materials are regularly carried on Route 2:

- Gasoline
- Fuel oil
- Kerosene
- Liquified Petroleum Gas (LPG)
- Propane
- Sodium aluminate
- Sulfuric acid
- NOS Liquids 3082

Materials regularly carried on Route 8A are as follows:

- Gasoline
- Fuel oil
- Kerosene
- LPG
- Propane

Ten to 24 trains per day travel on the main freight line of the Pan Am Systems Railroad, a single track that runs adjacent to the Deerfield River. On each of these trains, an average of four cars carries hazardous materials. The CEM Plan lists the Pan Am Railroad as a hazardous transportation route. Rail accidents can be caused by faulty or sabotaged track; collision with another train, vehicle or other object on the track; mechanical failure of the train; or driver error. Depending on the freight, an accident could cause residents to evacuate the area. According to the HMEP, the hazardous materials regularly carried on these trains passing through Charlemont include:

- Hydrocyanic Acid
- Hydrochloric Acid
- Chlorine.
- Caustic soda
- Methanol
- Sodium chlorate
- LPG
- Sulfuric acid

The trains themselves pose a potential hazard since 3 or 4 engines are used per train and each engine has a 2,000-gallon fuel tank. A spill along this line could easily contaminate the Deerfield River, and would pose a risk to Charlemont residences, farms, and businesses located downstream. Since the development of the Franklin County Hazardous Material Emergency Plan in 2006, the transport of ethanol through the region has increased by both rail and truck. The Massachusetts Department of Environmental Protection issued a white paper in July 2011 stating that trains containing 60 – 80 cars full (up to 3.2 million gallons total) of ethanol travel from St. Albans, VT south through Franklin County and on into Connecticut on a weekly basis.

<u>Industrial Accidents – Fixed Facilities</u>: An accidental hazardous material release can occur wherever hazardous materials are manufactured, stored, transported, or used. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas. Those facilities using, manufacturing, or storing toxic chemicals are required to report their locations and the quantities of the chemicals stored on-site to state and local governments. The Charlemont CEM Plan lists the following businesses and town facilities that use hazardous materials

Table 32. Businesses that use Hazardous Materials.

Facility Name	Facility Location	Hazardous Chemical Inventory
Charlemont Wastewater Treatment Plant	4 Factory Road	Chlorine
Charlemont DPW	3 Factory Road	Diesel, gasoline, salt, sand
Verizon Switch Station	South Street	Propane, batteries
Sprint Switch Station	Zoar Gap Road	Propane, batteries
Rice Propane	East Hawley Road	Propane

Despite the risks present along transportation corridors and at fixed facilities, previous occurrences of major releases have not occurred in Charlemont.

Extent

Without handy tools such as the Saffir-Simpson, Enhanced Fujita, and RSI, the *Extent* is challenging to describe for non-natural hazards. The Massachusetts State Emergency Response Commission (SERC) is a multi-agency working group with a focus on coordinating hazardous materials planning and training efforts. The SERC is broadly charged with implementing the U.S. EPA's Emergency Planning and Community Right-to-Know Act (EPCRA) statute and mitigating the effects of a release or spill of hazardous materials. Information below is from the SERC web site.

The Massachusetts Contingency Plan (310 CMR 40.000) establishes requirements for reporting the release of a hazardous material that are more stringent than those contained in EPCRA Section 304. Information submitted to the Massachusetts DEP in compliance of the Massachusetts obligation shall be considered adequate for satisfying the EPCRA requirements for Emergency Release Notification under Section 304. Although written and or verbal notifications received by the SERC will be forwarded to the DEP, separate notifications to the National Response Center and to local officials are also required.

Aside from notification and reporting requirements, few tools are available for characterizing the potential strength or magnitude of a hazard, which are the two primary components of *Extent*.

Probability of Future Events

The probability of future events is affected by several factors increases in transportation of hazardous materials, increases in use/handling at fixed facilities, improvements in safety for both categories of risk, and changes in the frequency of events such as floods and landslides that can impact transportation and fixed facilities. Although it is beyond the scope of this plan to quantify the first three factors, the Town should assume that the frequency of events such as floods and landslides that can impact transportation and fixed facilities will likely increase.

Vulnerability Assessment

Although this section provides some information on hazardous materials, quantifying the impact with dollar losses was not possible.

Exposure

Hazardous materials can be found in any community, as they are used in homes, hospitals, and factories, and are shipped daily via land, air, railways, and pipelines (FEMA, 2019). If released, these materials can damage the environment, critical infrastructure, property, and people.

Built Environment Impacts

Most hazardous material releases do not usually have a direct effect on critical facilities and infrastructure. Some critical infrastructure uses hazardous materials to operate such as chlorine for water treatment and PCB's for electric transformers. Similarly, the contamination of the water supply may be treated like a hazardous material release. Propane, oil, and natural gas, necessary fuels for heating, can also be hazardous if released during their delivery due to their explosive potential. Transportation may be limited if a key roadway or railway is blocked by an incident.

A hazardous material release can bring possible losses to structure due to inaccessibility, contamination, and structural and contents losses if an explosion is present; and possible economic losses caused by business closures and associated business disruption losses.

Population Impacts

Populations near rail and facilities housing hazardous materials are more likely to be exposed to a potential spill. Younger and older populations may be more susceptible to the spill itself and may not be able to leave the area. Also, areas more exposed to hazardous material spills have often been the home of environmental justice communities with low incomes.

Environment Impacts

A hazardous material release can also include significant environmental impacts listed below:

- Hydrologic effects
    - Surface and groundwater contamination
    - Other effects on water quality such as changes in water temperature
    - Damage to streams, lakes, ponds, estuaries, and wetland ecosystems
- Air and soil quality effects
    - Pollutants, smoke, and dust
    - Loss of Quality in Landscape and Soil Quality
- Damage to plant communities
    - Loss of biodiversity

    - Damage to vegetation
- Damage to animal species
    - Animal fatalities
    - Degradation of wildlife and aquatic habitat
    - Pollution of drinking water for wildlife
    - Loss of biodiversity
    - Disease

National Flood Insurance Repetitive Loss Properties

B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))

According to FEMA, repetitive loss properties are those for which two or more losses of at least $1,000 each have been paid under the National Flood Insurance Program (NFIP) within any 10-year period since 1978. Severe repetitive loss properties are residential properties that have at least four NFIP payments over $5,000 each and the cumulative amount of such claims exceeds $20,000, or at least two separate claims payments with the cumulative amount exceeding the market value of the building.

According to data provided by FEMA during the completion of the Town's previous hazard mitigation plan, there are no repetitive loss properties located in Charlemont. It is believed by Town officials that this is still the case. To confirm this information for the 2022 plan update, current NFIP data on repetitive loss structures for the community was sought from FEMA through multiple requests, including through the Massachusetts State NFIP Coordinator, State Hazard Mitigation Officer, and direct communication by the consultant team with FEMA Region 1. However, these requests are still pending. As suggested by the FEMA Region 1 Planning Staff to MEMA staff during its annual State Consultation (May 12, 2022), any updated information on repetitive loss properties will be included as a later addition to this plan update once the pending data request is granted. Please also note that a summary of the Town's participation and compliance with the NFIP, including current policy and historical claims statistics, is provided in Table 7 of Chapter 5 (Capability Assessment).

Hazard Ranking

Ranking hazards helps the Town set goals and mitigation priorities. To compare the risk of different hazards, and prioritize which are more significant, requires a scoring system for equalizing the units of analysis. As not all hazards assessed in this plan have precisely quantifiable probability or impact data, a scoring system based on multi-criteria decision analysis (MCDA) methodology was developed to rank all the hazards. This multi-criteria ranking analysis approach prioritizes hazard risk based on a blend of quantitative factors from the available data, such as historical data, local knowledge, public survey, and Hazus assessment. This hazard ranking analysis assigns varying degrees of risk to five categories for each of the hazards, including: probability (how often it can occur), impact (economic, social, and environmental loss), spatial extent (the size of the area affected), warning time (how long does a community have to prepare for the event), and duration. Each degree of risk was assigned a value ranging from 1 to 4. The weighting factor derived from a review of best practice plans. Some of these hazard characteristics, like probability and impact, are more important than others and are weighted more heavily.

To calculate a rank score value for a given hazard, the assigned risk value for each category was multiplied by the weighting factor. The sum of all five categories represents the final rank score, as demonstrated in the following equation:

Hazard Score Value = [(Probability x 30%) + (Impact x 30%) + (Spatial Extent x 20%) + (Warning Time x 10%) + (Duration x 10%)]

Table 33 provides the hazard characteristic, level description, level criteria, level index value, and weighting value.

Table 33. Hazard Ranking Criteria

Hazard Characteristic	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, in any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.	1	30%
	Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shudown of critical facilities for more than one day.	2	
	Critical	Mulitiple deaths/injuires possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical faicliteis for more than one week.	3	
	Catastrophic	High number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	4	
Spatial Extent	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
Warning Time	Long	More than 24 hours	1	10%
	Moderate	12 to 24 hours	2	
	Short	6 to 12 hours	3	
	Very short or no warning	less than 6 hours	4	
Duration	Very short	Less than 6 hours	1	10%
	Short	Less than 24 hours	2	
	Moderate	Less than one week	3	
	Long	More than one week	4	

Table 34 provides the final hazard ranking for Charlemont. Each hazard characteristic is assigned a value between 1 (lowest value) and 4 (highest value). When the risk values were calculated, if the value was greater than 3, it was assigned as a high risk hazard. If the value was greater than 2 and less than or equal to 3, it was assigned as a moderate risk. If the value was less than or equal to 2, it was assigned as a low risk hazard. The flood, extreme temperatures, and severe winter storms hazards were ranked highest. The wildfires/brushfires, hurricanes/wind, thunderstorms, drought, infectious disease, invasive species, hazardous materials, and earthquakes are all ranked as moderate. The landslide and tornado hazards are ranked as low.

Table 34. Final Hazard Ranking of Hazards for Charlemont

Hazards	Probability	Impact	Spatial Extent	Warning Time	Duration	Value	Rank
Flood	4	4	2	4	2	3.4	High
Landslide	1	2	1	4	1	1.6	Low
Wildfires/Brushfires	2	1	3	3	3	2.1	Mod.
Hurricanes/Wind	2	3	4	1	2	2.6	Mod.
Severe Winter Storms	4	3	4	1	3	3.3	High
Tornadoes	1	1	1	3	1	1.2	Low
Thunderstorms	4	2	4	2	1	2.9	Mod.
Earthquakes	1	3	4	4	1	2.5	Mod.
Drought	2	3	4	1	4	2.8	Mod
Extreme Temperatures	4	2	4	2	2	3	High
Infectious Disease	4	2	4	2	2	2.7	Mod
Invasive Species	3	2	4	3	4	2.6	Mod
Hazardous Materials	1	3	2	4	2	2.2	Mod

Problem Statements

As suggested in FEMA's Local Mitigation Planning Handbook[10], the following problem statements were developed upon the completion and review of all risk assessment tasks. These statements are designed to briefly summarize the key hazard risks and vulnerabilities to the community based on potential impacts and losses from future events. They are among the issues of greatest concern and were used to assist in the identification and analysis of potential mitigation actions for Chapter 6 (Mitigation Strategy). These problem statements will be reviewed and revised as needed during future plan updates to reflect the most current information resulting from the risk assessment.

Primary Hazards of Concern (High Hazard Rankings)

- Flooding
- Severe Winter Storms
- Extreme Temperatures

Primary Impacts, Geographic Areas, and/or Vulnerable Assets of Concern

- Critical Facilities and Flood Risk: Several critical facilities in Charlemont (including the police and fire stations, as well as Hawlemont Regional Elementary School) are at risk of inundation and damage from flooding of the Deerfield River. The key services provided by these critical facilities

[10] Local Mitigation Planning Policy Guide. FEMA. March 2013. P. 5-2.

cannot lapse. They should be relocated or protected in their current location. Roadway and bridge washouts/closures are also a significant local concern with potential major, long-term impacts. Areas that are at highest risk and/or experience chronic flooding include floodplains along Charlemont's numerous streams, sections along Route 2, and the southern, flat section of Legate Road.

- Power Outages: The linear patter of development along Route 2 coupled with the dispersed pattern of development in outlying areas makes the Town's residents vulnerable to sustained power outages caused by winter storms and severe winds that bring down trees and power lines. Power outages create major social and economic disruptions to the community and can lead to additional life/safety threats and secondary hazard events that extend beyond the initial cause. Town should focus on both preventative mitigation techniques (such as pruning and hazard tree management or undergrounding powerlines) as well as emergency response measures to expedite power restoration as much as possible.
- Extreme Heat and Vulnerable Populations: There are a relatively high number of elderly and other socially vulnerable populations who will be less capable of adapting to the projected increase in the frequency and severity of extreme heat events. Updated plans and procedures for the Town's response to these events are recommended along with public outreach materials that can be useful during summer months and in advance of forecasted heat waves (providing information on individual preparedness activities, cooling centers, etc.).
- Transportation of Hazardous Materials: Despite a lack of occurrences, the Town remains concerned about the risks posed by transport of hazardous materials along Route 2 and the rail line. Severe storms have washed out Route 2 (i.e., T.S. Irene) and rail lines in other states (i.e., T.S. Ida in Connecticut). Climate change will increase the risk of washouts, leading to increased risk of an incident even if the passage of hazardous materials through Charlemont does not increase. Hazardous material incidents pose significant environmental impacts to the community in addition to threats to public health and safety.
- Campgrounds and Flood Risk: Several campgrounds are located along the Deerfield River, including one (Mohawk Park) with over 50 large, recreational vehicles in the floodplain and one point of egress. Plans and procedures for warning and evacuating these areas should be kept up to date and routinely maintained and exercised. Most of the people staying in these areas are likely from out of town and may not be thinking about flood hazards and/or what to do in the event of flash flood events, so some visitor outreach and awareness measures during summer seasons would also be helpful.
- Dam Failure Inundation and Evacuation: Although there are no high hazard dams located in Charlemont, there are several located upstream that are of significant concern to the Town (Somerset Dam, Harriman Dam, and Sherman Dam). While having a very low probability of occurrence, the failure of these dams could result in severe consequences for the community. Even with advance warning the Town would have only a little over an hour to evacuate residents from the projected inundation zone which includes the village center, two schools, Town Hall, as

well as the police station and fire station (critical facilities tasked with supporting evacuation and other emergency response operations). The Mohawk Park Campground is also completely within the inundation area presenting additional logistical challenges in the event of a dam failure event as described above.

- Wildfires: While the Town has managed to address small wildfires and brush fires as they occur, the wildfire risks posed by the linear patter of development along Route 2 coupled with the dispersed pattern of development in outlying areas are viewed as higher than desired. The Town should focus on prevention and rapid deployment for addressing wildfires.

Chapter 5: Capability Assessment

Capability Assessment Purpose

The purpose of conducting a capability assessment is to determine the ability of a community to mitigate hazard risks and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs, or projects. As in any planning process, it is important to establish which goals or actions are feasible based on the organizational capacity of those agencies or departments tasked with their implementation. A capability assessment helps to determine which types of mitigation actions are practical and likely to be implemented over time based on a local jurisdiction's existing authorities, policies, programs, and resources available to support such implementation. This analysis will identify any critical capability gaps or shortfalls, as well the key strengths or positive measures already in place and which should continue to be supported.

The capability assessment serves as the foundation for designing an effective mitigation strategy. It not only helps establish the goals and actions for the Town of Charlemont's hazard mitigation plan, but it ensures that those goals and actions are realistically achievable under current local conditions. As highlighted in FEMA's 2022 Local Mitigation Planning Policy Guide, *"describing the current capabilities provides a rationale for which mitigation projects can be undertaken to address the vulnerabilities identified in the Risk Assessment."* [11]

The capability assessment for the Town of Charlemont includes a comprehensive examination of several components as summarized in Table 35.

[11] Local Mitigation Planning Policy Guide. FEMA. April 2022. P. 25.

Table 35. Capability Assessment Components

Components	Description
Planning and Regulatory Capabilities	Local plans, policies, codes, and ordinances that are relevant to reducing the potential impacts of hazards.
Administrative and Technical Capabilities	Local human resources and their skills/tools that can be used to support mitigation activities.
Financial Capabilities	Fiscal resources the community has access to for helping to fund hazard mitigation projects.
Education and Outreach Capabilities	Local programs and methods already in place that can be used to support mitigation activities.
NFIP Participation and Compliance	Summary of information relevant to the community's participation in the NFIP and continued compliance with NFIP requirements.
Capability Assessment Conclusions	A summary of capability findings.

Review and Incorporation of Existing Studies

A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))

Many sources were used to develop this plan, including web-based resources, reports, and stakeholder engagement. Throughout the plan, these sources are cited within the text as footnotes. The Massachusetts State Hazard Mitigation and Climate Adaptation Plan, as well as several Town of Charlemont plans, were reviewed for consistency. The goal was to develop a plan that would easily integrate with the key aspects of plans in the Town and State. This section reviews how the content of several key plans and studies influenced the development of this plan. The risk assessment also details resources used toward development of this mitigation plan update. A summary of the most relevant plans is provided below.

State Hazard Mitigation and Climate Adaptation Plan (2018)

The Commonwealth's 2018 State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) is an innovative, first-of-its-kind statewide plan that fully integrates a traditional hazard mitigation plan with a climate change adaptation plan. The SHMCAP fulfills two important requirements, including (1) updating the 2013 State Hazard Mitigation Plan as required by Federal regulations (44 CFR Part 201.4); and (2) fulfilling requirements for a state climate adaptation plan per Massachusetts Executive Order 569. The SHMCAP has five goals as shown below:[12]

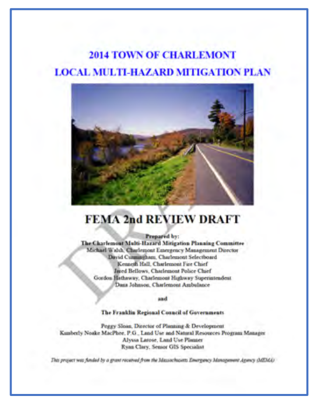
[12] Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018. P. 7-2.

1. Enhance the Commonwealth's resiliency to natural hazards and climate change by integrating programs and building institutional capacity.
2. Reduce the impacts of natural hazards and climate change with forward-looking policies, plans, and regulations.
3. Understand our vulnerabilities and risks and develop immediate and long-term risk reduction strategies for current and future conditions using the best available science.
4. Increase the resilience of State and local government, people, natural systems, the built environment, and the economy by investing in performance-based solutions.
5. Support implementation of this plan through increased education, awareness, and incentives for action for state agencies, local governments, private industry, non-profits, and the public.

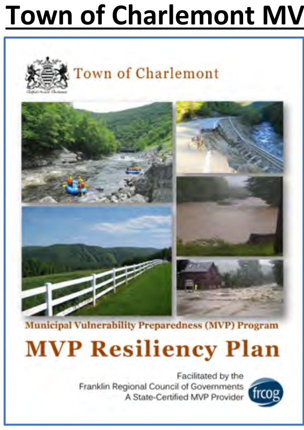
The Town of Charlemont's Hazard Mitigation Plan is consistent and aligned with the SHMCAP. The goals in the following chapter include several of the themes shown in the State plan, including the integration of hazard mitigation and climate adaptation strategies in local policies, plans, and regulations; improving public education and awareness; building local capacity; and reducing risk to people, property, and infrastructure to natural hazards and climate change. In addition, as seen in Chapter 4, the risk assessment has been updated to be organized using the same hazard classification scheme as used for the SHMCAP.

2014 Town of Charlemont Local Multi-Hazard Mitigation Plan

The Town of Charlemont's previous hazard mitigation plan was developed by the Franklin Regional Council of Governments (FRCOG). This plan includes nine natural hazards and hazardous materials as a manmade hazard. This plan included one goal statement, "to minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to natural disasters." Mitigation actions were included for each hazard identified. All the hazards identified are included in this plan update. Each of the mitigation actions were reviewed for their status and relevancy to this update. The critical facility list from this plan was reviewed and combined with the critical facilities named in the MVP plan.



Town of Charlemont MVP Resiliency Plan (2018)



The Commonwealth's Municipal Vulnerability Preparedness (MVP) program provides support for cities and towns in Massachusetts to plan for resiliency and implement key climate change adaptation actions for resiliency. In 2017, Charlemont was awarded an MVP Planning Grant to assess its vulnerability to and prepare for climate change impacts, build community resilience, and receive designation from the Executive Office of Energy and Environmental Affairs (EEA) as an MVP Community. Communities with this designation become eligible for MVP Action Grant funding and other opportunities to support the implementation of priority climate adaptation actions.

For the development of Charlemont's MVP Resiliency Plan, the Town followed the Community Resilience Building (CRB) framework with technical assistance provided by the Franklin Regional Council of Governments (FRCOG). A CRB Workshop was held at the Federated Church in Charlemont on May 18, 2018, with the following central objectives:

1. Define top local natural and climate-related hazards of concern.
2. Identify existing and future strengthen and vulnerabilities.
3. Develop prioritized actions for the town.
4. Identify immediate opportunities to collaboratively advance actions to increase resilience.

The Town's resulting MVP Resiliency Plan and supporting materials served as a primary source of information and community-based inputs for the update to this Hazard Mitigation Plan. These inputs include the identification of top climate-influenced hazards and vulnerable areas or community assets (infrastructural, societal, and environmental), current community concerns and challenges presented by these hazards, and specific recommendations to improve Charlemont's resilience to hazards.

Charlemont Floodplain Action Plan (2017)

The Town's Floodplain Action Plan includes a description and assessment of flooding sources in Charlemont (including flood hazard/inundation maps), past mitigation actions, and floodplain development, and it identifies a series of recommendations for future mitigation actions to reduce flood risk. It was prepared as a deliverable of the Massachusetts Silver Jackets Team Special Projects program, with participation from the US Army Corps of Engineers (USACE), the US Geological Survey (USGS), the Massachusetts Emergency Management Agency (MEMA), and Massachusetts Department of Conservation & Recreation's (DCR) Flood Hazard Management Program. The plan also served as a useful tool for the community while going through the MVP planning process described above.

Charlemont Comprehensive Emergency Management Plan (2015)

The CEMP outlines an emergency management program for planning and responding to potential emergency or disaster situations. It assigns responsibilities and functions to provide for the safety and welfare of citizens in the event of natural or man-made hazards. The plan addresses Mitigation, Preparedness, Response, and Recovery aspects of emergency management and guides responding agencies and organizations through specific hazards; including associated programs, training, and protective actions. It lists a series of generic mitigation actions for the Town to consider pursuing for a variety of hazards and across multiple departments and organizations.

Charlemont Open Space and Recreation Plan (2004)

The intent of the document is not to address hazard mitigation or flood control in a direct or comprehensive way. However, it inventories the natural features and environments in the town, many of which, such as wetlands, aquifer recharge areas, farms, rivers, streams, and brooks, contain floodplain, dam failure inundation or localized flooding areas. The plan highlights the importance of balancing future development with the preservation of the community's natural and scenic resources.

The preservation of open space and farmland will provide flood storage capacity which reduces the amount of impervious surface in an area, as well as other benefits not directly related to natural hazard mitigation.

Master Plan for the Town of Charlemont (2002)

The purpose of the Town's Master Plan is to serve as a set of guiding principles for the future of the town. It is a collective expression of how the community views itself and what it would like to become. Charlemont's Master Plan, prepared back in 2002, was developed over a three-year period as a joint effort of town residents, the members of various Town boards, and graduate planning students and faculty from the University of Massachusetts. It includes distinct plan elements that are focused on the following topics: Land Use; Housing; Historical and Cultural Resources; Economic Development; Agricultural, Open Space and Natural Resources; Transportation; Services; Recreation; and Town Center. Although it is 20 years old (with exception of the Economic Development chapter as described below), the plan still serves as the long-range plan to guide future development in Charlemont. More information on how the Master Plan relates to and/or addresses the mitigation of natural hazards is provided later in this section (see results of the *Safe Growth Survey*).

In addition to the above plans which were determined to be most relevant for the hazard mitigation plan update, the following plans, studies, reports, and other technical documents were reviewed to gain a clearer understanding of their existing or potential effects on hazard risk reduction:

- ***Economic Development Master Plan Chapter (2011)*** – update chapter for the Town's 2002 Master Plan described above.
- ***Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed (2017)*** – prepared by FRCOG, this regional plan integrates the 9 elements of a Section 319 (Clean Water Act) Watershed-Based Plan, the tenets of EPA's Healthy Watersheds Initiative, and focuses on strategies and projects to protect and restore the watershed's green infrastructure as a cost-effective climate change adaptation strategy. Some of the recommendations from the Watershed-Based Plan tie in directly with recommendations identified in Charlemont's MVP Resiliency Plan described above.

Hazard Mitigation Plans and MVP plans from surrounding communities were reviewed. The HMPC reviewed these plans for information regarding hazards and their impact as well as for mitigation action ideas. The HMPC looked specifically for actions that they may want to replicate as well as for opportunities to collaborate with other communities. The list of some of the plans reviewed is below:

- Town of Savoy, MA Hazard Mitigation Plan, April 2021
- Town of Colrain Hazard Mitigation Plan, October 2020
- Town of Shelburne Hazard Mitigation Plan, January 2021
- Town of Rowe Multi-Hazard Mitigation Plan, 2016
- Town of Buckland Hazard Mitigation Plan, October 2020

- Town of Hawley Multi-Hazard Mitigation Plan, January 2013

Planning and Regulatory Capabilities

C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))

Error! Reference source not found. is based off Worksheet 4.1 from FEMA's *Local Mitigation Planning Handbook*. It was used by the HMPC to document and review the current planning and regulatory capabilities of the Town including local plans, policies, codes, and ordinances that are relevant to reducing the potential impacts of hazards.

Table 36. Planning and Regulatory Findings

Planning/Regulatory Tool	Responsible Authority	General Description and Effectiveness for Hazard Risk Reduction
Plans		
Comprehensive/Master Plan	Master Plan Committee	The plan includes numerous objectives that are consistent with hazard risk reduction (such as preserving open space and protecting key landscapes), though this is not an explicit goal or guiding principle for the plan.
Open Space & Recreation Plan	Planning Board	The plan has hazards listed and grouped within sections of the plan. Some of these need to be updated.
Economic Development Plan	Selectboard	Talks about permanent protection of environmentally significant lands, as well as identifying areas that are flood prone and adhering to land use and building codes, and not building in flood prone areas.
Capital Improvements Plan	Capital Improvement Committee	The plan is more about capital items for Town departments. It does not involve economic development on properties in town yet.
Comprehensive Emergency Management Plan	EMD	The CEMP addresses hazards and could be used in support of the implementation of mitigation actions.
Wastewater Management Plan	Sewer Department	The Sewer Department is a separate entity from the Town, but they do have their own hazard plan.
Building Code, Permitting, and Inspections		

Planning/Regulatory Tool	Responsible Authority	General Description and Effectiveness for Hazard Risk Reduction
Building Code	FRCOG	The Town of Charlemont is a member of the Franklin County Cooperative Building Inspection Program, which provides building inspection services. Version/Year: They use the most current version of the State Building Code (780 CMR), which includes numerous provisions for reducing risks posed by natural hazards (e.g., flood-resistant construction, seismic design standards, wind and snow load requirements, etc.).
Building Code Effectiveness Grading Schedule (BCEGS)	ISO/Verisk	BCEGS Commercial Score: 4 BCEGS Residential Score: 4 *(Franklin County Cooperative Inspection Program 2)*
ISO Fire Protection Rating	ISO/Verisk	Public Protection Classification: 9
Site Plan Review Requirements	Planning Board	The Planning Board has just added a more stringent ticket process for their permits. Prior to issuing of a Special Permit, the Planning Board will consider potential topographic change, removal of cover vegetation, risk of erosion or siltation and increased storm water runoff (effective for ensuring that permitted projects do not increase flooding potential).
Zoning and Development Regulations		
Zoning Bylaws	Planning Board	The Town has adopted several regulations that serve to limit or regulate development in floodplains, to manage stormwater runoff, and to protect groundwater and wetland resources, the latter of which often provide important flood storage capacity. The Zoning Bylaws specifically address building within the floodplain, including Sections 23.9 (Special Permit Criteria), 34.3 (Erosion Control) and 45 (Floodplain District).
Subdivision Regulations	Planning Board	The Town's Subdivision Rules and Regulations contain several provisions that mitigate the potential for flooding and other hazards. The subdivision regulations need updating still, this is a work in progress for the Planning Board.
Floodplain Regulations	Conservation Commission	Adopted as part of Zoning Bylaws in 2011 (Section 45). The Conservation Commission has a DEP representative who helps them in administering and

Planning/Regulatory Tool	Responsible Authority	General Description and Effectiveness for Hazard Risk Reduction
		enforcing the regulations. This is considered quite effective.

Safe Growth Survey

As part of the assessment for planning and regulatory capabilities, the Town was asked to complete a *Safe Growth Survey*. This unique survey instrument was drawn from the Safe Growth Audit concept developed for the American Planning Association (APA) to help communities evaluate the extent to which they are positioned to grow safely relative to natural hazards. The survey covered six topic areas including the following:

- Land Use
- Transportation
- Environmental Management
- Public Safety, Zoning Ordinance
- Subdivision Regulations
- Capital Improvement Program and Infrastructure Policies

While somewhat of a subjective exercise, the Safe Growth Survey was used to provide some measure of how adequately existing planning mechanisms and tools for the Town of Charlemont were being used to address the notion of safe growth. In addition, the survey instrument was aimed at further integrating the subject of hazard risk management into the dialogue of local community planning and to possibly consider and identify new actions as it relates to those local planning policies or programs already in place or under development. It is anticipated that the Safe Growth Survey will be used again during future plan updates to help measure progress over time and to continue identifying possible mitigation actions as it relates to future growth and community development practices, and how such actions may better be incorporated into local planning mechanisms.

The results of the Safe Growth Survey are summarized in **Error! Reference source not found.**Table 37. This includes describing how strongly the Town agrees or disagrees with 25 statements as they relate to the Town of Charlemont's current plans, policies, and programs for guiding future community growth and development, according to the following scale:

1=Strongly Disagree 2=Somewhat Disagree 3=Neutral 4=Somewhat Agree 5=Strongly Agree

Table 37. Safe Growth Survey Results

COMPREHENSIVE/MASTER PLAN	
Land Use	
1. The comprehensive/master plan includes a future land use map that clearly identifies natural hazard areas.	1 2 $\boxed{3}$ 4 5
2. Current land use policies discourage development and/or redevelopment within natural hazard areas.	1 2 3 $\boxed{4}$ 5
3. The comprehensive/master plan provides adequate space for expected future growth in areas located outside of natural hazard areas.	1 2 3 $\boxed{4}$ 5
Transportation	
4. The transportation element limits access to natural hazard areas.	1 2 $\boxed{3}$ 4 5
5. Transportation policy is used to guide future growth and development to safe locations.	1 2 3 $\boxed{4}$ 5
6. Transportation systems are designed to function under disaster conditions (e.g., evacuation, mobility for fire/rescue apparatus, etc.).	1 2 3 $\boxed{4}$ 5
Environmental Management	
7. Environmental features that serve to protect development from hazards (e.g., wetlands, riparian buffers, etc.) are identified and mapped.	1 2 3 $\boxed{4}$ 5
8. Environmental policies encourage the preservation and restoration of protective ecosystems.	1 2 3 $\boxed{4}$ 5
9. Environmental policies provide incentives to development that is located outside of protective ecosystems.	1 2 $\boxed{3}$ 4 5
Public Safety	
10. The goals and policies of the comprehensive/master plan are related to and consistent with those in the hazard mitigation plan.	1 2 3 $\boxed{4}$ 5

11.	Public safety is explicitly included in the comprehensive/master plan's growth and development policies.	1	2	3	$\boxed{4}$	5
12.	The monitoring and implementation section of the comprehensive/master plan covers safe growth objectives.	1	2	3	$\boxed{4}$	5
ZONING BYLAWS						
13.	The zoning bylaws conform to the comprehensive/master plan in terms of discouraging development and/or redevelopment within natural hazard areas.	1	2	$\boxed{3}$	4	5
14.	The bylaws contain natural hazard overlay zones that set conditions for land use within such zones.	1	2	3	$\boxed{4}$	5
15.	Rezoning procedures recognize natural hazard areas as limits on zoning changes that allow greater intensity or density of use.	1	2	3	$\boxed{4}$	5
16.	The bylaws prohibit development within, or filling of, wetlands, floodways, and floodplains.	1	2	3	$\boxed{4}$	5
SUBDIVISION REGULATIONS						
17.	The subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas.	1	2	3	$\boxed{4}$	5
18.	The regulations provide for conservation subdivisions or cluster subdivisions to conserve environmental resources.	1	2	3	$\boxed{4}$	5
19.	The regulations allow density transfers where hazard areas exist.	1	2	3	$\boxed{4}$	5
CAPITAL IMPROVEMENT PROGRAM AND INFRASTRUCTURE POLICIES						
20.	The capital improvement program limits expenditures on projects that would encourage development and/or redevelopment in areas vulnerable to natural hazards.	1	2	3	$\boxed{4}$	5
21.	Infrastructure policies limit the extension of existing facilities and services that would encourage development in areas vulnerable to natural hazards.	1	2	3	$\boxed{4}$	5

22. The capital improvements program provides funding for hazard mitigation projects identified in the hazard mitigation plan.	1 2 3 $\boxed{4}$ 5
OTHER	
23. Small area or corridor plans recognize the need to avoid or mitigate natural hazards.	1 2 3 $\boxed{4}$ 5
24. The building code contains provisions to strengthen or elevate new or substantially improved construction to withstand hazard forces.	1 2 3 $\boxed{4}$ 5
25. Economic development and/or redevelopment strategies include provisions for mitigating natural hazards or otherwise enhancing social and economic resiliency to hazards.	1 2 3 $\boxed{4}$ 5

Administrative and Technical Capabilities

Table 38 is based off Worksheet 4.1 from FEMA's *Local Mitigation Planning Handbook*. It was used by the HMPC to document and review the current administrative and technical capabilities of the Town. These include staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions.

Table 38. Administrative and Technical Findings

Administrative/Technical Resource	Full-time (FT) / Part-time (PT) / Volunteer (V)	General Description and Effectiveness for Hazard Risk Reduction
Administration		
Planning Board	V	The Planning Board is made up of volunteers and works often with FRCOG to get the help they need to address bylaw changes and enforcement needs
Conservation Commission	V	The Conservation Commission has an agent who is extremely helpful in coordination
Hazard Mitigation Planning Committee	V	Charlemont has access to the REPC through FRCOG, but the rest of the committee is volunteer
Maintenance Programs to Reduce Risk (e.g., tree trimming, drainage clearance)	Highway- FT Tree Warden- V	These two departments work well with the public safety departments. Both are very capable; the problem would be the availability of the volunteer Tree Warden.

Administrative/Technical Resource	Full-time (FT) / Part-time (PT) / Volunteer (V)	General Description and Effectiveness for Hazard Risk Reduction
Mutual Aid Agreements	PT	Fire, Police, DPW all have a Western MA agreement for aid.
Other Resources?		FRCOG – MACC – Tristate incident team.
Staff		
Chief Building Official	FT	FRCOG Building Program, good coordination.
Floodplain Administrator	N/A	The Town has not formally designated a community Floodplain Administrator.
Emergency Manager	PT (2 hours/week)	Currently the Town's Fire Chief serves in this role; coordination is good, but hard because of the dual roles sometimes.
Community Planner	N/A	FRCOG is available for external support.
Civil Engineer	N/A	The Town would have to contract out for this.
GIS Coordinator	N/A	FRCOG is available for external support.
Resource Development Staff or Grant Writers	FT	The Town Administrator currently does this.
Public Information Officer	FT	This is also the Town Administrator
Technical		
Staff with knowledge of land development and land management practices	FT/PT	The staff and boards with this knowledge have been very effective. This includes the Planning Board, Conservation Commission and Agricultural Commission in the past.
Staff trained in construction practices related to buildings and/or infrastructure	FT/PT/V	This includes the FRCOG Building Department, as well as Town Fire Inspectors. This is very effective.
Staff with an understanding of natural hazards and risk mitigation	V/PT	This includes the Town's EMD, Fire Department, and Emergency Services staff. They have been very effective in previous disasters.
Hazards data and information	V/ FT	Various Town departments and the administration for more coverage and knowledge.
Warning systems/services (e.g., Reverse 911, outdoor warning signals, etc.)	PT/FT	The Town Administrator has been trained in this so that there is a full-time staff member. This works effectively.

Financial Capabilities

Table 39 is based off Worksheet 4.1 from FEMA's *Local Mitigation Planning Handbook*. It was used by the HMPC to identify the Town's eligibility and access to funding sources that can be used to support the implementation of hazard mitigation projects.

Table 39. Financial Findings

Financial Tool/Source	Accessible for Hazard Mitigation (Yes/No)	General Description and Effectiveness for Hazard Risk Reduction
General funds	Yes	We have used funds to purchase equipment or other needs for emergencies, such as generators.
Capital Improvement Program (CIP) funding	Yes	This is a way for boards and commissions to lay out equipment and projects that need funding. It certainly could be useful for future mitigation actions.
Special purpose taxes	No	
Fees for water, sewer, gas, or electric services	No	Tax rates are already high.
Stormwater utility fee	No	
Development impact fees	No	
Incur debt through general obligation bonds and/or special tax bonds	No	
Incur debt through private activities	No	
FEMA Hazard Mitigation Assistance (HMA)	Yes	The Town has applied for HMGP grants in the past.
HUD Community Development Block Grant (CDBG)	Yes	The Town participated in a regional grant through the housing authority.
Other federal funding programs	Yes	EPA, USACE, and other federal agencies do make grant funding available for a variety of resilience-themed projects and initiatives that the Town may be eligible to pursue in the future.
State funding programs	Yes	The Commonwealth makes a variety of funding programs available on a routine basis to support local risk reduction projects. Some of the most applicable opportunities for the Town to pursue in the future include MVP Action Grants and other programs through EEA, such as the Culvert

Financial Tool/Source	Accessible for Hazard Mitigation (Yes/No)	General Description and Effectiveness for Hazard Risk Reduction
		Replacement Municipal Assistance Grant Program.

