TOWN OF GRANVILLE

2021 MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) - HAZARD MITIGATION PLAN (HMP)

Prepared by:

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1.0 INTRODUCTION

The Town of Granville prepared a Municipal Vulnerability Preparedness and Hazard Mitigation Plan (MVP-HMP) to create an action roadmap to reduce the impacts of natural hazards and climate change within the community and the region. The Granville MVP-HMP was adopted by the Board of Selectmen on *[DATE]* to replace The Town of Granville Hazard Mitigation Plan from 2016.

1.1 What is a Hazard Mitigation Plan?

Natural hazards, such as earthquakes, hurricanes, and flooding, can result in loss of life, disruptions to everyday life, and property damage. Hazard mitigation is the effort to reduce these impacts through community planning, policy changes, education programs, infrastructure projects, and other activities (FEMA, 2020a). Hazard mitigation planning uses a multi-step process with the participation of a wide range of stakeholders to:

1. Define local hazards.
2. Assess vulnerabilities and risks.
3. Review current mitigation measures.
4. Develop priority action items.

HMPs focus resources and attention on the community's greatest vulnerabilities. The resulting plan identifies implementation measures that save lives and money. For every dollar spent on federal hazard mitigation grants, an average of six dollars are saved (FEMA, 2018a). There are many additional benefits of mitigation planning. HMPs increase public awareness of natural hazards that may affect the community. They help state, local, and tribal governments to collaborate and combine hazard risk reduction with other community goals and plans.

Figure 1-1. FEMA Hazard Mitigation Planning Saves Money Graphic (FEMA, 2018a)

Once an HMP is completed, hazard mitigation funding is available to address the community's top mitigation priorities through the Federal Emergency Management Agency (FEMA). To be eligible for FEMA grants (listed in Table 1-1), local governments are required to prepare an HMP that meets the requirements summarized in Figure 1-2, established in the *Robert T. Stafford Disaster Relief and Emergency Assistance A*ct, as amended by the *Disaster Mitigation Act of 2000.*

Table 1-1. FEMA Grants (FEMA, 2020b)

FEMA Grants	Purpose
Hazard Mitigation Grant Program (HMGP)	Helps communities implement hazard mitigation measures following a Presidential Major Disaster Declaration.
Building Resilient Infrastructure and Communities (BRIC)	Assists in implementing a sustained pre-disaster natural hazard mitigation program, to reduce risk to the population and structures from future hazard events.
Public Assistance Grant Program (PA)	Provides supplemental grants so that communities can quickly respond and recover from major disasters or emergencies.
Fire Management Assistance Grant Program (FMAG)	Available for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands.

1.2 MVP-HMP Report Layout

The report presents the results of the planning process, which was informed by input received from the Core Team and during the CRB Workshop and Public Listening Sessions. This report is organized as follows:

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1.3 What is a Municipal Vulnerability Preparedness Plan?

A Municipal Vulnerability Preparedness (MVP) plan identifies priority action items to address vulnerabilities and utilize strengths in preparation for climate change. In 2017, the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) initiated the state's MVP grant program to help communities become more resilient to the impacts of climate change. The program has two grant phases:

1. The first phase of grants are Planning Grants, which funds the vulnerability analyses, engagement, and planning processes. Towns convene a team of municipal staff, engage stakeholders in a Community Resilience Building (CRB) Workshop, and engage community members in developing the plan. Communities that complete the Planning Grant program and prepare an MVP plan are eligible for the second phase of MVP grant funding and receive increased standing for other state grants.
2. The second phase of the MVP program are Action Grants, which funds the implementation of priority climate adaptation actions described in the MVP plan. Since these Action Grants are only distributed to Massachusetts municipalities, they are less competitive than similar grants awarded at the national level.

Community Resilience Building Workshop

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The Community Resilience Building Workshop's central objectives are to:

- Define top local natural and climate-related hazards of concern
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Each step in the process (below) is rich in information and dialogue and results in actionable plans and strong collaboration.

1.4 Combining Hazard Mitigation and Municipal Vulnerability Preparedness Planning in Granville

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The town prepared this joint MVP-HMP in accordance with FEMA guidelines for hazard mitigation planning (*Title 44 Code of Regulations (CFR) 201.6*) and with the Massachusetts Executive Office of Energy & Environmental Affairs' (EOEEA) requirements for MVP plans. This approach followed the state's lead in adopting the first-ever Massachusetts State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPSS, 2018). By completing a joint MVP-HMP, Granville was able to fulfill the requirements and enhance the impact of both processes.

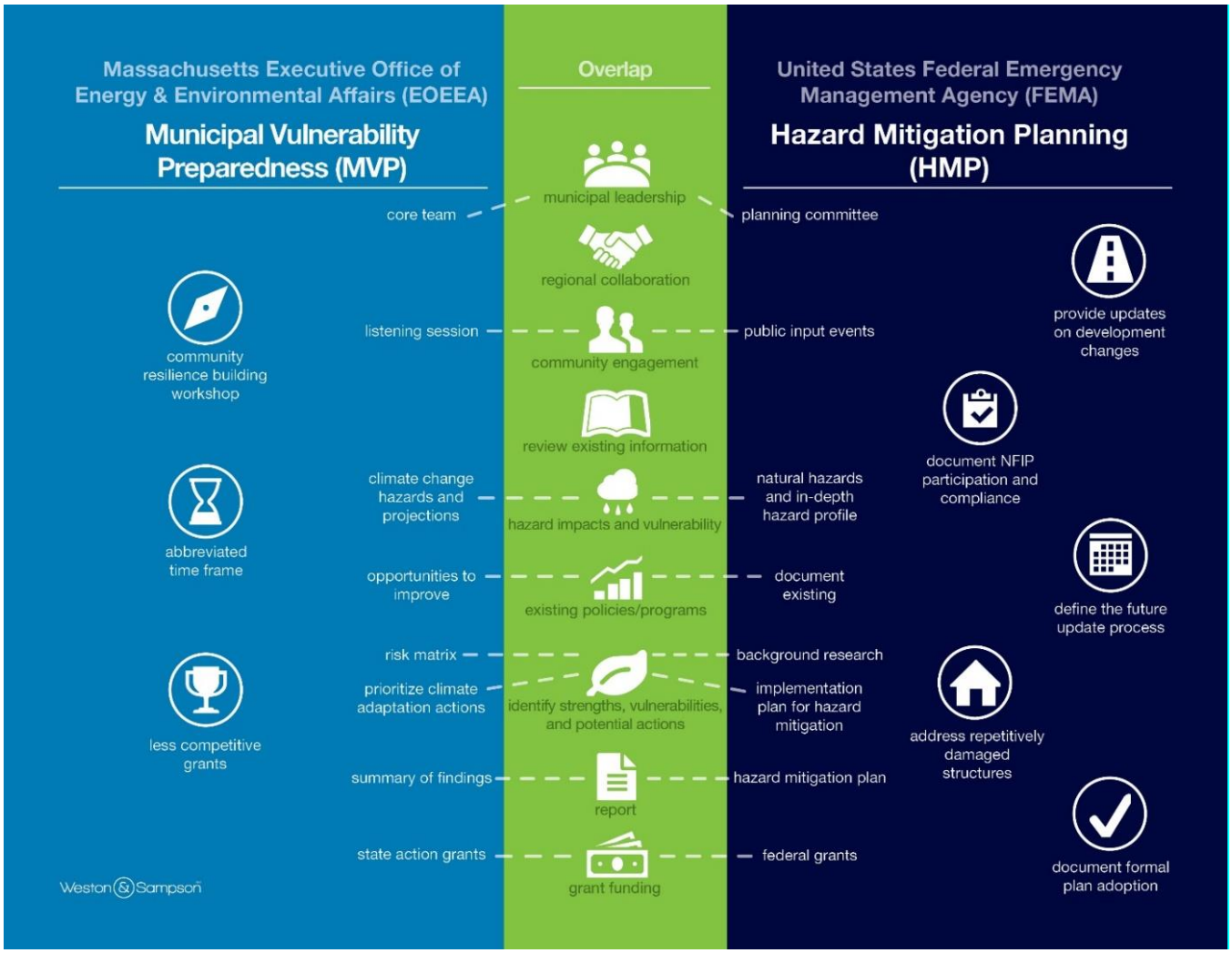

Figure 1-2. Comparison of the MVP and HMP Process

1.5 Planning Process Summary

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1. The Core Team, which includes representation from municipal and local leadership
2. Local, regional, and state-level stakeholders who could be vulnerable to, or provide strength against, natural hazards and climate change
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Table 1-2. Granville's Core Team

Name	Title
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Doug Roberts	DPW Superintendent
Nicole Berndt	Board of Health Chair
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Matt Ripley	Fire Chief
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1.4.2 Stakeholder Involvement: Community Resilience Building (CRB) Workshop

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Figure 1-3. Examples of infrastructural, environmental, and societal features in Granville. These include the Granville roads (left), Granville State Forest (center) and Granville Town Hall (right). Photos by the Town of Granville, DCR, and Granville Police Department

Participants also identified and prioritized key actions that would improve the Town's resilience to natural and climate-related hazards. A full list of community representatives who were invited and those who participated in the process are presented in Appendix C, along with the materials from each webinar. The broad representation of local and regional entities that participated in these webinars ensures that the MVP-HMP aligns with the operational policies and hazard mitigation strategies at different levels of government and implementation. Ten participants attended the three webinars. The participants included municipal staff, regional partners, PVPC, the MVP Regional Coordinator, and Springfield Water and Sewer.