Education and Outreach Capabilities

Table 40 is based off Worksheet 4.1 from FEMA's *Local Mitigation Planning Handbook*. It was used by the HMPC to identify education and outreach programs that can be used to support mitigation activities.

Table 40. Education and Outreach Findings

Program/Method	Yes/No	Description and Effectiveness for Hazard Risk Reduction
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access, and functional needs populations, etc.	Yes	There are various river groups that help with disaster resilience and mitigation such as the Deerfield watershed, the Connecticut River watershed. The primary focus is on the rivers and local brooks, and they could incorporate flooding/disaster effects.
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Limited	The Town does not have enough staff to actively pursue a lot of community outreach but is working on this.
Natural disaster or safety-related school programs	Yes	The Charlemont Fire Department has an ongoing educational program in the schools to teach fire safety, particularly during Fire Prevention Week, which falls during the first week of October.
StormReady certification	No	
Firewise USA® certification	No	
Public-private partnership initiatives addressing disaster-related issues	Yes (FRCOG)	No formal partnerships but the Town does have a good list of businesses. Multi-agency coordination helps the Town for big incidents that it is not equipped to handle.
Other programs/methods?	Yes	Town has used flyers and its monthly newsletter with success in the past. Seniors meet every Wednesday.

National Flood Insurance Program (NFIP) Participation and Compliance

C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))

As summarized in Table 41, the HMPC used Worksheet 4.3 from FEMA's *Local Mitigation Planning Handbook* to collect information regarding the Town's participation in and compliance with the NFIP. This worksheet, in addition to a separate *NFIP Survey* completed by the Town Administrator, helped the HMPC to identify areas for improvement and other ideas that could be potential mitigation actions. These actions, including those related to continued compliance with NFIP requirements, are identified and further discussed in Chapter 6 (Mitigation Strategy).

Table 41. NFIP Participation and Compliance Findings

NFIP Topic	Source of Information	Comments
Insurance Summary		
How many NFIP policies are in the community? What is the total premium and coverage?	State NFIP Coordinator, FEMA (PIVOT)	As of March 17, 2022, a total of 12 NFIP policies are in force. The total premium is $10,910 for a total of $2,384,100 in coverage.
How many claims have been paid in the community? What is the total amount of paid claims? How many of the claims were for substantial damage?	State NFIP Coordinator, FEMA (PIVOT, CIS)	There has been a total of 5 claims paid in the community, totaling $48,625 in losses. No paid claims were for substantial damage.
How many structures are exposed to flood risk within the community?	GIS analysis (FEMA FIRMs + building footprint data)	It has been estimated that 247 structures are at risk to the 1-percent annual chance flood.
Describe any areas of flood risk with limited NFIP policy coverage	N/A	No address-specific data has been made available by FEMA, but it is generally assumed that owners of property located in special flood hazard areas are underinsured when it comes to flood insurance coverage (based on only 12 current policies under the NFIP in comparison to nearly 250 structures estimated to be exposed to high flood risk).

NFIP Topic	Source of Information	Comments
Staff Resources		
Is the Community FPA or NFIP Coordinator certified?	N/A	The Town has not formally designated a community Floodplain Administrator but will do upon adopting the MA 2020 State Model Floodplain Bylaw. This person will be capable of securing lists of repetitive loss properties.
Is floodplain management an auxiliary function?	HMPC	Yes
Provide an explanation of NFIP administration services (e.g., permit review, GIS, education or outreach, inspections, engineering capability)	MA 2020 Model Floodplain Bylaw	Typical services include (1) understanding the regulations for floodplain development; (2) ensuring that permits are applied for when development of any kind is proposed in the floodplain; (3) involvement with the permit process and/or permit application review; (4) coordinating with other local departments as needed; (5) notifying adjacent communities prior to alteration of a watercourse; (6) dealing with compliance issues and enforcement actions such as correcting violations; and (7) maintaining records of floodplain development, and keeping FEMA current and historic maps available for public inspection.
What are the barriers to running an effective NFIP program in the community, if any?	Town Administrator	No significant barriers identified. The State's Flood Hazard Management Program provides useful information and resources to assist the Town with running an effective program.
Compliance History		
Is the community in good standing with the NFIP?	State NFIP Coordinator, FEMA	Yes
Are there any outstanding compliance issues (i.e., current violations)?	State NFIP Coordinator, FEMA	No
When was the most recent Community Assistance Visit (CAV) or Community Assistance Contact (CAC)?	State NFIP Coordinator, FEMA (CIS)	Last CAC was 09/23/2008 Last CAV was 07/22/1997
Is a CAV or CAC scheduled or needed?	Town Administrator	No

NFIP Topic	Source of Information	Comments
Regulation		
When did the community enter the NFIP?	State NFIP Coordinator, FEMA (CIS)	07/02/1980 (Regular Entry) 07/01/1975 (Emergency Entry)
Are the FIRMs digital or paper?	FEMA Map Service Center	Paper. The only digital flood hazard data is FEMA Q3 floodplain areas, which was digitized by the FRCOG and is considered quite dated.
Do floodplain development regulations meet or exceed FEMA or State minimum requirements? If so, in what ways?	Community Records	Floodplain regulations are met by the Conservation Commission and Zoning Bylaws, which meet all current FEMA/NFIP requirements and State minimum requirements. These regulations will be routinely updated as necessary to maintain compliance with existing NFIP and State minimum standards for floodplain management.
Provide an explanation of the permitting process.	Town Zoning Bylaws, Section 45 (Floodplain District)	All development in the Floodplain Overlay District, including structural and non-structural activities, are reviewed by the Conservation Commission for compliance with Chapter 131, Section 40 of the Massachusetts General Laws and with the following: (1) Section of the Massachusetts State Building code which addresses floodplain and coastal high hazard areas (currently 780 CMR 3107, "Flood Resistant Construction"); (2) Wetlands Protection Regulations, Department of Environmental Protection (DEP) (currently 310 CMR 10.00); Inland Wetlands Restriction, DEP (currently 310 CMR 13.00); and (4) Minimum Requirements for the Subsurface Disposal of Sanitary Sewage, DEP (currently 310 CMR 15, Title 5). Any variances from the provisions and requirements of the above referenced state regulations may only be granted in accordance with the required variance procedures of the state regulations.
Community Rating System (CRS)		
Does the community participate in CRS?	Town Administrator	No, however the Town will continue to explore the benefits of CRS participation as Risk Rating

NFIP Topic	Source of Information	Comments
		2.0 goes into effect and as updates to the CRS program are made by FEMA.
What is the community's CRS Class Ranking?	N/A	N/A
What categories and activities provide CRS points and how can the class be improved?	N/A	N/A
Does the plan include CRS planning requirements	Yes	Yes, many of the planning requirements under CRS Activity 510 are included in the plan but will not be evaluated or scored for credit until the Town decides to apply for CRS participation.

Table 8 provides some additional information in response to the updated requirements included in FEMA's 2022 Local Mitigation Planning Policy Guide:[13]

Table 42. Additional NFIP Participation and Compliance Information

Required Information	Response
Adoption of NFIP minimum floodplain management criteria via local regulation.	The Town adopted a floodplain overlay district in 2011, which has been defined as the FEMA floodplain on the 1980 (current) Flood Insurance Rate Maps and Flood Boundary & Floodway Maps. The town follows the mandatory standards set forth by the Massachusetts Wetlands Protection Act, as well as NFIP regulations for floodplain development. There are currently no local restrictions on development in the floodplain outside of these existing standards.
Adoption of the latest effective Flood Insurance Rate Map (FIRM), if applicable.	Town Zoning Bylaws, Section 45, adopted in 2011, establishes the Floodplain Overlay District as shown on the official Flood Insurance Rate Map (FIRM) for the Town of Charlemont dated July 2, 1980.
Implementation and enforcement of local floodplain management regulations to regulate and permit development in SFHAs.	See explanation of the Town's permitting process provided in Table 7.

[13] Local Mitigation Planning Policy Guide. FEMA. April 2022. P. 26.

Required Information	Response
Appointment of a designee or agency to implement the addressed commitments and requirements of the NFIP.	The Town has not formally appointed a designee or agency but will do upon adopting the MA 2020 State Model Floodplain Bylaw.
Description of how participants implement the substantial improvement/substantial damage provisions of their floodplain management regulations after an event.	The Town implements the SI/SD provisions of its floodplain management regulations as required per the NFIP (CFR Title 44, Parts 59 thru 65) and Massachusetts State Building Code (780 CMR). The Town will also coordinate with State Flood Hazard Management Program to assure that proper practices are followed and that a post-disaster plan will be in place to implement all SI/SD provisions.

Conclusions

As members of the HMPC stated the Town of Charlemont is "not a wealthy community," and it does not have the capabilities and resources often afforded to larger communities with more full-time staff and higher budgets for municipal departments and services. This is not likely to change anytime soon as the local tax rate is already considered very high (one of the highest residential tax burdens in Massachusetts) and future economic growth will continue to be limited due to existing land development constraints. However, as described earlier in this chapter, the community does have a high degree of planning and regulatory capability to address hazard mitigation and long-term climate adaptation. In addition, Charlemont's abilities to address these and many other municipal issues are greatly supported by the Franklin Regional Council of Governments (FRCOG), a regional service organization serving the twenty-six towns of Franklin County. The FRCOG is the former county government, which was abolished in 1997 and reestablished as a voluntary membership organization. Today the FRCOG operates 12 programs with more than 40 staff, and an annual operating budget of approximately $3 million.

Although Charlemont may not be a resource-rich community, it does have the ability to expand and improve on the capabilities described in this chapter. Specific opportunities to address existing gaps or limitations in local capabilities to reduce risk have been identified for each capability type and are further described below. Each of these opportunities were then considered by the HMPC during the plan update process as potential new mitigation actions to be included in the Mitigation Strategy.

<u>Opportunities to Expand and Improve on Capabilities to Reduce Risk</u>

Planning and Regulatory Capabilities

- Adopt the 2020 MA State Model Floodplain Bylaw to continue limiting new development within the 100-year floodplain and to prohibit the storage of hazardous materials within the district.

- Require a Special Permit for all new construction to help ensure projects do not increase localized flooding, erosion, or other impacts from stormwater runoff.
- Update the Town's Subdivision Rules and Regulations to require the Definitive Plan to identify potential natural hazard risks and mitigation measures where applicable (i.e., temporary and permanent erosion control measures for streams and surface water bodies, prohibition of permanent alterations of watercourses, etc.), and to include Impact Statements for construction beyond a certain number of lots.
- Encourage and consider requiring utility companies to place utility lines underground in all new subdivisions and/or where repetitive outages occur (the Town currently requires this for all utilities within sight of Route 2).
- Consider amending local regulations as needed to require the preservation of existing vegetation and mature trees to the maximum extent possible to mitigate erosion and landslide potential. This includes updating the Subdivision Rules and Regulations to require a Stormwater Management Plan that would allow water to infiltrate on-site, to the extent feasible, incorporate Low Impact Development (LID) strategies, and require drainage to be designed based on a 100-year storm.
- Consider adopting performance standards for commercial and industrial uses to regulate the storage and use of hazardous materials.
- Consider adopting a Water Supply Protection Overlay District to preserve and maintain existing and potential groundwater and surface water resources within the town. The town's ISO Fire Protection Rating of Class 9 is based on a fire suppression system that includes a creditable dispatch center and fire department, but no creditable water supply.

Administrative and Technical Capabilities

- Seek and implement more capacity building initiatives for Town staff as appropriate, including but not limited to continuing education and professional development opportunities.
- Identify and designate a Town position to serve as the community Floodplain Administrator (FPA) as required through the 2020 MA State Model Floodplain Bylaw.
- Increase budgeted hours for the Emergency Management Director (currently limited to 2 hours per week), to assist with more pre-disaster planning and public outreach/education efforts.
- Continue to coordinate with FRCOG for assistance as it relates to administrative and technical support, capability enhancements, and/or other resource needs.

Financial Capabilities

- Continue to coordinate with FRCOG as it relates to positioning the Town to pursue and capture future grant funding for hazard risk reduction projects. This is particularly true for federal mitigation grants available through FEMA's HMA grant programs as well as MVP Action Grants through the Massachusetts MVP program.

Education and Outreach Capabilities

- Seek to expand opportunities for public/private partnerships to support public education and community outreach initiatives related to hazard awareness and risk reduction efforts.
- Consider expanding the Fire Department's ongoing educational program for schools to address natural hazards and mitigation topics, and to also engage with the community's aging population (i.e., annual outreach to seniors at one of their weekly meetings).

Possible New Actions Related to NFIP Participation and Compliance

- Formally designate a community Floodplain Administrator (FPA).
- Evaluate current floodplain management activities and coordinate with Insurance Services Office, Inc. to apply for participation in FEMA's Community Rating System (CRS).
- Evaluate permit application forms to determine possible modifications focused on flood hazard prevention.
- Develop a checklist for review of building/development permit plans and for inspection of development in floodplains.
- To assist with implementing substantial damage provisions of the NFIP, develop a local post-disaster substantial damage plan in coordination with the State Flood Hazard Management Program and the Massachusetts Local Guidance for NFIP Substantial Damage Planning.

Chapter 6. Mitigation Strategy

The hazard mitigation strategy is the culmination of work presented in the planning area profile, risk assessment, and capability assessment. It is also the result of multiple meetings and public engagement. The work of the Hazard Mitigation Planning Committee (HMPC) was essential in developing the mitigation goals and actions included in this chapter. As described in Chapter 3: Planning Process, the HMPC worked in a consistent, coordinated manner to identify and prioritize the goals and mitigation actions for this Plan.

Mitigation Goals

C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))

Mitigation goals represent broad statements that are achieved through the implementation of more specific mitigation actions. These actions include both hazard mitigation policies (such as land use regulations) and hazard mitigation projects (such as structure or infrastructure projects). To develop goals for this Town of Charlemont, MA Hazard Mitigation Plan Update the HMPC reviewed the previous plan's goal statements, the Municipal Vulnerability Preparedness (MVP) plan goal statements, and the goals of the State Hazard Mitigation and Climate Adaptation Plan (SHMCAP).

The 2014 Town of Charlemont Multi-Hazard Mitigation Plan which included two goal statements, one for mitigation and one for preparedness and response. The revised goal statements include a Mission Statement that incorporates most of the previous plan's goal statement. Mention of specific hazards was removed to prevent accidentally eliminating a potential hazard.

2022 Mission Statement

Mission Statement

- Reduce or eliminate risk to people, property, and infrastructure from natural hazards and climate change.

After careful review of the MVP Plan and the 2014 Multi-Hazard Mitigation Plan, it was clear that climate change needed to be added to the mission statement and goal statements. In addition, three categories of mitigation action were created: public engagement, capacity building, and infrastructure and critical facilities. The following goal statements were developed for each category:

Public Engagement

- Increase citizen awareness of how to mitigate risks posed by climate change and natural hazards.

Capacity Building

- Increase the Town's capacity for mitigating risk by investing in regional collaboration, employee education, project implementation and the integration of hazard mitigation and climate adaptation strategies into local plans and policies.

Infrastructure and Critical Facilities

- Protect critical facilities and infrastructure from the impacts of natural hazards and climate change.

Figure 19. Goal Statements.

The mitigation actions from the 2014 Town of Charlemont Multi-Hazard Mitigation Plan were reviewed for their status and relevance to this plan update. The following table shows the previous plan's sixty mitigation actions (45 mitigation actions and 15 preparedness actions) and the status of each. The table also indicates if each action has been kept for this updated plan.

Table 43. Status of 2014 Mitigation Actions.

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
1	Utilize existing emergency preparedness outreach materials on westernmaready.gov and other sources to disseminate information through tax mailings, the Town website, and at local events such as Yankee Doodle Days and farmers markets on what to include in a 'home survival kit,' how to prepare homes and other structures to withstand flooding and high winds, and the proper evacuation procedures to follow during a natural disaster as well as which local radio stations provide emergency information. Review materials annually and update as needed.	Completed	Information is on the Town website under emergency management and pamphlets etc. available in the town hall.	YES - updated/revised description provided at right, if applicable	Consider expanding the Fire Department's educational program for schools to address natural hazards and mitigation topics and expand it to engage with the community's aging population (i.e., annual outreach to seniors at one of their weekly meetings). Action #7
2	Records of damages to the built and natural environment due to natural hazards are not consistently maintained. Data often resides with an individual and can be lost if those individual leaves his or her position. The town will implement a formal system of data collection and maintenance which will help improve the Town's hazard mitigation planning. Better data could also increase the Town's chance of qualifying for various grants.	Partially Completed / In Progress	Started a binder and printed out plans/reports but information is incomplete.	YES - updated/revised description provided at right, if applicable	Collect data following disasters to facilitate benefit-cost analysis in grant applications. Action #5
3	Conduct outreach to farmers and owners of property with old barns to inventory what	Delayed	Town does not have a full agricultural	YES - updated/revised	Develop a community education and outreach

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	chemicals they have stored on-site, and to offer assistance with disposing of old chemicals that are no longer in use.		commission and there is no record that this item was completed.	description provided at right, if applicable	program so residents know how to shelter-in-place and mitigate risk on their properties. Action#13
4	Submit a recommendation to the Planning Board to add performance standards for commercial and industrial uses to the Zoning Bylaws to regulate the storage and use of hazardous materials.	Completed	Town has a current bylaw that states no use shall be allowed which would create a hazard due to fire, explosion or other similar causes, other potentially hazard condition shall be fenced, covered, or otherwise rendered safe and it is in the special permit application to provide a list and plan for the materials.	NO - explanation provided at left	
5	Submit a recommendation to the Planning Board to update the Floodplain District bylaw to prohibit the storage or use of hazardous materials within the 100-year floodplain.	Delayed	The planning board has been doing zoning bylaw revisions, will make sure these are still in the cue.	YES - updated/revised description provided at right, if applicable	Adopt the 2020 MA State Model Floodplain Bylaw. Action #8
6	Submit a recommendation to the Planning Board to consider implementing a Water Supply Protection District to preserve and	Delayed	The planning board has been doing zoning bylaw	YES - updated/revised description	Update bylaws to include preserving and maintaining existing and

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	maintain existing and potential groundwater and surface water resources within the town.		revisions, will make sure these are still in the cue.	provided at right, if applicable	potential groundwater and surface water resources within the Town and adopting a Water Supply Protection Overlay District. Action #9
7	Seek funding to hire an engineer to inspect municipal buildings and structures to determine if they are particularly vulnerable to earthquake damage (built prior to 1975) and determine if any retrofitting measures could mitigate this vulnerability. Prioritize buildings and mitigation measures and seek funding to implement the highest priorities.	Delayed	Not feasible to hire an engineer to identify earthquake vulnerability. Seems more cost effective and beneficial to educate the community about the earthquake risk.	YES - updated/revised description provided at right, if applicable	Develop a community education and outreach program so residents know how to shelter-in-place and mitigate risk on their properties. Action#13
8	Utilize existing resources through FEMA's Ready.gov or other sources to conduct education and outreach to schools, businesses, and residents about proper procedures to follow during and after an earthquake through the following methods: • Conduct an annual earthquake drill at the Hawlemont School, and provide printouts of FEMA's What to Do Before, During, and After an Earthquake, or similar fact sheet, for teacher's to post in classrooms. • Distribute FEMA's Earthquake Preparedness: What Every Childcare Provider	Delayed	The Town has applied for a grant to get personnel for the fire department to help with these types of projects.	YES - updated/revised description provided at right, if applicable	Develop a community education and outreach program so residents know how to shelter-in-place and mitigate risk on their properties. Action #13

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	Needs to Know booklet to licensed childcare providers in town. • Provide a link to FEMA's Earthquake Safety Checklist or similar resource on the Town website				
9	Submit a recommendation to the Planning Board to revise the subdivision regulations to require all new utilities be placed underground.	Delayed		YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10
10	Develop and maintain a list of areas where repetitive power outages occur. Meet with National Grid to discuss future potential opportunities to underground existing utility lines in priority locations on the list. Work with National Grid to identify funding sources and to develop funding applications as needed.	Partially Completed / In Progress	National grid has been doing power updates on the east end of Town.	NO - explanation provided at left	
11	Identify priority areas for tree maintenance near utility lines in town and submit the list to National Grid for inclusion in its five-year action plan, which includes regular tree maintenance to reduce the number of limbs near overhead power lines, to reduce risk to infrastructure from severe winter storms. Meet bi-annually with the utility to ensure priority areas are included in the plan.	Completed + To Be Continued	The Tree Warden has worked with National Grid and done tree trimming all through Town where it was needed immediately he is currently doing the trees that are the Town's responsibility.	NO - explanation provided at left	

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
12	Conduct regular tree maintenance along town roads to reduce the number of limbs near overhead power lines to reduce risk to infrastructure from severe winter storms.	Completed + To Be Continued	The Tree Warden has been addressing the trees and keeping a list, budget constraints make this an ongoing action item.	NO - explanation provided at left	
13	Submit a recommendation to the Planning Board to incorporate dam safety into the Special Permit criteria and Subdivision Regulations. Applicants should consult Inundation Maps during their preparation of subdivision plans. The applicant should assess the risk to the potential development from the dam and supply that information along with mitigation measures to the town as part of the review process.	Delayed	There is no evidence this has been completed.	YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10
14	To reduce the risk of damage from high wind events, use Community Development Block Grant home rehabilitation funds to assist low to moderate income homeowners in bringing homes up to code, including grandfathered mobile homes. Work with the HRA to develop and distribute a brochure to publicize the program at the Town Hall, public events, through tax mailings, and on the Town website.	Delayed	There is a program the Town participates in with the RHA but information is not in prominent places on the website or in Town Hall.	YES - updated/revised description provided at right, if applicable	To reduce the risk of damage from High wind events, use Community Development Block Grant home rehabilitation funds to assist Low to moderate income homeowners in bringing homes up to code, including grandfathered mobile homes. Work with the

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
					HRA to develop and distribute a brochure to publicize the program at the Town Hall, public events, through tax mailings, and on the Town website. Action #19
15	Submit a recommendation to the Planning Board to add requirements to Section 42: Mobile Home Parks and Campgrounds of the Charlemont Zoning Bylaws to ensure adequate support and anchoring systems are used for temporary and permanent mobile homes.	Delayed	I do not find evidence that this was completed in our updated zoning regulations /bylaws.	YES - updated/revised description provided at right, if applicable	Add requirements to Section 42: Mobile Home Parks and Campgrounds of the Charlemont Zoning Bylaws to ensure adequate support and anchoring systems are used for temporary and permanent mobile homes. Action #11
16	Submit a recommendation to the Planning Board to revise the subdivision regulations to require all new utilities be placed underground.	Delayed	This has not been done.	YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10
17	Develop and maintain a list of areas where repetitive power outages occur. Meet with National Grid to discuss future potential	Completed + To Be Continued	National Grid has been doing power updates on the east end of Town. It	NO - explanation provided at left	

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	opportunities to underground existing utility lines in priority locations on the list. Work with National Grid to identify funding sources and to develop funding applications as needed.		is not considered cost effective to underground utilities.		
18	Identify priority areas for tree maintenance near utility lines in town and submit the list to National Grid for inclusion in its five-year action plan, which includes regular tree maintenance to reduce the number of limbs near overhead power lines, to reduce risk to infrastructure from severe winter storms. Meet bi-annually with the utility to ensure priority areas are included in the plan.	Completed + To Be Continued	The Tree Warden has worked with National Grid and done tree trimming all through town where it was needed immediately, he is currently doing the trees that are the Town's responsibility.	NO - explanation provided at left	
19	Conduct regular tree maintenance along town roads to reduce the number of limbs near overhead power lines to reduce risk to infrastructure from severe winter storms.	Completed + To Be Continued	The Tree Warden has been addressing the trees and keeping a list, budget constraints make this an ongoing action item.	NO - explanation provided at left	
20	To reduce the risk of damage from high wind events, use Community Development Block Grant home rehabilitation funds to assist low to moderate income homeowners in bringing homes up to code, including grandfathered mobile homes. Work with the HRA to develop and distribute a brochure to publicize the	Delayed	There is a program the Town participates in with the RHA but information is not in prominent places on the website or in Town Hall.	YES - updated/revised description provided at right, if applicable	To reduce the risk of damage from High wind events, use Community Development Block Grant home rehabilitation funds to assist Low to moderate

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	program at the Town Hall, public events, through tax mailings, and on the Town website.				income homeowners in bringing homes up to code, including grandfathered mobile homes. Work with the HRA to develop and distribute a brochure to publicize the program at the Town Hall, public events, through tax mailings, and on the Town website. Action #19
21	Submit a recommendation to the Planning Board to add requirements to Section 42: Mobile Home Parks and Campgrounds of the Charlemont Zoning Bylaws to ensure adequate support and anchoring systems are used for temporary and permanent mobile homes.	Delayed	I do not find evidence that this was completed in our updated zoning regulations /bylaws.	YES - updated/revised description provided at right, if applicable	Add requirements to Section 42: Mobile Home Parks and Campgrounds of the Charlemont Zoning Bylaws to ensure adequate support and anchoring systems are used for temporary and permanent mobile homes. Action #11
22	Submit a recommendation to the Planning Board to revise the subdivision regulations to	Delayed	I do not find evidence that this was completed in our updated zoning regulations /bylaws.	YES - updated/revised description provided at	Amend the Subdivision Regulations to mitigate risks of natural hazards

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	require all new utilities be placed underground.			right, if applicable	and climate change. Action #10
23	Develop and maintain a list of areas where repetitive power outages occur. Meet with National Grid to discuss future potential opportunities to underground existing utility lines in priority locations on the list. Work with National Grid to identify funding sources and to develop funding applications as needed.	Completed + To Be Continued	National grid has been doing power updates on the east end of Town.	NO - explanation provided at left	
24	Identify priority areas for tree maintenance near utility lines in town and submit the list to National Grid for inclusion in its five-year action plan, which includes regular tree maintenance to reduce the number of limbs near overhead power lines, to reduce risk to infrastructure from severe winter storms. Meet bi-annually with the utility to ensure priority areas are included in the plan.	Completed + To Be Continued	The Tree Warden has worked with National Grid and done tree trimming all through town where it was needed immediately, he is currently doing the trees that are the Town's responsibility.	NO - explanation provided at left	
25	Conduct regular tree maintenance along town roads to reduce the number of limbs near overhead power lines to reduce risk to infrastructure from severe winter storms.	Completed + To Be Continued	The Tree Warden has been addressing the trees and keeping a list, budget constraints make this an ongoing action item.	NO - explanation provided at left	

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
26	Submit a recommendation to the Planning Board to review and amend the Floodplain District Overlay Zoning Bylaw using the FRCOG Model Floodplain District Bylaw to reduce the risk of flooding and damage to infrastructure and natural resources. Special consideration should be given to further restricting or limiting new development within the 100-year floodplain and dam breach inundation areas and requiring more detailed standards for review of storm water plans for developments.	Completed	Floodplain bylaw adapted in the 2019 regulations.	NO - explanation provided at left	
27	Seek funding and technical assistance to update and expand the Vulnerability Assessment for properties located within the 100-year floodplain, using Assessors' data and other available information.	Delayed	I did not find an assessment.	YES - updated/revised description provided at right, if applicable	Develop a plan to raise or move Town owned buildings in the floodplain. Action #4
28	Submit a recommendation to the Planning Board to amend the Definitive Plan requirements for a subdivision to include identifying any potential flooding impacts and include flooding mitigation measures, if appropriate.	Delayed	Our last subdivision bylaw update was 2007 this is something we need to complete.	YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10
29	To reduce the risk of flooding and damage to infrastructure and natural resources from uncontrolled storm water runoff, submit a	Delayed	Our last subdivision bylaw update was 2007	YES - updated/revised description	Amend the Subdivision Regulations to mitigate risks of natural hazards

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	recommendation to the Planning Board to implement standards in the Subdivision Rules and Regulations to require temporary and permanent erosion control measures for streams and surface water bodies and prohibiting permanent alterations of watercourses or streams.		this is something we need to complete.	provided at right, if applicable	and climate change. Action #10
30	To reduce the impacts of new development on flooding, submit a recommendation to the Planning Board to amend the Subdivision Regulations to require Impact Statements for construction beyond a certain number of lots.	Delayed	Our last subdivision bylaw update was 2007 this is something we need to complete.	YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10
31	Support local and regional, watershed-wide open space protection efforts, particularly in floodplain areas. Research options for amending Charlemont's zoning so that it supports local and regional open space protection efforts, particularly in floodplain areas.	Completed + To Be Continued	This is incorporated in the permit application process.	NO - explanation provided at left	
32	The Town should consider becoming a part of FEMA's Community Rating System. Seek out technical assistance to help the Town take the steps necessary to join the program.	Delayed	I find no evidence this has been done.	YES - updated/revised description provided at right, if applicable	To assist with implementing substantial damage provisions of the NFIP, develop a local post-disaster substantial damage plan in coordination with the

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
					State Flood Hazard Management Program and the *Massachusetts Local Guidance for NFIP Substantial Damage Planning*. Action #18
33	To reduce the impact of new development on flooding and vice versa, submit a recommendation to the Planning Board to add flood prevention and mitigation to the list of criteria evaluated by the Board when reviewing a Special Permit application.	Completed + To Be Continued	This is a check off in the application process for the Planning Board.	NO - explanation provided at left	
34	To reduce the impact of new development on flooding, submit a recommendation to the Planning Board to update the Subdivision Rules and Regulations to require a Stormwater Management Plan that would allow water to infiltrate on-site to the extent feasible, incorporate Low Impact Development (LID) strategies, and require drainage to be designed based on a 100-year storm.	Delayed	Our last subdivision bylaw update was 2007 this is something we need to complete.	YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10
35	Include the Charlemont Sewer District in future hazard mitigation discussions. Work collaboratively to seek funding to assess floodproofing solutions for the wastewater treatment facility.	Partially Completed / In Progress	Working with the Sewer District since Irene on any thing that we have found that includes them.	YES - updated/revised description provided at right, if applicable	Identify and implement floodproofing solutions for the Wastewater Treatment Facility run by the Charlemont Sewer District. Action #3

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
36	Monitor the Rice Brook on the property adjacent to the Hawlemont School property. Take actions to mitigate future damage to school property as necessary.	Partially Completed / In Progress	Monitoring this.	NO - explanation provided at left	
37	Seek funding to increase the staff of the Fire Department's inspection and safety unit.	Delayed	The Town has applied for a grant to get personnel for the Fire Department to help with these types of projects.	YES - updated/revised description provided at right, if applicable	Increase the staff of the Fire Department's inspection and safety unit. Action #1
38	Coordinate with the FRCOG and other appropriate agencies, to request that the State revise burn permit guidelines to better align with safer weather conditions.	Completed + To Be Continued	The Town uses the Franklin County burn permit system now and posts information to the Fire Department page of the website.	NO - explanation provided at left	
39	Educate residents through materials posted on the Town website and distributed via tax mailings and when issuing burn permits about the risk of wildfire and brushfire and how to reduce this risk by adopting general fire safety techniques.	Completed + To Be Continued	The Town uses the Franklin County burn permit system now and posts information to the Fire Department page of the website.	NO - explanation provided at left	
40	To reduce the risk of landslides from new development, submit a recommendation to the Planning Board to add erosion control measures to the Zoning Bylaws that would	Completed + To Be Continued	This is a check off in the application process for the Planning Board.	NO - explanation provided at left	

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	require the site design, materials, and construction processes be designed to avoid erosion damage, sedimentation or uncontrolled surface water runoff and regulate slope and vegetative cover.				
41	To reduce the risk of landslides occurring from development activities, submit a recommendation to the Planning Board to amend the Subdivision Rules and Regulations to address impacts of uncontrolled surface water runoff and sedimentation of streams and surface water bodies by requiring temporary and permanent erosion control measures.	Delayed	Our last subdivision bylaw update was 2007 this is something we need to complete.	YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10
42	To reduce the impacts of new development on landslides, submit a recommendation to the Planning Board to amend the Subdivision Regulations to require Impact Statements for construction beyond a certain number of lots.	Delayed	Our last subdivision bylaw update was 2007 this is something we need to complete.	YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10
43	Submit a recommendation to the Planning Board to revise the Subdivision Rules and Regulations to require a Stormwater Management Plan that would allow water to infiltrate on-site to the extent feasible, incorporate Low Impact Development (LID) strategies, and require drainage to be designed based on a 100-year storm.	Delayed	Our last subdivision bylaw update was 2007 this is something we need to complete.	YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
44	To mitigate the impact of new development on landslide risk, submit a recommendation to the Planning Board to amend the Subdivision Rules and Regulations to require the preservation of existing vegetation and mature trees to the maximum extent possible.	Delayed	Our last subdivision bylaw update was 2007 this is something we need to complete.	YES - updated/revised description provided at right, if applicable	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change. Action #10
45	To mitigate potential damage from an ice jam, identify potential ice jam locations and implement monitoring of these locations during the winter and spring for signs of ice jams.	Completed + To Be Continued	Town actively monitors the ice jams- the last few years with the milder temperatures this has not been as big of an issue	YES - updated/revised description provided at right, if applicable	To mitigate potential damage from an ice jam, identify potential ice jam locations and implement monitoring of these locations during the winter and spring for signs of ice jams. Action #21

Table 44. Status of 2014 Preparedness Actions.

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
1	Identify potential locations for new shelters that are equipped with an auxiliary power supply, are earthquake resistant as well as outside of floodplain and dam	Completed + To Be Continued	This was completed following Irene.	NO - explanation provided at left	

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	inundation areas. Disseminate this information to appropriate town departments.				
2	Equip existing shelters with back-up power supplies.	Completed + To Be Continued	There is a generator at the Federated Church.	NO - explanation provided at left	
3	Acquire portable generators for critical Town facilities, such as Town Hall, Police Station, and Highway Garage.	Partially Completed / In Progress	There is a generator at the Fire Station and Town Hall.	NO - explanation provided at left	
4	Inventory supplies at existing shelters and develop a needs list and storage requirements. Establish MOUs with local or neighboring vendors for supplying shelters with potable water, food and first aid supplies in the event of a natural disaster.	Delayed	This needs to be completed.	YES - updated/revised description provided at right, if applicable	Increase capacity to shelter residents by identifying a shelter outside of the flood inundation zone from the Deerfield River Dam, signing MOU's with private bus companies to facilitate evacuations, and inventorying and storing shelter supplies. Action #25
5	Create, maintain, and train a volunteer base for assisting town emergency management staff during and after emergencies. Encourage Charlemont residents to join the Franklin County Citizen Emergency Response Team (CERT) or Medical Reserve Corps (MRC).	Partially Completed / In Progress	Our current EMD/Fire Chief is a member of the FRCOG incident response team and other emergency preparedness groups, he has been actively encouraging fire department members and town officials to participate.	NO - explanation provided at left	
6	Consider assisting the FRCOG and the Regional Emergency Planning	Delayed	Our current EMD/Fire Chief is a member of the FRCOG	NO - explanation provided at left	

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
	Committee (REPC) in updating and implementing the Draft 2009 Regional Debris Management Plan.		incident response team and other emergency preparedness groups, he has been actively encouraging fire department members and town officials to participate.		
7	Research appropriate vulnerability assessment models for fixed facility and transportation hazardous materials accidents, collect relevant data, and populate model to further prioritize manmade hazard action items.	Delayed	Emphasis in this plan is natural hazards.	NO - explanation provided at left	
8	Develop an evacuation plan and notification system in the event of a chemical spill in a fixed structure or in a transportation setting such as Route 2, Route 8A, or the railroad.	Completed + To Be Continued	Reverse 911 and an evacuation plan are in place.	NO - explanation provided at left	
9	Request Evacuation Plans and information about drills from facilities in town that use hazardous materials and coordinate town emergency response with facilities' emergency response staff.	Completed + To Be Continued	The EMD Director has met with some companies.	YES - updated/revised description provided at right, if applicable	Request evacuation plans from private companies and companies that use hazardous materials. Action #23
10	Ensure all public safety officials in town have copies of the most recent Emergency Action Plans and inundation maps for the Deerfield River high hazard dams.	Completed + To Be Continued	Emergency Services has these plans.	NO - explanation provided at left	

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
11	Prepare evacuation plans for dam failures on the Deerfield River using inundation maps from Emergency Action Plans, available evacuation plans for critical facilities like the Hawlemont Regional Elementary School and the Academy at Charlemont (if available) and the recommendations contained in the Draft Town Recommendations: Supplement to the Failure of the Harriman Dam Evacuation Planning Report (July 6, 2010).	Partially Completed / In Progress	This action has been revised to meet current needs.	YES - updated/revised description provided at right, if applicable	New alarm system to notify of Harriman Dam failure. Action #15
12	Identify shelters outside of the inundation zones for evacuees from a dam failure on the Deerfield River. If needed, execute MOUs with neighboring towns for use of shelters within those towns.	Partially Completed / In Progress	This action has been revised to meet current needs.	YES - updated/revised description provided at right, if applicable	Increase Town capacity to mitigate risk by signing memorandums of understanding with local and regional partners. Action #20
13	Ensure that the Hawlemont Regional Elementary School and the Academy at Charlemont have up-to-date evacuation plans for a dam failure on the Deerfield River.	Partially Completed / In Progress	This action has been revised to meet current needs.	YES - updated/revised description provided at right, if applicable	New alarm system to notify of Harriman Dam failure. Action #15
14	Review evacuation procedures for the flood prone areas in town (identified on the Critical Facilities and Infrastructure Map) and update.	Completed		NO - explanation provided at left	

Action #	Action Description	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
15	Coordinate with state and regional agencies to identify a location(s) for the temporary storage of contaminated/hazardous flood debris.	Cancelled	Not considered essential.	NO - explanation provided at left	

The Municipal Vulnerability Preparedness (MVP) plan was developed in 2018 and includes twenty-eight suggested actions divided into categories of highest priority, high priority, moderate priority, and low priority. The MVP is part of a Massachusetts state-wide initiative through the Executive Office of Energy and Environmental Affairs (EEA) to provide support to cities and towns to plan for resiliency and implement climate change adaptation actions. The actions identified in Charlemont's MVP were reviewed and considered when developing mitigation actions for this plan update. As of Spring 2022, four of these recommendations are not necessary for consideration in this plan (they are marked by shading in the lists below).

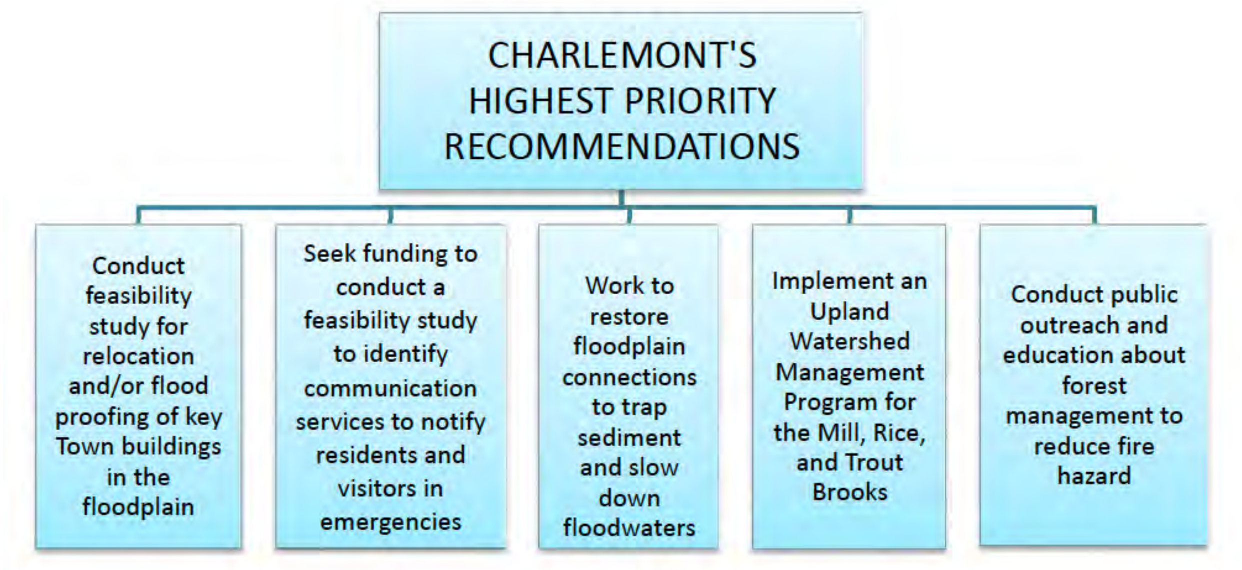


Figure 20. Charlemont's Highest Priority Recommendations.

The recommendation above that states, "Conduct feasibility study for relocation and/or flood proofing for key Town buildings in the floodplain," has been addressed. The Town is currently engaged in a plan to move emergency services out of the floodplain.

High Priority Recommendations

- Contact legislators or other state officials to encourage additional funding of bridge and culvert repairs. (Charlemont has been actively pursuing grants and funding to repair bridges and have implemented a priority replacement plan.)
- Work with AT&T to upgrade existing cell towers and identify locations to add new ones as needed to provide cell phone coverage to the entire Town. (The cell tower in town has been upgraded to three companies of service and broadband.)
- Work with Eversource to install electrical grid upgrades to reduce the likelihood of power outages during emergencies. (This is currently in place.)
- Work with the Council on Aging and the Federated Church to maintain list of vulnerable persons with special needs and establish an appropriate mode of communication for emergencies.

- Execute a Memorandum of Agreement (MOA) with the Federated Church to provide food and sheltering services to all Town residents, especially vulnerable populations, during emergencies. Formalizing this relationship will be especially important as the Church undergoes a change in leadership in the coming year.

Moderate Priority Recommendations

- Using MassDOT culvert database and Highway Dept. GPS units, track ongoing problems and establish need for culvert repairs/ reconstruction.
- Need better communication between Towns regarding the response to an emergency on the railroad. Participation in the Franklin County Multi-Agency Coordinating Committee (MACC) would provide the needed vehicle for coordinating communications and responses. Participate in a regional effort to encourage Pan Am Railways to clean up discarded railroad ties that pose a fire hazard.
- Seek funding for off-site storage of important Town documents stored in these critical facilities.
- Conduct a feasibility study of the costs of building a municipal drinking water system in the Village Center.
- Encourage household emergency preparedness.
- Execute a Memorandum of Agreement (MOA) with the bus company serving the public schools to provide buses and drivers in an emergency.
- Execute Memorandums of Agreement (MOAs) with local businesses that have buses (e.g., Academy at Charlemont, Crab Apple Whitewater) to provide buses and drivers in an emergency.
- Work with landowners to purchase easements protecting properties from development and/or seek to purchase the properties outright for permanent protection.
- Add to Town funds available to assist local land trusts to purchase land for permanent protection.

Low Priority Recommendations

- Everbridge now has a new emergency communications system for a Harriman Dam failure, but the Town needs a better system of notifying residents.
- Regional emergency preparedness planners should identify an alternative site for and EOC to be located outside of the floodplain, e.g., the recently closed Heath School.
- The same sections of Route 2 coming down the hill from Savoy routinely freeze before the rest of the road. Conduct a feasibility assessment with MassDOT on the installation of temperature sensors and warnings in these critical areas.

- Seek to protect uncontaminated land along Route 2 below Warfield Mountain as a potential source of public drinking water that was identified as a high yield aquifer in a previous public water supply study.
- Execute a Memorandum of Agreement (MOA) with the Academy at Charlemont to provide buses for transportation and short-term sheltering services during an emergency.

Comprehensive Range of Mitigation Actions

C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))

The HMPC considered sixty actions to be too many. Each of the actions to be considered for this plan update were organized by which goal they supported. All the actions supporting each goal were combined with relevant MVP recommendations. This list was considered with potential new actions based on the results of the risk and capability assessments, including the specific problem statements and enhancement opportunities identified as part of those assessments.

Beyond reviewing the mitigation actions from previous plans and conclusions from the updated risk and capability assessments, the HMPC considered a comprehensive range of mitigation actions. During each HMPC meeting, the group was educated on the possible range of mitigation actions. FEMA's online Mitigation Ideas[14] publication was shared, and the following list of example actions was shared electronically with the HMPC.

Table 45. Types of Mitigation Actions.

Mitigation Action Category	Examples of Mitigation Actions
Local Plans and Regulations	• Comprehensive plans • Land use ordinances • Subdivision regulations • Development review • Building codes and enforcement • NFIP Community Rating System

[14] Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards. 2013. Federal Emergency Management Agency. Retrieved from www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf.

Mitigation Action Category	Examples of Mitigation Actions
	• Capital improvement programs • Open space preservation • Stormwater management regulations and master plans
Structure and Infrastructure Projects	• Acquisitions and elevations of structures in flood-prone areas • Utility undergrounding • Structural retrofits • Floodwalls and retaining walls • Detention and retention structures • Culverts
Natural Systems Protection	• Sediment and erosion control • Stream corridor restoration • Forest management • Conservation easements • Wetland restoration and preservation
Education and Awareness Programs	• Radio or television spots • Websites with maps and information • Real estate disclosure • Presentations to school groups or neighborhood organizations • Mailings to residents in hazard-prone areas
Preparedness and Response Actions	• Creating mutual aid agreements with neighboring communities to meet emergency response needs • Purchasing radio communications equipment for the Fire Department • Developing procedures for notifying citizens of available shelter locations during and following an event

The HMPC considered previously identified actions, areas of weakness and mitigation opportunities identified in the risk assessment and capability assessment, as well as the possible types of mitigation actions when developing the action list for this plan update. The following actions were added based the planning process for development of this plan update.

Mitigation Action Plan

C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))

An online Mitigation Action Tracker was developed for the Town to track the implementation of each mitigation action. The Mitigation Action Tracker is an Excel spreadsheet with separate tabs showing pre-sorted actions and can sort the list of actions based on several criteria or "essential details." These details listed below are included to facilitate the Town's ability to sort through the actions as well as to apply for grant funding.

- Action Title
- Action Description
- Implementation Timeline
- Responsible Department
- Supporting Agencies or Departments
- Potential Funding Sources
- Estimated Cost
    - High (over $100,000)
    - Medium ($20,000 - $100,000)
    - Low (under $20,000)
- Hazard(s) Addressed
- Critical Facility Protection
- Type of Mitigation Action
- Associated Goal Statement

The HMPC prioritized actions that protect socially vulnerably populations, protect future development, and account for future climate projections. Finally, the actions were sorted into priority order based on the following criteria. The Town recognizes that they may implement actions in any order. The priority list is meant to function as a guide.

High

- Large benefit that warrants cost and time.
- Mitigates risk to multiple hazards.

Medium

- Some benefit to people and property.
- Somewhat cost effective.

Low

- Not a significant benefit to people or property.
- Only addresses one or two hazards.
- Requires an impractical amount of funding.

Figure 21. Priority Ranking Criteria.

Below is a list of all mitigation actions sorted by priority. There is at least one action identified for each natural hazard profiled in this plan. All the risks identified in this plan are addressed and emphasis is placed on mitigating risk to community lifelines. The highest-ranking actions are shown in red, the medium priority actions in orange, and the low priority actions in green. The HMPC and the Town Select Board understand that mitigation actions may not be implemented in order of priority, they may be implemented in the order by which they receive funding. The actions are also included in Appendix C.

Table 46. 2022 Hazard Mitigation Actions.

Action #	Action Title	Estimated Cost	Potential Funding Source	Lead Department	Implementation Schedule
High Priority Mitigation Actions					
1	Increase the staff of the Fire Department's inspection and safety unit.	High	AFF grant	Fire Department	1-5 years
2	Based on the FRCOG Culvert Inventory & Assessment Program prioritize replacement and maintenance of culverts based on program findings.	High	FEMA BRIC or HMGP, MVP	Highway Department	1-5 years
3	Identify and implement floodproofing solutions for the Wastewater Treatment Facility run by the Charlemont Sewer District.	High	FEMA BRIC or HMGP, MVP	Sewer District	1-5 years
4	Develop a plan to raise or move Town owned buildings in the floodplain.	High	USDA or ARPA	Selectboard	1-5 years
5	Collect data following disasters to facilitate benefit-cost analysis in grant applications.	Low	Town Funds	Town Administrator	1-5 years
6	Identify and designate a Town position to serve as the community Floodplain Administrator (FPA) as required through the 2020 MA State Model Floodplain Bylaw.	Low	Town Funds	Building Inspector	1-5 years
7	Consider expanding the Fire Department’s educational program for schools to address natural hazards and mitigation topics and expand it to engage with the community’s aging population (i.e., annual outreach to seniors at one of their weekly meetings).	Low	Town Funds	Fire Department	1-5 years

Action #	Action Title	Estimated Cost	Potential Funding Source	Lead Department	Implementation Schedule
8	Adopt the 2020 MA State Model Floodplain Bylaw.	Low	Town Funds	Planning Board	1-5 years
Medium Priority Mitigation Actions					
9	Update Bylaws to include preserving and maintain existing and potential groundwater and surface water resources within the town and adopting a Water Supply Protection Overlay District.	Low	FRCOG	Planning Board	1-5 years
10	Amend the Subdivision Regulations to to mitigate risks of natural hazards and climate change.	Low	Town Funds	Planning Board	1-5 years
11	Add requirements to Section 42: Mobile Home Parks and Campgrounds of the Charlemont Zoning Bylaws to ensure adequate support and anchoring systems are used for temporary and permanent mobile homes.	Low	Town Funds	Building Department	1-5 years
12	Have Town staff participate in continuing education and professional development opportunities to increase their capacity.	Medium	FEMA BRIC or HMGP	Town Administrator	1-5 years
13	Develop a community education and outreach program so residents know how to shelter-in-place and mitigate risk on their properties.	Low	FEMA BRIC or HMGP	Emergency Management Department, Town Administrator	1-5 years
14	Work with the Council on Aging and the Federated Church to maintain list of vulnerable persons with special needs and establish an appropriate mode of communication for emergencies.	Low	Town Funds	Emergency Management Department, Town Administrator	1-5 years

Action #	Action Title	Estimated Cost	Potential Funding Source	Lead Department	Implementation Schedule
15	New alarm system to notify of Harriman Dam failure.	High	FEMA BRIC or HMGP	Fire Department	1-5 years
16	Evaluate permit application forms to determine possible modifications focused on flood hazard prevention.	Low	Town Funds	Building Department	1-5 years
17	Develop a checklist for review of building/development permit plans and for inspection of development in floodplains.	Low	Town Funds	Building Department	1-5 years
18	To assist with implementing substantial damage provisions of the NFIP, develop a local post-disaster substantial damage plan in coordination with the State Flood Hazard Management Program and the *Massachusetts Local Guidance for NFIP Substantial Damage Planning*.	Low	FEMA BRIC or HMGP	Planning Board, Emergency Management Department	over 5 years
Low Priority Mitigation Actions					
19	To reduce the risk of damage from High wind events, use Community Development Block Grant home rehabilitation funds to assist Low to moderate income homeowners in bringing homes up to code, including grandfathered mobile homes. Work with the HRA to develop and distribute a brochure to publicize the program at the Town Hall, public events, through tax mailings, and on the Town website.	Medium	CDBG	Town Administrator	1-5 years

Action #	Action Title	Estimated Cost	Potential Funding Source	Lead Department	Implementation Schedule
20	Increase Town capacity to mitigate risk by signing memorandums of understanding with local and regional partners.	Low	Town Funds	Emergency Management Department	1-5 years
21	To mitigate potential damage from an ice jam, identify potential ice jam locations and implement monitoring of these locations during the winter and spring for signs of ice jams.	Low	Town Funds	Highway Department, Police Department	1-5 years
22	Mitigate risks associated with the railroad by encouraging Pan Am Railways to remove discarded railroad ties that pose a fire hazard.	Low	Town Funds	Conservation Commission	1-5 years
23	Request evacuation plans from private companies and companies that use hazardous materials.	Low	Town Funds	Emergency Management Department	1-5 years
24	Conduct a feasibility assessment with MassDOT on the installation of temperature sensors and warnings on sections of Route 2 that routinely freeze first.	Low	MassDOT	Highway Department	1-5 years
25	Increase capacity to shelter residents by identifying a shelter outside of the flood inundation zone from the Deerfield River Dam, signing MOU's with private bus companies to facilitate evacuations, and inventorying and storing shelter supplies.	Medium	Town Funds	Emergency Management Department	1-5 years

Possible Funding Sources

All the mitigation actions included in this plan have identified one or more potential funding sources. The HMPC focused on projects eligible for MVP Action Grant funding and FEMA Hazard Mitigation Assistance (HMA) funding. Below is a list of some of the federal and state funding mechanisms to keep in mind when identifying or implementing mitigation actions.

Federal Emergency Management Agency (FEMA) Mitigation Grants

The Federal Emergency Management Agency (FEMA) makes grant funding available for a range of mitigation activities via several Hazard Mitigation Assistance (HMA) programs. These grant programs provide funding for eligible mitigation activities that reduce disaster losses and protect life and property from future disaster damages. They are not intended to fund repair, replacement, or deferred maintenance activities but are rather designed to assist in developing long-term, cost-effective improvements that will reduce risk to natural hazards.

- **Building Resilient Infrastructure and Communities (BRIC)**
  BRIC is a new FEMA hazard mitigation program designed to replace the agency's former HMA Pre-Disaster Mitigation (PDM) grant program, aiming to categorically shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience. It is a result of recent amendments made to Section 203 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) by Section 1234 of the Disaster Recovery Reform Act of 2018 (DRRA). BRIC will support states, local communities, tribes, and territories as they undertake hazard mitigation projects reducing the risks they face from natural hazards. The BRIC program's guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency.

- **Hazard Mitigation Grant Program (HMGP)**
  The HMGP is authorized under Section 404 of the Stafford Act. The HMGP provides grants to states, tribes, and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not lost during the recovery and reconstruction process following a disaster. HMGP is typically available only in the months after a federal disaster declaration, as funding amounts are determined based on a percentage of the funds spent on FEMA's Public and Individual Assistance programs.

- **Flood Mitigation Assistance (FMA) Program**
  The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of

1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the NFIP. FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities. One limitation of the FMA program is that it is generally used to provide mitigation for structures that are insured or located in Special Flood Hazard Areas (SFHAs) as mapped by FEMA. Federal funding for this nationally competitive grant program is generally an annual allocation (subject to Congressional appropriation) and eligibility is linked to a community's good standing in the NFIP.

Municipal Vulnerability Preparedness Action Grants[15]

The MVP Action Grant offers financial resources to municipalities seeking to advance priority climate adaptation actions to address climate change impacts resulting from extreme weather, sea level rise, inland and coastal flooding, severe heat, and other climate impacts.

Responses to the RFR may be submitted by municipalities who have received designation from the Executive Office of Energy and Environmental Affairs (EEA) as a Climate Change Municipal Vulnerability Preparedness (MVP) Community, or "MVP Community." All projects are required to provide monthly updates, project deliverables, a final project report, and a brief project summary communicating lessons learned. The municipality is also required to match 25% of total project cost using cash or in-kind contributions. All proposals must include the following:

- Completed application template
- Project budget and deliverables
- MVP yearly progress report describing any relevant work toward advancing community priorities since earning MVP designation
- Statement of match
- Letters of support from landowner (if applicable), partners, and the public

Project types include:

- **Detailed Vulnerability and Risk Assessment** – In-depth vulnerability or risk assessment of a particular sector, location, or other aspect of the municipality.
- **Public Education and Communication** – Projects that increase public understanding of climate change impacts within and beyond the community and foster effective partnerships to develop support.
- **Local Bylaws, Ordinances, Plans, and other Management Measures** – Projects to develop, amend, and implement local ordinances, bylaws, standards, plans, and other management

[15] State of Massachusetts. *MVP Action Grant.* https://www.mass.gov/service-details/mvp-action-grant.

measures to reduce risk and damages from extreme weather, heat, flooding, and other climate change impacts.

- **Redesigns and Retrofits** – Engineering and construction projects to redesign, plan, or retrofit vulnerable community facilities and infrastructure (e.g., wastewater treatment plants, culverts, and critical municipal roadways/evacuation routes) to function over the life of the infrastructure given projected climate change impacts.
- **Energy Resilience Strategies** — Projects that incorporate clean energy generation and that are paired with resilience enabling technology to maintain electrical and/or heating and cooling services at critical facilities.
- **Chemical Safety and Climate Vulnerabilities** — Projects that seek to engage the business and manufacturing community through assistance or training on identifying vulnerabilities to chemical releases due to severe weather events, reducing use of toxic or hazardous chemicals, outreach to improve operations and maintenance procedures to prevent chemical releases and accidents, outreach to improve emergency and contingency planning, and/or identifying existing contaminated sites that pose chemical dispersion risks during flood events.
- **Nature-Based Storm-Damage Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques** – Projects that utilize natural resources and pervious surfaces to manage coastal and inland flooding, erosion, and other storm damage, such as stormwater wetlands and bio-retention systems, and other Smart Growth and Low Impact Development techniques.
- **Nature-Based, Infrastructure and Technology Solutions to Reduce Vulnerability to Extreme Heat and Poor Air Quality** – Projects that utilize natural resources, vegetation, and increasing pervious surface to reduce ambient temperatures, provide shade, increase evapotranspiration, improve local air quality, and otherwise provide cooling services within the municipality.
- **Nature-Based Solutions to Reduce Vulnerability to other Climate Change Impacts** – Nature-based projects that address other impacts of climate change such as extreme weather, damaging wind and power outages, and increased incidence of pests and vector-borne illnesses and other public health issues.
- **Acquisition of Land to Achieve a Resiliency Objective** — Land purchases are eligible for grant funding if the parcel has been identified through a climate vulnerability assessment as an appropriate location for a specific eligible adaptation activity to occur, such as accommodating an infrastructure or facility redesign or retrofit project, providing natural flood storage to reduce downstream flooding, or removal of pavement and planting of trees to reduce flooding and heat island effects.
- **Ecological Restoration and Habitat Management to Increase Resiliency** — Projects that repair or improve natural systems for community and ecosystem adaptation, such as right-sizing culverts, dam removal, restoration of coastal wetlands, etc.

- **Subsidized Low Income Housing Resilience Strategies** — Investments in resiliency measures for affordable housing to protect vulnerable populations that may not have the resources to recover from an extreme climate event.
- **Mosquito Control Districts** — Projects to reduce the risk to public health from mosquito-borne illness and to increase mosquito surveillance and control capacity by incentivizing municipalities not in an organized mosquito control project or district to form a new mosquito control district or join an existing mosquito control district. Also funding for municipalities currently in a mosquito control district for new or proactive mosquito control measures.

System to Integrate this Plan with other Planning Mechanisms

C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))

For the Town of Charlemont to succeed in reducing hazard risks over the long term, the information, conclusions, and recommendations of this hazard mitigation plan should be integrated throughout government operations. Many other local plans and processes will present opportunities to address hazard mitigation in a way that can support multiple community objectives, so an important part of maintaining and implementing this hazard mitigation plan will be to identify and capitalize on these opportunities to leverage activities that have co-benefits (including but not limited to risk reduction).

The HMPC will remain tasked with helping to ensure that all new or updated local plan documents are informed by and consistent with the goals and actions of this hazard mitigation plan and will not contribute to increased hazard vulnerability in Charlemont. Specifically, this includes but is not limited to the implementation or future updates to the following local plans as identified and further described in Chapter 5 (Capability Assessment):

- Master Plan for the Town of Charlemont
- Charlemont Open Space and Recreation Plan
- Town of Charlemont MVP Resiliency Plan
- Charlemont Floodplain Action Plan
- Charlemont Comprehensive Emergency Management Plan

Additional opportunities to integrate the requirements of this plan into other local planning mechanisms shall continue to be identified through future meetings of the HMPC and through the five-year review process described in this chapter. Other planning mechanisms include local regulations and existing code enforcement procedures (i.e., zoning bylaws, site plan review, etc.), internal municipal policies, special projects or initiatives, and other routine government or community decision-making activities such as capital improvement planning and the Town's annual budget process. Emphasis for identifying these integration opportunities will be placed on those governance structures used to manage local land use and community development in both the pre-disaster and post-disaster environment. Also, as it relates to implementing specific mitigation actions identified in this plan, it will be the responsibility of each assigned lead department to determine additional measures that can support action completion or enhancement. This includes integrating mitigation actions from this plan into other local planning documents, processes, or mechanisms as deemed appropriate and most effective.

While it is recognized that there are many possible benefits to integrating components of this plan into other local planning mechanisms, the routine maintenance of this stand-alone plan is considered by the Town to be the most effective and appropriate method to identify, prioritize, and implement local hazard mitigation actions. In moving forward however the Town will consider the incorporation of some other plan documents into the hazard mitigation plan, such as any future iterations of the Town's MVP Resiliency Plan or Floodplain Action Plan.

Chapter 7. Plan Implementation and Maintenance

The Hazard Mitigation Planning Committee (HMPC) will implement the mitigation strategy and specific mitigation actions outlined in this plan, and update and maintain the plan according to the guidelines below. The HMPC includes key stakeholders in the Town, who will use the plan's goals, as well as continued analysis of hazard risks and capabilities, to weigh the available resources against the costs and benefits for each mitigation action. The Town understands the value of this plan and its positive mitigation impact and intend to continue updating this plan and implementing the plan's strategies.

Continued Public Participation

A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))

Public participation is an integral component of the mitigation planning process and will continue to be essential as this plan is implemented and updated over time. Based on the high level of interest in the mitigation planning process and in the Municipal Vulnerability Preparedness project, Town residents and stakeholders are interested in mitigation. The HMPC included several education and outreach mitigation actions designed to engage the public. The Town intends to involve the public throughout the five-year implementation of this plan, as well as in the reviewing and updating processes. The Town Administrator will take the lead in soliciting participation from the public. This participation will take multiple forms, including all of those outlined in the Chapter 3: Planning Process of this plan. Efforts to involve the public include:

- Advertising on the Town's website, and via flyers and press releases. Flyers will be posted in frequently visited locations including the Senior Center and Town offices.
- Representatives from the Franklin Regional Council of Governments and the private sector will join Town officials in implementing mitigation actions and participating in plan update meetings.
- Copies of this plan will remain on the Town's website; and a hard copy will be kept in the Town Administrator's office for public review. Updates to the plan will also be posted on the Town's website.
- The Town of Charlemont will continue to work with private industry, regional agencies, and adjacent communities as this plan is implemented.

Method and Schedule for Keeping the Plan Current

A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))

The HMPC and the Town of Charlemont recognize the importance of keeping the mitigation plan up to date. Keeping the plan current includes monitoring, evaluating, and updating the plan over a five-year period. The overall responsibility for monitoring the implementation of the plan rests jointly with the HMPC members, led by the Town's Administrator. The Town Select Board appoints the Town Administrator to lead this effort.

Process to Track Actions

Together the Town Administrator and the HMPC will maintain the Mitigation Action Tracker (a tool to record the status of each mitigation action). They will send a reminder email with a link to the web-based Mitigation Action Tracker on a semi-annual basis (January and July) to all Department Heads responsible for a mitigation action. They may also distribute the Mitigation Action Progress Worksheet (shown in Appendix C) for Department Heads who prefer a form over a digital spreadsheet.

If the Town experiences a large-scale disaster, the Town Administrator will assemble a HMPC meeting to update the list of mitigation actions and review their order based on current priorities.

Process to Evaluate Effectiveness of the Plan

The HMPC has agreed to meet on a semi-annual basis to review the implementation of the mitigation plan. The first meeting will take place in January; the second, in July.

At the first meeting (January 2023), the HMPC will review the effectiveness of the planning process, public and stakeholder engagement, risk analysis, and the mitigation strategy, including its implementation. It is recommended that the HMPC use the worksheet provided in Appendix C.

Process to Update the Plan

At each semi-annual meeting, the HMPC will review the plan's goal statements and mitigation action status. If necessary, the goal statements and mitigation actions may be revised to reflect current Town priorities. In addition, the HMPC will discuss methods for continuing to integrate the mitigation plan with other plans, processes, and projects in the Town.

They will prepare a one-page brief regarding each semi-annual HMPC meeting to share with the Select Board and to post on the Town website. The HMPC recognizes the value in keeping the public and key stakeholders informed about the implementation and status of the mitigation plan.

HMPC members will continue to participate in regional and state-based meetings to stay current with best risk-mitigation practices. Such meetings may include the Massachusetts Emergency Management Agency (MEMA), the Franklin Regional Council of Governments (FRCOG), and the MA Department of Conservation and Recreation.

The Town of Charlemont agrees to update and adopt this mitigation plan on a five-year basis. The update will include a comprehensive review and planning process like the one used to develop this mitigation plan update. It will update the mitigation action list, current land use practices, collect and review best available data, review the capability assessment, and engage the public and stakeholders. This process will occur according to FEMA guidelines. The HMPC will seek funding for the development of the plan update **two years** before the plan expires. The plan update process gives the Town the chance to add and/or re-prioritize mitigation actions based on current risk, capabilities, and public/stakeholder suggestions. The Town Administrator will serve as the Project Manager for the update process.

Responsible Parties for Plan Implementation and Maintenance

Town Administrator, Sarah Reynolds

Town of Charlemont

157 Main Street, P.O. Box 677

Charlemont, MA 01339

Phone: 413-339-4335

Emergency Management Director, Dennis Annear

Town of Charlemont

157 Main Street, P.O. Box 677

Charlemont, MA 01339

Phone: 413-339-4335

For State resources:

Massachusetts Emergency Management Agency:

Address: 400 Worcester Road, Framingham, MA 01702-5399

Phone: 508-820-2000 (MEMA Headquarters and Communications Center)

or 978-328-1500 (MEMA Region 1 Office)

Website: https://www.mass.gov/orgs/massachusetts-emergency-management-agency

For Federal resources:

Federal Emergency Management Agency:

Address: 99 High Street, Boston, MA 02110

Phone: 877-336-2734

Email: fema-r1-info@fema.dhs.gov

Website: https://www.fema.gov/region-i-ct-me-ma-nh-ri-vt

Appendix A. Planning Process Supporting Materials

Hazard Mitigation Planning Committee Meetings

HMPC Meeting Participants 3/1/2022

Name	Title	Organization
Bill Bohn	Risk Assessment Lead	Subcontractor to Jamie Caplan Consulting
Jamie Caplan	Project Manager	Jamie Caplan Consulting
Sarah Reynolds	Town Administrator	Town of Charlemont
Jeffrey Zukowski	Hazard Mitigation Planner	MA Emergency Management Agency

HMPC Meeting Participants 4/12/2022

Name	Title	Organization
Dennis Annear	Emergency Management Director	Town of Charlemont
Jared Bellows	Police Chief	Town of Charlemont
Jamie Caplan	Project Manager	Jamie Caplan Consulting
Gordon Hathaway	Highway Superintendent	Town of Charlemont
Dana Johnson	Charlemont Ambulance	Town of Charlemont
Thorne Palmer	Sewer District	Town of Charlemont
Sarah Reynolds	Administrator	Town of Charlemont
Doug Telling	Board of Health	Town of Charlemont
Marguerite Willis	Select Board Chair	Town of Charlemont
Jeffrey Zukowski	Hazard Mitigation Planner	MA Emergency Management Agency

HMPC Meeting Participants 5/25/2022

Name	Title	Organization
Jamie Caplan	Project Manager	Jamie Caplan Consulting
Sarah Reynolds	Town Administrator	Town of Charlemont
Jeffrey Zukowski	Hazard Mitigation Planner	MA Emergency Management Agency

HMPC Meeting Participants 6/16/2022

Name	Title	Organization
Jamie Caplan	Project Manager	Jamie Caplan Consulting
Sarah Reynolds	Town Administrator	Town of Charlemont
Jeffrey Zukowski	Hazard Mitigation Planner	MA Emergency Management Agency

Public Meeting Outreach

Press Release for 4/13/2022 Public Meeting

PRESS RELEASE
For Immediate Release
March 21, 2022

Contact: Sarah Reynolds, Administrator
Town of Charlemont
413-339-4335 ext.8

Town of Charlemont Invites the Public to a Virtual Meeting to Learn About the Hazard Mitigation Plan Update

The Town of Charlemont is developing an update to the 2014 Town of Charlemont Hazard Mitigation Plan that identifies and prioritizes actions the Town can take to mitigate the impacts of natural hazards and climate change. Citizen participation is essential.

A virtual public meeting will be held on:

- Wednesday, April 13, 2022, at 12:30pm via Zoom.

Join on your computer or mobile app.

- https://us02web.zoom.us/j/85466038113?pwd=UHp3NGd3OWNoT0NOdS84cHRWZnNsUT09
- Meeting ID: 854 6603 8113
- Passcode: 753624

At the meeting, you will have an opportunity to contribute your ideas for making the Town more resilient to natural hazards such as flooding, snowstorms, high winds, and extreme temperatures. This plan is being developed by a Hazard Mitigation Planning Committee comprised of Town officials and local stakeholders. Jamie Caplan Consulting LLC, a Northampton, MA based firm, is leading this effort on behalf of the Town and the Massachusetts Emergency Management Agency. Federal Emergency Management Agency (FEMA) approval, and Town adoption, of the Hazard Mitigation Plan Update allows the Town to apply for pre- and post-disaster hazard mitigation grant funds.

Charlemont developed a Municipal Vulnerability Preparedness (MVP) plan in 2018 that also identified possible actions to mitigate risks to natural hazards and climate change. The Hazard Mitigation Plan Update will include all of those identified actions still relevant today.

For questions regarding this project, please contact Sarah Reynolds, Administrator, Town of Charlemont, Phone: 413-339-4335 ext. 8 or administrator@townofcharlemont.org.

Flyer for 4/13/2022 Meeting

Hazard Mitigation Public Meeting

April 13, 2022

12:30pm - 1:30 pm

Zoom Link on Town Website or Attend at the Senior Center

Share your ideas to make Town more resilient to natural hazards such as floods, drought, high winds, and winter storms.

APRIL 13, 2022

PUBLIC MEETING ON ZOOM

Charlemont's Hazard Mitigation Planning Committee is updating the Town's Hazard Mitigation Plan. This plan serves as a strategy for reducing current and future risks of natural hazards and climate change. The public is invited to learn about the Hazard Mitigation Plan and share their ideas for reducing impacts associated with natural hazards, such as flooding, winter storms and hurricanes. Approved by FEMA, the plan allows the Town to apply for pre-disaster mitigation grant funding.

FOR MORE INFORMATION CONTACT

Sarah Reynolds

Town of Charlemont

413-339-4335

administrator@townofcharlemont.org

Town of Charlemont April Newsletter Cover

IMPORTANT MEETINGS

East Oxbow Bridge, Virtual meeting, April 5,2022 6pm

Meeting info available at:

https://www.mass.gov/massdot-highway-design-public-hearings

Hazard Mitigation Plan Public Meeting

Wednesday April 13 1:30 pm

Information on town website

Or call 413-339-4335 ext. 8

Town of Charlemont Newsletter Volume 1/ issue 3

Broadband Update and Sign-Up News

High Speed Broadband is now a reality in Charlemont. The construction project for our network is moving toward completion. Subscribers have been activated in 3 of the 5 service areas in town. The two areas remaining, FAS02 and FAS03, are in the testing and validation phase of the project and installations will begin as soon as these phases are completed. Over 230 subscribers are now active, generating revenue for the project that will help cover its cost. Feedback from those connected has been very positive.

We would like to remind residents that haven't yet signed up for Broadband that the window for the subsidy for installation will soon close. In most cases, the subsidy will cover the cost of installation, making it free to the subscriber, as long as you agree to take service for 12 months. If you wait, then the cost of installation will be on you, the subscriber.

Details are in The Charlemont Drop Policy on the Charlemont Connect website. Detailed information about the Charlemont Broadband Project can be found on our website Charlemont Connect. It includes information on the phone service that is available separately, as well as construction progress, and such topics streaming TV via the internet.

Charlemont Fire Association and Department News

The Charlemont Fire Association is putting on a fundraiser! The purchase of a visible street sign that will not only allow us to better find your residence in the case of emergencies but allow us to replace equipment and other needs of the Fire department not covered by our budget.

Each sign is $20 and if needed includes a post to mount it. To order please call us at (413)339-4335 or email us at chafire7@gmail.com. We may not be in the station at the time of your call, please leave us a message and we will get back to you as soon as we can.

1

Town Website Announcement

Massachusetts

Charlemont

Charlemont
157 Main Street, 0133
413-339-4335
Contact Us

Home Departments Committees Files Calendar Communit

Hazard Mitigation Public Meeting

Charlemont's Hazard Mitigation Planning Committee is updating the Town's Hazard Mitigation Plan. This plan serves as a strategy for reducing current and future risks of natural hazards and climate change. The public is invited to learn about the Hazard Mitigation Plan and share their ideas for reducing impacts associated with natural hazards, such as flooding, winter storms, and hurricanes. Approved by FEMA, the plan allows the Town to apply for pre-disaster mitigation grant funding. Attached to this article is a flyer. The meeting is accessible by attending in person on April 13, 2022 at 12:30 pm at the town hall or by the zoom link below:

- Zoom link: https://us02web.zoom.us/j/85466038113?pwd=UHp3NGd3OWNoT0NOdS84cHRWZnNsUT09
- Meeting ID: 854 6603 8113
- Passcode: 753624

Attached Files:

- Charlemont public mtg 1 flyer.docx
- Charlemont public mtg 1 flyer.pdf

Flyer for 6/29/2022 Meeting

JUNE 29, 2022

PUBLIC MEETING ON ZOOM

Charlemont's Hazard Mitigation Planning Committee has updated the Town's Hazard Mitigation Plan. This plan serves as a strategy for reducing current and future risks of natural hazards and climate change. The public is invited to learn about the Hazard Mitigation Plan and share their ideas for reducing impacts associated with natural hazards, such as flooding, winter storms and hurricanes. Approved by FEMA, the plan allows the Town to apply for pre-disaster mitigation grant funding.

Hazard Mitigation Public Meeting

June 29, 2022

5:00pm - 6:00 pm

Zoom Link on Town Website or Attend at the Senior Center

Share your ideas to make Town more resilient to natural hazards such as floods, drought, high winds, and winter storms.

FOR MORE INFORMATION CONTACT

Sarah Reynolds

Town of Charlemont

413-339-4335

administrator@townofcharlemont.org

Press Release for 6/29/2022 Meeting

PRESS RELEASE
For Immediate Release
June 16, 2022

Contact: Sarah Reynolds, Administrator
Town of Charlemont
413-339-4335 ext.8

Town of Charlemont Invites the Public to a Virtual Meeting to Learn About the Hazard Mitigation Plan Update

The Town of Charlemont has developed an update to the 2014 Town of Charlemont Hazard Mitigation Plan that identifies and prioritizes actions the Town can take to mitigate the impacts of natural hazards and climate change. Citizen participation is essential.

A virtual public meeting will be held on:

- Wednesday, June 29, 2022, from 5:00pm – 6:00pm via Zoom.

Join on your computer or mobile app.