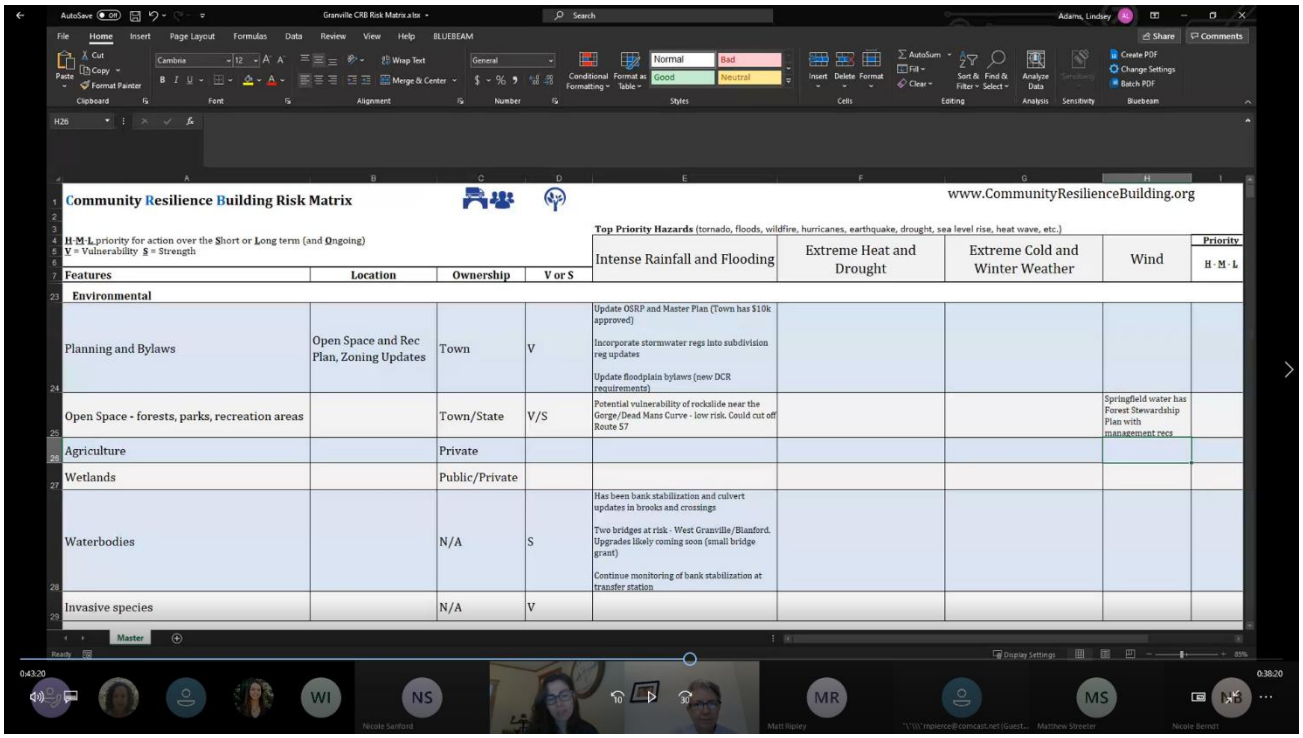

Figure 1-4. A screenshot from Granville's Community Resilience Building Webinar Recording

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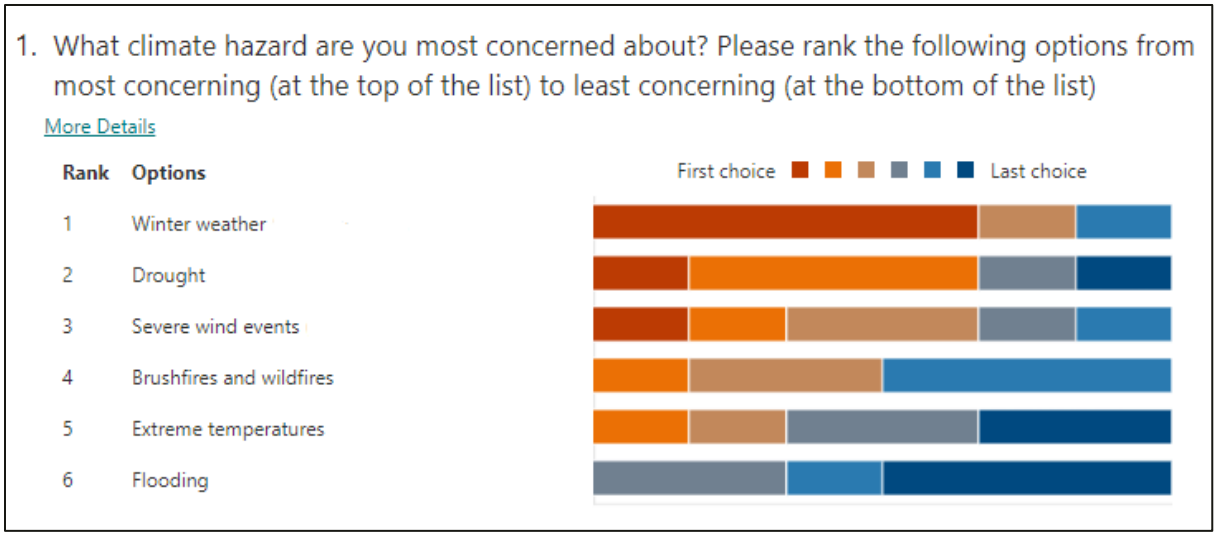

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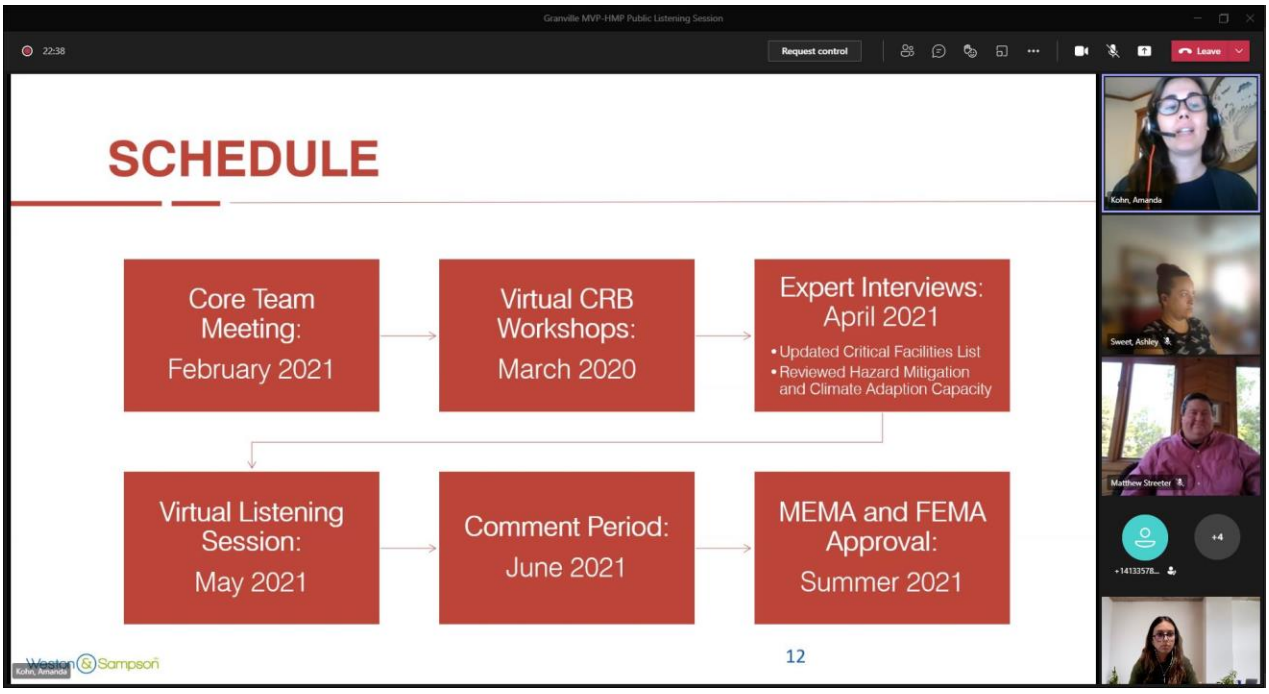

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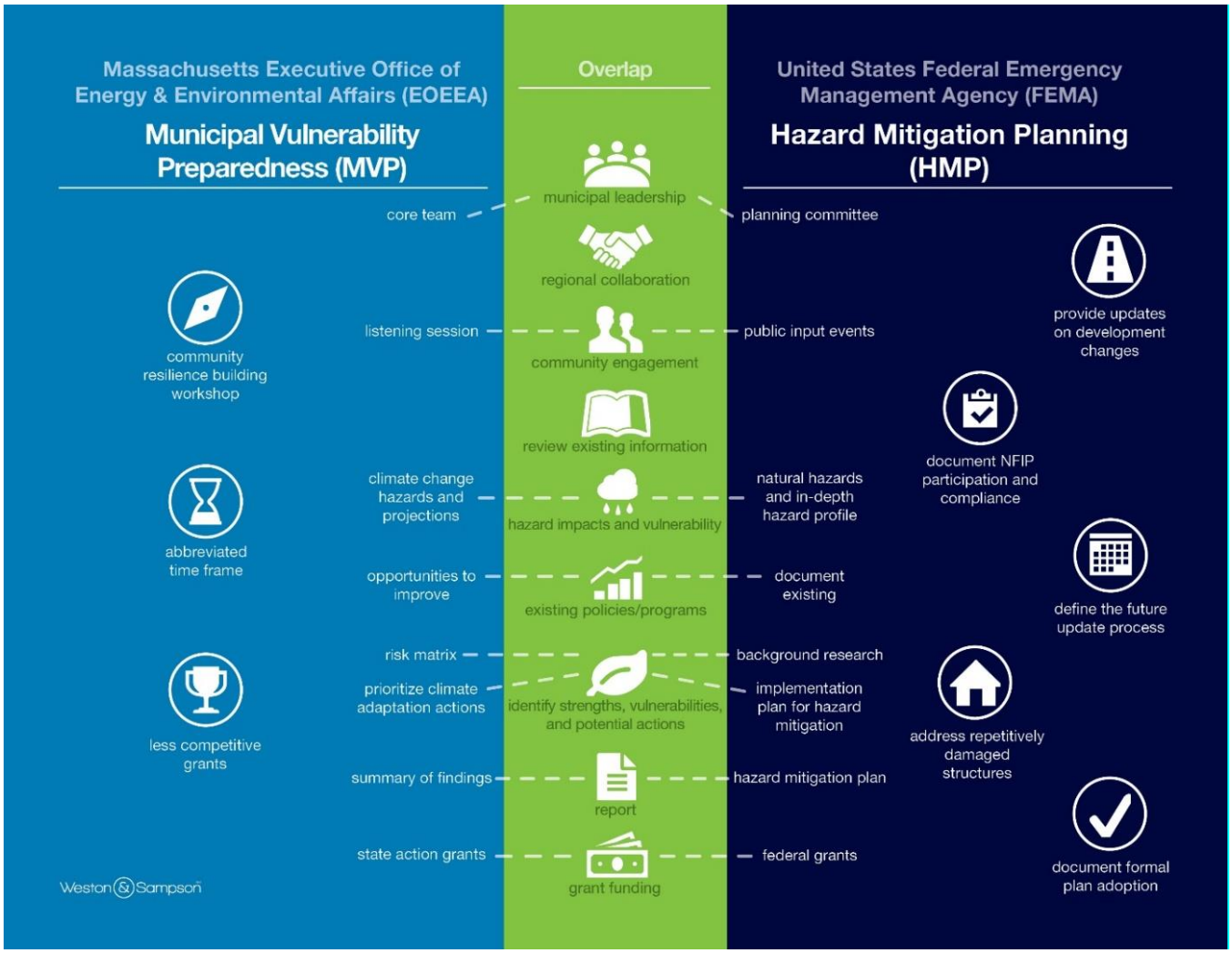