- https://us02web.zoom.us/j/84932816413?pwd=ZzI5QlQ0VFY0YWVBbGxQakd6dUNjdz09
- Meeting ID: 849 3281 6413
- Passcode: 386937

At the meeting, you will have an opportunity to contribute your ideas for making the Town more resilient to natural hazards such as flooding, snowstorms, high winds, and extreme temperatures. This plan was developed by a Hazard Mitigation Planning Committee comprised of Town officials and local stakeholders. Jamie Caplan Consulting LLC, a Northampton, MA based firm, led this effort on behalf of the Town and the Massachusetts Emergency Management Agency. Federal Emergency Management Agency (FEMA) approval, and Town adoption, of the Hazard Mitigation Plan Update allows the Town to apply for pre- and post-disaster hazard mitigation grant funds.

Charlemont developed a Municipal Vulnerability Preparedness (MVP) plan in 2018 that also identified possible actions to mitigate risks to natural hazards and climate change. The Hazard Mitigation Plan Update will include all of those identified actions still relevant today.

For questions regarding this project, please contact Sarah Reynolds, Administrator, Town of Charlemont, Phone: 413-339-4335 ext. 8 or administrator@townofcharlemont.org.

Appendix B. Mitigation Actions.

Action Priority Ranking Consideration

Action #	Action Title	Estimated Cost	Estimated Benefit	Lead Department	Priority
1	Increase the staff of the Fire Department's inspection and safety unit.	High	Medium	Fire Department	High
2	Based on the FRCOG Culvert Inventory & Assessment Program prioritize replacement and maintenance of culverts based on program findings.	High	High	Highway Department	High
3	Identify and implement floodproofing solutions for the Wastewater Treatment Facility run by the Charlemont Sewer District.	High	High	Sewer District	High
4	Develop a plan to raise or move Town owned buildings in the floodplain.	High	High	Selectboard	High
5	Collect data following disasters to facilitate benefit-cost analysis in grant applications.	Low	Medium	Town Administrator	High
6	Identify and designate a Town position to serve as the community Floodplain Administrator (FPA) as required through the 2020 MA State Model Floodplain Bylaw.	Low	Medium	Building Inspector	High
7	Consider expanding the Fire Department's educational program for schools to address natural hazards and mitigation topics, and expand it to engage with the community's aging population (i.e., annual outreach to seniors at one of their weekly meetings).	Low	High	Fire Department	High
8	Adopt the 2020 MA State Model Floodplain Bylaw.	Low	Medium	Planning Board	High
9	Update Bylaws to include preserving and maintain existing and potential groundwater and surface water resources within the town and adopting a Water Supply Protection Overlay District.	Low	Medium	Planning Board	Medium

Action #	Action Title	Estimated Cost	Estimated Benefit	Lead Department	Priority
10	Amend the Subdivision Regulations to to mitigate risks of natural hazards and climate change.	Low	Medium	Planning Board	Medium
11	Add requirements to Section 42: Mobile Home Parks and Campgrounds of the Charlemont Zoning Bylaws to ensure adequate support and anchoring systems are used for temporary and permanent mobile homes.	Low	Medium	Building Department	Medium
12	Have Town staff participate in continuing education and professional development opportunities to increase their capacity.	Medium	Medium	Town Administrator	Medium
13	Develop a community education and outreach program so residents know how to shelter-in-place and mitigate risk on their properties.	Low	Medium	Emergency Management Department, Town Administrator	Medium
14	Work with the Council on Aging and the Federated Church to maintain list of vulnerable persons with special needs and establish an appropriate mode of communication for emergencies.	Low	High	Emergency Management Department, Town Administrator	Medium
15	New alarm system to notify of Harriman Dam failure.	High	Medium	Fire Department	Medium
16	Evaluate permit application forms to determine possible modifications focused on flood hazard prevention.	Low	Medium	Building Department	Medium
17	Develop a checklist for review of building/development permit plans and for inspection of development in floodplains.	Low	Medium	Building Department	Medium
18	To assist with implementing substantial damage provisions of the NFIP, develop a local post-disaster substantial damage plan in coordination with the State Flood Hazard Management Program and the *Massachusetts Local Guidance for NFIP Substantial Damage Planning*.	Low	Medium	Planning Board, Emergency Management Department	Medium
19	To reduce the risk of damage from High wind events, use Community	Medium	Medium	Town Administrator	Low

Action #	Action Title	Estimated Cost	Estimated Benefit	Lead Department	Priority
	Development Block Grant home rehabilitation funds to assist Low to moderate income homeowners in bringing homes up to code, including grandfathered mobile homes. Work with the HRA to develop and distribute a brochure to publicize the program at the Town Hall, public events, through tax mailings, and on the Town website.				
20	Increase Town capacity to mitigate risk by signing memorandum's of understanding with local and regional partners.	Low	Low	Emergency Management Department	Low
21	To mitigate potential damage from an ice jam, identify potential ice jam locations and implement monitoring of these locations during the winter and spring for signs of ice jams.	Low	Low	Highway Department, Police Department	Low
22	Mitigate risks associated with the railroad by encouraging Pan Am Railways to remove discarded railroad ties that pose a fire hazard.	Low	Low	Conservation Commission	Low
23	Request evacuation plans from private companies and companies that use hazardous materials.	Low	Low	Emergency Management Department	Low
24	Conduct a feasibility assessment with MassDOT on the installation of temperature sensors and warnings on sections of Route 2 that routinely freeze first.	Low	Low	Highway Department	Low
25	Increase capacity to shelter residents by identifying a shelter outside of the flood inundation zone from the Deerfield River Dam, signing MOU's with private bus companies to facilitate evacuations, and inventorying and storing shelter supplies.	Medium	Low	Emergency Management Department	Low

Hazards Addressed and Critical Facilities Protected

Action #	Priority	Critical Facility Protection	Flood	Landslide	Wildfires and Brushfires	Hurricanes and Wind	Severe Winter Storms	Tornadoes	Thunderstorms	Earthquakes	Drought	Extreme Temperatures	Infectious Disease	Invasive Species	Hazardous Materials
1	High	No			Yes							Yes			
2	High	Yes	Yes				Yes		Yes						
3	High	Yes	Yes												
4	High	Yes	Yes												
5	High	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
6	High	No	Yes				Yes		Yes						
7	High	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8	High	No	Yes												
9	Medium	No									Yes	Yes	Yes	Yes	
10	Medium	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	
11	Medium	No	Yes	Yes		Yes	Yes	Yes		Yes					
12	Medium	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13	Medium	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	Medium	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	Medium	No	Yes												
16	Medium	No	Yes												
17	Medium	No	Yes			Yes	Yes	Yes	Yes						
18	Medium	No	Yes												
19	Low	No				Yes	Yes	Yes	Yes						
20	Low	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
21	Low	Yes	Yes				Yes					Yes			
22	Low	No			Yes							Yes			Yes
23	Low	No													Yes
24	Low	Yes					Yes					Yes			
25	Low	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Types of Mitigation Actions

Action #	Action Title	Priority
Education and Awareness Programs		
7	Consider expanding the Fire Department's educational program for schools to address natural hazards and mitigation topics and expand it to engage with the community's aging population (i.e., annual outreach to seniors at one of their weekly meetings).	High
12	Have Town staff participate in continuing education and professional development opportunities to increase their capacity.	Medium
13	Develop a community education and outreach program so residents know how to shelter-in-place and mitigate risk on their properties.	Medium
19	To reduce the risk of damage from High wind events, use Community Development Block Grant home rehabilitation funds to assist Low to moderate income homeowners in bringing homes up to code, including grandfathered mobile homes. Work with the HRA to develop and distribute a brochure to publicize the program at the Town Hall, public events, through tax mailings, and on the Town website.	Low
Local Plans and Regulations		
1	Increase the staff of the Fire Department's inspection and safety unit.	High
5	Collect data following disasters to facilitate benefit-cost analysis in grant applications.	High
9	Update Bylaws to include preserving and maintain existing and potential groundwater and surface water resources within the town and adopting a Water Supply Protection Overlay District.	Medium
10	Amend the Subdivision Regulations to to mitigate risks of natural hazards and climate change.	Medium
11	Add requirements to Section 42: Mobile Home Parks and Campgrounds of the Charlemont Zoning Bylaws to ensure adequate support and anchoring systems are used for temporary and permanent mobile homes.	Medium
14	Work with the Council on Aging and the Federated Church to maintain list of vulnerable persons with special needs and establish an appropriate mode of communication for emergencies.	Medium
16	Evaluate permit application forms to determine possible modifications focused on flood hazard prevention.	Medium
17	Develop a checklist for review of building/development permit plans and for inspection of development in floodplains.	Medium
18	To assist with implementing substantial damage provisions of the NFIP, develop a local post-disaster substantial damage plan in coordination with the State Flood Hazard Management Program and the *Massachusetts Local Guidance for NFIP Substantial Damage Planning*.	Medium

Action #	Action Title	Priority
20	Increase Town capacity to mitigate risk by signing memorandums of understanding with local and regional partners.	Low
23	Request evacuation plans from private companies and companies that use hazardous materials.	Low
25	Increase capacity to shelter residents by identifying a shelter outside of the flood inundation zone from the Deerfield River Dam, signing MOU's with private bus companies to facilitate evacuations, and inventorying and storing shelter supplies.	Low
Natural Systems Protection		
6	Identify and designate a Town position to serve as the community Floodplain Administrator (FPA) as required through the 2020 MA State Model Floodplain Bylaw.	High
8	Adopt the 2020 MA State Model Floodplain Bylaw.	High
Structure and Infrastructure Projects		
2	Based on the FRCOG Culvert Inventory & Assessment Program prioritize replacement and maintenance of culverts based on program findings.	High
3	Identify and implement floodproofing solutions for the Wastewater Treatment Facility run by the Charlemont Sewer District.	High
4	Develop a plan to raise or move Town owned buildings in the floodplain.	High
15	New alarm system to notify of Harriman Dam failure.	Medium
21	To mitigate potential damage from an ice jam, identify potential ice jam locations and implement monitoring of these locations during the winter and spring for signs of ice jams.	Low
22	Mitigate risks associated with the railroad by encouraging Pan Am Railways to remove discarded railroad ties that pose a fire hazard.	Low
24	Conduct a feasibility assessment with MassDOT on the installation of temperature sensors and warnings on sections of Route 2 that routinely freeze first.	Low

Mitigation Actions Sorted by Goal Statement

Action #	Action Title	Estimated Cost	Potential Funding Source	Lead Department	Supporting Partners or Departments	Implementation Schedule	Priority
Public Engagement							
13	Develop a community education and outreach program so residents know how to shelter-in-place and mitigate risk on their properties.	Low	FEMA BRIC or HMGP	Emergency Management Department, Town Administrator		1-5 years	Medium
14	Work with the Council on Aging and the Federated Church to maintain list of vulnerable persons with special needs and establish an appropriate mode of communication for emergencies.	Low	Town Funds	Emergency Management Department, Town Administrator	Council on Aging	1-5 years	Medium
19	To reduce the risk of damage from High wind events, use Community Development Block Grant home rehabilitation funds to assist Low to moderate income homeowners in bringing homes up to code, including grandfathered mobile homes. Work with the HRA to develop and distribute a brochure to publicize the program at the Town Hall, public events, through tax mailings, and on the Town website.	Medium	CDBG	Town Administrator	MA Executive Office of Housing and Economic Development	1-5 years	Low
Capacity Building							
7	Consider expanding the Fire Department's educational program for schools to address natural hazards and mitigation topics and	Low	Town Funds	Fire Department	Council on Aging	1-5 years	High

Action #	Action Title	Estimated Cost	Potential Funding Source	Lead Department	Supporting Partners or Departments	Implementation Schedule	Priority
	expand it to engage with the community's aging population (i.e., annual outreach to seniors at one of their weekly meetings).						
1	Increase the staff of the Fire Department's inspection and safety unit.	High	AFF grant	Fire Department		1-5 years	High
5	Collect data following disasters to facilitate benefit-cost analysis in grant applications.	Low	Town Funds	Town Administrator	FRCOG	1-5 years	High
6	Identify and designate a Town position to serve as the community Floodplain Administrator (FPA) as required through the 2020 MA State Model Floodplain Bylaw.	Low	Town Funds	Building Inspector	Town Administrator	1-5 years	High
8	Adopt the 2020 MA State Model Floodplain Bylaw.	Low	Town Funds	Planning Board	Building Inspector	1-5 years	High
12	Have Town staff participate in continuing education and professional development opportunities to increase their capacity.	Medium	FEMA BRIC or HMGP	Town Administrator	Selectboard	1-5 years	Medium
9	Update Bylaws to include preserving and maintain existing and potential groundwater and surface water resources within the town and adopting a Water Supply Protection Overlay District.	Low	FRCOG	Planning Board	Conservation Commission	1-5 years	Medium
10	Amend the Subdivision Regulations to mitigate risks of natural hazards and climate change.	Low	Town Funds	Planning Board	Building Inspector	1-5 years	Medium

Action #	Action Title	Estimated Cost	Potential Funding Source	Lead Department	Supporting Partners or Departments	Implementation Schedule	Priority
11	Add requirements to Section 42: Mobile Home Parks and Campgrounds of the Charlemont Zoning Bylaws to ensure adequate support and anchoring systems are used for temporary and permanent mobile homes.	Low	Town Funds	Building Department	Planning Board	1-5 years	Medium
16	Evaluate permit application forms to determine possible modifications focused on flood hazard prevention.	Low	Town Funds	Building Department	Planning Board	1-5 years	Medium
17	Develop a checklist for review of building/development permit plans and for inspection of development in floodplains.	Low	Town Funds	Building Department	Planning Board	1-5 years	Medium
18	To assist with implementing substantial damage provisions of the NFIP, develop a local post-disaster substantial damage plan in coordination with the State Flood Hazard Management Program and the *Massachusetts Local Guidance for NFIP Substantial Damage Planning*.	Low	FEMA BRIC or HMGP	Planning Board, Emergency Management Department		over 5 years	Medium
20	Increase Town capacity to mitigate risk by signing memorandums of understanding with local and regional partners.	Low	Town Funds	Emergency Management Department	FRCOG	1-5 years	Low
23	Request evacuation plans from private companies and companies that use hazardous materials.	Low	Town Funds	Emergency Management Department		1-5 years	Low

Action #	Action Title	Estimated Cost	Potential Funding Source	Lead Department	Supporting Partners or Departments	Implementation Schedule	Priority
21	To mitigate potential damage from an ice jam, identify potential ice jam locations and implement monitoring of these locations during the winter and spring for signs of ice jams.	Low	Town Funds	Highway Department, Police Department		1-5 years	Low
22	Mitigate risks associated with the railroad by encouraging Pan Am Railways to remove discarded railroad ties that pose a fire hazard.	Low	Town Funds	Conservation Commission	Pan Am Railways	1-5 years	Low
25	Increase capacity to shelter residents by identifying a shelter outside of the flood inundation zone from the Deerfield River Dam, signing MOU's with private bus companies to facilitate evacuations, and inventorying and storing shelter supplies.	Medium	Town Funds	Emergency Management Department		1-5 years	Low
Infrastructure and Critical Facilities							
2	Based on the FRCOG Culvert Inventory & Assessment Program prioritize replacement and maintenance of culverts based on program findings.	High	FEMA BRIC or HMGP, MVP	Highway Department	FRCOG	1-5 years	High
3	Identify and implement floodproofing solutions for the Wastewater Treatment Facility run by the Charlemont Sewer District.	High	FEMA BRIC or HMGP, MVP	Sewer District	Building Inspector	1-5 years	High
4	Develop a plan to raise or move Town owned buildings in the floodplain.	High	USDA or ARPA	Selectboard	Building Inspector	1-5 years	High

Action #	Action Title	Estimated Cost	Potential Funding Source	Lead Department	Supporting Partners or Departments	Implementation Schedule	Priority
15	New alarm system to notify of Harriman Dam failure.	High	FEMA BRIC or HMGP	Fire Department	MA Office of Dam Safety	1-5 years	Medium
24	Conduct a feasibility assessment with MassDOT on the installation of temperature sensors and warnings on sections of Route 2 that routinely freeze first.	Low	MassDOT	Highway Department	MassDOT	1-5 years	Low

Appendix C. Plan Implementation and Review Supporting Materials.

Plan Update Evaluation Worksheet

Plan Section	Considerations	Explanation
Planning Process	Should the town invite any additional stakeholders to participate in the planning process? What public outreach activities have occurred? How can public involvement be improved?	
Risk Assessment	What disasters has the town, or the region experienced? Should the list of hazards be modified? Are new data sources, maps or studies available? If so, what have they revealed, and should the information be incorporated into the plan update? Has development in the region occurred and could it create or reduce risk?	
Capability Assessment	Has the town adopted new policies, plans, regulations, or reports that could be incorporated into this plan? Are there different or additional administrative, human, technical, and financial resources available for mitigation planning? Are there different or new education and outreach programs and resources available for mitigation activities?	
Mitigation Strategy	Is the mitigation strategy being implemented as anticipated? Were the cost and timeline estimate accurate? Should new mitigation actions be added to the Action Plan? Should existing mitigation actions be revised or removed from the plan? Are there new obstacles that were not anticipated in the plan that will need to be considered in the next plan update? Are there new funding sources to consider? Have elements of the plan been incorporated into other planning mechanisms?	
Implementation Plan	Was the plan monitored and evaluated as anticipated? What are needed improvements to the plan implementation procedures?	

Mitigation Action Progress Worksheet

<table>
<tr><th colspan="5">Mitigation Action Progress Worksheet</th></tr>
<tr><td>Progress Report Period</td><td colspan="2">From Date</td><td colspan="2">To Date</td></tr>
<tr><td>Action/Project Title</td><td colspan="4"></td></tr>
<tr><td>Responsible Department</td><td colspan="4"></td></tr>
<tr><td>Contact Name</td><td colspan="4"></td></tr>
<tr><td>Contact Phone/Email</td><td colspan="4"></td></tr>
<tr><td>Project Description</td><td colspan="4"></td></tr>
<tr><td>Project Goal</td><td colspan="4"></td></tr>
<tr><td>Project Objective</td><td colspan="4"></td></tr>
<tr><td>Project Cost</td><td colspan="4"></td></tr>
<tr><td colspan="5">Project Status</td></tr>
<tr><td>Date of Project Approval</td><td>Date of Project Start</td><td>Anticipated Date of Completion</td><td>Project Canceled</td><td>Project Delayed</td></tr>
<tr><td colspan="5">Explanation of Delay or Cost Overruns</td></tr>
<tr><td colspan="5">Project Report Summary</td></tr>
<tr><td colspan="5">What was accomplished for this project during this reporting period?</td></tr>
<tr><td colspan="5">What obstacles, problems, or delays did the project encounter?</td></tr>
<tr><td colspan="5">Plans for next reporting period.</td></tr>
</table>

Appendix D. Hazus Reports

TOWN OF CHARLEMONT, MA HAZARD MITIGATION PLAN UPDATE

July 2022

Town of Charlemont

157 Main Street

Charlemont, MA 01339

Phone: 413-339-4335

https://charlemont-ma.us

Prepared by:

JAMIE CAPLAN CONSULTING LLC

Emergency Management Services

351 Pleasant Street, Suite B # 208 · Northampton, MA 01060

Phone: 413-586-0867 · Fax: 413-727-8282 · www.jamiecaplan.com

Hazus: Flood Global Risk Report

Region Name: CharlemontFlood

Flood Scenario: 100year

Print Date: Tuesday, July 5, 2022

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 26 square miles and contains 137 census blocks. The region contains over 1 thousand households and has a total population of 1,266 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 689 buildings in the region with a total building replacement value (excluding contents) of 178 million dollars. Approximately 91.00% of the buildings (and 78.05% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 689 buildings in the region which have an aggregate total replacement value of 178 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	**Exposure ($1000)**	**Percent of Total**
Residential	138,810	78.0%
Commercial	21,683	12.2%
Industrial	7,009	3.9%
Agricultural	1,131	0.6%
Religion	645	0.4%
Government	1,709	1.0%
Education	6,865	3.9%
Total	**177,852**	**100%**

Building Exposure by Occupancy Type for the Study Region ($1000's)

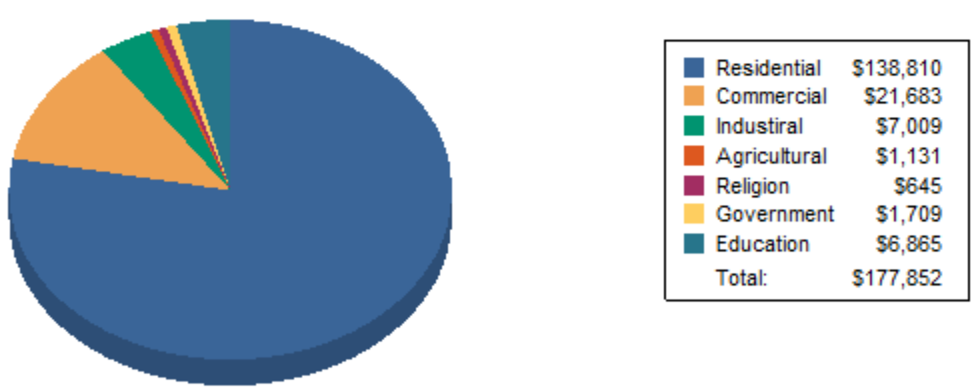


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	87,961	74.3%
Commercial	15,179	12.8%
Industrial	6,037	5.1%
Agricultural	924	0.8%
Religion	0	0.0%
Government	1,449	1.2%
Education	6,865	5.8%
Total	**118,415**	**100%**

Building Exposure by Occupancy Type for the Scenario ($1000's)

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	CharlemontFlood
Scenario Name:	100year
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure

Building Damage

General Building Stock Damage

Hazus estimates that about 20 buildings will be at least moderately damaged. This is over 68% of the total number of buildings in the scenario. There are an estimated 2 buildings that will be completely destroyed. The definition of the ‘damage states’ is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	2	9	8	36	5	23	3	14	2	9	2	9
Total	**2**		**8**		**5**		**3**		**2**		**2**	

Counts By Damage Level

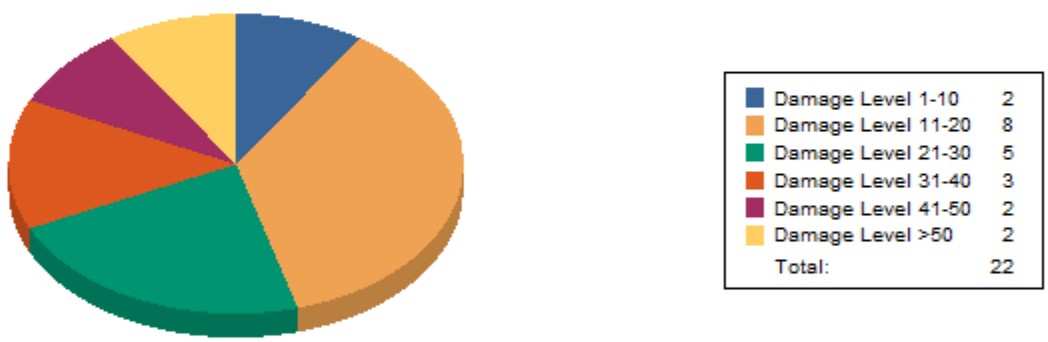


Table 4: Expected Building Damage by Building Type

Building Type	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	>50 Count	>50 (%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	2	9	8	36	5	23	3	14	2	9	2	9

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use

Emergency Operation Centers	9	0	0	0
Fire Stations	8	0	0	0
Hospitals	0	0	0	0
Police Stations	4	1	0	1
Schools	5	1	0	1

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

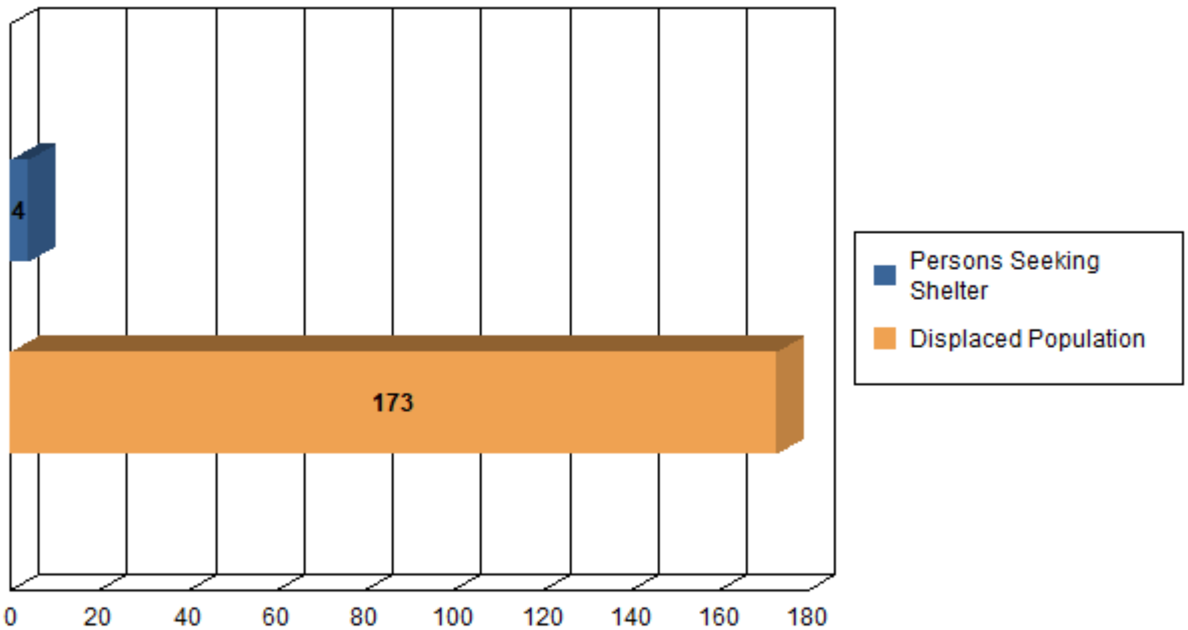
Analysis has not been performed for this Scenario.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 58 households (or 173 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 4 people (out of a total population of 1,266) will seek temporary shelter in public shelters.

Displaced Population/Persons Seeking Short Term Public Shelter



Economic Loss

The total economic loss estimated for the flood is 43.54 million dollars, which represents 36.77 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

9.17 **9.17** 9.17

9.17

The total building-related losses were 17.01 million dollars. 61% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 21.06% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

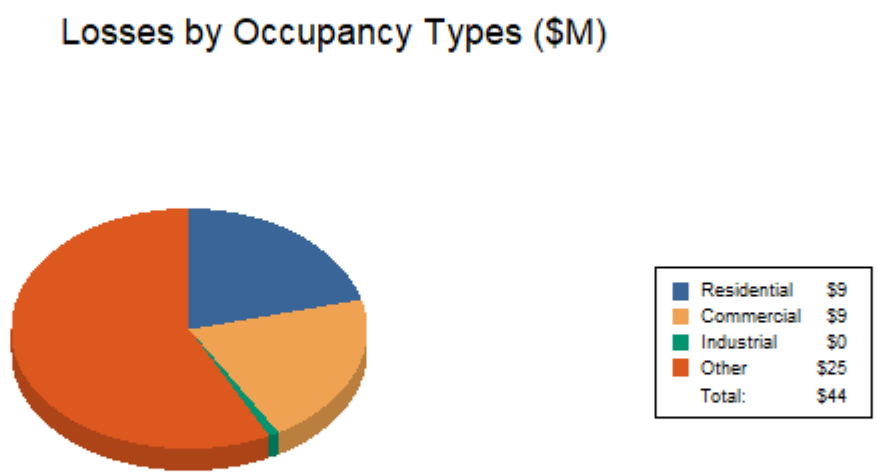
Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						

Building	5.24	1.41	0.11	0.90	7.67
Content	2.37	3.07	0.30	3.48	9.22
Inventory	0.00	0.06	0.02	0.04	0.12
Subtotal	**7.61**	**4.54**	**0.44**	**4.43**	**17.01**
Business Interruption					
Income	0.09	2.08	0.00	0.67	2.84
Relocation	0.87	0.15	0.00	0.43	1.45
Rental Income	0.40	0.11	0.00	0.02	0.53
Wage	0.21	2.05	0.00	19.46	21.72
Subtotal	**1.56**	**4.39**	**0.01**	**20.58**	**26.54**
Total	**9.17**	**8.93**	**0.44**	**25.00**	**43.54**

ALL



Appendix A: County Listing for the Region

Massachusetts
- Franklin

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Franklin	1,266	138,810	39,042	177,852
Total	**1,266**	**138,810**	**39,042**	**177,852**
Total Study Region	**1,266**	**138,810**	**39,042**	**177,852**

Hazus: Earthquake Global Risk Report

Region Name: CharlemontEQ

Earthquake Scenario: 1500year

Print Date: July 05, 2022

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 160.33 square miles and contains 1 census tracts. There are over 1 thousand households in the region which has a total population of 4,494 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 642 (millions of dollars). Approximately 92.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 374 and 1,775 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 2 thousand buildings in the region which have an aggregate total replacement value of 642 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 73% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 2,149.00 (millions of dollars). This inventory includes over 31.69 miles of highways, 75 bridges, 1,176.88 miles of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	75	79.3368
	Segments	4	170.8627
	Tunnels	0	0.0000
		Subtotal	**250.1995**
Railways	Bridges	8	42.8857
	Facilities	0	0.0000
	Segments	7	81.6969
	Tunnels	0	0.0000
		Subtotal	**124.5826**
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	**0.0000**
Bus	Facilities	0	0.0000
		Subtotal	**0.0000**
Ferry	Facilities	0	0.0000
		Subtotal	**0.0000**
Port	Facilities	0	0.0000
		Subtotal	**0.0000**
Airport	Facilities	0	0.0000
	Runways	0	0.0000
		Subtotal	**0.0000**
		Total	**374.80**

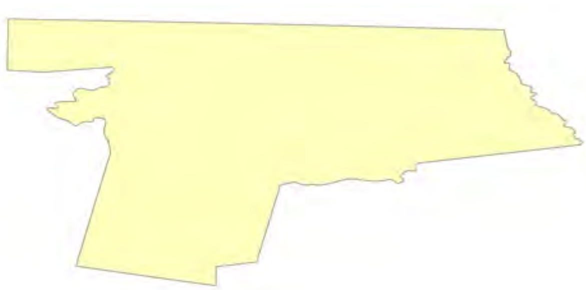
Table 2: Utility System Lifeline Inventory

System	Component	# Locations /	Replacement value (millions of dollars)

			Segments	
Potable Water	Distribution Lines		NA	18.9482
	Facilities		0	0.0000
	Pipelines		0	0.0000
		Subtotal		**18.9482**
Waste Water	Distribution Lines		NA	11.3689
	Facilities		4	613.2657
	Pipelines		0	0.0000
		Subtotal		**624.6346**
Natural Gas	Distribution Lines		NA	7.5793
	Facilities		0	0.0000
	Pipelines		0	0.0000
		Subtotal		**7.5793**
Oil Systems	Facilities		0	0.0000
	Pipelines		0	0.0000
		Subtotal		**0.0000**
Electrical Power	Facilities		2	1124.6778
		Subtotal		**1124.6778**
Communication	Facilities		0	0.0000
		Subtotal		**0.0000**
		Total		**1,775.80**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	1500year
Type of Earthquake	Probabilistic
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	1,500.00
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	6.50

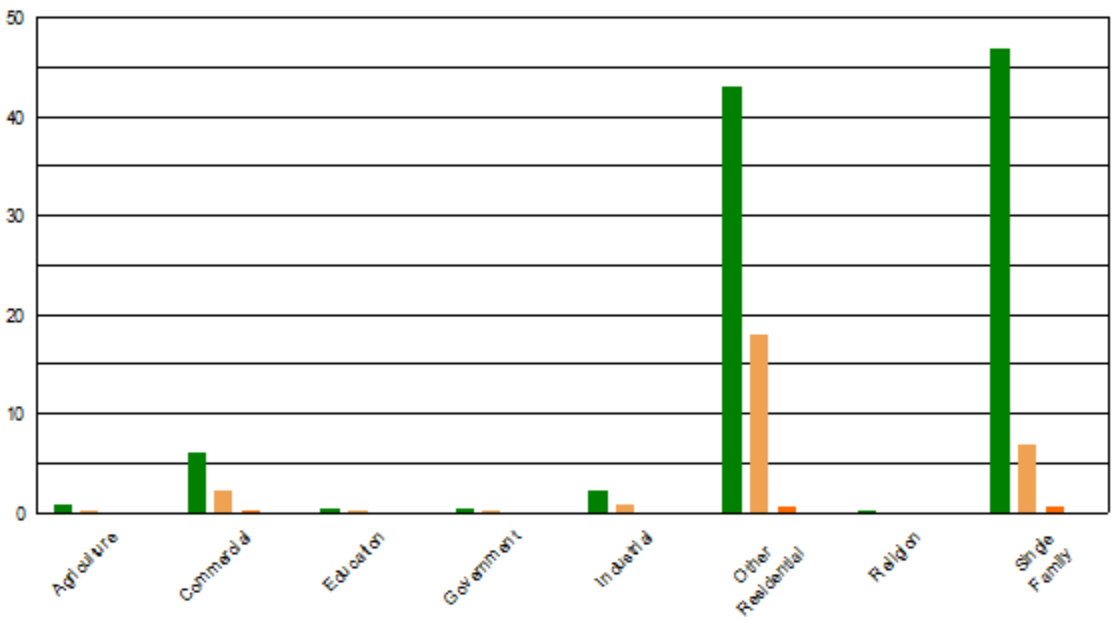
Depth (km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Direct Earthquake Damage

Building Damage

Hazus estimates that about 30 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type



Complete

Extensive

Moderate

Slight

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)

	None Count	None (%)	Slight Count	Slight (%)	Moderate Count	Moderate (%)	Extensive Count	Extensive (%)	Complete Count	Complete (%)
Agriculture	16.80	0.65	0.89	0.89	0.27	0.93	0.04	1.97	0.00	1.78
Commercial	113.40	4.41	6.05	6.02	2.21	7.64	0.32	16.33	0.02	19.48
Education	11.22	0.44	0.55	0.55	0.20	0.69	0.03	1.38	0.00	1.99
Government	8.42	0.33	0.41	0.41	0.15	0.52	0.02	1.01	0.00	1.09
Industrial	46.70	1.82	2.30	2.29	0.87	3.01	0.12	6.03	0.01	6.02
Other Residential	467.26	18.16	42.96	42.77	18.06	62.46	0.70	36.17	0.02	15.51
Religion	6.51	0.25	0.33	0.33	0.13	0.46	0.02	1.09	0.00	1.70
Single Family	1902.28	73.94	46.94	46.74	7.03	24.29	0.70	36.02	0.06	52.43
Total	**2,573**		**100**		**29**		**2**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Wood	1936.97	75.29	43.64	43.45	4.39	15.17	0.19	10.02	0.00	0.00
Steel	100.79	3.92	4.18	4.16	1.46	5.05	0.16	8.00	0.00	3.21
Concrete	18.29	0.71	0.82	0.81	0.27	0.92	0.01	0.73	0.00	0.00
Precast	6.93	0.27	0.45	0.44	0.30	1.04	0.06	2.97	0.00	0.47
RM	24.13	0.94	0.98	0.98	0.54	1.87	0.08	4.18	0.00	0.00
URM	124.40	4.84	11.62	11.57	5.30	18.31	0.94	48.34	0.11	96.32
MH	361.07	14.04	38.76	38.59	16.67	57.64	0.50	25.76	0.00	0.00
Total	**2,573**		**100**		**29**		**2**		**0**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had hospital beds available for use. On the day of the earthquake, the model estimates that only hospital beds (%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, % of the beds will be back in service. By 30 days, % will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	5	0	0	5
EOCs	9	0	0	9
PoliceStations	4	0	0	4
FireStations	8	0	0	8

Transportation Lifeline Damage

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	After Day 7
Highway	Segments	4	0	0	3	3
	Bridges	75	0	0	75	75
	Tunnels	0	0	0	0	0
Railways	Segments	7	0	0	5	5
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	Total #	# of Locations			
		With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	4	0	0	4	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	2	0	0	2	2
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	589	1	0
Waste Water	353	1	0
Natural Gas	235	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	1,898	0	0	0	0	0
Electric Power		0	0	0	0	0

EARTHQUAKE · WIND · FLOOD · TSUNAMI

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, Brick/Wood comprises 73.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)

Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.00	0.00	0.00	0 (@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 4,494) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter

Displaced households as a result of the earthquake	Persons seeking temporary public shelter
0	0

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

· Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
· Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
· Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
· Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.00	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.01	0.00	0.00	0.00
	Other-Residential	0.14	0.01	0.00	0.00
	Single Family	0.11	0.01	0.00	0.00
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0.25	0.03	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.07	0.01	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.05	0.01	0.00	0.00
	Other-Residential	0.03	0.00	0.00	0.00
	Single Family	0.02	0.00	0.00	0.00
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0.19	0.02	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.03	0.00	0.00	0.00
	Other-Residential	0.05	0.01	0.00	0.00
	Single Family	0.04	0.00	0.00	0.00
	Total	**0**	**0**	**0**	**0**

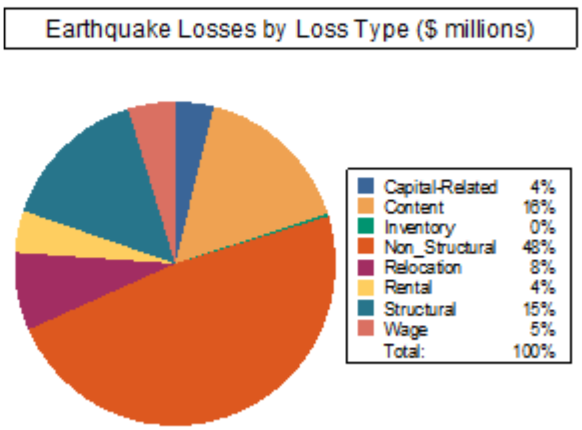
Economic Loss

The total economic loss estimated for the earthquake is 11.37 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 1.75 (millions of dollars); 20 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 65 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.



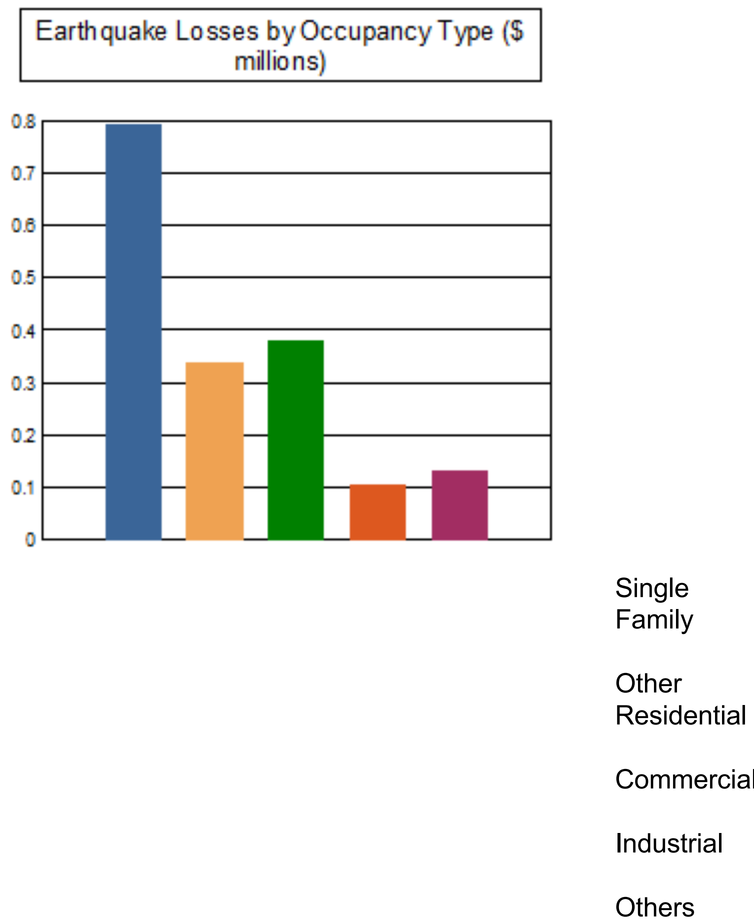


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.0143	0.0572	0.0020	0.0097	0.0832
	Capital-Related	0.0000	0.0061	0.0578	0.0012	0.0011	0.0662
	Rental	0.0144	0.0289	0.0271	0.0009	0.0014	0.0727

	Relocation	0.0467	0.0353	0.0327	0.0050	0.0160	0.1357
	Subtotal	**0.0611**	**0.0846**	**0.1748**	**0.0091**	**0.0282**	**0.3578**
Capital Stock Losses							
	Structural	0.1119	0.0637	0.0447	0.0155	0.0267	0.2625
	Non_Structural	0.4756	0.1631	0.1074	0.0459	0.0509	0.8429
	Content	0.1447	0.0289	0.0524	0.0305	0.0275	0.2840
	Inventory	0.0000	0.0000	0.0010	0.0056	0.0005	0.0071
	Subtotal	**0.7322**	**0.2557**	**0.2055**	**0.0975**	**0.1056**	**1.3965**
	Total	**0.79**	**0.34**	**0.38**	**0.11**	**0.13**	**1.75**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	170.8627	0.0000	0.00
	Bridges	79.3368	0.0001	0.00
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**250.1995**	**0.0001**	
Railways	Segments	81.6969	0.0000	0.00
	Bridges	42.8857	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**124.5826**	**0.0000**	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Bus	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	

Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**374.78**	**0.00**	

Table 13: Utility System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	18.9482	0.0060	0.03
	Subtotal	**18.9482**	**0.0060**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	613.2657	3.3883	0.55
	Distribution Lines	11.3689	0.0030	0.03
	Subtotal	**624.6346**	**3.3913**	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	7.5793	0.0010	0.01
	Subtotal	**7.5793**	**0.0010**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	1124.6778	6.2148	0.55
	Subtotal	**1124.6778**	**6.2148**	
Communication	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**1,775.84**	**9.61**	

Appendix A: County Listing for the Region

Franklin,MA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Massachusetts					
	Franklin	4,494	529	112	642
Total Region		**4,494**	**529**	**112**	**642**

Hazus: Earthquake Global Risk Report

Region Name: CharlemontEQ

Earthquake Scenario: 2500year

Print Date: July 05, 2022

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 160.33 square miles and contains 1 census tracts. There are over 1 thousand households in the region which has a total population of 4,494 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 642 (millions of dollars). Approximately 92.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 374 and 1,775 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 2 thousand buildings in the region which have an aggregate total replacement value of 642 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 73% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 2,149.00 (millions of dollars). This inventory includes over 31.69 miles of highways, 75 bridges, 1,176.88 miles of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	75	79.3368
	Segments	4	170.8627
	Tunnels	0	0.0000
	Subtotal		**250.1995**
Railways	Bridges	8	42.8857
	Facilities	0	0.0000
	Segments	7	81.6969
	Tunnels	0	0.0000
	Subtotal		**124.5826**
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	Subtotal		**0.0000**
Bus	Facilities	0	0.0000
	Subtotal		**0.0000**
Ferry	Facilities	0	0.0000
	Subtotal		**0.0000**
Port	Facilities	0	0.0000
	Subtotal		**0.0000**
Airport	Facilities	0	0.0000
	Runways	0	0.0000
	Subtotal		**0.0000**
	Total		**374.80**

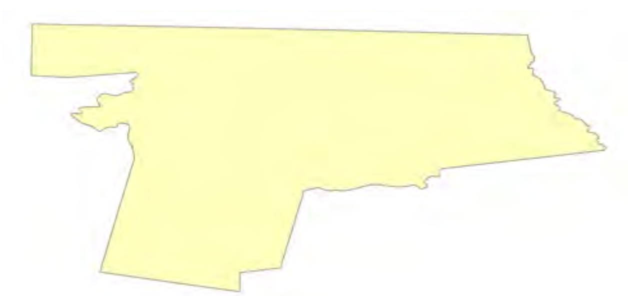
Table 2: Utility System Lifeline Inventory

System	Component	# Locations /	Replacement value (millions of dollars)

			Segments	
Potable Water	Distribution Lines		NA	18.9482
	Facilities		0	0.0000
	Pipelines		0	0.0000
		Subtotal		**18.9482**
Waste Water	Distribution Lines		NA	11.3689
	Facilities		4	613.2657
	Pipelines		0	0.0000
		Subtotal		**624.6346**
Natural Gas	Distribution Lines		NA	7.5793
	Facilities		0	0.0000
	Pipelines		0	0.0000
		Subtotal		**7.5793**
Oil Systems	Facilities		0	0.0000
	Pipelines		0	0.0000
		Subtotal		**0.0000**
Electrical Power	Facilities		2	1124.6778
		Subtotal		**1124.6778**
Communication	Facilities		0	0.0000
		Subtotal		**0.0000**
		Total		**1,775.80**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	2500year
Type of Earthquake	Probabilistic
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	2,500.00
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	7.00

Depth (km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Direct Earthquake Damage

Building Damage

Hazus estimates that about 52 buildings will be at least moderately damaged. This is over 2.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

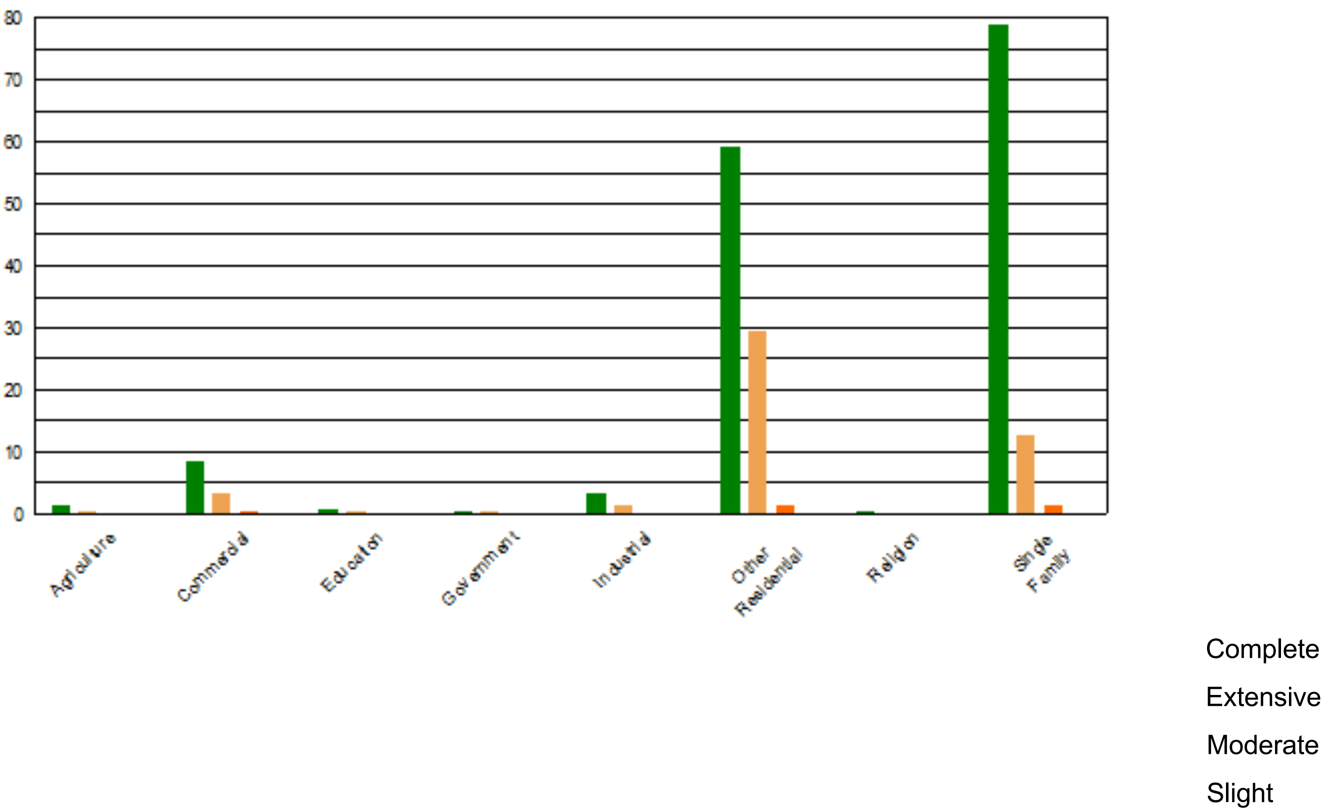


Table 3: Expected Building Damage by Occupancy

None		Slight		Moderate		Extensive		Complete	
Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)

Agriculture	16.22	0.65	1.28	0.84	0.43	0.89	0.07	1.85	0.00	1.63
Commercial	109.35	4.38	8.56	5.59	3.49	7.23	0.55	15.04	0.04	17.74
Education	10.84	0.43	0.79	0.52	0.32	0.66	0.05	1.27	0.00	1.81
Government	8.14	0.33	0.58	0.38	0.24	0.50	0.03	0.94	0.00	1.03
Industrial	45.09	1.80	3.28	2.14	1.41	2.91	0.21	5.65	0.01	5.69
Other Residential	438.83	17.56	59.11	38.60	29.49	61.11	1.51	40.85	0.06	25.31
Religion	6.29	0.25	0.47	0.31	0.20	0.42	0.04	0.98	0.00	1.48
Single Family	1863.93	74.60	79.05	51.62	12.68	26.28	1.23	33.42	0.11	45.32
Total	**2,499**		**153**		**48**		**4**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Wood	1900.17	76.05	75.66	49.41	8.97	18.59	0.39	10.63	0.00	0.00
Steel	97.72	3.91	6.08	3.97	2.48	5.15	0.29	7.87	0.01	4.33
Concrete	17.63	0.71	1.23	0.80	0.49	1.02	0.03	0.87	0.00	0.40
Precast	6.60	0.26	0.59	0.39	0.45	0.92	0.10	2.69	0.00	0.43
RM	23.39	0.94	1.35	0.88	0.85	1.76	0.15	3.96	0.00	0.00
URM	117.50	4.70	15.35	10.03	7.73	16.02	1.57	42.59	0.21	83.23
MH	335.68	13.43	52.85	34.51	27.29	56.55	1.16	31.38	0.03	11.61
Total	**2,499**		**153**		**48**		**4**		**0**	

*Note:

RM	Reinforced Masonry
URM	Unreinforced Masonry
MH	Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had hospital beds available for use. On the day of the earthquake, the model estimates that only hospital beds (%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, % of the beds will be back in service. By 30 days, % will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	5	0	0	5
EOCs	9	0	0	9
PoliceStations	4	0	0	4
FireStations	8	0	0	8

Transportation Lifeline Damage

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	With Functionality > 50 % After Day 7
Highway	Segments	4	0	0	3	3
	Bridges	75	0	0	75	75
	Tunnels	0	0	0	0	0
Railways	Segments	7	0	0	5	5
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	Total #	# of Locations With at Least Moderate Damage	With Complete Damage	with Functionality > 50 % After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	4	0	0	4	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	2	0	0	2	2
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	589	2	1
Waste Water	353	1	0
Natural Gas	235	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	1,898	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, Brick/Wood comprises 71.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)

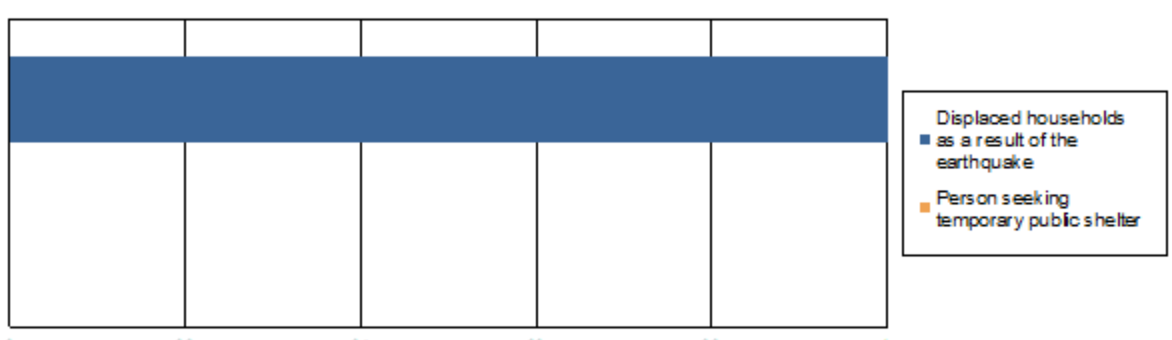
Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.00	0.00	0.00	0 (@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 4,494) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter



Displaced households as a result of the earthquake	Persons seeking temporary public shelter
1	0

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.01	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.01	0.00	0.00	0.00
	Other-Residential	0.23	0.03	0.00	0.00
	Single Family	0.19	0.02	0.00	0.00
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0.42	0.06	0.01	0.01
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.11	0.02	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.08	0.01	0.00	0.00
	Other-Residential	0.04	0.00	0.00	0.00
	Single Family	0.04	0.00	0.00	0.00
	Total	**1**	**0**	**0**	**0**
5 PM	Commercial	0.31	0.04	0.00	0.01
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.01	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00

Industrial	0.05	0.01	0.00	0.00
Other-Residential	0.09	0.01	0.00	0.00
Single Family	0.07	0.01	0.00	0.00
Total	**1**	**0**	**0**	**0**

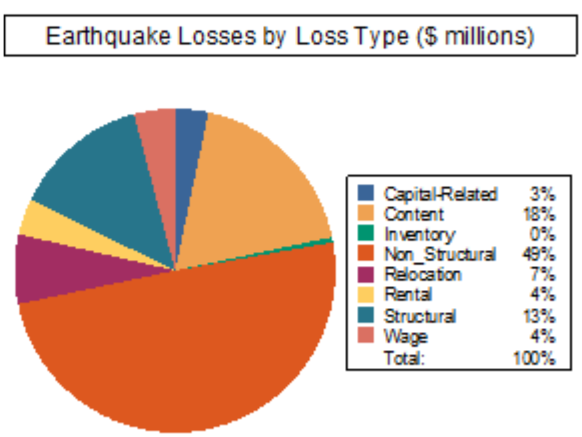
Economic Loss

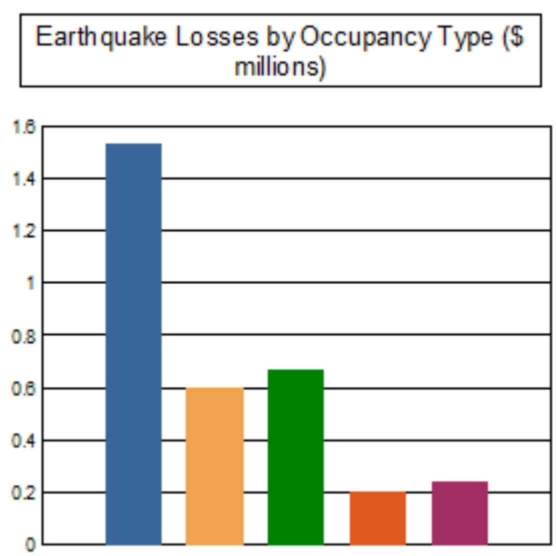
The total economic loss estimated for the earthquake is 24.41 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 3.25 (millions of dollars); 18 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 66 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.





Single Family

Other Residential

Commercial

Industrial

Table 11: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.0243	0.0933	0.0034	0.0151	0.1361
	Capital-Related	0.0000	0.0103	0.0945	0.0020	0.0017	0.1085
	Rental	0.0257	0.0472	0.0429	0.0014	0.0023	0.1195
	Relocation	0.0841	0.0589	0.0534	0.0083	0.0264	0.2311
	Subtotal	**0.1098**	**0.1407**	**0.2841**	**0.0151**	**0.0455**	**0.5952**
Capital Stock Losses							
	Structural	0.1951	0.1032	0.0721	0.0252	0.0432	0.4388
	Non_Structural	0.9221	0.2969	0.2022	0.0905	0.0948	1.6065
	Content	0.3083	0.0603	0.1080	0.0621	0.0566	0.5953
	Inventory	0.0000	0.0000	0.0020	0.0114	0.0012	0.0146
	Subtotal	**1.4255**	**0.4604**	**0.3843**	**0.1892**	**0.1958**	**2.6552**
	Total	**1.54**	**0.60**	**0.67**	**0.20**	**0.24**	**3.25**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	170.8627	0.0000	0.00
	Bridges	79.3368	0.0003	0.00
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**250.1995**	**0.0003**	
Railways	Segments	81.6969	0.0000	0.00
	Bridges	42.8857	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**124.5826**	**0.0000**	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00

	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Bus	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**374.78**	**0.00**	

Table 13: Utility System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	18.9482	0.0103	0.05
	Subtotal	**18.9482**	**0.0103**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	613.2657	7.4634	1.22
	Distribution Lines	11.3689	0.0052	0.05
	Subtotal	**624.6346**	**7.4686**	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	7.5793	0.0018	0.02
	Subtotal	**7.5793**	**0.0018**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	1124.6778	13.6780	1.22
	Subtotal	**1124.6778**	**13.6780**	

Communication	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**1,775.84**	**21.16**	

Appendix A: County Listing for the Region

Franklin,MA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Massachusetts					
	Franklin	4,494	529	112	642
Total Region		**4,494**	**529**	**112**	**642**

Hazus: Hurricane Global Risk Report

Region Name: charlemontHU

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date: Tuesday, July 5, 2022

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

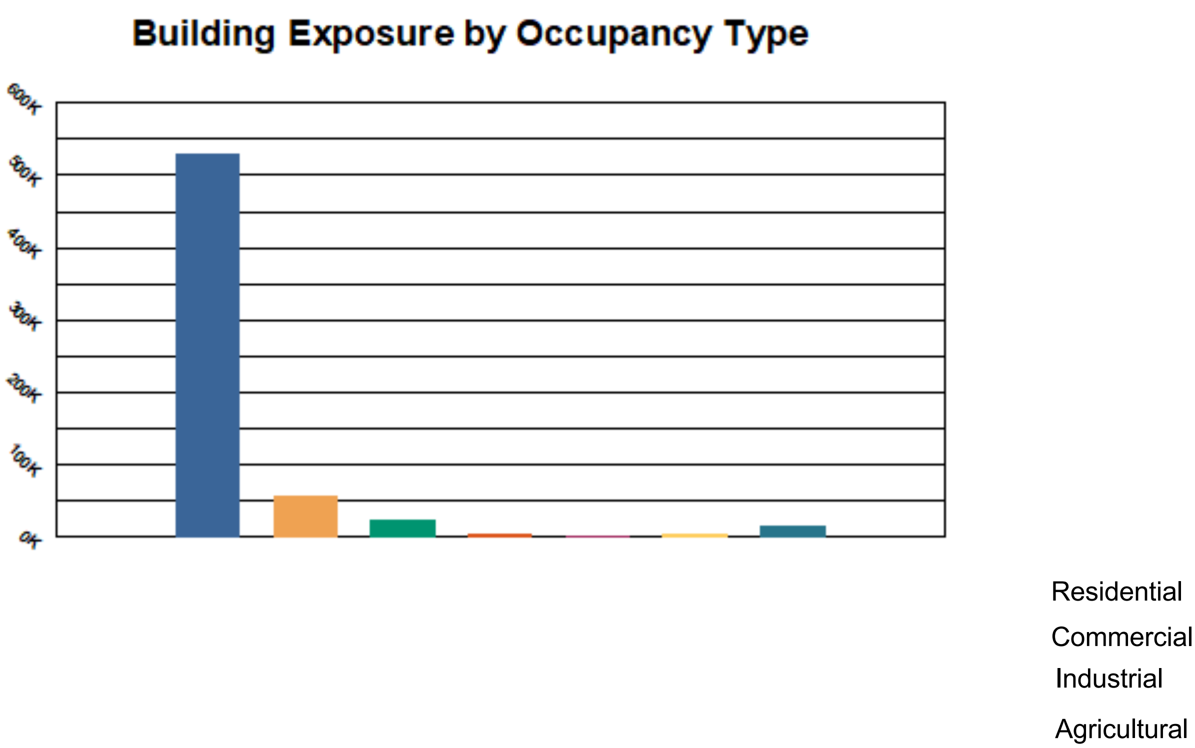
The geographical size of the region is 160.37 square miles and contains 1 census tracts. There are over 1 thousand households in the region and a total population of 4,494 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 642 million dollars (2014 dollars). Approximately 92% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 2,704 buildings in the region which have an aggregate total replacement value of 642 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



Religious

Government

Education

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	529,722	82.48%
Commercial	57,712	8.99%
Industrial	24,874	3.87%
Agricultural	5,098	0.79%
Religious	3,590	0.56%
Government	5,026	0.78%
Education	16,196	2.52%
Total	**642,218**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation facilities.

Hurricane Scenario

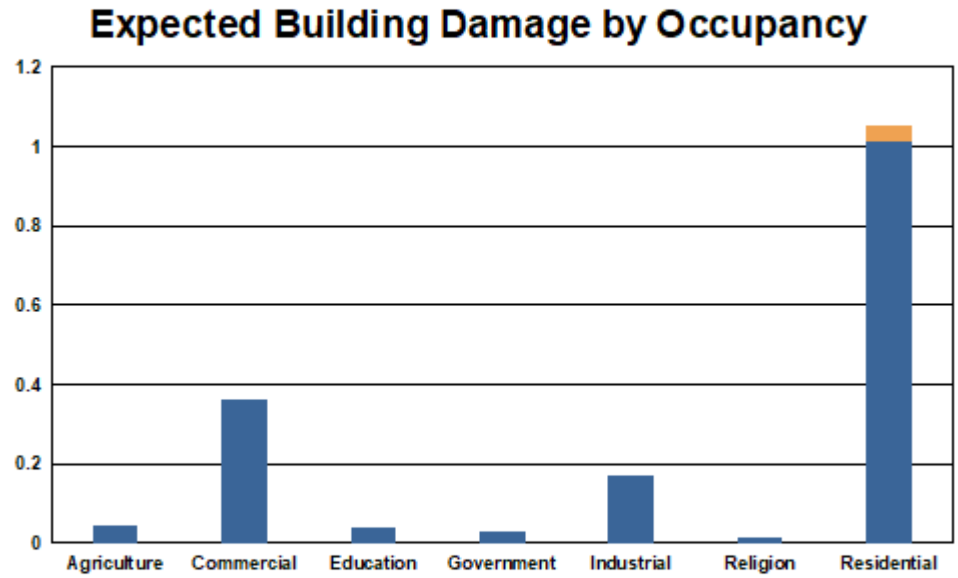
Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



Minor

Moderate

Severe

Destruction

Table 2: Expected Building Damage by Occupancy : 100 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	17.96	99.77	0.04	0.23	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	121.64	99.70	0.36	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Education	11.96	99.67	0.04	0.33	0.00	0.00	0.00	0.00	0.00	0.00
Government	8.97	99.66	0.03	0.34	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	49.83	99.66	0.17	0.34	0.00	0.00	0.00	0.00	0.00	0.00
Religion	6.98	99.78	0.02	0.22	0.00	0.00	0.00	0.00	0.00	0.00
Residential	2,484.95	99.96	1.01	0.04	0.04	0.00	0.00	0.00	0.00	0.00
Total	**2,702.29**		**1.67**		**0.04**		**0.00**		**0.00**	

Table 3: Expected Building Damage by Building Type : 100 - year Event

Building Type	None Count	None (%)	Minor Count	Minor (%)	Moderate Count	Moderate (%)	Severe Count	Severe (%)	Destruction Count	Destruction (%)
Concrete	5	99.56	0	0.44	0	0.00	0	0.00	0	0.00
Masonry	63	99.62	0	0.36	0	0.01	0	0.00	0	0.00
MH	312	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	98	99.64	0	0.36	0	0.00	0	0.00	0	0.00
Wood	1,974	99.98	0	0.02	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.

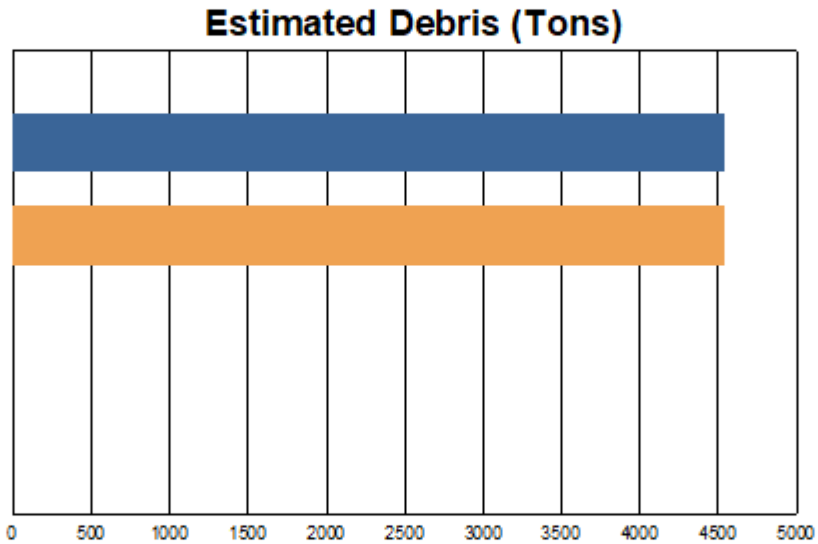
Thematic Map of Essential Facilities with greater than 50% moderate

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	Probability of at Least Moderate	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	9	0	0	9
Fire Stations	8	0	0	8
Police Stations	4	0	0	4
Schools	5	0	0	5

Induced Hurricane Damage

Debris Generation



Total Debris	4,532
Tree Debris	4,532
Brick/ Wood	0
Concrete/ Steel	0

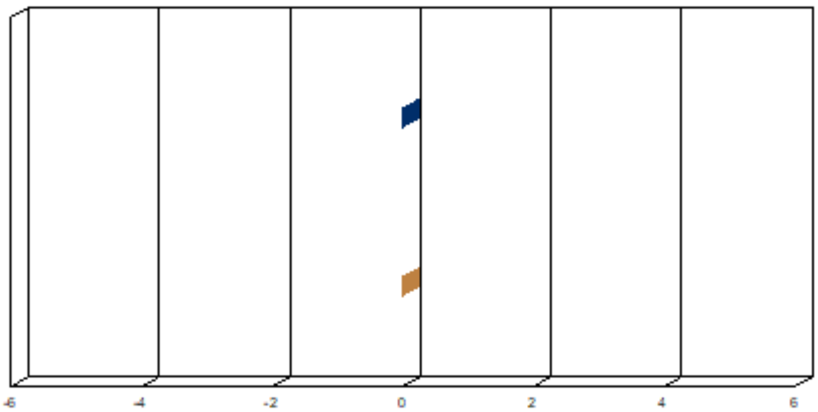
Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 4,532 tons of debris will be generated. Of the total amount, 4,299 tons (95%) is Other Tree Debris. Of the remaining 233 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 233 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

<u>Shelter Requirement</u>

Estimated Shelter Needs



Displaced Households	0
Temporary Shelter	0

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 4,494) will seek temporary shelter in public shelters.

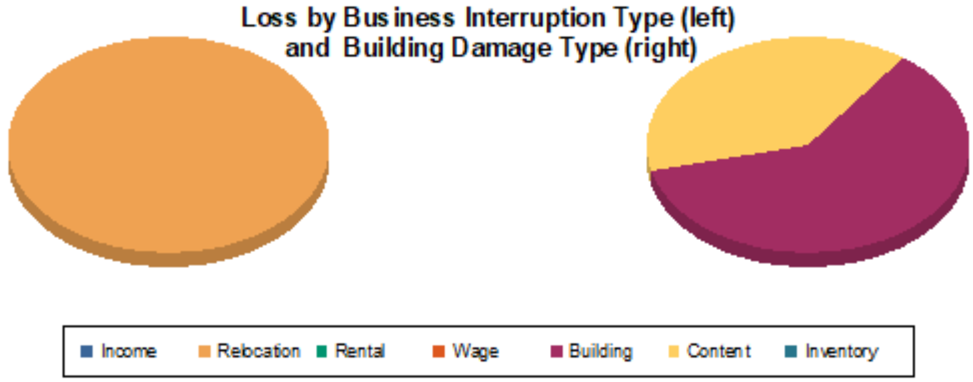
Economic Loss

The total economic loss estimated for the hurricane is 0.6 million dollars, which represents 0.09 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 1 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 98% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.



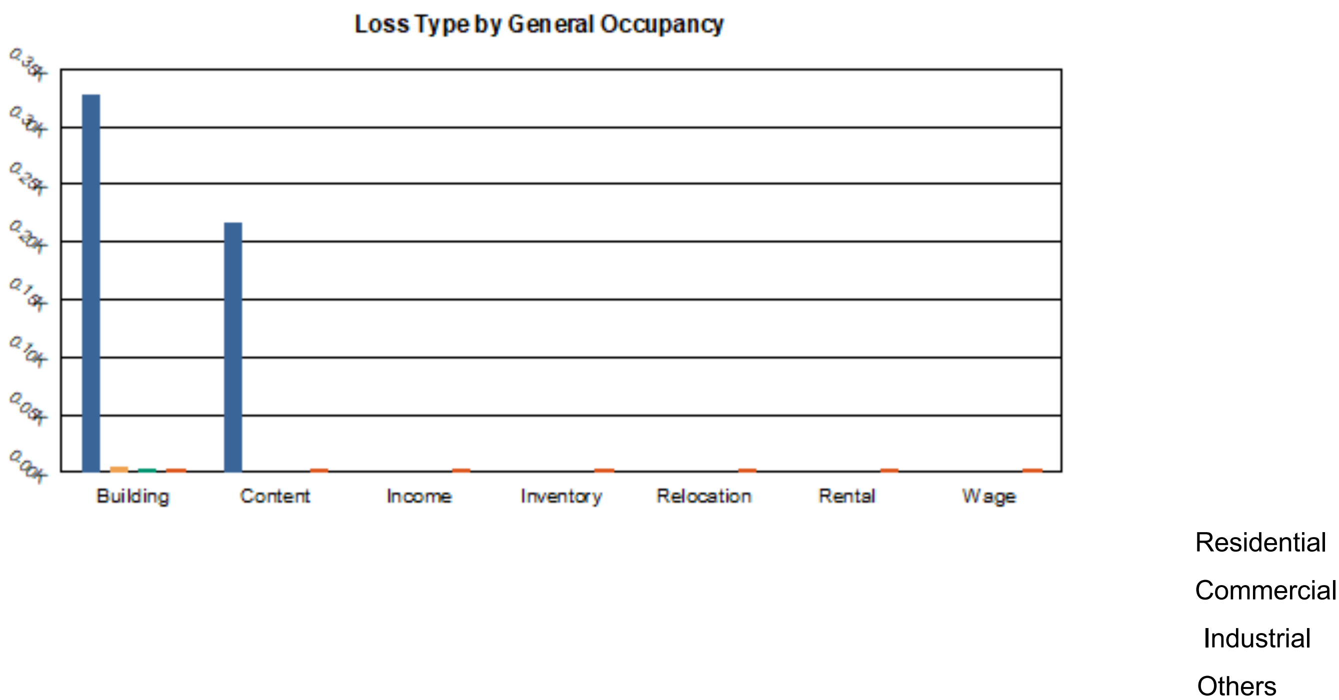


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	328.95	5.77	2.49	2.48	339.69
	Content	216.51	0.00	0.00	0.00	216.51
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**545.46**	**5.77**	**2.49**	**2.48**	**556.20**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.06	0.00	0.00	0.00	0.06

Rental	0.00	0.00	0.00	0.00	0.00
Wage	0.00	0.00	0.00	0.00	0.00
Subtotal	**0.06**	**0.00**	**0.00**	**0.00**	**0.06**

Total

Total	**545.52**	**5.77**	**2.49**	**2.48**	**556.26**

Appendix A: County Listing for the Region

Massachusetts
- Franklin

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Franklin	4,494	529,722	112,496	642,218
Total	**4,494**	**529,722**	**112,496**	**642,218**
Study Region Total	**4,494**	**529,722**	**112,496**	**642,218**

Hazus: Hurricane Global Risk Report

Region Name: charlemontHU

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date: Tuesday, July 5, 2022

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Note:
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There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 642 million dollars (2014 dollars). Approximately 92% of the buildings (and 82% of the building value) are associated with residential housing.

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General Building Stock

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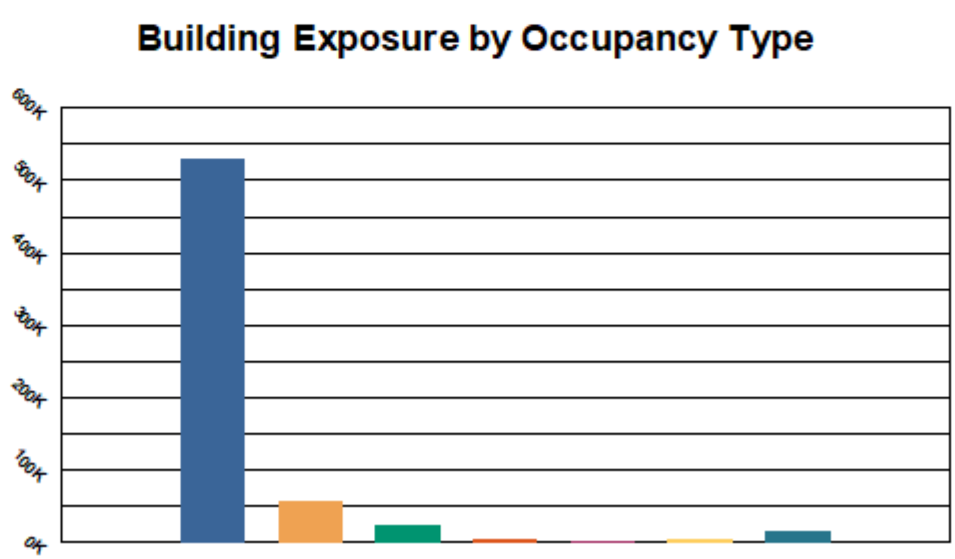

Residential
Commercial
Industrial
Agricultural

Religious

Government

Education

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	529,722	82.48%
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Education	16,196	2.52%
Total	**642,218**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation facilities.

Hurricane Scenario

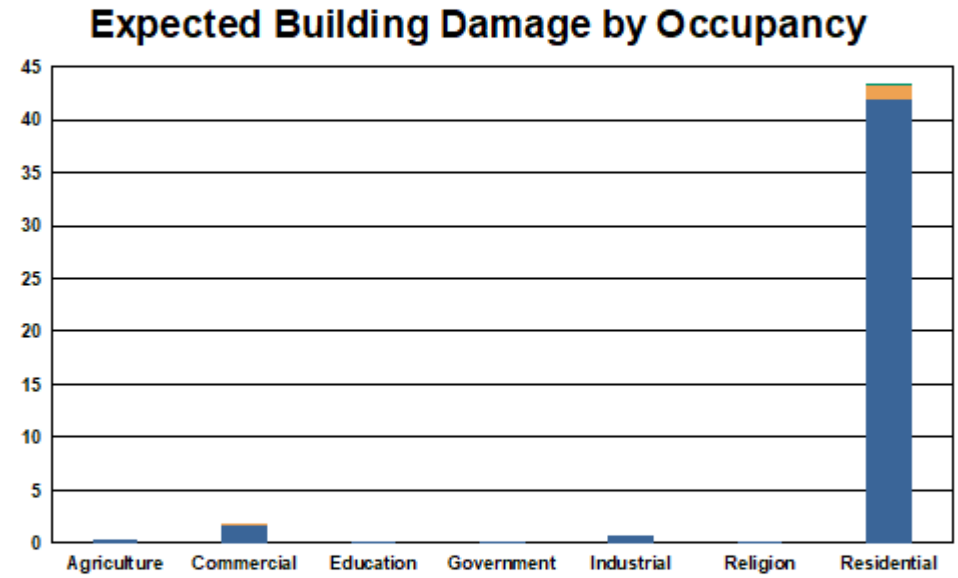
Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 2 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



Minor
Moderate
Severe
Destruction

Table 2: Expected Building Damage by Occupancy : 500 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	17.69	98.27	0.28	1.54	0.03	0.15	0.01	0.04	0.00	0.00
Commercial	120.20	98.52	1.69	1.38	0.11	0.09	0.00	0.00	0.00	0.00
Education	11.82	98.53	0.17	1.45	0.00	0.03	0.00	0.00	0.00	0.00
Government	8.87	98.60	0.12	1.37	0.00	0.02	0.00	0.00	0.00	0.00
Industrial	49.23	98.45	0.73	1.47	0.03	0.07	0.01	0.01	0.00	0.00
Religion	6.92	98.88	0.08	1.10	0.00	0.02	0.00	0.00	0.00	0.00
Residential	2,442.71	98.26	41.89	1.69	1.37	0.05	0.04	0.00	0.00	0.00
Total	**2,657.43**		**44.96**		**1.55**		**0.05**		**0.00**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

Building Type	None Count	(%)	Minor Count	(%)	Moderate Count	(%)	Severe Count	(%)	Destruction Count	(%)
Concrete	5	98.05	0	1.91	0	0.04	0	0.00	0	0.00
Masonry	61	97.62	1	2.04	0	0.32	0	0.02	0	0.00
MH	312	99.93	0	0.06	0	0.02	0	0.00	0	0.00
Steel	97	98.51	1	1.44	0	0.05	0	0.00	0	0.00
Wood	1,937	98.10	37	1.86	1	0.04	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.