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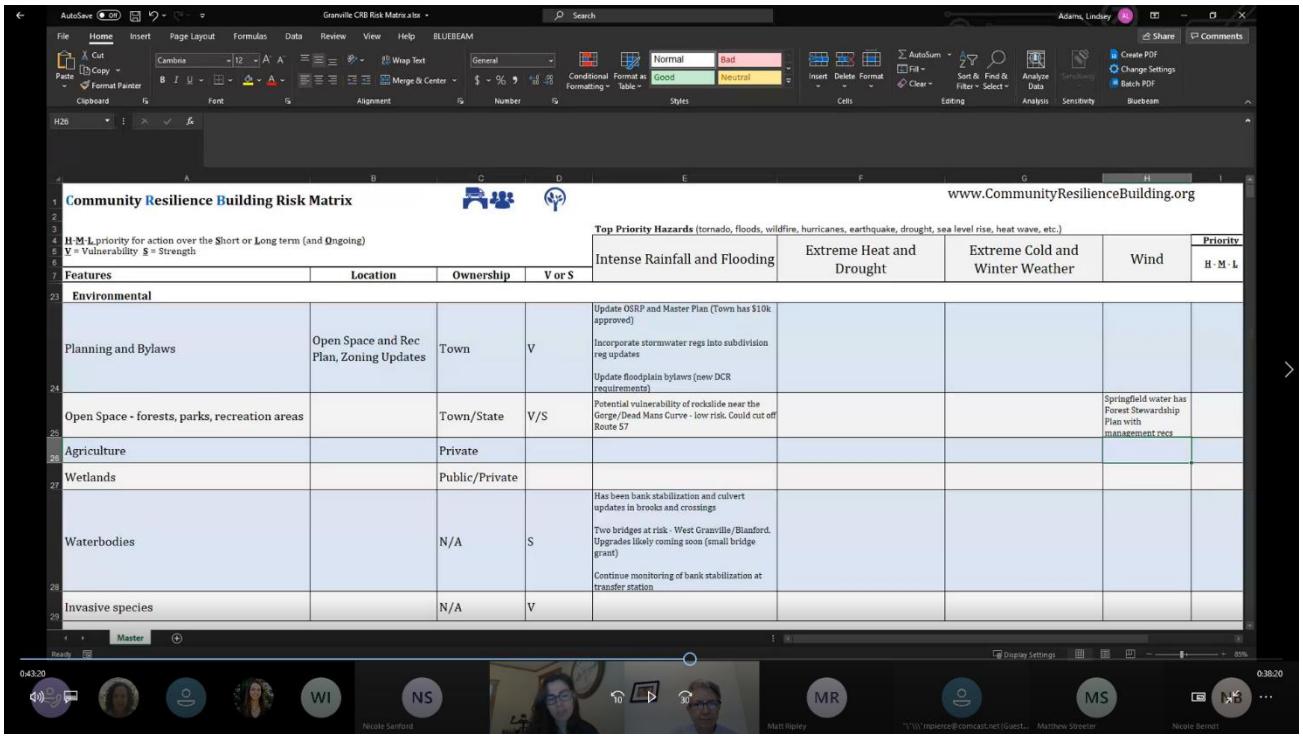

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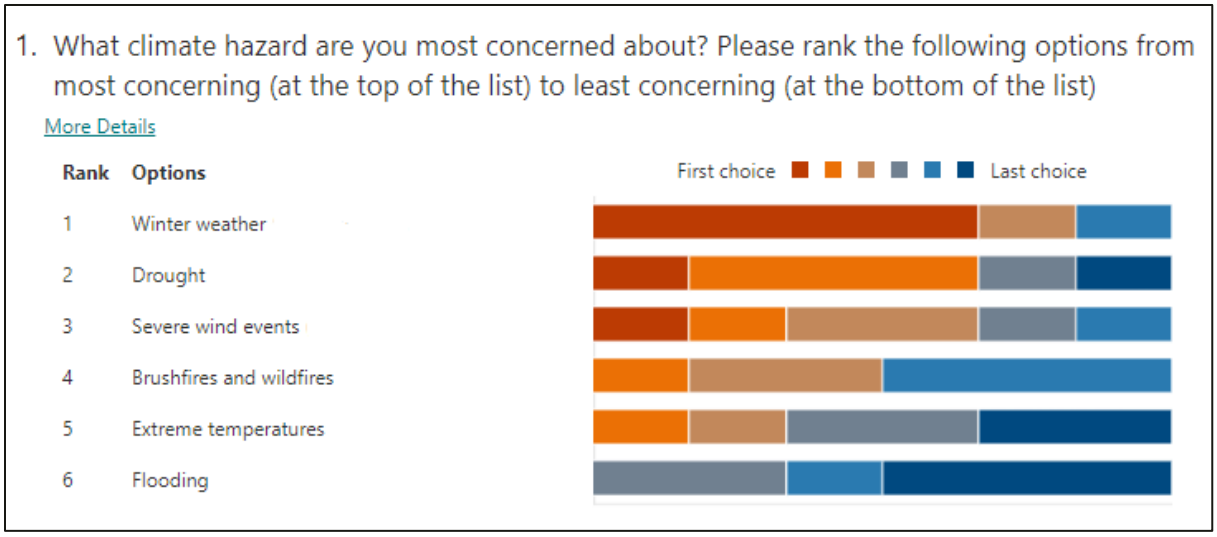

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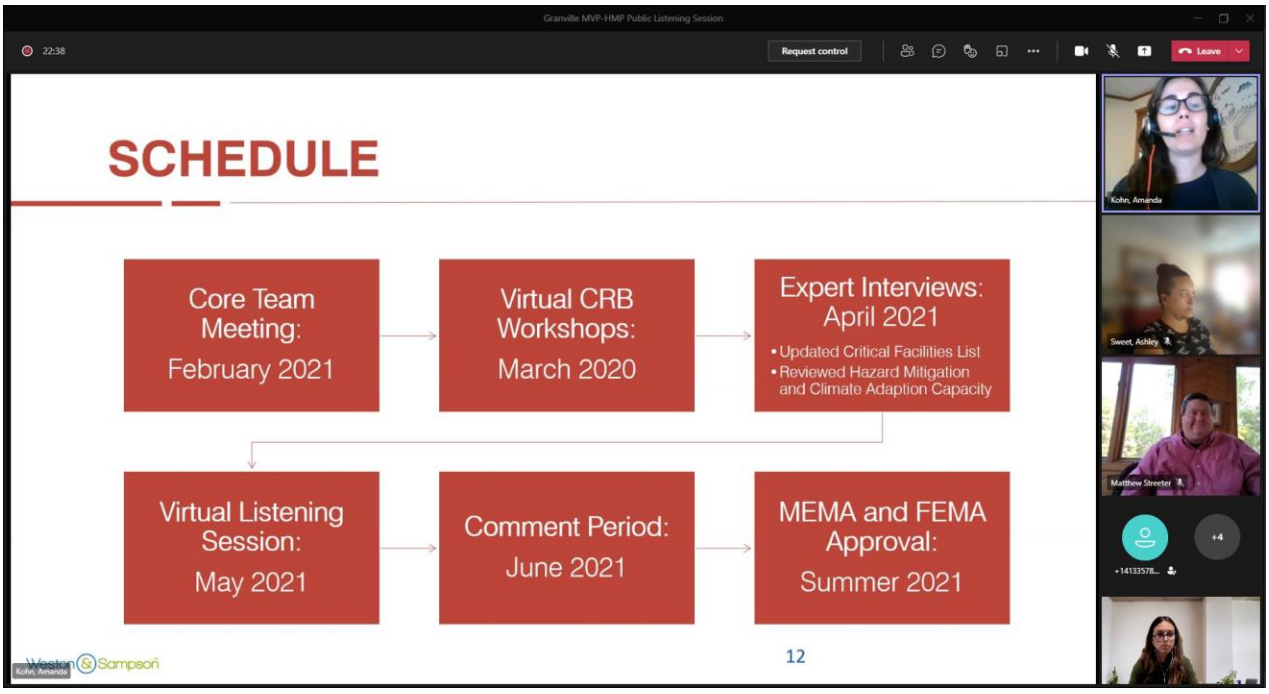

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2.0 HAZARD MITIGATION AND CLIMATE ADAPTATION GOALS

The Town of Granville's Core Team convened to discuss, review, and endorse the following hazard mitigation and climate adaptation goals for the MVP-HMP.

The Town of Granville aims to minimize the loss of life, damage to property, and the disruption of governmental services sand general business activities due to flooding, severe snowstorm and ice storms, severe thunderstorms, hurricanes, tornadoes, brushfires, earthquakes, dam failures, drought, and global health crises through the following avenues:

Protection: Develop programs, strategies, and actions to protect the following Town assets from natural hazards and climate change impacts:

- Residents, with an emphasis on supporting the elderly, young, and low-income populations
- Cultural and historic resources
- Critical infrastructure
- Utilities, including electric power, water, and wastewater
- Public facilities and services
- Homes and businesses
- Open space and other environmental features
- Future development

Planning: Incorporate climate adaptation and hazard mitigation measures into local plans, bylaws, regulations, and practices to protect critical infrastructure and property and to encourage resilient development, based on up-to-date information on climate change projections and emerging risks.

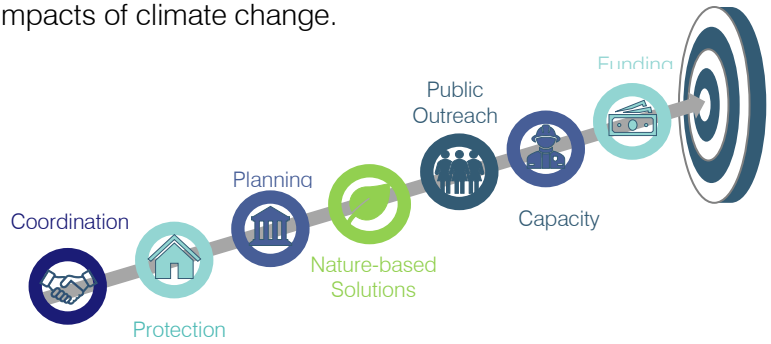
Nature-based Solutions: Investigate, design, and implement hazard mitigation and climate adaptation measures that employ nature-based solutions and protect the natural environment.

Coordination: Collaborate in hazard mitigation planning and climate adaptation with utility providers, local businesses, institutions, non-profits, surrounding communities, and state, regional and federal agencies.

Capacity: Increase the capacity for all Town departments, committees, and boards to respond to climate change impacts and natural hazard events with adequate data, guidance, staff, training, and equipment.

Public Outreach: Increase awareness and provide resources for hazard mitigation and climate resilience to businesses and residents through outreach and education.

Funding: Identify and seek funding for measures to mitigate or eliminate each known significant hazard area and reduce the impacts of climate change.



3.0 COMMUNITY PROFILE, LAND USE, AND DEVELOPMENT TRENDS

Figure 3-1. Granville Town Hall (Granville Police Department, 2020)

3.1. Community Profile

Resting at the foot of the Berkshires, west of the Connecticut River Valley, Granville is a true frontier town. Throughout the Town's history, Granville has maintained its quiet New England characteristics and never expanded into a suburban center like many of its neighboring towns. The Town of Granville was first settled in 1736 by English colonists. Shortly after the end of the Indian Wars in 1750, Granville was incorporated as a town. The original settlers were gifted 100-acre lots, which aided in the fast expansion of Granville to its peak of 2,100 residents in 1810. However, the rocky soil created challenges for farmers and many people began to move west, some whom established the town of Granville, Ohio. Granville now has a population of 1,691, which provides for a population density of 39 people per square mile. Due to the sparse population of the town, many of the natural and cultural resources have remained intact and protected. Approximately 90% of Granville's land mass is covered in forest, and almost half of the total area of the town is protected from development (Granville, 2004). Additionally, the Town is zoned for agricultural or residential use only.

Granville is located on the southwestern side of Hampden County, bordered by Blandford and Russel to the north; Westfield to the northeast; Southwick to the east; Tolland to the west; and Granby and Hartland, Connecticut, to the south. Granville is approximately 18 miles west of the City of Springfield, the economic hub of Hampden County and the third largest city in Massachusetts. Governance of Granville is overseen by three elected selectboard members who employ a Town Administrator to manage the day-to-day operations of the town. Granville maintains a website at townofgranville.net.

The only environmental justice populations located near the Town of Granville are in Westfield, where there is an environmental justice population based on income and/or minority population. Additional demographic information can be found in Table 3-1.

Table 3-1. Population Demographics

2019	Granville	Massachusetts
Population	1,691	6,892,503
Under the Age 18	22%	20%
Over Age 65	17%	17%
Bachelor's degree or higher	31%	45%
Median household income	$82,885	$85,843
Poverty Rate	9%	9%
With a Disability	9%	12%
Limited English-Speaking Skills	0%	9%
Housing Units	696	2,928,732
Renter-Occupancy Rate	37%	38%

(US Census Bureau, 2019)

Figure 3-2. Southwick Regional School

(SRS District, 2019)

3.2. Societal Features

Although it is a small town, Granville still offers numerous social services, including a public library, volunteer fire department, council on aging, and regional youth services. The Town's volunteer base and services are strengths that can be utilized for hazard mitigation and resiliency planning, especially to reach the Town's most vulnerable populations. Vulnerable populations include residents whose everyday stressors make it harder to adapt and recover when shocks or hazards occur. In Granville, seniors, youth, people who are disabled, non-English speakers, and low-income individuals are considered vulnerable. Youth are the largest vulnerable group in Granville and

represent 22% of the total population, 2% more than Massachusetts as a whole (Table 3.1), and residents 65 and older represent 17% of the town's population. Organizations representing young residents include the school system and regional youth sports and other services. Organizations representing older residents include the Council on Aging, Library, and Board of Health.

3.2.1. *CRB Workshop Discussion of Societal Features*

Workshop participants identified key societal aspects of Granville that are most vulnerable to, or provide protection against, natural hazards and climate change impacts.

Table 3-2: Societal Features Identified in the CRB Workshop

Strengths	Vulnerabilities
• Communications systems (CodeRED and emergency communication redundancies) • Emergency services • Regional services including regional food bank	• Limited cell phone reception in some areas of Town • Vector-borne diseases • Limited emergency service volunteers • People with possible barriers to building resilience • Lack of business coming into Town – rely on residents for tax base

Figure 3-3: Societal features in Granville.

Granville Country Store, Fire Department, and Daycare Services (left to right; Town of Granville 2020)

3.3. Economic Features

The primary product that is exported from Granville is water. Three adjacent towns own reservoirs and wooded areas within the Town where they draw their drinking water from (Granville, 2004). Granville is only zoned for agricultural and residential uses, meaning that many residents of the Town commute out of Granville for work. On average, Granville residents travel 35 minutes to work, which is five minutes longer than the state's average. Approximately 25% of adults living in Granville work in the education, healthcare, and social assistance industry, while 12% work in manufacturing and 10% in construction. Granville also supports a growing population of self-employed entrepreneurs. See Table 3-3 for additional economic information.

Table 3-3: Economic Statistics

	Granville	Massachusetts
Labor Force	996	3,858,104
Unemployment Rate	4.4%	6.0%
Employed in Top Employment Industry – Education, Healthcare & Social Assistance	25.2%	28.2%
Mean Travel Time to Work (minutes)	34.8	29.7

(United States Census Bureau, 2019)

3.4. Infrastructure Features

Massachusetts State Route 57, a main corridor into Springfield, runs east-west through the center of Granville. This state road carries commuters, commercial traffic, and substantial weekend recreation traffic through Granville. Connecticut Route 189 joins with Route 57 in Granville village, carrying traffic south to Granby and Hartford, Connecticut. With so much through traffic, roads are a critical maintenance issue for Granville. Additionally, many of the drainage crossings along Route 57 are undersized and result in flooding and erosion along the road. Route 57 is a designated evacuation route for Pioneer Valley, and therefore is a priority for funding. The Town has applied for funding to address these issues and has managed to fund five of the eight miles of impaired roadway. Although Granville provides drinking water for many adjacent towns, the residents within Granville get their drinking water from private wells and have on-site septic systems. The impacts of drought on private drinking water wells are a concern in Granville. Granville has 16 dams, with one rated as "High Hazard" and one rated as "Significant Hazard". Electric and communication infrastructure is vulnerable to forest fires spurred by droughts and power outages due to wind, ice, and tree damage. Emergency services are generally well equipped; however, the Town is working to enhance response times and reliability by conducting an inventory of supplies and ensuring that all facilities are equipped to handle hazard. Additionally, services to, and through, Granville could be impacted if critical roadways and bridges are flooded. An example of one critical road that is vulnerable to flooding is Route 57. See Section 3.8 for more information on critical facilities in Granville.

Figure 3-4: Infrastructural features in Granville.

The Fire Department (left) and a road with a tree down in Granville (right; Town of Granville)

3.4.1. *CRB Workshop Discussion of Existing Infrastructure*

Workshop participants identified key infrastructure features in Granville that are most vulnerable to, or provide protection against, natural hazards and climate change impacts, seen in Table 3-4.

Table 3-4: Infrastructural Features Identified in the CRB Workshop

Strengths	Vulnerabilities
• Municipal buildings	• Undersized culverts and drainage • Privately owned drinking water wells, especially shallow wells and those without backup power • Narrow bridges • Dams • Lack of utility redundancies • Roadways flooding during heavy rain; freezing during winter conditions

3.5. Environmental Features

Granville has a total land area of 43 square miles. There are two major watersheds in Granville: the Farmington River Watershed, flowing to the south and the Westfield River Watershed, flowing to the north and east. Other bodies of water in Granville include the Borden Brook Reservoir, Cobble Mountain Reservoir, Granville Reservoir, Cooley Lake, Parsons Pond, Mountain Laurel Pond, Pond Brook, Japhet Brook, Dickinson Brook, Drake Brook, Seymour Brook Pond Brook, Hubbard Brook, Halfway Brook, Valley Brook, Phelon Brook, Hall Pond Brook, Ellis Brook, Trumble Brook, Ripley Brook, Borden Brook, and many other smaller unnamed streams, many. Due to the topography of the town and its ample water resources, Granville has become the primary drinking water source for many surrounding communities. In order to secure drinking water resources for the future, the cities of Springfield, Westfield, and Hartford have purchased nearly a third of Granville's total land. Access to these areas have historically been restricted; however, Springfield, along with the Commonwealth, have investigated allowing access to certain areas.

There are seven Natural Heritage and Endangered Species Program (NHESP) certified vernal pools, in Granville, two of which are NHESP Priority Habitats of Rare Species. Adjacent towns of Southwick, Westfield, and Tolland have NHESP certified vernal pools just over the town boundary, many of which are also NHESP Priority Habitats extending into Granville. The NHESP lists the Northern Spring Salamander and Eastern Box Turtle as species of special concern in Granville. It is also home to many species of birds, one of which is listed on the State's Endangered list. Nonpoint source pollution is a concern within many of the waterbodies (including stormwater runoff, yard fertilizers, etc.) because these waterbodies provide habitat for native species and drinking water for many surrounding communities. One medium-yield aquifer is located north of Cooley Lake at the intersection of Route 57 and 189. The wealth of water resources in Granville explains the designation of Outstanding Resource Waters (ORW) and classification as cold-water fisheries that support brown, brook, and rainbow trout.

In 2004, Granville completed its Open Space and Recreation Plan intending to offer tools and materials needed to move forward, looking at Granville from its early history to its projected future. The Town's assets, liabilities and collective goals are considered in detail. The Plan describes the Town's vast tracts of valuable forest land, wetlands, farmlands, soils, terrain, water quality, historic attractions, town-wide gathering center, and examines how and why they need protection. Unlike many New England municipalities, Granville does not have many, if any, hazardous material sites. Future potential development represents both a strength and vulnerability and proper oversight and

consideration of environmental concerns and groundwater resources needs to be considered in siting and design. An estimated 80% of the northwest section of Granville is protected as watershed land. Additionally, Granville has a thriving forest system, with 90% of its 27,563 acres covered in forests. Future drought conditions and lack of forest management could perpetuate uncontrolled burns and shift this resource toward a vulnerability.

Figure 3-5. Figure 3-4: Environmental features in Granville.

Granville State Forest sign (left), Sportsmen's National Land Trust (center), and Granville State Forest (right; Town of Granville, 2020)

3.5.1. *CRB Workshop Discussion of the Environment*

Workshop participants identified key environmental features in Granville that are most vulnerable to, or provide protection against, natural hazards and climate change impacts, listed in Table 3-5.