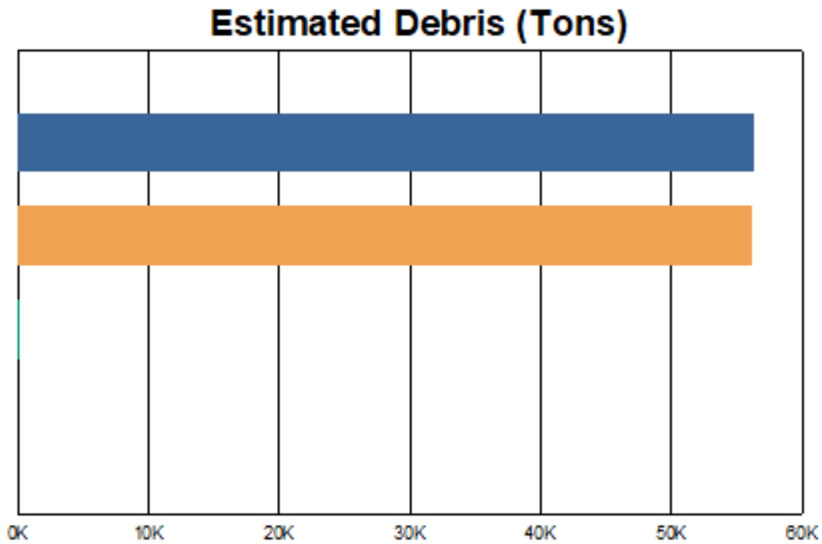
Thematic Map of Essential Facilities with greater than 50% moderate

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	Probability of at Least Moderate	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	9	0	0	9
Fire Stations	8	0	0	8
Police Stations	4	0	0	4
Schools	5	0	0	5

Induced Hurricane Damage

Debris Generation



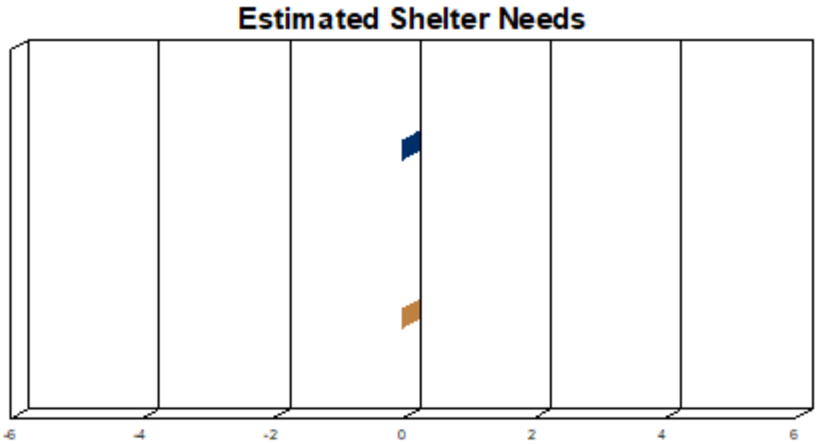
Total Debris	56,305
Tree Debris	56,220
Brick/ Wood	85
Concrete/ Steel	0

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 56,305 tons of debris will be generated. Of the total amount, 53,329 tons (95%) is Other Tree Debris. Of the remaining 2,976 tons, Brick/Wood comprises 3% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 3 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,891 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Displaced Households	0
Temporary Shelter	0

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 4,494) will seek temporary shelter in public shelters.

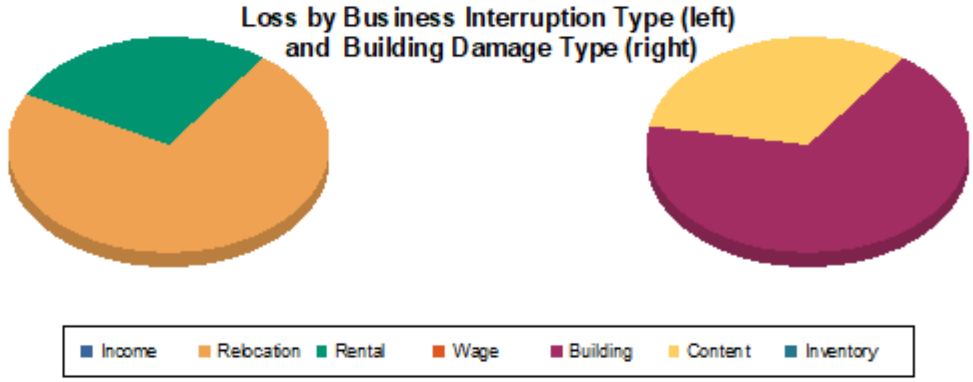
Economic Loss

The total economic loss estimated for the hurricane is 3.9 million dollars, which represents 0.61 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 4 million dollars. 3% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 99% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.



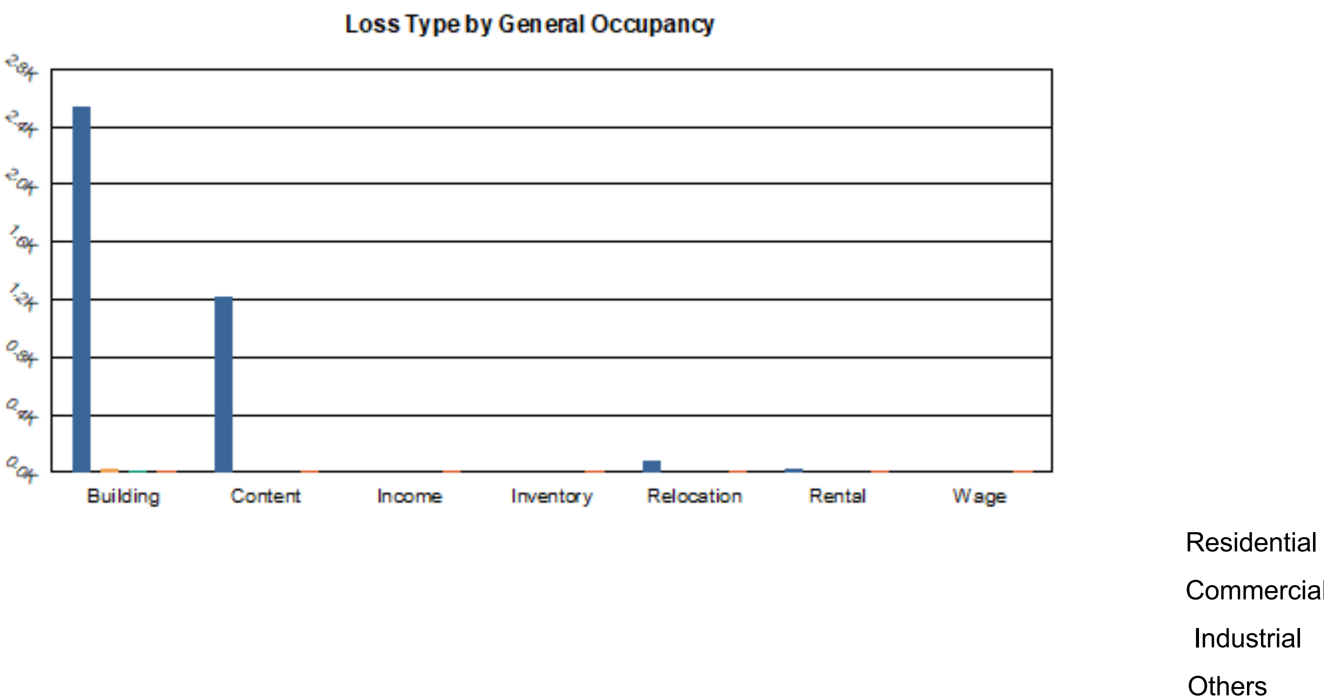


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	2,540.12	19.73	8.83	9.78	2,578.46
	Content	1,225.04	0.00	1.56	0.57	1,227.17
	Inventory	0.00	0.00	0.29	0.06	0.35
	Subtotal	**3,765.16**	**19.73**	**10.68**	**10.41**	**3,805.97**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	74.45	0.43	0.04	0.10	75.02

Rental	28.01	0.00	0.00	0.00	28.01
Wage	0.00	0.00	0.00	0.00	0.00
Subtotal	**102.46**	**0.43**	**0.04**	**0.10**	**103.02**

Total

Total	**3,867.62**	**20.15**	**10.72**	**10.51**	**3,909.00**

Appendix A: County Listing for the Region

Massachusetts
- Franklin

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	**Residential**	**Non-Residential**	**Total**
Massachusetts				
Franklin	4,494	529,722	112,496	642,218
Total	**4,494**	**529,722**	**112,496**	**642,218**
Study Region Total	**4,494**	**529,722**	**112,496**	**642,218**

Hazus: Hurricane Global Risk Report

Region Name: charlemontHU

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Tuesday, July 5, 2022

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HAZUS
EARTHQUAKE · WIND · FLOOD · TSUNAMI

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

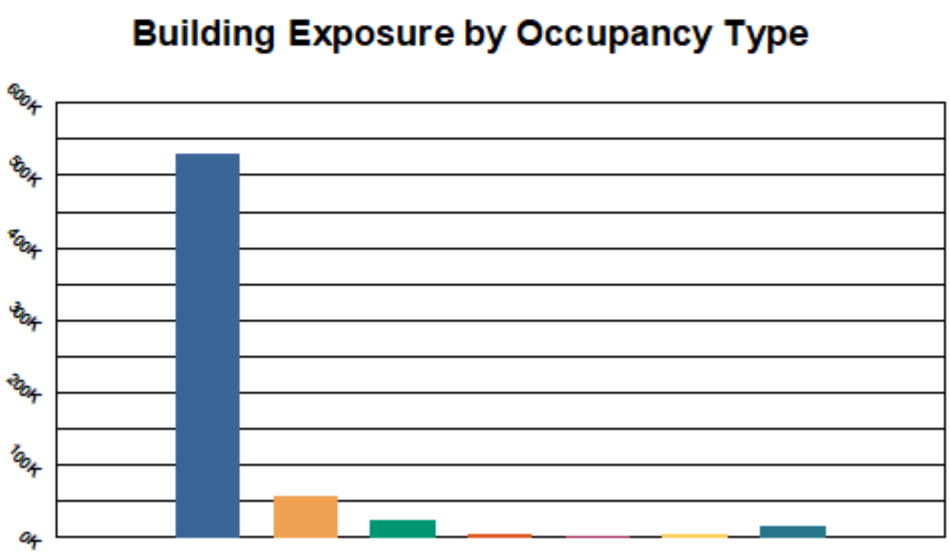
The geographical size of the region is 160.37 square miles and contains 1 census tracts. There are over 1 thousand households in the region and a total population of 4,494 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 642 million dollars (2014 dollars). Approximately 92% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 2,704 buildings in the region which have an aggregate total replacement value of 642 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



Residential
Commercial
Industrial
Agricultural

Religious

Government

Education

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	529,722	82.48%
Commercial	57,712	8.99%
Industrial	24,874	3.87%
Agricultural	5,098	0.79%
Religious	3,590	0.56%
Government	5,026	0.78%
Education	16,196	2.52%
Total	**642,218**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation facilities.

Hurricane Scenario

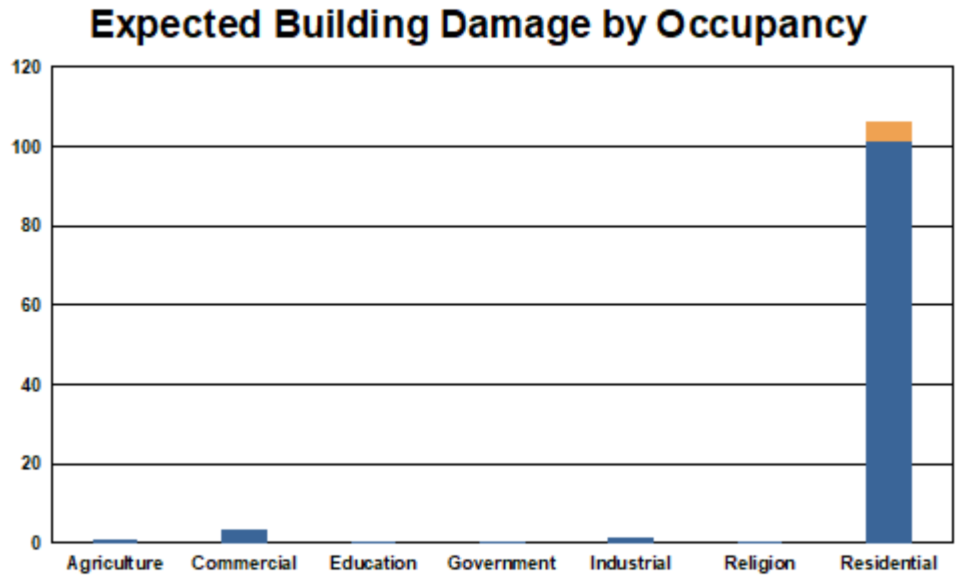
Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 6 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



Minor

Moderate

Severe

Destruction

Table 2: Expected Building Damage by Occupancy : 1000 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	17.28	96.02	0.60	3.35	0.08	0.45	0.03	0.18	0.00	0.00
Commercial	118.37	97.03	3.31	2.71	0.30	0.25	0.02	0.01	0.00	0.00
Education	11.65	97.10	0.34	2.81	0.01	0.09	0.00	0.00	0.00	0.00
Government	8.76	97.37	0.23	2.56	0.01	0.07	0.00	0.00	0.00	0.00
Industrial	48.50	97.00	1.36	2.72	0.11	0.21	0.03	0.06	0.00	0.00
Religion	6.83	97.60	0.17	2.36	0.00	0.04	0.00	0.00	0.00	0.00
Residential	2,379.98	95.74	101.06	4.07	4.86	0.20	0.06	0.00	0.04	0.00
Total	**2,591.39**		**107.06**		**5.37**		**0.14**		**0.05**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None Count	(%)	Minor Count	(%)	Moderate Count	(%)	Severe Count	(%)	Destruction Count	(%)
Concrete	5	96.44	0	3.40	0	0.17	0	0.00	0	0.00
Masonry	60	95.36	2	3.78	0	0.78	0	0.08	0	0.00
MH	311	99.68	1	0.25	0	0.06	0	0.00	0	0.01
Steel	95	97.27	3	2.58	0	0.14	0	0.01	0	0.00
Wood	1,881	95.27	90	4.56	3	0.17	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.

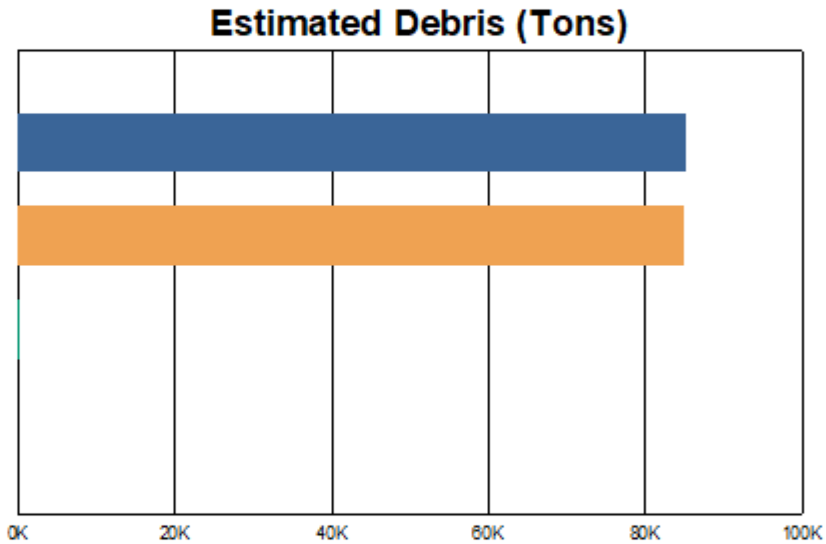
Thematic Map of Essential Facilities with greater than 50% moderate

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	Probability of at Least Moderate	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	9	0	0	9
Fire Stations	8	0	0	8
Police Stations	4	0	0	4
Schools	5	0	0	5

Induced Hurricane Damage

Debris Generation



Total Debris	85,087
Tree Debris	84,868
Brick/ Wood	219
Concrete/ Steel	0

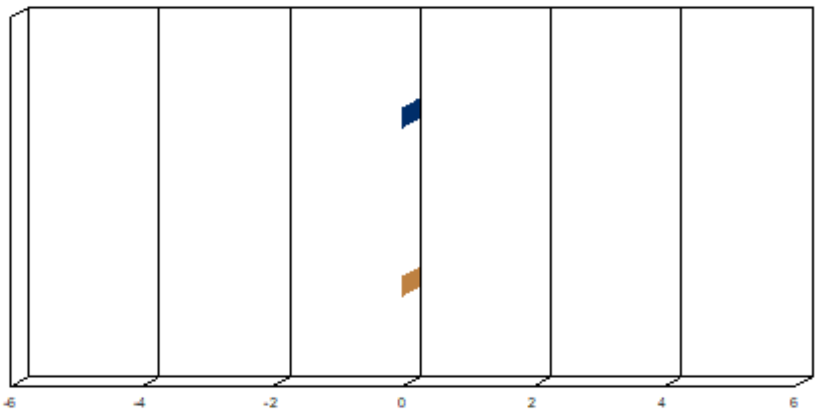
Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 85,087 tons of debris will be generated. Of the total amount, 80,504 tons (95%) is Other Tree Debris. Of the remaining 4,583 tons, Brick/Wood comprises 5% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 9 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 4,364 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Estimated Shelter Needs



Displaced Households	0
Temporary Shelter	0

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 4,494) will seek temporary shelter in public shelters.

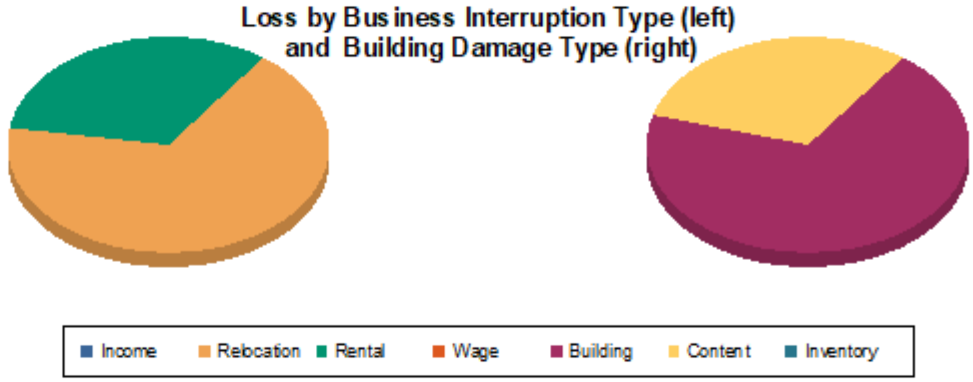
Economic Loss

The total economic loss estimated for the hurricane is 5.9 million dollars, which represents 0.92 % of the total replacement value of the region’s buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 6 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 98% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.



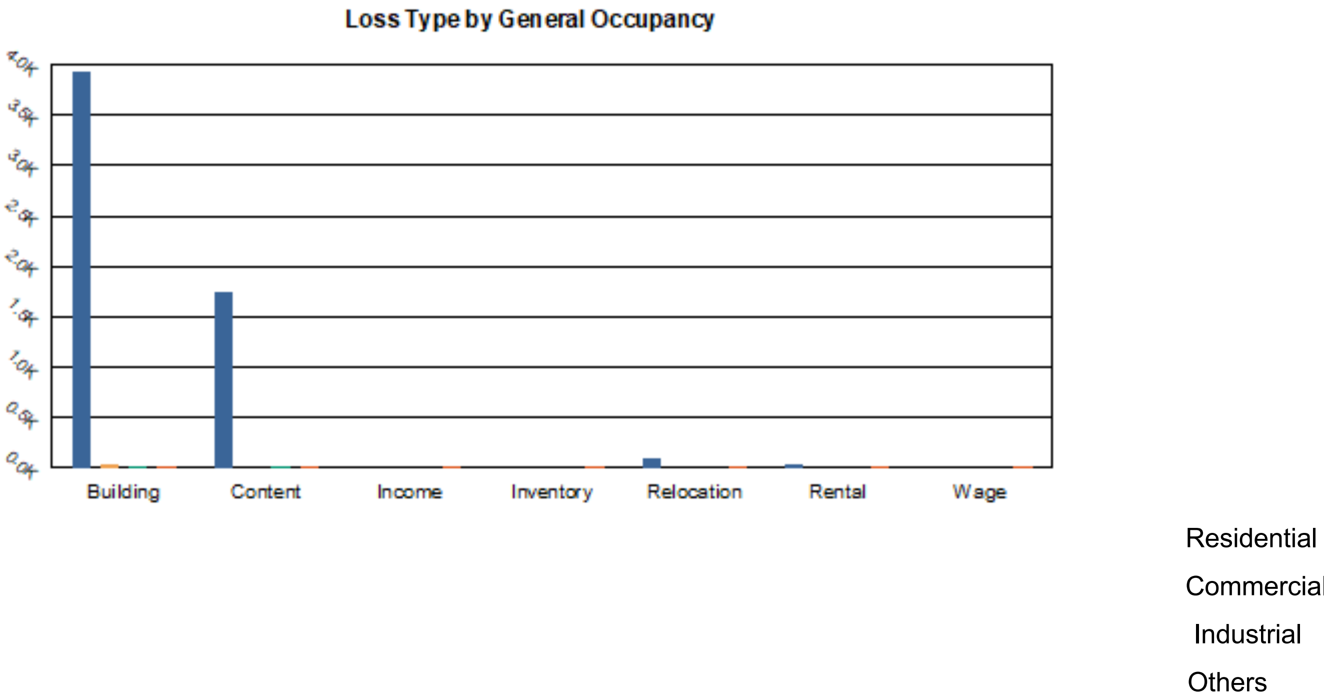


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
<u>Property Damage</u>						
	Building	3,929.60	41.39	20.44	21.80	4,013.24
	Content	1,746.18	2.61	5.05	2.45	1,756.28
	Inventory	0.00	0.05	0.91	0.20	1.16
	Subtotal	**5,675.78**	**44.05**	**26.40**	**24.45**	**5,770.68**
<u>Business Interruption Loss</u>						
	Income	0.00	0.07	0.00	0.00	0.07
	Relocation	92.02	1.19	0.11	0.47	93.79

Rental	45.37	0.03	0.00	0.01	45.41
Wage	0.00	0.02	0.00	0.00	0.02
Subtotal	**137.39**	**1.31**	**0.11**	**0.48**	**139.30**

Total

Total	**5,813.17**	**45.36**	**26.52**	**24.93**	**5,909.97**

Appendix A: County Listing for the Region

Massachusetts
- Franklin

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	**Residential**	**Non-Residential**	**Total**
Massachusetts				
Franklin	4,494	529,722	112,496	642,218
Total	**4,494**	**529,722**	**112,496**	**642,218**
Study Region Total	**4,494**	**529,722**	**112,496**	**642,218**

Hazus: Hurricane Global Risk Report

Region Name: charlemontHU

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Wednesday, July 13, 2022

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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Appendix A contains a complete listing of the counties contained in the region.

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There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 642 million dollars (2014 dollars). Approximately 92% of the buildings (and 82% of the building value) are associated with residential housing.

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General Building Stock

Hazus estimates that there are 2,704 buildings in the region which have an aggregate total replacement value of 642 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

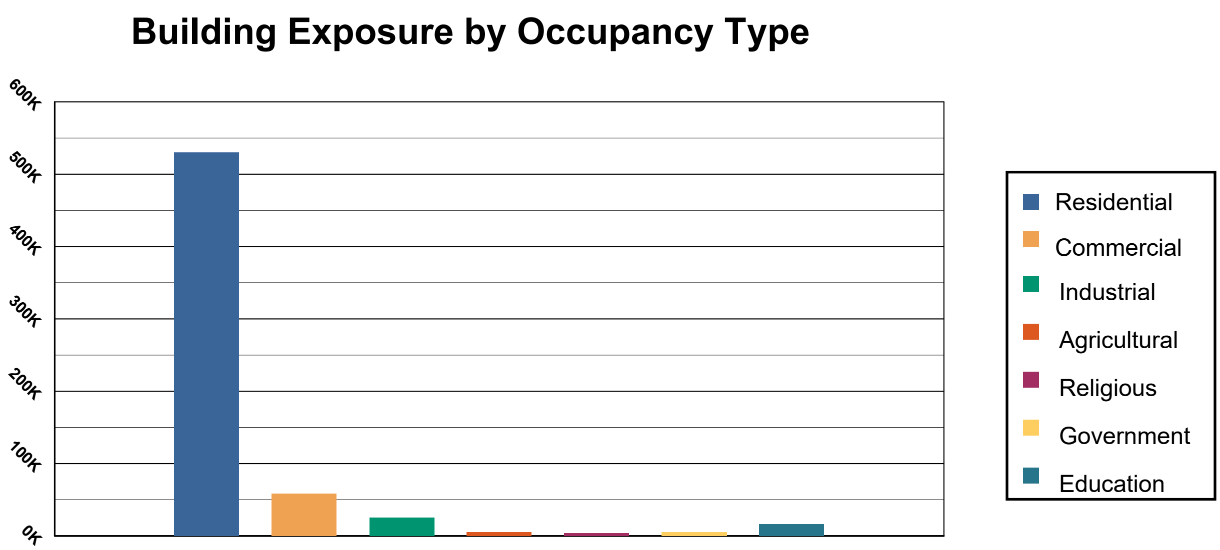

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	529,722	82.48%
Commercial	57,712	8.99%
Industrial	24,874	3.87%
Agricultural	5,098	0.79%
Religious	3,590	0.56%
Government	5,026	0.78%
Education	16,196	2.52%
Total	**642,218**	**100.00%**

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For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation facilities.

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Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 6 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

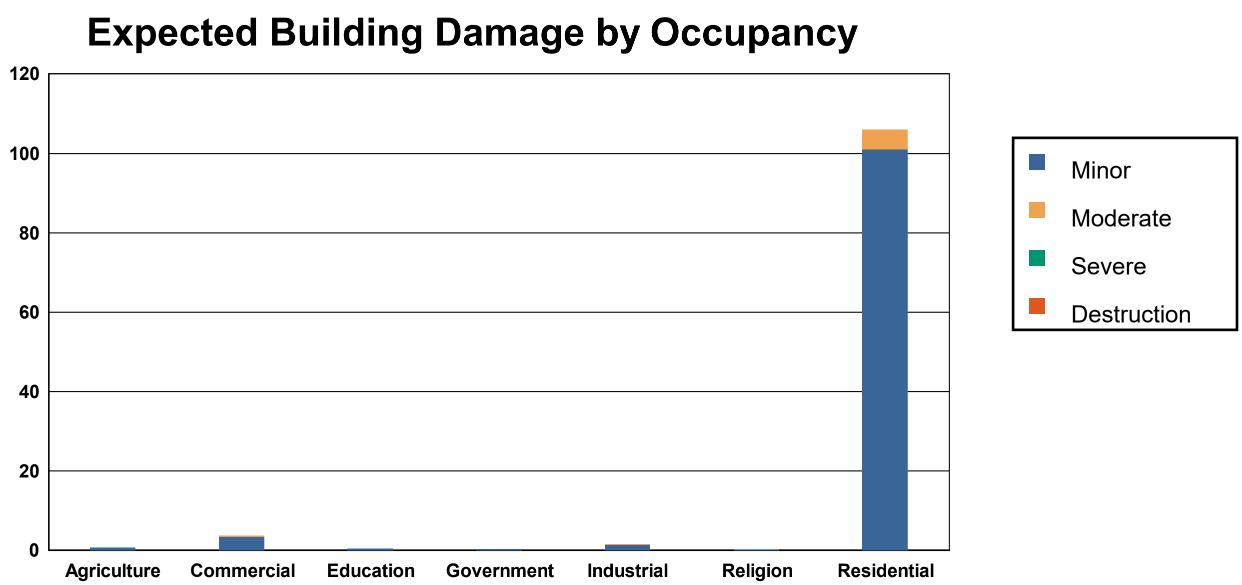


Table 2: Expected Building Damage by Occupancy : 1000 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	17.28	96.02	0.60	3.35	0.08	0.45	0.03	0.18	0.00	0.00
Commercial	118.37	97.03	3.31	2.71	0.30	0.25	0.02	0.01	0.00	0.00
Education	11.65	97.10	0.34	2.81	0.01	0.09	0.00	0.00	0.00	0.00
Government	8.76	97.37	0.23	2.56	0.01	0.07	0.00	0.00	0.00	0.00
Industrial	48.50	97.00	1.36	2.72	0.11	0.21	0.03	0.06	0.00	0.00
Religion	6.83	97.60	0.17	2.36	0.00	0.04	0.00	0.00	0.00	0.00
Residential	2,379.98	95.74	101.06	4.07	4.86	0.20	0.06	0.00	0.04	0.00
Total	**2,591.39**		**107.06**		**5.37**		**0.14**		**0.05**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	5	96.44	0	3.40	0	0.17	0	0.00	0	0.00
Masonry	60	95.36	2	3.78	0	0.78	0	0.08	0	0.00
MH	311	99.68	1	0.25	0	0.06	0	0.00	0	0.01
Steel	95	97.27	3	2.58	0	0.14	0	0.01	0	0.00
Wood	1,881	95.27	90	4.56	3	0.17	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

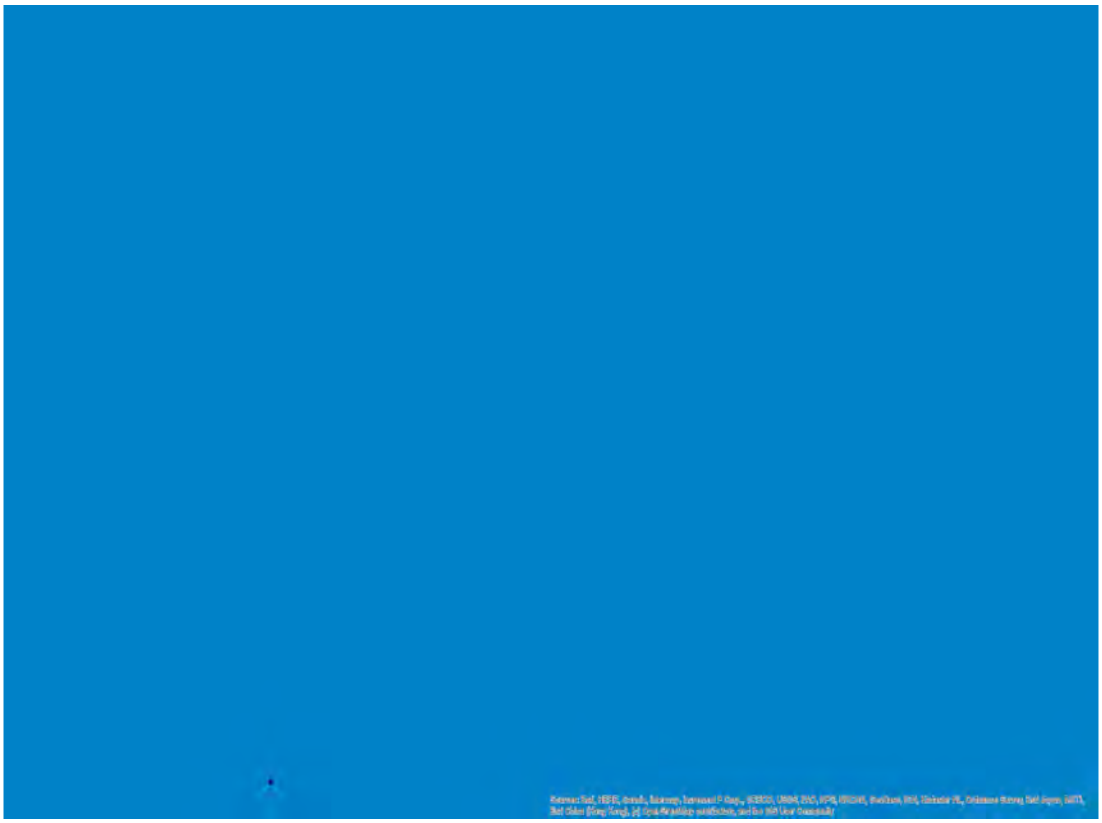
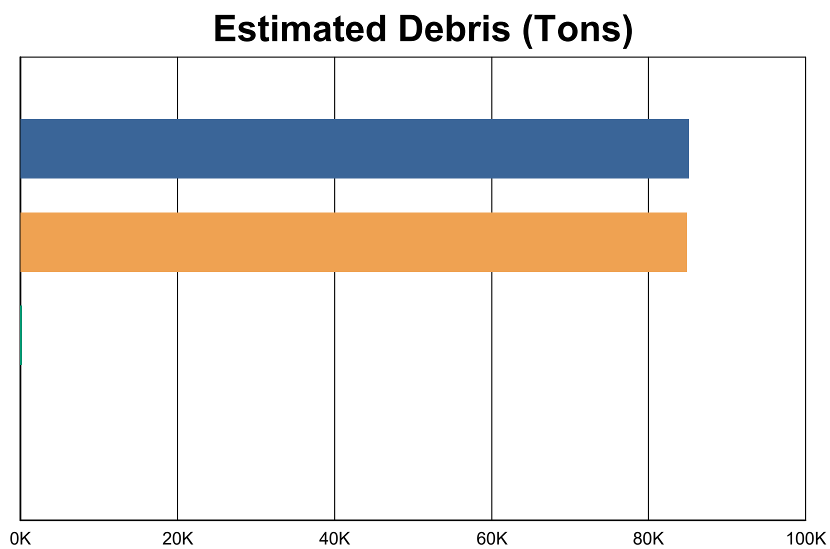


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	9	0	0	9
Fire Stations	8	0	0	8
Police Stations	4	0	0	4
Schools	5	0	0	5

Induced Hurricane Damage

Debris Generation



Total Debris	85,087
Tree Debris	84,868
Brick/ Wood	219
Concrete/ Steel	0

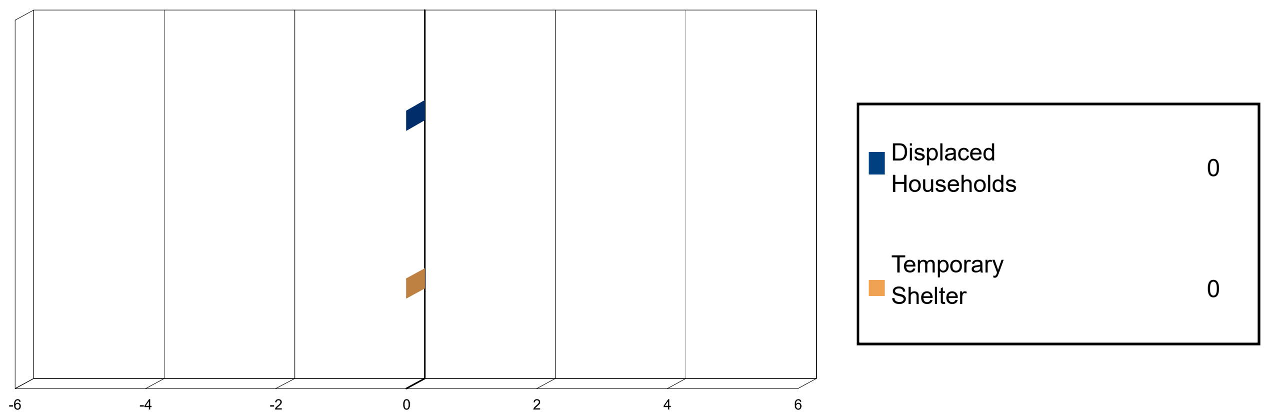
Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 85,087 tons of debris will be generated. Of the total amount, 80,504 tons (95%) is Other Tree Debris. Of the remaining 4,583 tons, Brick/Wood comprises 5% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 9 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 4,364 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Estimated Shelter Needs



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 4,494) will seek temporary shelter in public shelters.