Table 3-5: Environmental Features Identified in the CRB Workshop

Strengths	Vulnerabilities
• Planning and bylaws protect the Town • Open Space • Local Agriculture • Wetlands and Waterbodies	• Outdated plans and bylaws (currently being updated) • Stress on local agriculture • Invasive species

3.6. **Land Use**

Granville covers an area of 27,563 acres. According to MassAudubon's Losing Ground Report, only 1% of the town is developed, while 93% remains as natural land and another 5% is open land. Ninety-four percent of the land area in Granville is natural land, most of which is drinking water protected land owned by neighboring municipalities. Developed land, mostly consisting of residential housing, makes up only one percent of the land cover in Granville (Figure 3-6).

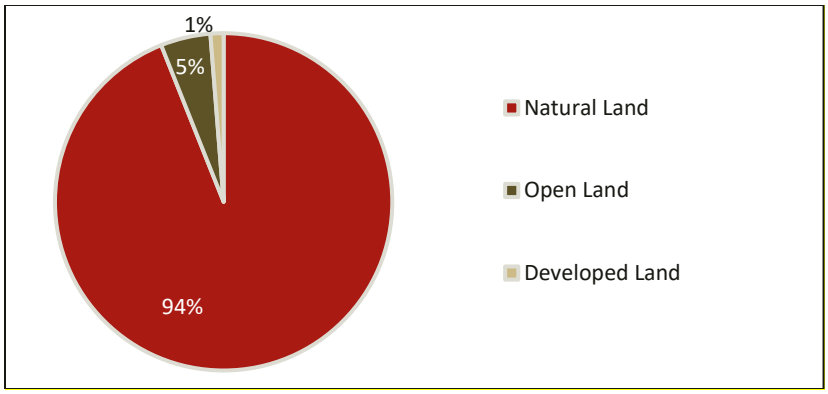


Figure 3-1 Land Use Distribution in Granville, MA

3.7. Recent and Potential Development

There is currently one major development in construction in Granville, a 6.3 mW large scale, ground mounted photo-voltaic solar array cover approximately 21.7 acres. Since 2017, the town has seen five new residences constructed. Additionally, the Rockwood Farm Anaerobic Digester was also completed in the past four years. This 450 kW anaerobic digester facility is located at Rockwood Farm, a dairy farm located in Granville. The facility has a net-metering agreement with the Town to utilize power produced for municipal facilities.

Much of Granville is undevelopable because it is located in drinking water protection area and the land is owned by neighboring municipalities. The Town is currently zoned in favor of residential and agricultural development, but with the decline of agriculture, residents of Granville cover the majority of the tax base. A list of recent development can be found in Appendix B.

3.8. Community Lifelines and Critical Facilities

Community lifelines and critical facilities are essential components of the Town's function and protecting them from natural hazards is paramount. These resources enable the continued performance of the town and are essential to the life and safety of Granville's residents. Community lifelines and critical facilities include:

1. Resources that can be utilized to respond and recover from natural hazards.
2. Facilities where additional assistance might be needed.
3. Hazardous sites that could be dangerous if it is compromised during a natural disaster.

Community lifelines and critical facilities in the Town of Granville have been identified with help from knowledgeable Town staff, MassGIS data, and existing Town and regional plans, including the Granville Hazard Mitigation Plan (PVPC, 2016). They have been separated into categories and are listed in table 3-7.

Table 3-6: Granville Community Lifelines and Critical Facilities

Feature Type	Name	Address
SAFETY AND SECURITY		
Emergency Operations Center	Fire Headquarters	709 Main Road

Feature Type	Name	Address
Department of Public Works	Department of Public Works	69 Old Westfield Road
Other Public Safety Buildings	Fire Station 2 (West Granville)	1578 Main Road
	Police Station	707 Main Road
FOOD, WATER, SHELTER		
Agriculture	Hilltown Pork	243 Sodom Street
	Maple Corner Farm	794 Beech Hill Road
	Mimi's Hilltop Apiary	35 North Lane
	Moutain Orchard	676 Main Road
	Nestrovich Orchards	561 Main Road
	Rockwood Farm	355 Granby Road
	Sandman's Wild Blueberries	104 McCarthy Road
	Sussmann's Wild Blueberries	44 North Lane
Food/Grocery	Granville Country Store	11 Granby Road
	Gran-Val Scoop	223 Granby Road
Food Assistance Support	Council on Aging (Town Hall)	707 Main Road
	See also Regional Service	
Designated Shelter	Town Hall	707 Main Road
	Granville Village School	409 Main Road
Drinking Water Supply	Granville Center Water Company	Serves approximately 35 residences, Town Hall, Fire Station, Granville Center. Office at 29 Locust Drive, Bedford, NY
	Private Wells	Majority of town
Wastewater	Private Septic Systems	100% of town
HEALTH AND MEDICAL		
Health Services	See Regional Services	
Long-term Care, Nursing Home, Assisted Living	None	
ENERGY		
Fuel Station	Granville County Store	11 Granby Road
Electricity – Eversource	Transmission Lines	Runs north-south through eastern half of town
Electric Generation -Rockwood Ag-grid	Methane Digester	355 Granby Road
Electric Generation – Springfield Hydro Power Plant (Managed by Holyoke G&E)	Hydrogeneration Power Plant	Access Of 500 Wildcat Road Russell- near border
Natural Gas – Kinder Morgan	Pipeline	Run east-west through central section of town and connects to north-south near North Lane that heads south
Sites with Backup Power	Town Hall/PD	707 Main Road
	Fire Headquarters	709 Main Road
	Department of Public Works	69 Old Westfield Road
	Maple Corner Farm Ski Area	794 Beech Hill Rd

Feature Type	Name	Address
COMMUNICATIONS		
Cell Towers	SBA Cell Tower	24 Sodom Street
	SBA Cell Tower	697 Old Westfield Road
	American Tower Corp Cell Tower	156 North Lane
	Westfield Water Cell Tower	450 Blandford Road
Wired Telephone Service	Verizon Telephone Switch	504 Main Road
		172 North Lane
Public Service/Safety Communication Towers	Sodom Mountain Cell Tower (Receiver Site: Granville FD/Town, Southwick FD/PD)	24 Sodom Street
	Westfield Water Cell Tower (Main FD/Town Repeater Site)	450 Blandford Road
	Fire Headquarters (Backup FD/Town Repeater Site)	709 Main Road
	Fire Station 2 (West Granville) (Receiver Site for FD/Town)	1578 Main Road
	Mass State Police - American Tower Cell Tower	156 North Lane
	Mass State Police - Westfield Water Cell Tower	450 Blandford Road
Communication	CodeRed	Reverse 911
	Granville Country Caller	Monthly community mailer
	Community Access Channel	Comcast Channel 15
	Granville EM Facebook	"Granville Emergency Management"
	Granville Fire Facebook	"Granville MA Fire Department"
	Granville Police Facebook	"Granville MA Police Department"
TRANSPORTATION		
Evacuation Routes	East to Southwick MA West to Tolland MA	Main Road (Route 57)
	To Granby CT	Granby Road (Route 189)
	To Westfield MA	Old Westfield Road
	To Hartland CT	West Hartland Road
HAZARDOUS MATERIAL AND WASTE MANAGEMENT		
Waste Management	Transfer Station	89 Water Street
Landfills & Junkyards	Town Line Auto Salvage	713 Old Westfield Road
	Hansen's Garage	53 Silver Street
Chapter 21E Potentially Tier Classified Site	General Store (Tier 1D)	1576 Main Rd
Underground Storage Tanks	Granville Country Store	11 Granby Rd
Tier II Facility	Verizon Granville Dial OFC	504 Main Road
COMMUNITY AND CULTURAL SITES		
Campgrounds	Prospect Mountain	1360 Main Road

Feature Type	Name	Address
	Campground (private)	
	Granville State Forest (public)	West Hartland Road
Religious Centers	Granville Federated Church	16 Granby Road
	West Granville Congregational Church	1580 Main Rd
Library	Granville Public Library	2 Granby Road
US Post Office	Granville Post Office	467 Main Road
REGIONAL FACILITIES AND SERVICES		
Schools	Southwick-Tolland-Granville Regional School District	93 Feeding Hills Road, Southwick
Regional Shelter		
Food Assistance	Our Community Food Pantry	220 College Hwy., Southwick
Grocery Store	Several	Big Y Southwick (closest)
Hospital/Medical Response	Baystate Noble Hospital	115 W Silver St, Westfield
Other Municipalities' Assets	Springfield Water	
	Westfield Water	
	MDC (Hartford, CT)	
NATURAL RESOURCE ASSETS		
BioMap2 Areas	State layer available	Map in Appendix B
Groundwater Protection Areas	State layer available	Map in Appendix B
Surface Water Protection Areas	State layer available	Map in Appendix B
Parks and Open Space	State layer available	Map in Appendix B
Waterbodies	State layer available	Map in Appendix B
DAMS – See map below for exact location		
Borden Brook Reservoir	High Hazard	Access off Borden Brook Road Blanford - near border
Cobble Mountain Reservoir Dam	High Hazard	Coble Mountain Road Russell- near border
Phelon Pond Dam	Low Hazard	Phelon Road
Cooley Lake Dam	Significant Hazard	Granby Road (RT. 189)
Granville Reservoir Dam	High Hazard	Old Westfield Road
Degano Pond Dam	Low Hazard	Blandford Road
E.A. Jensen Pond Dam	N/A	Blandford Road
Don Noble Pond Dam	N/A	Old Westfield Road
Dickinson Pond Dam	Low Hazard	Main Road (East of the Old Westfield Rd)
Noble & Cooley Drum Shop Upper Pond Dam	N/A	Water Street
Noble & Cooley Drum Shop Lower Pond Dam		Water Street
Wells Mills Dam	N/A	Old Westfield Road
Lower Arnold Pond Dam	N/A	Wendy's Road (East of Blandford Road)
Japhet Reservoir Dam	N/A	Main Road (East of the Old Westfield Rd)
Strong Pond Dam	N/A	Old Westfield Road

Feature Type	Name	Address
Granville S.F. Dam	N/A	West Hartland Road
Woodger Pond Dam	N/A	Main Road (West of the Old Westfield Rd)
Bahre Pond Dam	Low Hazard	West Hartland Road

4.0 HAZARD PROFILES, RISK ASSESSMENT & VULNERABILITIES

Each natural hazard that has the potential to occur in Granville has varied risk based on the severity, extent of impact, probability, and the vulnerability of the assets within the social, natural, and built environment. For each hazard, a hazard profile was developed. These hazard profiles present information that can be used to assist in determining risk, which is further explained within this section. Each profile is structured the same to make information easy to locate within the plan.

In some cases, more data is readily available or documented for some hazards than others. Because of that, some profiles are more robust than others. Whenever possible the hazard profiles were updated with information from:

- Local, State, and National Hazard Mitigation and Climate Adaptation Resources.
- Local and National Hazard and Weather Event Databases.
- Workshop and Survey Results.
- Geographic Information System (GIS) Assessments.
- HAZUS Software Analysis.

4.1 Hazard Profiles

4.1.1 Description

Using the 2018 State Hazard Mitigation and Climate Adaptation Plan (MEMA and EOPSS) and the 2016 Granville Hazard Mitigation Plan (PVPC) as a guide for the types of hazards that can occur in the state, the following hazards are included in this plan:

Flooding Hazards
- Riverine
- Inland/Stormwater
- Coastal
- Tidal

Dam Hazards
- Dam Failure

Wind Related Hazards
- Severe Storms and Thunderstorms
- Hurricanes and Tropical Storms
- Tornados
- Nor'easters

Winter Storm Hazards
- Heavy Snow and Blizzards
- Ice Storms

Geological Hazards
- Earthquakes
- Landslides

Fire Hazards

- Brushfires
- Urban Conflagrations

Extreme Temperature Hazards

- Extreme Heat
- Extreme Cold

Drought Hazards

- Drought

4.1.2 Severity

The severity of the hazard is synonymous with the magnitude, or how serious the hazard event is. Where possible, the severity of a hazard can be measured using an established indicator like the Richter Scale for earthquakes. Severity is sometimes described as the duration or force of an event. In other cases, severity is ranked by the consequence or risk. For example, a catastrophic event may have widespread infrastructural damage and loss of life, whereas a minor event may have minimal infrastructure damage and no loss of life.

4.1.3 Probability

Probability is the likelihood, or the estimated potential, for a natural hazard to occur within a specific time period. The probability of an event is often directly related to the severity. For example, minor rain events have a high probability of occurring each year, as they are fairly common occurrences; however, there are intense rain events that are only likely to occur every fifty years, as they are far less common.

4.1.4 Location

Some hazards, such as drought, are equally likely to occur across the entire geographic extent of Granville. However, some hazards are more likely to occur in specific areas and therefore these geographic locations are considered more vulnerable, such as a floodplain.

4.1.5 Historic Occurrences

Tracking historic occurrences of hazards and federally declared disasters that occur in Granville or Hampden County helps planners understand the possible severity, frequency, and geographic extent of hazards.

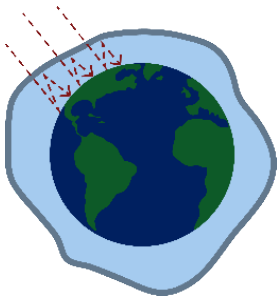
Within this Chapter, the National Oceanic and Atmospheric Association's (NOAA) National Centers for Environmental Information (NCEI) Storm Events Database (2020) was used as the primary source for historic occurrences of hazard events. The definitions for the event types can be found online under the Storm Data Preparation documentation (NOAA, 2018a). Throughout the hazard profiles, record information has been provided from this database. Record information is not always synonymous with a single storm event but rather recorded occurrences of an event. For example, if a storm causes flooding over four days, the database may return four records for a single event. This information, although incomplete, is the only information readily available on historic records over the last twenty years that is not institutional or local knowledge based. Data for the date range of 2000-2020 has been provided in most circumstances, however at the time of data collection, the database was only updated to reflect events through October 2020. Some hazard profiles provide additional historical information beyond this time frame when it was available.

4.1.6 Federally Declared Disasters in Massachusetts

Tracking historic hazards and federally declared disasters that occur in Massachusetts, and more specifically Hampden County, helps planners understand the possible extent and frequency of hazards. Historically, Massachusetts has experienced multiple types of hazards, including flooding, blizzards, and hurricanes. Since 2000, there have been 29 storms in Massachusetts that resulted in federal or state disaster declarations. Seventeen disaster declarations occurred in Hampden County. Federally declared disasters present additional FEMA grant opportunities for regional recovery and mitigation projects. The hazard profiles included in this chapter contain more information about federally declared disasters.

4.1.7 Impacts of Climate Change

Many of the hazards that Granville commonly experiences are projected to increase in both severity and frequency due to climate change. Climate change refers to changes in regional weather patterns that are linked to warming of the Earth's atmosphere as a result of both human activity and natural fluctuations. The Earth's atmosphere has naturally occurring greenhouse gases (GHGs) like carbon dioxide (CO2) that capture heat and contribute to the regulation of the Earth's climate. When fossil fuels (including oil, coal, and gas) are burned, GHGs are released into the atmosphere and the Earth's temperature tends to increase. The global temperature increase affects the jet stream and climate patterns.



Due to these changes, the future climate in Massachusetts is expected to resemble historic climate patterns of Southern New England or Mid-Atlantic States more closely, depending upon GHG emission scenarios. Climate change has already started to impact Massachusetts and these trends are likely to continue. Climate change is anticipated to affect Massachusetts's typical precipitation cycle, leading to more intense rainfall and storms and more episodic or flash droughts. Temperatures will increase in both summer and winter. Each of the hazard profiles provided below includes more detail on how hazard frequency and intensity is likely to shift with climate change.

4.1.8 Vulnerability and Risk

To understand risk, one must first understand vulnerability. Vulnerability is determined by the amount of exposure, sensitivity, and adaptative capacity of an asset in the social, natural, and built environment and is the predisposition to being negatively affected by a natural hazard. The amount of exposure is influenced by the location of the asset and the severity of the event. Sensitivity refers to the impact of a natural hazard due to the existing conditions or characteristics of the assets. For example, a building with an older roof may be more sensitive to wind damage and may lose its ability to function or keep rain out of the building. Adaptive capacity is the ability of a system, service, or asset to adapt or prepare for an anticipated hazard or climate impact (as further explained in Chapter 3).

Risk, or the possible adverse outcome, is determined through the consideration of vulnerability, the severity of an event, and the probability of that event occurring. In some instances, risk can be calculated in dollar amount or other metrics. In other cases, risk can be conveyed through the consequence and follow-on impacts. The consequence may be the amount of damage, length of service disruption, and the loss of life or number of injuries. Follow-on impacts could include public health concerns and environmental damage.

4.1.9 Top Hazards as Defined in the CRB Workshop

Workshop participants were asked to identify the four top hazards/climate change impacts that Granville faces. Extensive discussion led to the selection of the following:

- Intense Rainfall and Flooding
- Extreme Heat and Drought
- Extreme Cold and Winter Weather
- Wind

The workshop was designed to bring stakeholders together to brainstorm action items that will result in a more climate resilient future while also supporting the Town's unique features and characteristics. Concerns related to hazardous events such as flooding, and winter weather were topics of discussion. Stakeholders also discussed concerns around drought events because of the reliance in the Town on private drinking water wells. Workshop participants also reviewed challenges impacting the regional school system, vulnerable populations, and remoteness of many residents. There was extensive discussion about wind causing power outages, and the potential for future events to worsen in frequency and severity. Stakeholders described how power outages from severe storms could leave many residents without power for extended periods because of the large spatial extent of the Town. Granville has a large number of trees, which can be a great strength to the community, but can also be a challenge when they cause damage to overhead power lines during strong storms. Workshop participants highlighted that downed trees due to winter storms and high winds is one of the most pressing issues in Granville. There was discussion about cutting back tree cover to eliminate tree hazards over power lines.

4.2 Flood-Related Hazards

According to NOAA's National Severe Storms Laboratory (NSSL) a flood is "an overflowing of water onto land that is normally dry." Damaging flooding may happen with only a few inches of water, or it may cover a house to the rooftop. Floods can occur within minutes or over a long period, and may last days, weeks, or longer. Flooding can be caused by various weather events including hurricanes, extreme precipitation, thunderstorms, nor'easters, storm surge, and winter storms. Flooding is potential threat throughout Granville. Granville experiences two types of flooding: riverine flooding and stormwater flooding, which are described in detail in the sections below. While a single type of flooding may pose a threat to society, infrastructure, and the natural environment, they often occur simultaneously (both riverine and stormwater), resulting in compounded impacts to the Town.

Intense rainfall and flooding were among the four main hazards identified by participants during Granville's CRB Workshop. While Granville already experiences flood events, the impacts of climate change will likely lead to increasingly severe storms and increasingly severe impacts. The impacts of flooding include injury or death, property damage, and traffic disruption. The winter and spring thaw can also bring flooding challenges to the town, with clogged catch basins or ice flowing into dams.

Flood hazards are directly linked to erosion, which can compromise receiving water quality, slope stability, and the stability of building foundations. This puts current and future structures and populations located near steep embankments at risk. Erosion can also undercut streambeds and scour around stream crossing, creating a serious risk to roadways. Residents identified erosion occurring along the

Tennessee Gas Pipeline, which is located on a sparsely vegetated slope. They also discussed flooding due to dams in Town, and outdated culverts that are unable to manage current stormwater flows. Figure 4-1 shows the impacts of changing precipitation on the State.