Economic Loss

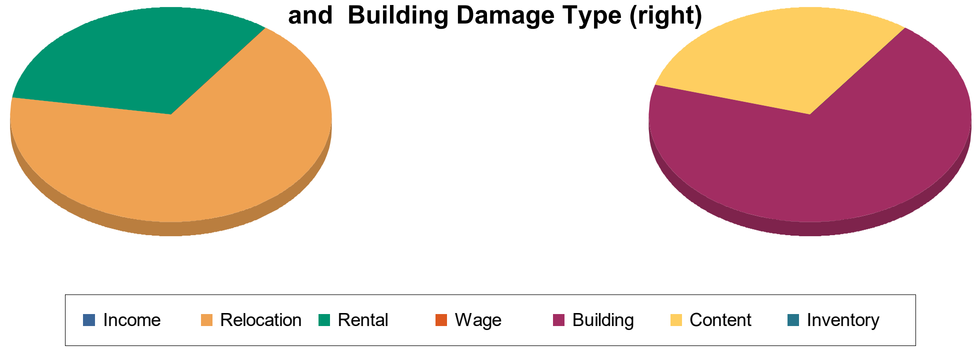
The total economic loss estimated for the hurricane is 5.9 million dollars, which represents 0.92 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 6 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 98% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left) and Building Damage Type (right)



Loss Type by General Occupancy

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	3,929.60	41.39	20.44	21.80	4,013.24
	Content	1,746.18	2.61	5.05	2.45	1,756.28
	Inventory	0.00	0.05	0.91	0.20	1.16
	Subtotal	**5,675.78**	**44.05**	**26.40**	**24.45**	**5,770.68**
Business Interruption Loss						
	Income	0.00	0.07	0.00	0.00	0.07
	Relocation	92.02	1.19	0.11	0.47	93.79
	Rental	45.37	0.03	0.00	0.01	45.41
	Wage	0.00	0.02	0.00	0.00	0.02
	Subtotal	**137.39**	**1.31**	**0.11**	**0.48**	**139.30**

Total

Total	**5,813.17**	**45.36**	**26.52**	**24.93**	**5,909.97**

Appendix A: County Listing for the Region

Massachusetts

- Franklin

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Franklin	4,494	529,722	112,496	642,218
Total	**4,494**	**529,722**	**112,496**	**642,218**
Study Region Total	**4,494**	**529,722**	**112,496**	**642,218**

Hazus: Hurricane Global Risk Report

Region Name: charlemontHU

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date: Wednesday, July 13, 2022

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 160.37 square miles and contains 1 census tracts. There are over 1 thousand households in the region and a total population of 4,494 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 642 million dollars (2014 dollars). Approximately 92% of the buildings (and 82% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 2,704 buildings in the region which have an aggregate total replacement value of 642 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

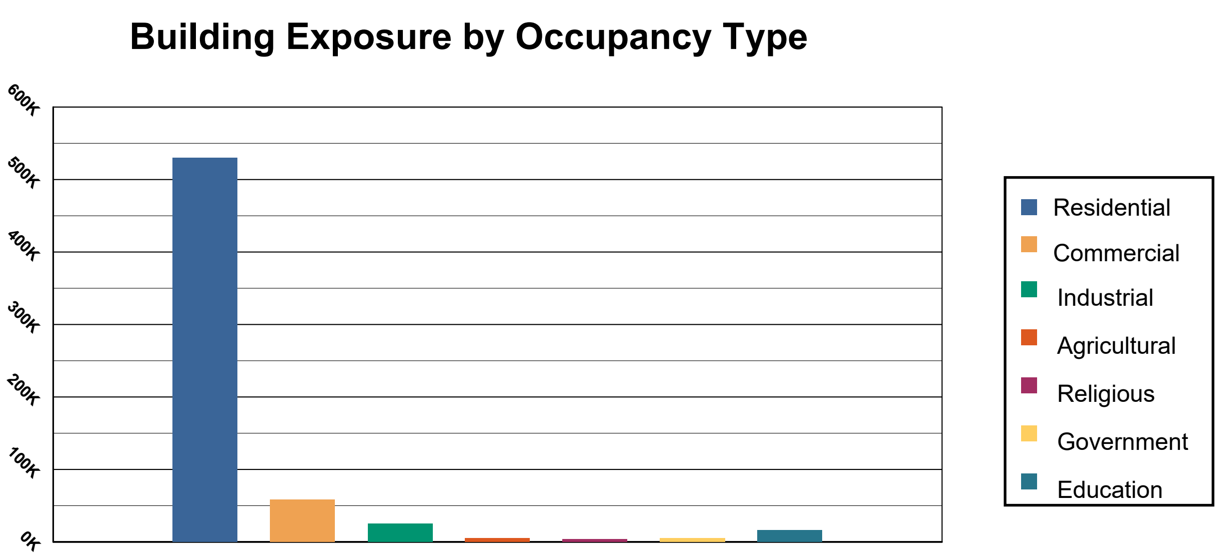


Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	529,722	82.48%
Commercial	57,712	8.99%
Industrial	24,874	3.87%
Agricultural	5,098	0.79%
Religious	3,590	0.56%
Government	5,026	0.78%
Education	16,196	2.52%
Total	**642,218**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 2 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

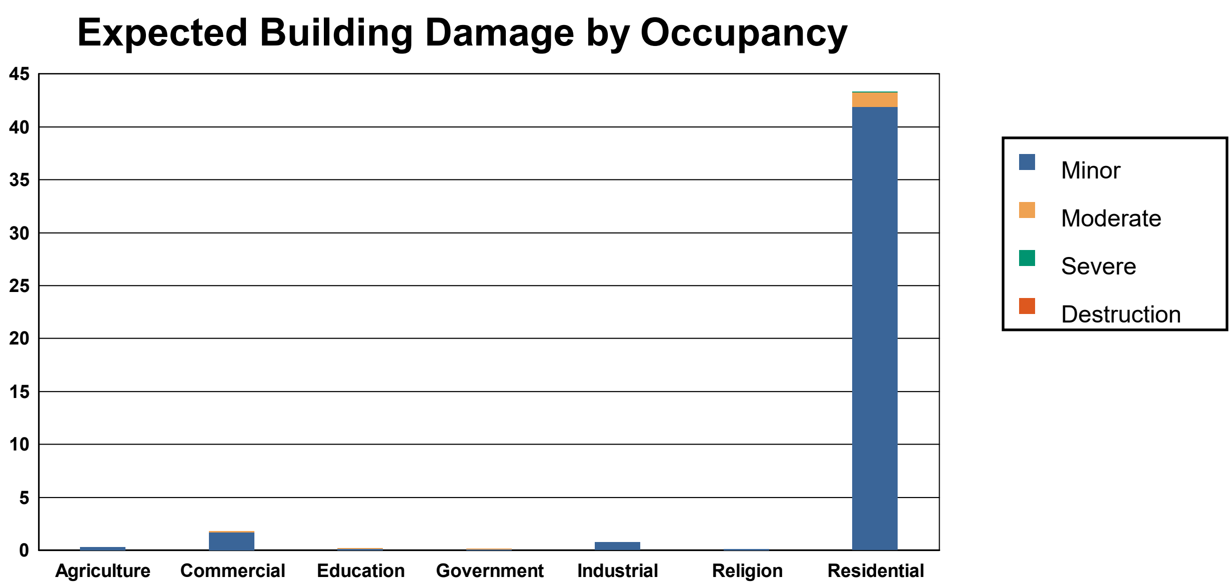


Table 2: Expected Building Damage by Occupancy : 500 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	17.69	98.27	0.28	1.54	0.03	0.15	0.01	0.04	0.00	0.00
Commercial	120.20	98.52	1.69	1.38	0.11	0.09	0.00	0.00	0.00	0.00
Education	11.82	98.53	0.17	1.45	0.00	0.03	0.00	0.00	0.00	0.00
Government	8.87	98.60	0.12	1.37	0.00	0.02	0.00	0.00	0.00	0.00
Industrial	49.23	98.45	0.73	1.47	0.03	0.07	0.01	0.01	0.00	0.00
Religion	6.92	98.88	0.08	1.10	0.00	0.02	0.00	0.00	0.00	0.00
Residential	2,442.71	98.26	41.89	1.69	1.37	0.05	0.04	0.00	0.00	0.00
Total	**2,657.43**		**44.96**		**1.55**		**0.05**		**0.00**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	5	98.05	0	1.91	0	0.04	0	0.00	0	0.00
Masonry	61	97.62	1	2.04	0	0.32	0	0.02	0	0.00
MH	312	99.93	0	0.06	0	0.02	0	0.00	0	0.00
Steel	97	98.51	1	1.44	0	0.05	0	0.00	0	0.00
Wood	1,937	98.10	37	1.86	1	0.04	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

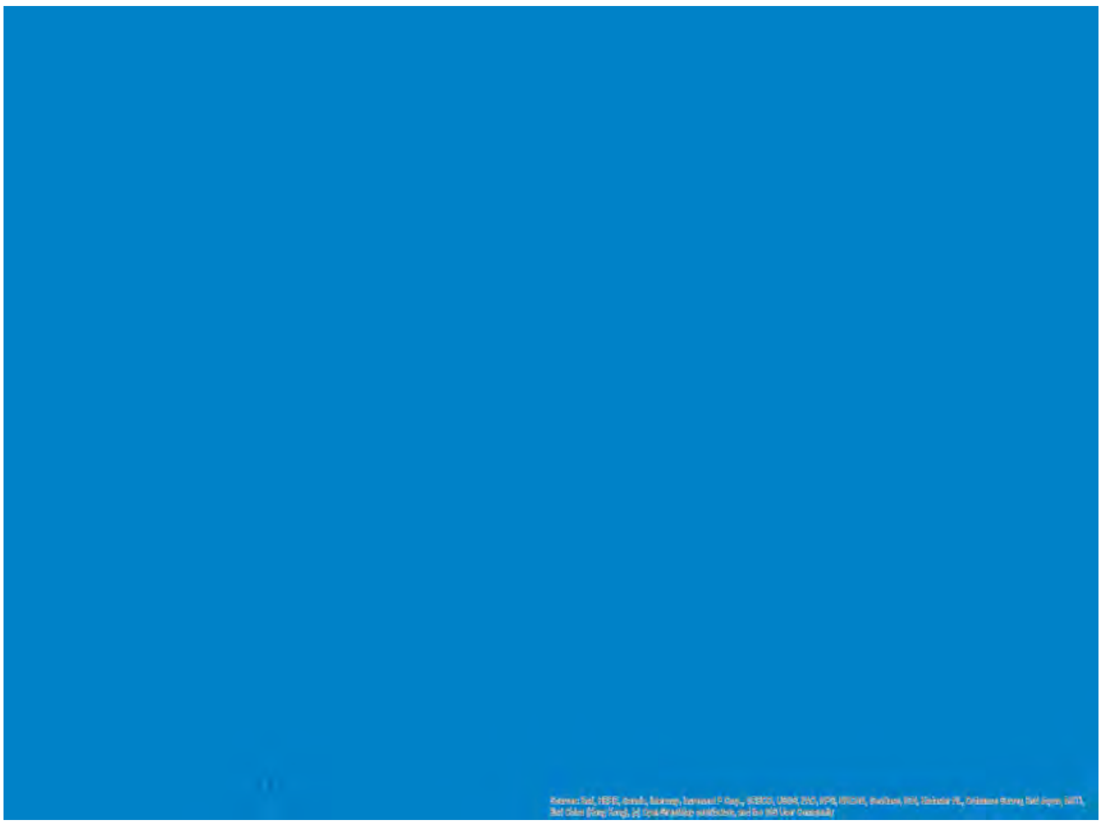
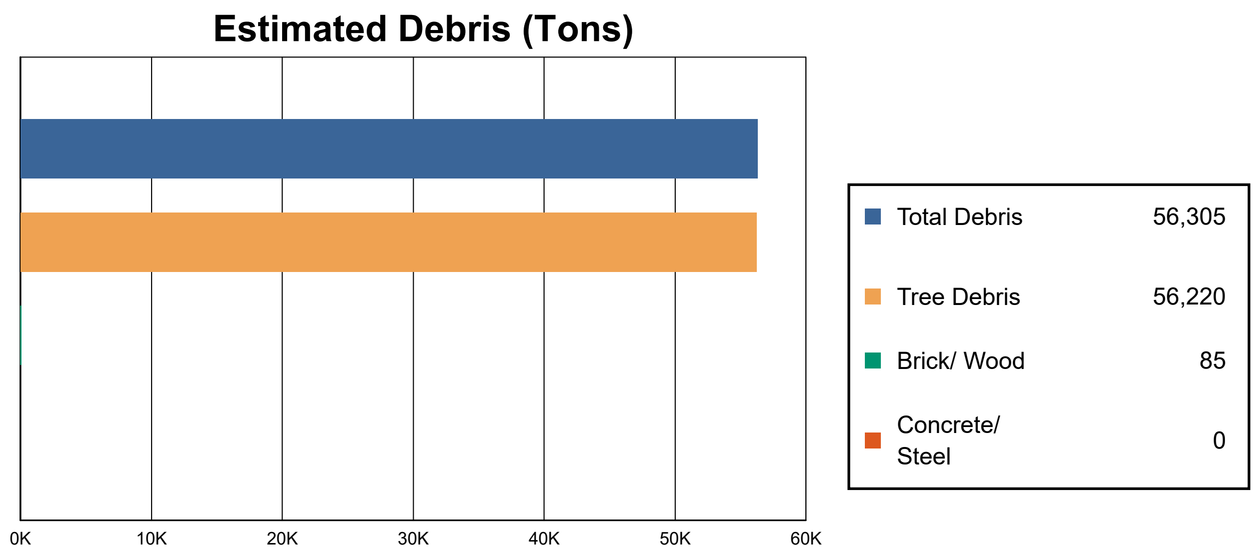


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	9	0	0	9
Fire Stations	8	0	0	8
Police Stations	4	0	0	4
Schools	5	0	0	5

Induced Hurricane Damage

Debris Generation

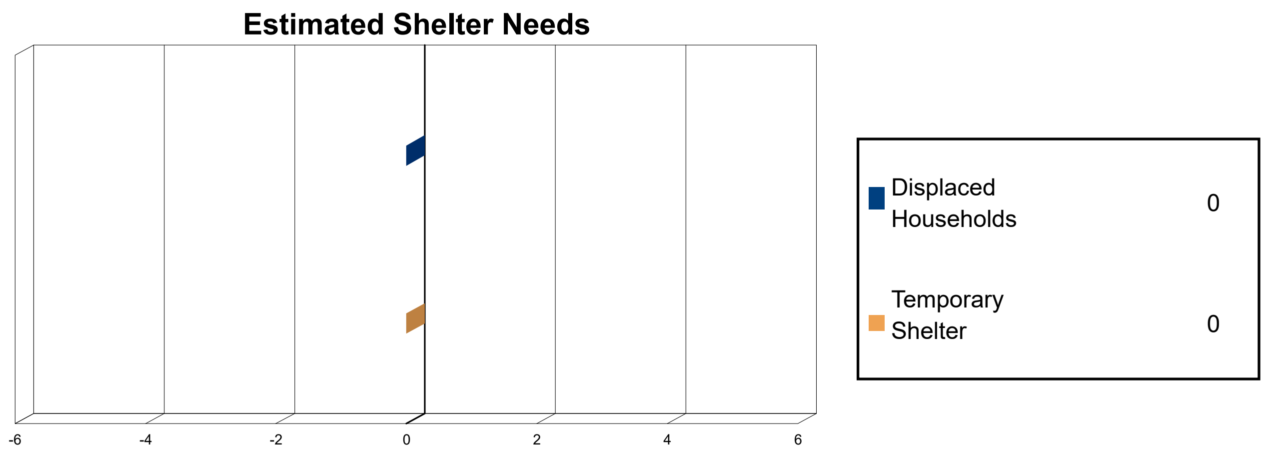


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 56,305 tons of debris will be generated. Of the total amount, 53,329 tons (95%) is Other Tree Debris. Of the remaining 2,976 tons, Brick/Wood comprises 3% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 3 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,891 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 4,494) will seek temporary shelter in public shelters.

Economic Loss

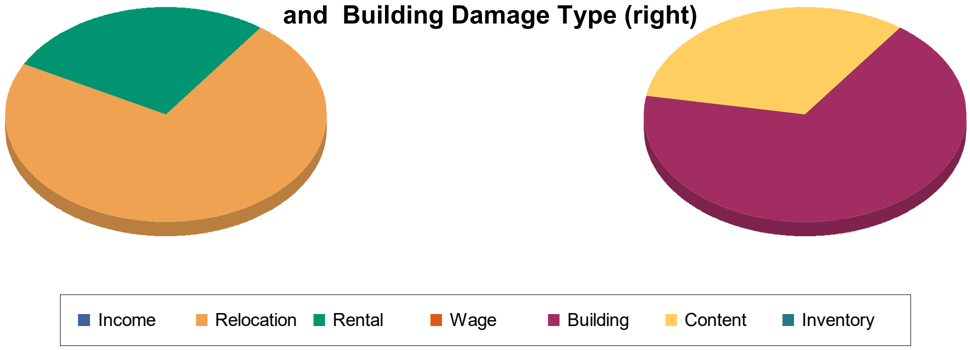
The total economic loss estimated for the hurricane is 3.9 million dollars, which represents 0.61 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 4 million dollars. 3% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 99% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left) and Building Damage Type (right)



Loss Type by General Occupancy

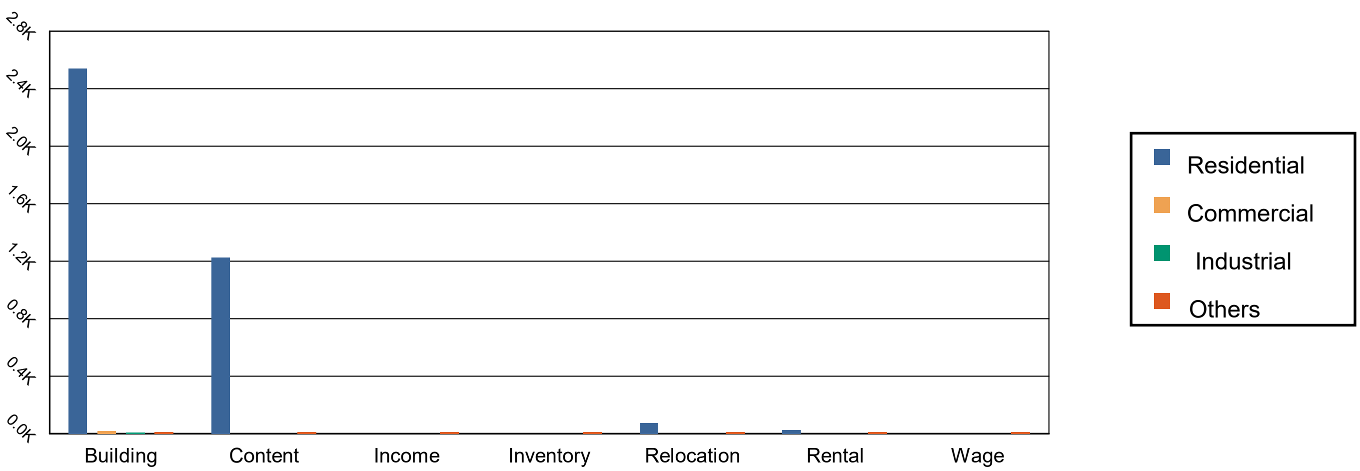


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	2,540.12	19.73	8.83	9.78	2,578.46
	Content	1,225.04	0.00	1.56	0.57	1,227.17
	Inventory	0.00	0.00	0.29	0.06	0.35
	Subtotal	**3,765.16**	**19.73**	**10.68**	**10.41**	**3,805.97**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	74.45	0.43	0.04	0.10	75.02
	Rental	28.01	0.00	0.00	0.00	28.01
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**102.46**	**0.43**	**0.04**	**0.10**	**103.02**

Total

Total	3,867.62	20.15	10.72	10.51	3,909.00

Appendix A: County Listing for the Region

Massachusetts

- Franklin

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Franklin	4,494	529,722	112,496	642,218
Total	**4,494**	**529,722**	**112,496**	**642,218**
Study Region Total	**4,494**	**529,722**	**112,496**	**642,218**

Hazus: Flood Global Risk Report

Region Name: CharlemontFlood

Flood Scenario: 100year

Print Date: Wednesday, July 13, 2022

Disclaimer:

This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is approximately 26 square miles and contains 137 census blocks. The region contains over 1 thousand households and has a total population of 1,266 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 689 buildings in the region with a total building replacement value (excluding contents) of 178 million dollars. Approximately 91.00% of the buildings (and 78.05% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 689 buildings in the region which have an aggregate total replacement value of 178 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	138,810	78.0%
Commercial	21,683	12.2%
Industrial	7,009	3.9%
Agricultural	1,131	0.6%
Religion	645	0.4%
Government	1,709	1.0%
Education	6,865	3.9%
Total	**177,852**	**100%**

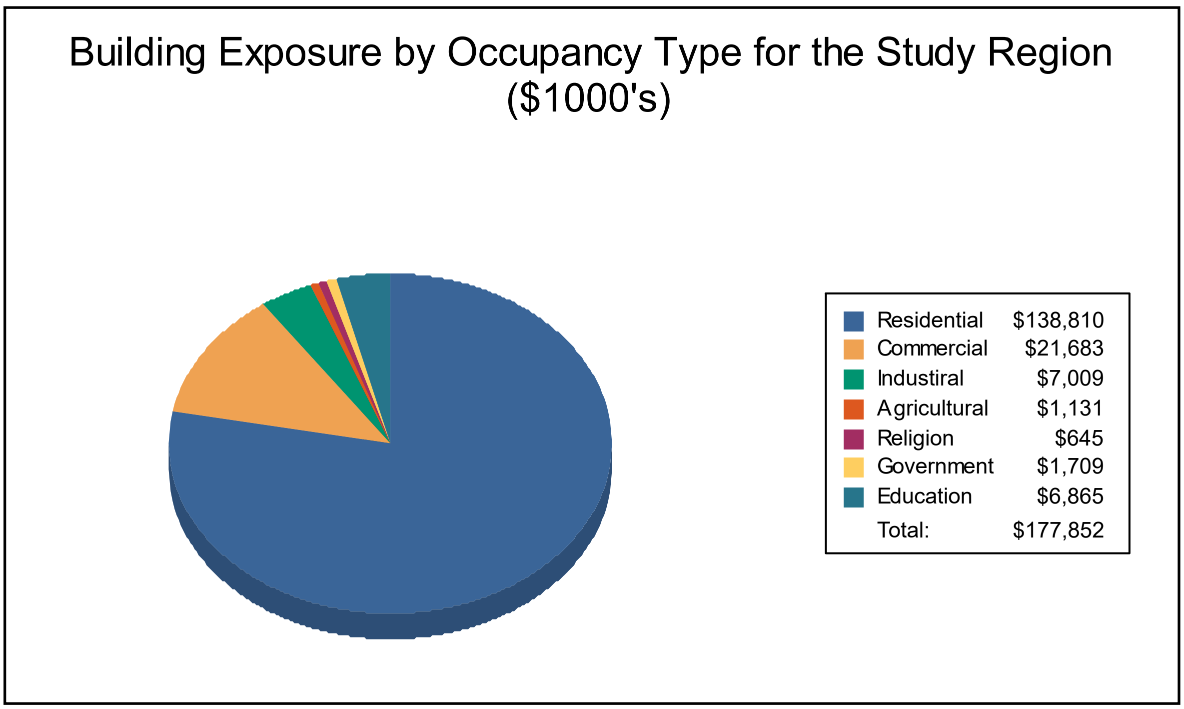
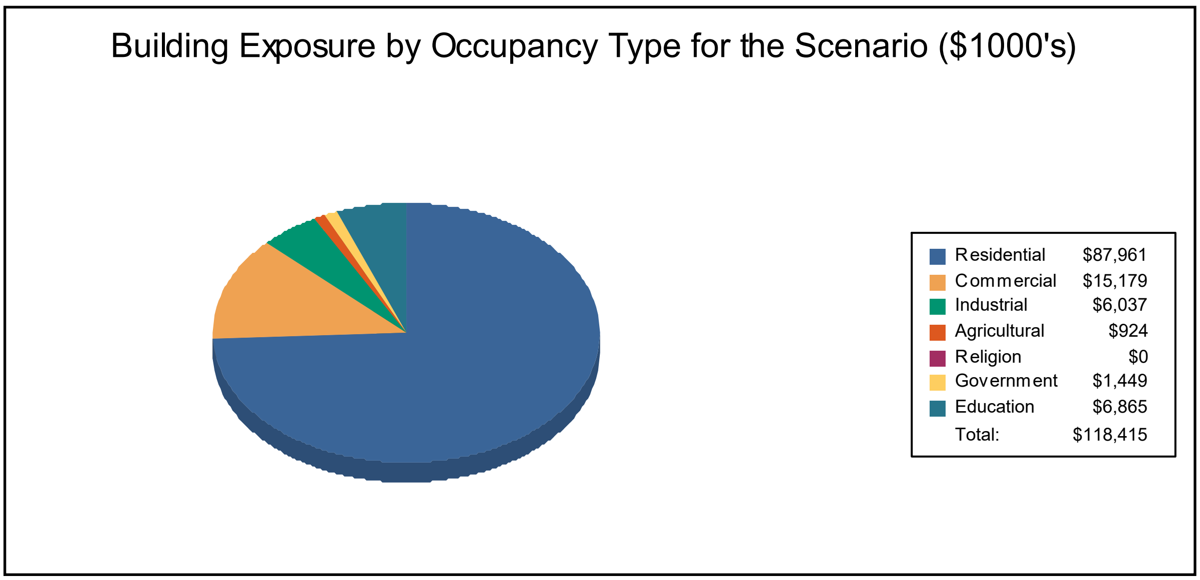


Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	87,961	74.3%
Commercial	15,179	12.8%
Industrial	6,037	5.1%
Agricultural	924	0.8%
Religion	0	0.0%
Government	1,449	1.2%
Education	6,865	5.8%
Total	**118,415**	**100%**



Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation centers.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	CharlemontFlood
Scenario Name:	100year
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure

Building Damage

General Building Stock Damage

Hazus estimates that about 20 buildings will be at least moderately damaged. This is over 68% of the total number of buildings in the scenario. There are an estimated 2 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Total Economic Loss (1 dot = $300K) Overview Map

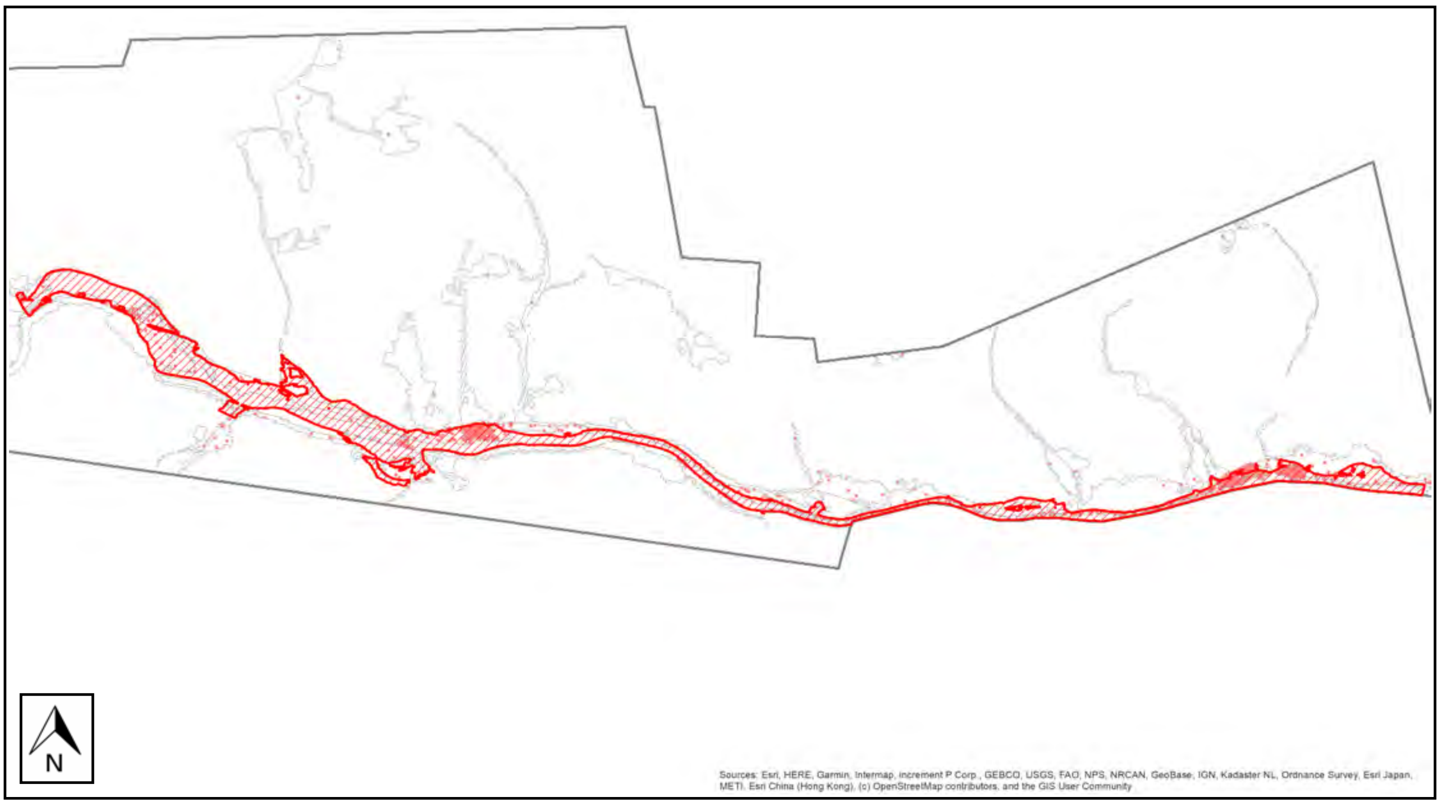


Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	2	9	8	36	5	23	3	14	2	9	2	9
Total	**2**		**8**		**5**		**3**		**2**		**2**	

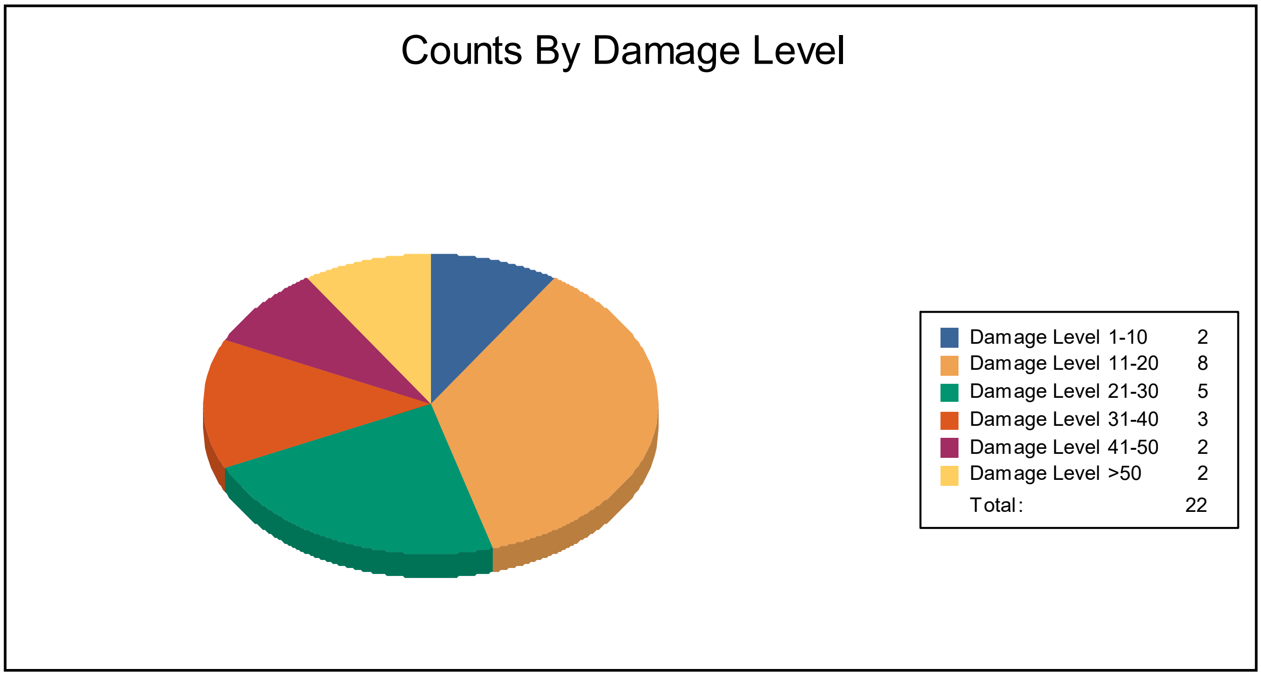


Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	2	9	8	36	5	23	3	14	2	9	2	9

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	9	0	0	0
Fire Stations	8	0	0	0
Hospitals	0	0	0	0
Police Stations	4	1	0	1
Schools	5	1	0	1

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

HAZUS
EARTHQUAKE • WIND • FLOOD • TSUNAMI

Induced Flood Damage

Debris Generation

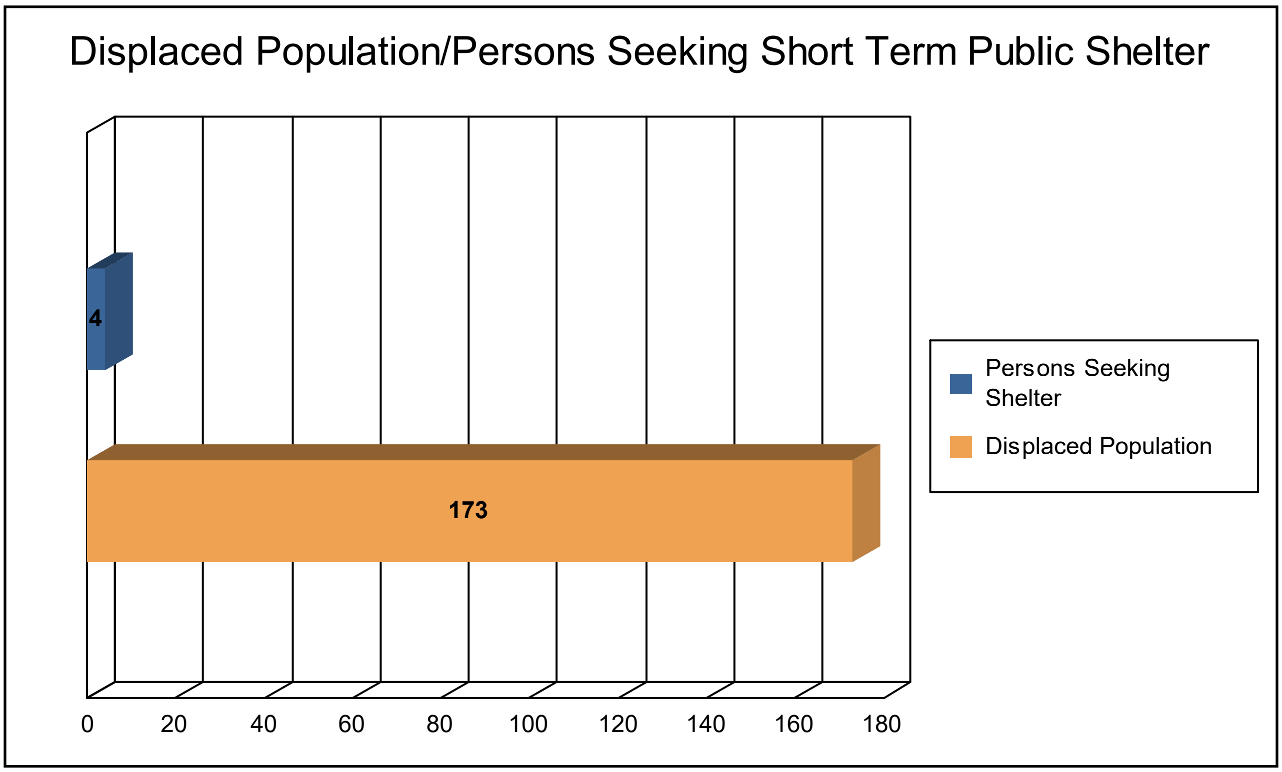
Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

Analysis has not been performed for this Scenario.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 58 households (or 173 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 4 people (out of a total population of 1,266) will seek temporary shelter in public shelters.



Economic Loss

The total economic loss estimated for the flood is 43.54 million dollars, which represents 36.77 % of the total replacement value of the scenario buildings.

Building-Related Losses

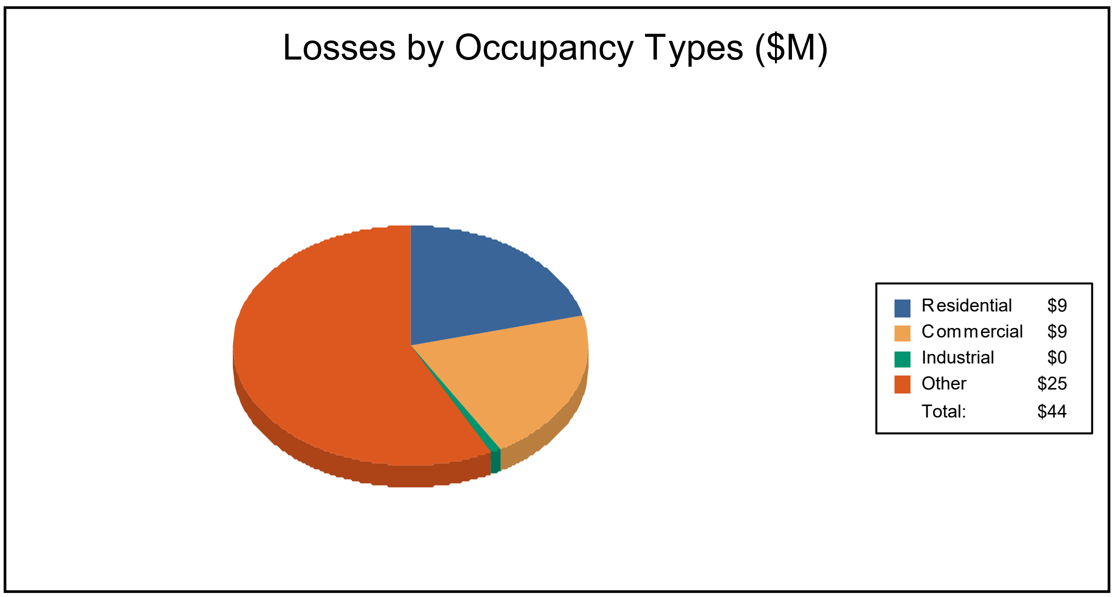
The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 17.01 million dollars. 61% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 21.06% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	5.24	1.41	0.11	0.90	7.67
	Content	2.37	3.07	0.30	3.48	9.22
	Inventory	0.00	0.06	0.02	0.04	0.12
	Subtotal	**7.61**	**4.54**	**0.44**	**4.43**	**17.01**
Business Interruption						
	Income	0.09	2.08	0.00	0.67	2.84
	Relocation	0.87	0.15	0.00	0.43	1.45
	Rental Income	0.40	0.11	0.00	0.02	0.53
	Wage	0.21	2.05	0.00	19.46	21.72
	Subtotal	**1.56**	**4.39**	**0.01**	**20.58**	**26.54**
ALL	**Total**	**9.17**	**8.93**	**0.44**	**25.00**	**43.54**



Appendix A: County Listing for the Region

Massachusetts

- Franklin

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Massachusetts				
Franklin	1,266	138,810	39,042	177,852
Total	**1,266**	**138,810**	**39,042**	**177,852**
Total Study Region	**1,266**	**138,810**	**39,042**	**177,852**

Hazus: Earthquake Global Risk Report

Region Name: CharlemontEQ

Earthquake Scenario: 1500year

Print Date: July 13, 2022

Disclaimer:

This version of Hazus utilizes 2010 Census Data.

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 160.33 square miles and contains 1 census tracts. There are over 1 thousand households in the region which has a total population of 4,494 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 642 (millions of dollars). Approximately 92.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 374 and 1,775 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 2 thousand buildings in the region which have an aggregate total replacement value of 642 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 73% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 2,149.00 (millions of dollars). This inventory includes over 31.69 miles of highways, 75 bridges, 1,176.88 miles of pipes.

Table 1: Transportation System Lifeline Inventory

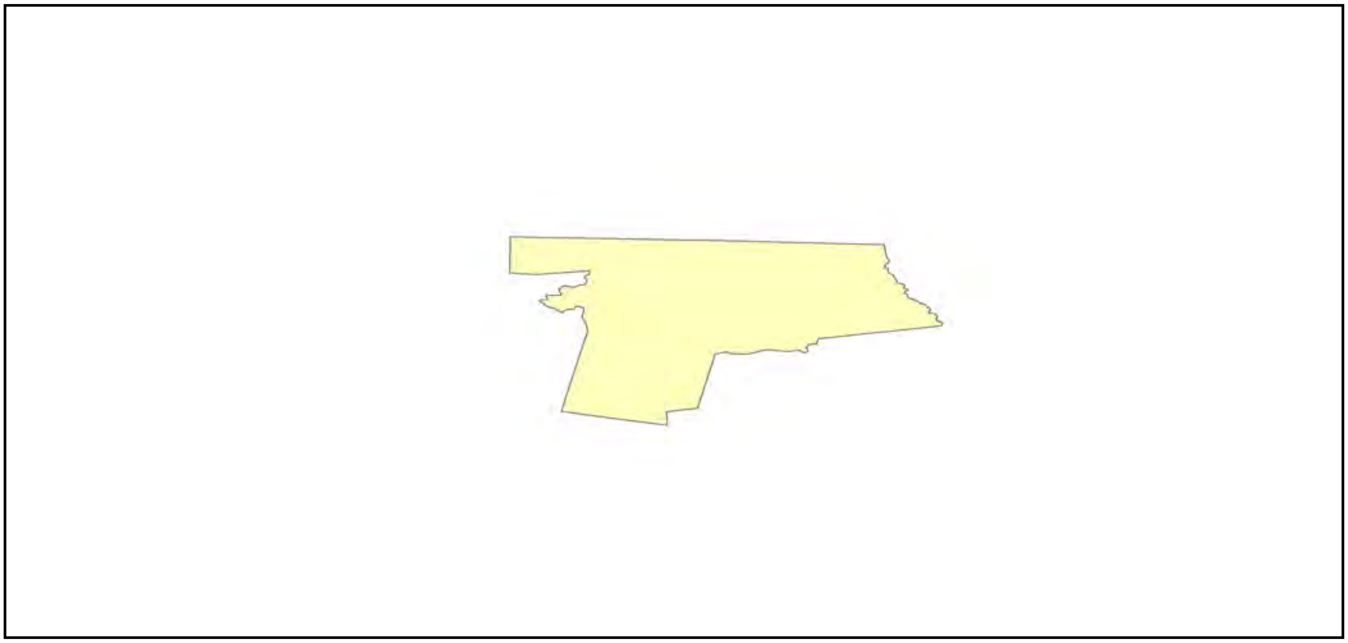
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	75	79.3368
	Segments	4	170.8627
	Tunnels	0	0.0000
		Subtotal	**250.1995**
Railways	Bridges	8	42.8857
	Facilities	0	0.0000
	Segments	7	81.6969
	Tunnels	0	0.0000
		Subtotal	**124.5826**
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	**0.0000**
Bus	Facilities	0	0.0000
		Subtotal	**0.0000**
Ferry	Facilities	0	0.0000
		Subtotal	**0.0000**
Port	Facilities	0	0.0000
		Subtotal	**0.0000**
Airport	Facilities	0	0.0000
	Runways	0	0.0000
		Subtotal	**0.0000**
		Total	**374.80**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	18.9482
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**18.9482**
Waste Water	Distribution Lines	NA	11.3689
	Facilities	4	613.2657
	Pipelines	0	0.0000
		Subtotal	**624.6346**
Natural Gas	Distribution Lines	NA	7.5793
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**7.5793**
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**0.0000**
Electrical Power	Facilities	2	1124.6778
		Subtotal	**1124.6778**
Communication	Facilities	0	0.0000
		Subtotal	**0.0000**
		Total	**1,775.80**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	1500year
Type of Earthquake	Probabilistic
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	1,500.00
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	6.50
Depth (km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Direct Earthquake Damage

Building Damage

Hazus estimates that about 30 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

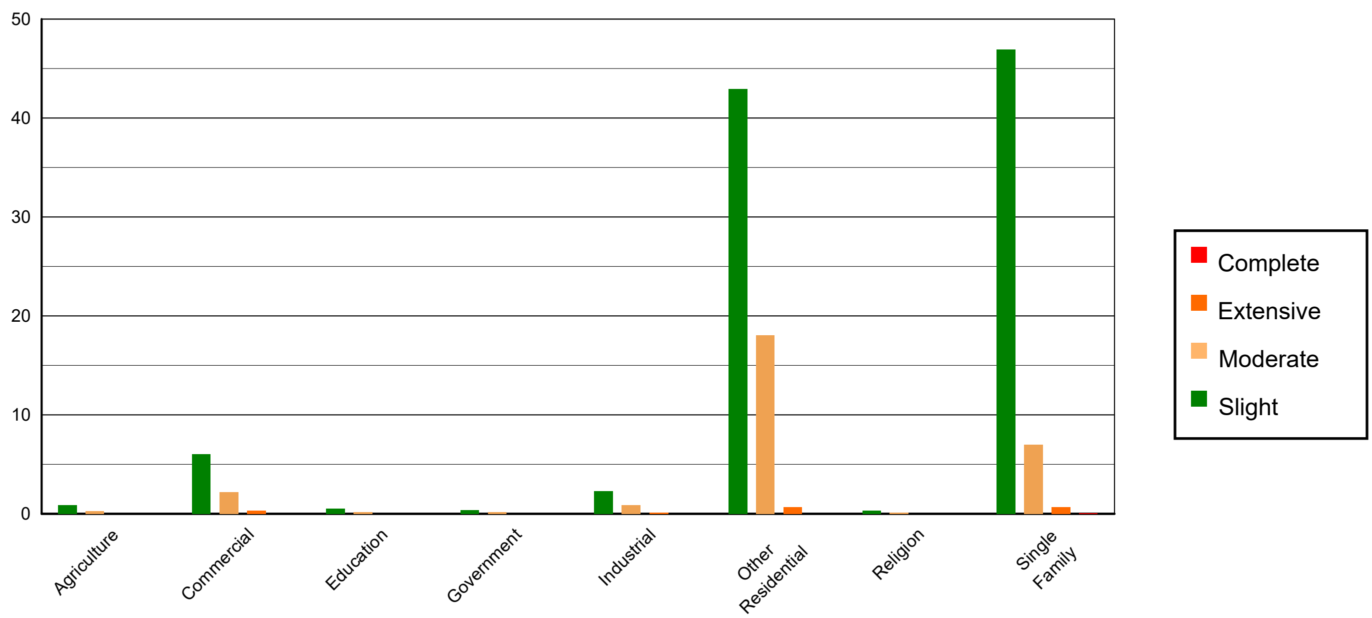


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	16.80	0.65	0.89	0.89	0.27	0.93	0.04	1.97	0.00	1.78
Commercial	113.40	4.41	6.05	6.02	2.21	7.64	0.32	16.33	0.02	19.48
Education	11.22	0.44	0.55	0.55	0.20	0.69	0.03	1.38	0.00	1.99
Government	8.42	0.33	0.41	0.41	0.15	0.52	0.02	1.01	0.00	1.09
Industrial	46.70	1.82	2.30	2.29	0.87	3.01	0.12	6.03	0.01	6.02
Other Residential	467.26	18.16	42.96	42.77	18.06	62.46	0.70	36.17	0.02	15.51
Religion	6.51	0.25	0.33	0.33	0.13	0.46	0.02	1.09	0.00	1.70
Single Family	1902.28	73.94	46.94	46.74	7.03	24.29	0.70	36.02	0.06	52.43
Total	**2,573**		**100**		**29**		**2**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	1936.97	75.29	43.64	43.45	4.39	15.17	0.19	10.02	0.00	0.00
Steel	100.79	3.92	4.18	4.16	1.46	5.05	0.16	8.00	0.00	3.21
Concrete	18.29	0.71	0.82	0.81	0.27	0.92	0.01	0.73	0.00	0.00
Precast	6.93	0.27	0.45	0.44	0.30	1.04	0.06	2.97	0.00	0.47
RM	24.13	0.94	0.98	0.98	0.54	1.87	0.08	4.18	0.00	0.00
URM	124.40	4.84	11.62	11.57	5.30	18.31	0.94	48.34	0.11	96.32
MH	361.07	14.04	38.76	38.59	16.67	57.64	0.50	25.76	0.00	0.00
Total	**2,573**		**100**		**29**		**2**		**0**	

*Note:

RM	Reinforced Masonry
URM	Unreinforced Masonry
MH	Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had hospital beds available for use. On the day of the earthquake, the model estimates that only hospital beds (%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, % of the beds will be back in service. By 30 days, % will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	0	0	0	0
Schools	5	0	0	5
EOCs	9	0	0	9
PoliceStations	4	0	0	4
FireStations	8	0	0	8

Transportation Lifeline Damage

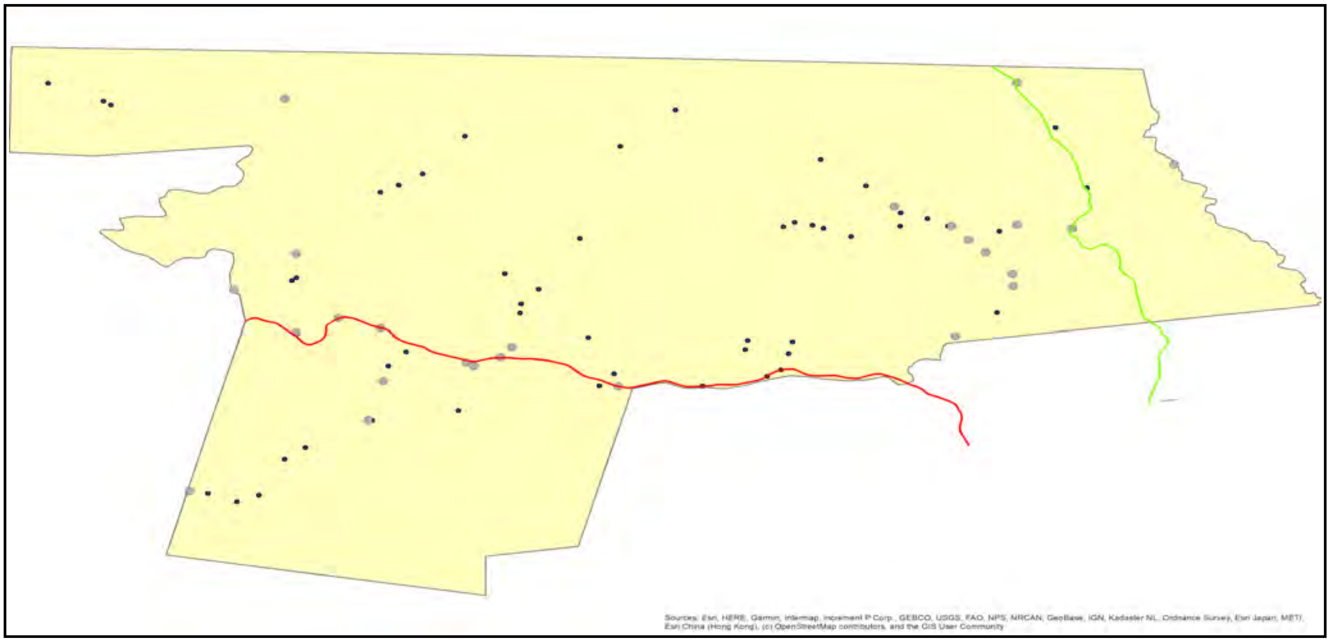


Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	4	0	0	3	3
	Bridges	75	0	0	75	75
	Tunnels	0	0	0	0	0
Railways	Segments	7	0	0	5	5
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	4	0	0	4	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	2	0	0	2	2
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	589	1	0
Waste Water	353	1	0
Natural Gas	235	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	1,898	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, Brick/Wood comprises 73.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)

Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.00	0.00	0.00	0 (@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 4,494) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter

Displaced households as a result of the earthquake	Persons seeking temporary public shelter
0	0

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.00	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.01	0.00	0.00	0.00
	Other-Residential	0.14	0.01	0.00	0.00
	Single Family	0.11	0.01	0.00	0.00
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0.25	0.03	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.07	0.01	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.05	0.01	0.00	0.00
	Other-Residential	0.03	0.00	0.00	0.00
	Single Family	0.02	0.00	0.00	0.00
	Total	**0**	**0**	**0**	**0**
5 PM	Commercial	0.19	0.02	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.03	0.00	0.00	0.00
	Other-Residential	0.05	0.01	0.00	0.00
	Single Family	0.04	0.00	0.00	0.00
	Total	**0**	**0**	**0**	**0**

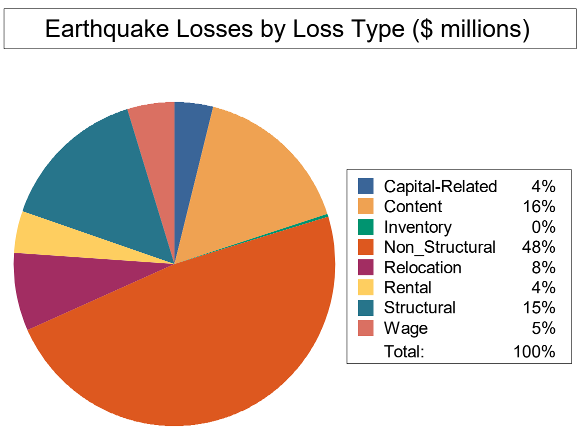
Economic Loss

The total economic loss estimated for the earthquake is 11.37 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 1.75 (millions of dollars); 20 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 65 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.



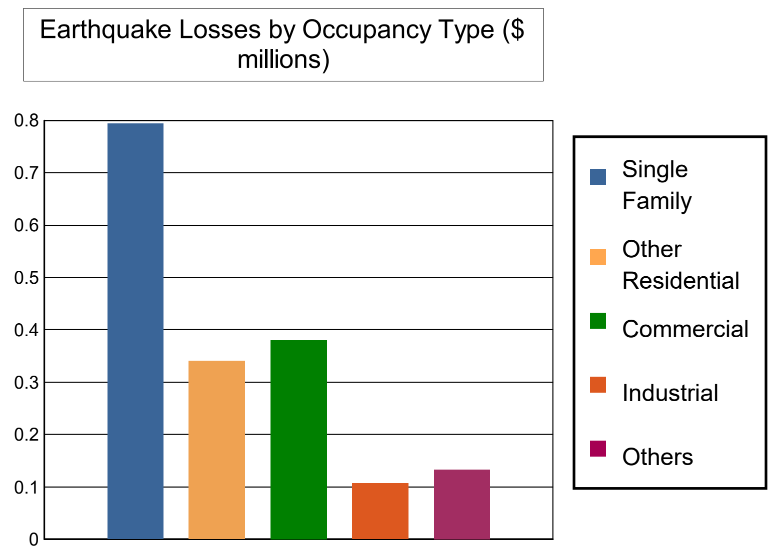


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.0143	0.0572	0.0020	0.0097	0.0832
	Capital-Related	0.0000	0.0061	0.0578	0.0012	0.0011	0.0662
	Rental	0.0144	0.0289	0.0271	0.0009	0.0014	0.0727
	Relocation	0.0467	0.0353	0.0327	0.0050	0.0160	0.1357
	Subtotal	**0.0611**	**0.0846**	**0.1748**	**0.0091**	**0.0282**	**0.3578**
Capital Stock Losses							
	Structural	0.1119	0.0637	0.0447	0.0155	0.0267	0.2625
	Non_Structural	0.4756	0.1631	0.1074	0.0459	0.0509	0.8429
	Content	0.1447	0.0289	0.0524	0.0305	0.0275	0.2840
	Inventory	0.0000	0.0000	0.0010	0.0056	0.0005	0.0071
	Subtotal	**0.7322**	**0.2557**	**0.2055**	**0.0975**	**0.1056**	**1.3965**
	Total	**0.79**	**0.34**	**0.38**	**0.11**	**0.13**	**1.75**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	170.8627	0.0000	0.00
	Bridges	79.3368	0.0001	0.00
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**250.1995**	**0.0001**	
Railways	Segments	81.6969	0.0000	0.00
	Bridges	42.8857	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**124.5826**	**0.0000**	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Bus	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**374.78**	**0.00**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	18.9482	0.0060	0.03
	Subtotal	**18.9482**	**0.0060**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	613.2657	3.3883	0.55
	Distribution Lines	11.3689	0.0030	0.03
	Subtotal	**624.6346**	**3.3913**	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	7.5793	0.0010	0.01
	Subtotal	**7.5793**	**0.0010**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	1124.6778	6.2148	0.55
	Subtotal	**1124.6778**	**6.2148**	
Communication	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**1,775.84**	**9.61**	

Appendix A: County Listing for the Region

Franklin,MA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Massachusetts					
	Franklin	4,494	529	112	642
Total Region		**4,494**	**529**	**112**	**642**

Hazus: Earthquake Global Risk Report

Region Name: CharlemontEQ

Earthquake Scenario: 2500year

Print Date: July 13, 2022

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 160.33 square miles and contains 1 census tracts. There are over 1 thousand households in the region which has a total population of 4,494 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 2 thousand buildings in the region with a total building replacement value (excluding contents) of 642 (millions of dollars). Approximately 92.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 374 and 1,775 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 2 thousand buildings in the region which have an aggregate total replacement value of 642 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 73% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of beds. There are 5 schools, 8 fire stations, 4 police stations and 9 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 2,149.00 (millions of dollars). This inventory includes over 31.69 miles of highways, 75 bridges, 1,176.88 miles of pipes.

Table 1: Transportation System Lifeline Inventory

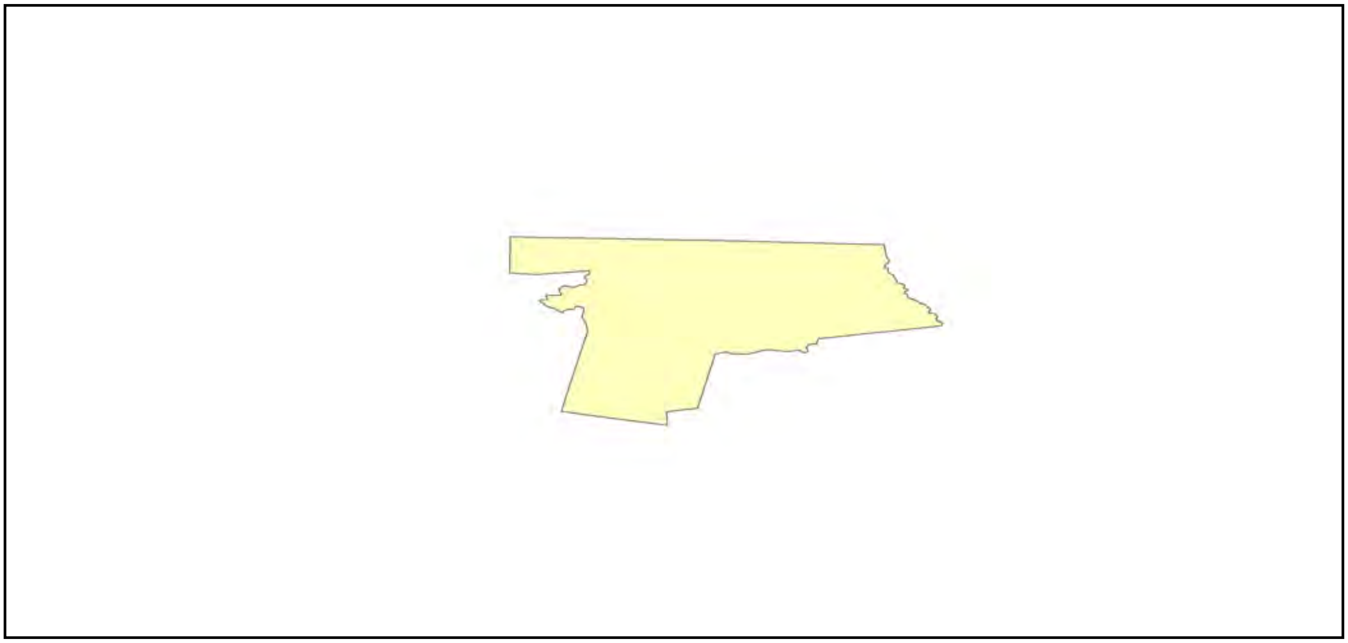
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	75	79.3368
	Segments	4	170.8627
	Tunnels	0	0.0000
		Subtotal	**250.1995**
Railways	Bridges	8	42.8857
	Facilities	0	0.0000
	Segments	7	81.6969
	Tunnels	0	0.0000
		Subtotal	**124.5826**
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	**0.0000**
Bus	Facilities	0	0.0000
		Subtotal	**0.0000**
Ferry	Facilities	0	0.0000
		Subtotal	**0.0000**
Port	Facilities	0	0.0000
		Subtotal	**0.0000**
Airport	Facilities	0	0.0000
	Runways	0	0.0000
		Subtotal	**0.0000**
		Total	**374.80**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	18.9482
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**18.9482**
Waste Water	Distribution Lines	NA	11.3689
	Facilities	4	613.2657
	Pipelines	0	0.0000
		Subtotal	**624.6346**
Natural Gas	Distribution Lines	NA	7.5793
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**7.5793**
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**0.0000**
Electrical Power	Facilities	2	1124.6778
		Subtotal	**1124.6778**
Communication	Facilities	0	0.0000
		Subtotal	**0.0000**
		Total	**1,775.80**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	2500year
Type of Earthquake	Probabilistic
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	2,500.00
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	7.00
Depth (km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Direct Earthquake Damage

Building Damage

Hazus estimates that about 52 buildings will be at least moderately damaged. This is over 2.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

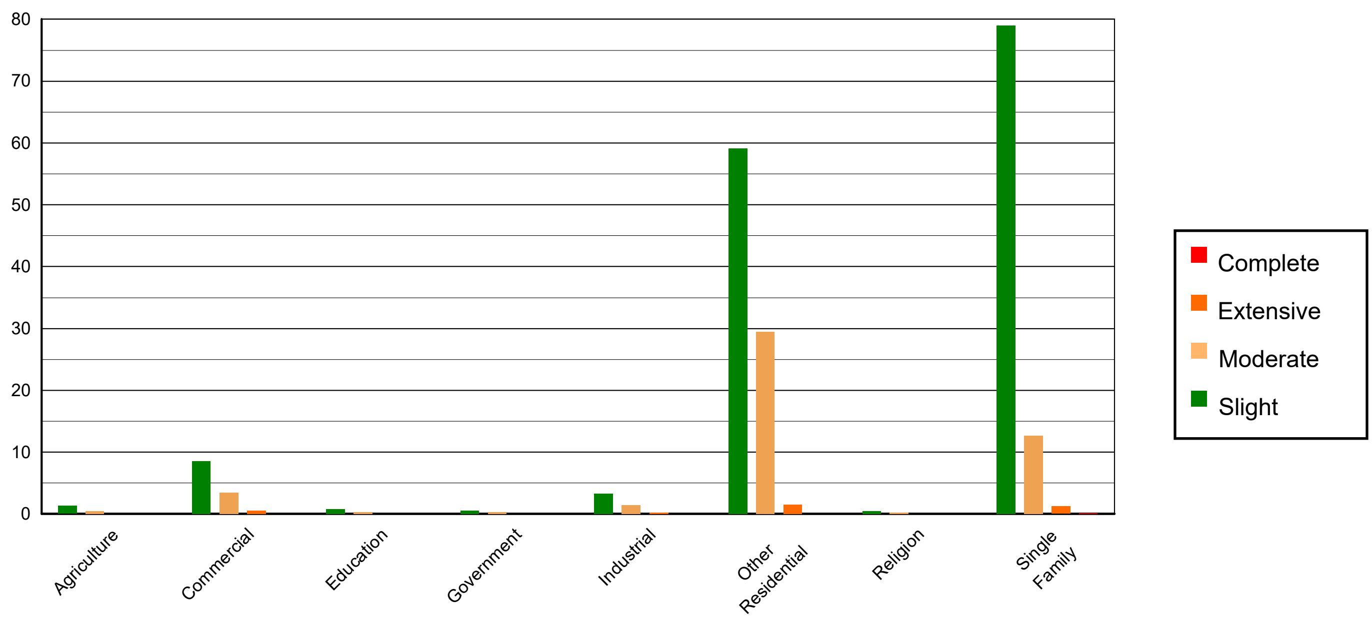


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	16.22	0.65	1.28	0.84	0.43	0.89	0.07	1.85	0.00	1.63
Commercial	109.35	4.38	8.56	5.59	3.49	7.23	0.55	15.04	0.04	17.74
Education	10.84	0.43	0.79	0.52	0.32	0.66	0.05	1.27	0.00	1.81
Government	8.14	0.33	0.58	0.38	0.24	0.50	0.03	0.94	0.00	1.03
Industrial	45.09	1.80	3.28	2.14	1.41	2.91	0.21	5.65	0.01	5.69
Other Residential	438.83	17.56	59.11	38.60	29.49	61.11	1.51	40.85	0.06	25.31
Religion	6.29	0.25	0.47	0.31	0.20	0.42	0.04	0.98	0.00	1.48
Single Family	1863.93	74.60	79.05	51.62	12.68	26.28	1.23	33.42	0.11	45.32
Total	**2,499**		**153**		**48**		**4**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	1900.17	76.05	75.66	49.41	8.97	18.59	0.39	10.63	0.00	0.00
Steel	97.72	3.91	6.08	3.97	2.48	5.15	0.29	7.87	0.01	4.33
Concrete	17.63	0.71	1.23	0.80	0.49	1.02	0.03	0.87	0.00	0.40
Precast	6.60	0.26	0.59	0.39	0.45	0.92	0.10	2.69	0.00	0.43
RM	23.39	0.94	1.35	0.88	0.85	1.76	0.15	3.96	0.00	0.00
URM	117.50	4.70	15.35	10.03	7.73	16.02	1.57	42.59	0.21	83.23
MH	335.68	13.43	52.85	34.51	27.29	56.55	1.16	31.38	0.03	11.61
Total	**2,499**		**153**		**48**		**4**		**0**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had hospital beds available for use. On the day of the earthquake, the model estimates that only hospital beds (%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, % of the beds will be back in service. By 30 days, % will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	5	0	0	5
EOCs	9	0	0	9
PoliceStations	4	0	0	4
FireStations	8	0	0	8

Transportation Lifeline Damage

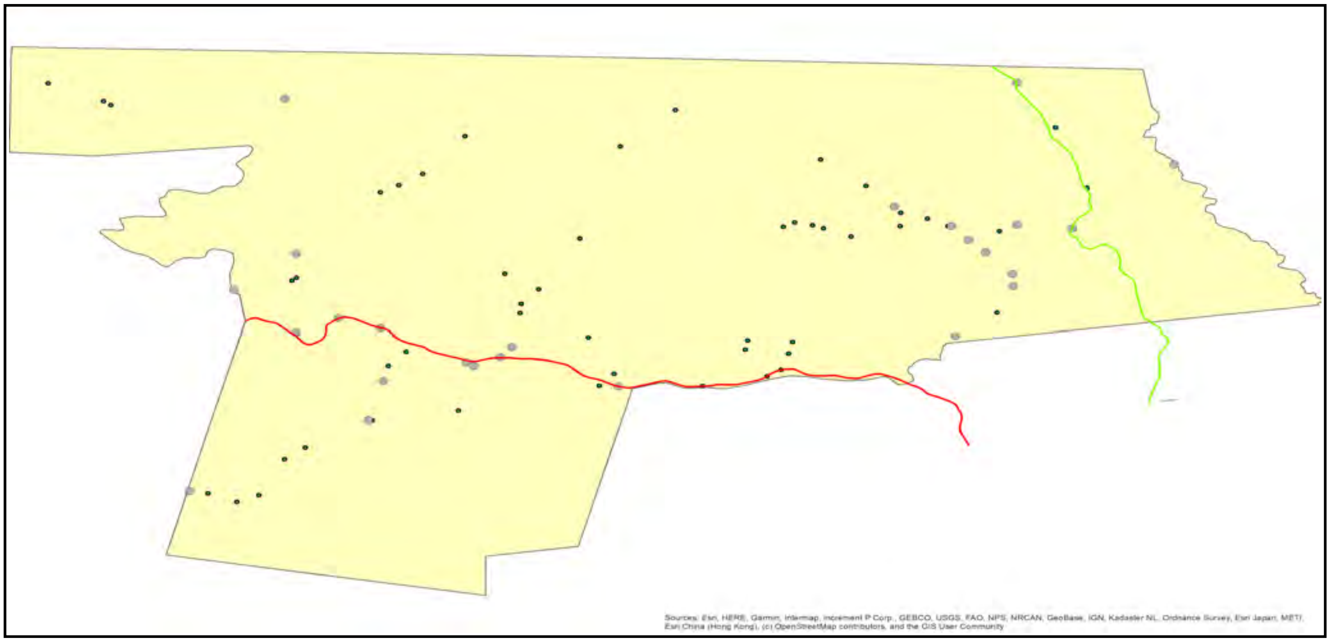


Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	With Functionality > 50 % After Day 7
Highway	Segments	4	0	0	3	3
	Bridges	75	0	0	75	75
	Tunnels	0	0	0	0	0
Railways	Segments	7	0	0	5	5
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	4	0	0	4	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	2	0	0	2	2
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	589	2	1
Waste Water	353	1	0
Natural Gas	235	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	1,898	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, Brick/Wood comprises 71.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)

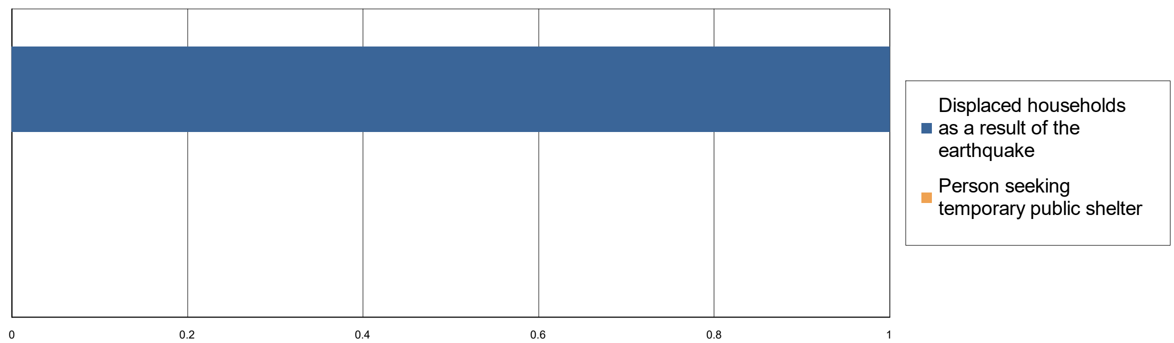
Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.00	0.00	0.00	0 (@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 4,494) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter



Displaced households as a result of the earthquake	Persons seeking temporary public shelter
1	0

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.01	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.01	0.00	0.00	0.00
	Other-Residential	0.23	0.03	0.00	0.00
	Single Family	0.19	0.02	0.00	0.00
	Total	**0**	**0**	**0**	**0**
2 PM	Commercial	0.42	0.06	0.01	0.01
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.11	0.02	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.08	0.01	0.00	0.00
	Other-Residential	0.04	0.00	0.00	0.00
	Single Family	0.04	0.00	0.00	0.00
	Total	**1**	**0**	**0**	**0**
5 PM	Commercial	0.31	0.04	0.00	0.01
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.01	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.05	0.01	0.00	0.00
	Other-Residential	0.09	0.01	0.00	0.00
	Single Family	0.07	0.01	0.00	0.00
	Total	**1**	**0**	**0**	**0**

Economic Loss

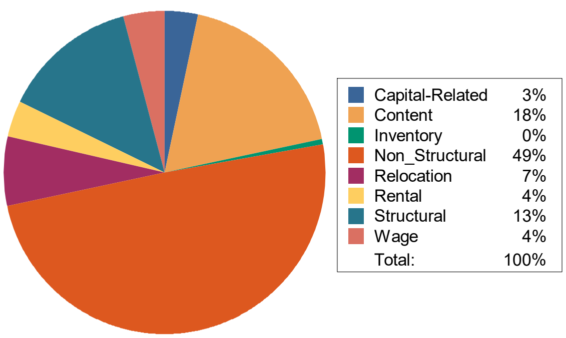
The total economic loss estimated for the earthquake is 24.41 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 3.25 (millions of dollars); 18 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 66 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type ($ millions)



Earthquake Losses by Occupancy Type ($ millions)

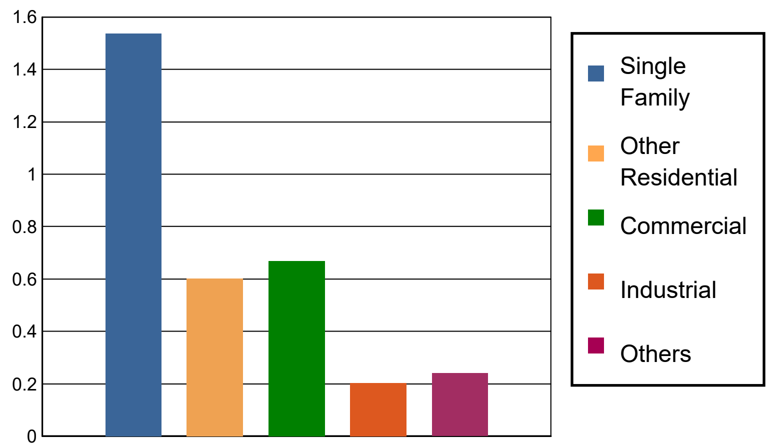


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.0243	0.0933	0.0034	0.0151	0.1361
	Capital-Related	0.0000	0.0103	0.0945	0.0020	0.0017	0.1085
	Rental	0.0257	0.0472	0.0429	0.0014	0.0023	0.1195
	Relocation	0.0841	0.0589	0.0534	0.0083	0.0264	0.2311
	Subtotal	**0.1098**	**0.1407**	**0.2841**	**0.0151**	**0.0455**	**0.5952**
Capital Stock Losses							
	Structural	0.1951	0.1032	0.0721	0.0252	0.0432	0.4388
	Non_Structural	0.9221	0.2969	0.2022	0.0905	0.0948	1.6065
	Content	0.3083	0.0603	0.1080	0.0621	0.0566	0.5953
	Inventory	0.0000	0.0000	0.0020	0.0114	0.0012	0.0146
	Subtotal	**1.4255**	**0.4604**	**0.3843**	**0.1892**	**0.1958**	**2.6552**
	Total	**1.54**	**0.60**	**0.67**	**0.20**	**0.24**	**3.25**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	170.8627	0.0000	0.00
	Bridges	79.3368	0.0003	0.00
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**250.1995**	**0.0003**	
Railways	Segments	81.6969	0.0000	0.00
	Bridges	42.8857	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**124.5826**	**0.0000**	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Bus	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**374.78**	**0.00**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	18.9482	0.0103	0.05
	Subtotal	**18.9482**	**0.0103**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	613.2657	7.4634	1.22
	Distribution Lines	11.3689	0.0052	0.05
	Subtotal	**624.6346**	**7.4686**	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	7.5793	0.0018	0.02
	Subtotal	**7.5793**	**0.0018**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	1124.6778	13.6780	1.22
	Subtotal	**1124.6778**	**13.6780**	
Communication	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**1,775.84**	**21.16**	

Appendix A: County Listing for the Region

Franklin,MA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Massachusetts					
	Franklin	4,494	529	112	642
Total Region		**4,494**	**529**	**112**	**642**