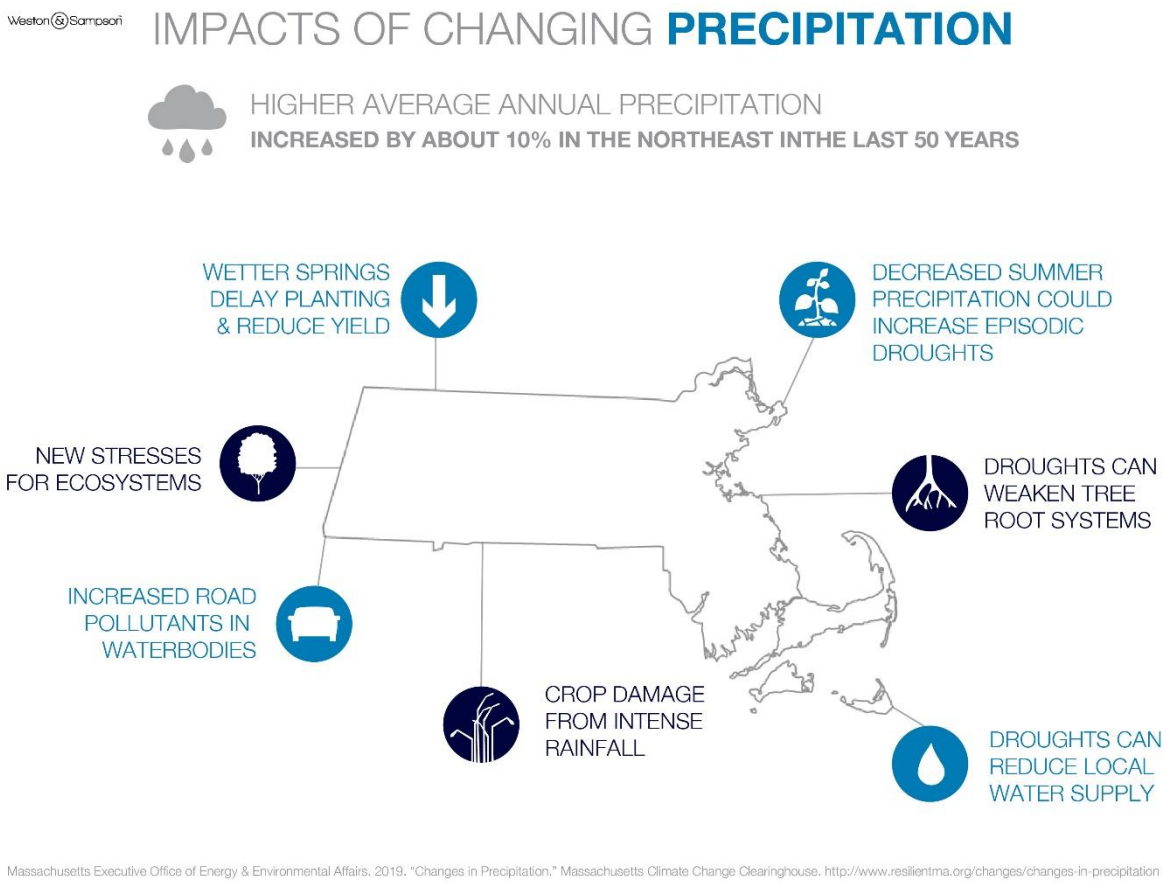


Figure 4-1. Impact of changing precipitation in future on the State of Massachusetts

Areas within FEMA Flood Zones, repetitive loss sites, and local areas identified as flood prone are more vulnerable to the impacts of flooding. The following sub-sections provide more information on historic flooding events, potential flood hazards, a vulnerability assessment, locally identified areas of flooding, and information on the risk of dam failures. The vulnerability assessment of flood hazard areas was informed by the most recent FEMA NFIP Flood Insurance Rate Maps (FIRMs) and a GIS vulnerability analysis. Flooding events in Granville have been classified as a high frequency event. According to the 2013 Massachusetts State Hazard Mitigation Plan, this hazard occurs more frequently than once in 5 years or greater than 20% per year.

4.2.1 Riverine Flooding

4.2.1.1 Description

Riverine or riparian flooding occurs when the volume of water in a waterbody exceeds the capacity and overflows the banks. Most waterbodies have the potential to experience riverine flooding, but many have flood control systems that mitigate the possibility of major damage. Granville is located within the Farmington River watershed and the Westfield River watershed. There are numerous rivers, streams,

ponds, wetlands, lakes, and reservoirs in the Town. Major bodies of water include the Cobble Mountain Reservoir, Borden Brook Reservoir, Granville Reservoir, and Cooley Lake.

4.2.1.2 Severity

Riverine flooding in Granville is highly variable and can range from a few inches in depth to a few feet. Isolated flooding can leave one neighborhood inaccessible, while an adjacent neighborhood remains safe due to elevation or proximity to the waterbody. Flooding severity is dependent on the duration of the flooding event and the ability of the flood water to recede.

4.2.1.3 Probability

Based on historic occurrences, riverine flooding events in Granville have been classified as a high frequency event. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard occurs more frequently than once in 5 years or greater than 20% per year.

4.2.1.4 Location

Riverine flooding in Granville occurs most frequently along the following bodies of water (Granville, 2016):

- Cobble Mountain Reservoir
- Borden Brook Reservoir
- Granville Reservoir
- Parsons Pond
- Degano Pond
- Ripley's Brook
- Half Pond Brook
- Pond Brook
- Valley Brook
- Halfway Brook
- Tillotson Brook
- Japhet Brook
- Dickinson Brook
- Seymour Brook

FEMA FIRMs designate areas most likely to experience flooding. The FIRMs delineate both the special flood hazard areas and the risk premium zones under the NFIP. This includes high risk areas that have a one percent chance of being flooded in any year (often referred to as the "100-year floodplain"), which under the NFIP, is linked to mandatory flood insurance purchase requirements for federally backed mortgage loans. It also identifies moderate to low-risk areas, defined as the area with a 0.2 percent chance of flooding in any year (often referred to as the "500-year floodplain"). The definitions of these flood zones are provided below. FEMA-designated flood zones for Granville are included in Appendix B. A FEMA flood zone surrounds most of the water bodies and wetlands areas listed above.

Flood Insurance Rate Map Zone Definitions

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

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

Zone X (0.2% annual chance): Zone X is the flood insurance rate zone that corresponds to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or depths are shown within this zone.

Source: (FEMA, 2019b) https://www.fema.gov/flood-zones

4.2.1.5 Historic Occurrences

Hampden County had four federally declared disasters related to flooding between 2000 and 2020, shown in Table 4-1.

Table 4-1. Previous Federal Disaster Declarations - Flooding

Disaster Name and Date of Event	Disaster Number	Type of FEMA Assistance	Counties Under Declaration
Severe Storm and Flooding October 7-16, 2005	DR-1614	Public Assistance; Individual & Households Program	**All** 14 Massachusetts Counties
Severe Storm and Flooding April 15-25, 2007	DR-1701	Public Assistance Grant	Essex, Plymouth, Barnstable, Dukes, Hampshire, **Hampden**, Franklin, Berkshire
Severe Winter Storm and Flooding December 11-18, 2008	DR-1813	Public Assistance	**All** 14 Massachusetts Counties
Severe Winter Storm, Snowstorm, and Flooding February 8-9, 2013	DR-4110	Public Assistance	**All** 14 Massachusetts Counties

Between 2000 and 2020, 62 heavy rain, flood, and flash flood events, were reported in Hampden County and recorded in the NOAA Storm Events Database (2020). Of the 62 recorded events, two were characterized as heavy rain with some flooding noted in the description; 41 were characterized as flood events while another 15 were flash flood events, and four were a combination of the three types of

events. There were no deaths or injuries reported resulting from any of these events. Property damage in Hampden County totaled $4,995,000, with $542,000 as a result of flash flooding and $4,463,000 as a result of flooding. See Appendix B for a detailed list of events.

Repetitive Loss Sites

As defined by FEMA and the NFIP, a repetitive loss property is any insured property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978 (FEMA, 2019e). There are no repetitive loss properties in Granville.

Notably, repetitive loss data only includes buildings that qualify for the repetitive loss designation, which does not represent all losses due to flooding. The number of buildings that experience losses due to flooding is likely higher than what is reported above.

4.2.1.6 Climate Change

Extreme rain and snow events are becoming increasingly common and severe, particularly in the Northeast region of the country (Figure 4-2). Severe rain or snow events that historically happened once a year in the middle of the 20th century now occur approximately every nine months. With this projected increase in rainfall, waterbodies in and around the Town will be increasingly likely to top their banks and cause localized flooding.

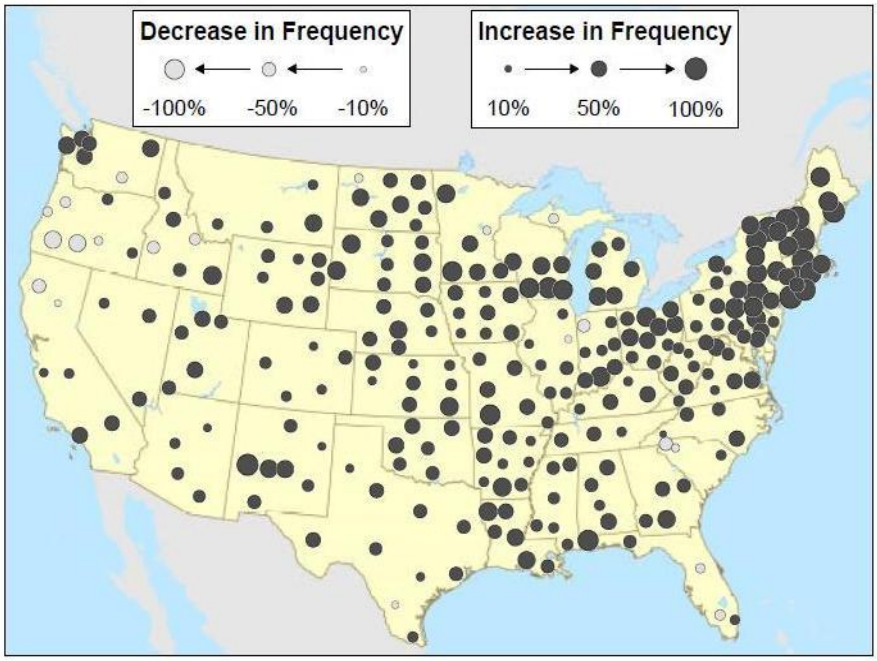


Figure 4-2. Changes in Frequency of Extreme Downpours

(Madsen and Willcox, 2012)

4.2.1.7 Vulnerability and Risk

The impacts of flooding can include injury or death, property damage, and traffic disruption. Flood hazards can also cause erosion, which can compromise water quality, slope stability, and the stability of building foundations. Erosion puts current and future structures and populations located near steep embankments or the coast, at risk. Erosion can also undercut streambeds and scour around stream crossings, creating a serious risk to roadways and bridges.

Much of the infrastructure in Granville, including bridges and the stormwater system, were designed for historic flooding scenarios. Since the design and construction of this infrastructure, the Town has experienced flood events that have surpassed historic norms that have put this vital infrastructure at risk.

Critical Facilities Flood Vulnerability Analysis

Hazard location and extent of riverine flooding was determined using the FIRM for Zone A. A flood exposure analysis was conducted for critical facilities and vulnerable populations throughout the municipality utilizing MassGIS data, FEMA flood maps, and information gathered from the municipality. Table 4-2 below displays critical facilities in Granville that are located within the 100-year FEMA flood zone.

Table 4-2. Critical Facilities Located within the FEMA Flood Zone

Facility	Address	100-Year Flood Zone
Granville Federated Church	16 Granby Road	X
Granville County Store	11 Granby Road	X
Fuel Station	11 Granby Road	X

Out of 41 critical facilities in Granville, three are in the 100-year flood zone as displayed above. It is important to protect this infrastructure from flooding as they are important facilities that residents rely on.

Development and Flood Vulnerability Analysis

To determine the Town's vulnerability to flooding, a Hazus flood analysis was conducted on land use types in Granville. The Town's land use was overlaid with the 500-year FEMA flood zones, and the overlap was noted. Social and economic loss was also taken into account in this analysis.

The results of the vulnerability assessment conducted for Granville's existing community assets are summarized in Tables 4-3. These include an exposure table for natural hazards with geographically defined risk areas (FIRM zones). Table 4-3 below shows the detailed exposure of buildings in 100-year flood zones by parcel type. The value of all buildings and their exposure to flooding within the FIRM zones is also listed. A total of 684 buildings are estimated to be located in Granville, with a total building value of $190,329,000. Approximately 91.52% of the buildings in Granville are residential.

Table 4-3. Exposure of Parcels in 500-Year Flood Zones by Land Use Type

Land Use Type	Property Value of Parcels	Percentage of Total Buildings Value	Property Value in the Flood Zone	Percentage of Total Building Value Impacted
Residential	$160,833,000	84.5	97,927,000	86.6
Commercial	10,060	5.3	$6,697,000	5.9
Industrial	6,198,000	3.3	$2,683,000	2.4
Religion	1,250,000	0.7	$0	0
Agricultural	4,729,000	2.5	$2,242,000	2.0
Government	725,000	0.4	$725,000	0.6
Education	6,534,000	3.4	$2,800,000	2.5

Land Use Type	Property Value of Parcels	Percentage of Total Buildings Value	Property Value in the Flood Zone	Percentage of Total Building Value Impacted
Total	$190,329,000	100	$113,074,000	100

Looking at building damage by occupancy, it is calculated that approximately four residential buildings with between one and ten occupants and one building with between 11 and 20 occupants may sustain damage. All damage will occur to wood construction buildings, and up to 90 tons of debris could be generated during a 500-year flood. Total building related losses, including direct building losses and business interruption losses, are estimated to be $26.49 million.

Recent and planned developments were overlaid with FEMA flood zone maps to determine their vulnerability to flooding. The exposure of potential development was documented by the area and percentage of parcels that overlap with a flood zone. Only one recently developed residential parcel is located partially within the 100-year flood zone.

4.2.2 Stormwater Flooding

4.2.2.1 Description

Stormwater flooding, also known as urban flooding, occurs during a short-term, high intensity precipitation event where the rate of rainfall is greater than the capacity of the stormwater management system. This may be due to an undersized culvert, poor drainage, topography, high amounts of impervious surfaces, debris that causes the stormwater system to function below its design standard, or a combination of these factors. In these cases, the stormwater management system becomes overwhelmed, causing water to inundate roadways and properties. The winter and spring thaw can also present flooding challenges for the Town by way of clogged catch basins, which can cause water to backup and flood parking lots and roadways.

4.2.2.2 Severity

Stormwater flooding is primarily a nuisance that will dissipate within a few hours, but under some circumstances it can cause serious property damage and put people at risk. Stormwater flooding is typically shorter in duration and more localized than riverine flooding. When stormwater flooding occurs the flood waters can range from a few inches to a few feet in depth.

4.2.2.3 Probability

Based on historic occurrences, stormwater flooding is considered a high frequency event. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur more frequently than once in 5 years or greater than 20% a year.

4.2.2.4 Location

Stormwater flooding is most likely to occur near stormwater collection sites that are undersized or at locations of blockages in the stormwater system. Stormwater flooding may also be caused by high water at stormwater outfall sites, causing backflow to occur. Stormwater flooding is a Town-wide hazard for Granville, with some known areas of undersized drainage being more susceptible.

4.2.2.5 Historic Occurrences

Stormwater flooding has occurred along Route 57. This is due to multiple undersized culverts along the roadway. The DPW has been working diligently in recent years to replace update these culverts to reduce flooding.

4.2.2.6 Climate Change

Most stormwater systems in Massachusetts are aging and were designed with rainfall data that is no longer accurate. Figure 4-3 shows how anticipated rainfall during design storms has increased from 1961 to 2015, especially for the larger 24-hour, 100-year event. With climate change, the intensity and duration of rainfall is projected to increase, which will further stress the current system. This combination of issue will likely result in an increase of stormwater flooding events within the Town.

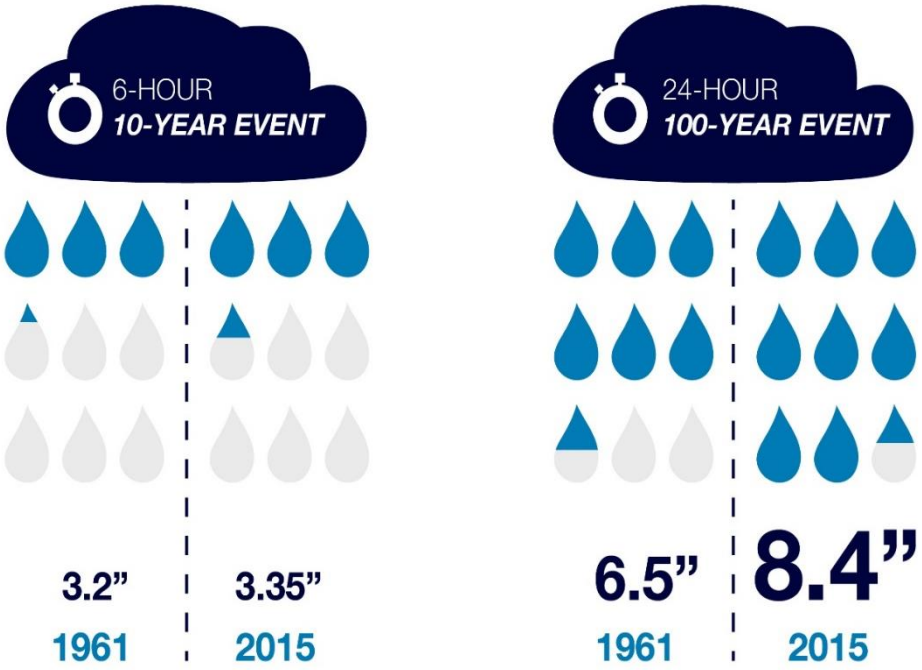


Figure 4-3. Stormwater Design Standards (NOAA TP 40, 1961 and NOAA, 2015)

Green infrastructure or low impact development improvements can help reduce demand on the existing stormwater system by increasing infiltration on-site. Rain gardens and pervious pavement are two examples of possible strategies. Upsizing culverts with new rainfall data is also recommended.

4.2.2.7 Vulnerability and Risk

The risks associated with stormwater flooding are relatively similar to those of riverine flooding. Property damage and public health and safety are primary concerns. Due to the localized nature of stormwater flooding, the risk can be less severe; however, predicted increase in frequency and severity of storm events means that even small storms can begin to overburden the stormwater system due to cumulative impacts. This results in an overall increase in stormwater flooding events and the associated impacts.

4.3 Dam Failure

4.3.1 Description

Dam failure is defined as a collapse of an impounding structure resulting in an uncontrolled release of impounded water from a dam (DCR, 2017a). There are two types of dam failures that can occur. Catastrophic failure occurs when there is a sudden, rapid, uncontrolled release of impounded water. Design failure occurs as a result of minor overflow events, including dam overtopping. This occurs when water exceeds the capacity of the dam, which can be due to inadequate spillway design or other outside factors such as settlement of the dam crest or back of spillways. Thirty-four percent of all dam failures

that occur in the United States are a result of overtopping (EEA and EOPSS, 2018). Many dam failures in the United States have been the secondary result of other disasters. Prominent causes include earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage (MEMA and DCR, 2013).

There are 16 dams located within the Town of Granville. In addition, there are regional dams that could impact Granville if they were to fail (DCR, 2019). Table 4-4 provides information on dams located in the Town of Granville.

Table 4-4. Granville Dam Inventory

Dam Name	Primary Owner	Hazard Class
Phelon Pond Dam	Unknown	Low
Cooley Lake Dam	Private	Significant
Granville Reservoir Dam	City of Westfield	High
Degano Pond Dam	Unknown	Low
E.A. Jensen Pond Dam	Unknown	N/A
Don Noble Pond Dam	Private	N/A
Dickinson Pond Dam	Private	Low
Noble & Cooley Drum Shop Pond Dam	Unknown	N/A
Wells Mills Dam	City of Westfield	N/A
Lower Arnold Pond Dam	City of Westfield	N/A
Japhet Reservoir Dam	City of Westfield	N/A
Strong Pond Dam	City of Westfield	N/A
Winchell Reservoir Dam	City of Westfield	N/A
Granville S.F. Dam	DCR	N/A
Woodger Pond Dam	Unknown	N/A
Bahre Pond Dam	DCR	Low

(DCR, 2019)

4.3.1 Severity

DCR categorizes dams according to the potential extent of the hazard in the case of a dam failure. Below is a description of dam hazard classification.

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

Significant Hazard: Dams located where failure or mis-operation may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities.

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

As of February 2017, all dams classified as a high hazard potential or a significant hazard potential were required to have an Emergency Action Plan (EAP) (DCR, 2019a). This plan must be updated annually and submitted to the DCR Commissioner and the Massachusetts Emergency Management Agency.

The plan should also be retained by the dam owner and the City or Town in which the dam is located. Guidelines and a template were established by the Office of Dam Safety to ensure that all EAPs follow the proper format. Granville may want to consider requesting the EAPs for dams upstream of the Town.

4.3.2 Probability

Dam failures as a result of flood events are of concern in Massachusetts given the high density of dams constructed in the 19th century (MEMA and DCR, 2013). Due to the large number of existing dams, DCR's Office of Dam Safety maintains records of dams located state-wide ensuring compliance with acceptable practices pertaining to dam inspection, maintenance, operation, and repair. Due in part to this proactive dam safety program, dam failure is classified as a low frequency event in the Town. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, a low frequency hazard may occur less frequently than once in 100 years (less than a 1% chance per year).

4.3.3 Location

A total of 16 dams, as indicated in Table 4-5 above, are located in the Town of Granville. The location of these dams is displayed on the critical facilities map in Appendix B.

4.3.4 Historic Occurrences

There have been no instances of dam failure in Granville, although there is one dam located in Town and owned by the City of Springfield that often causes flooding downstream when water is released from the impoundment. The municipalities are working together to understand and prepare for the release of water.

4.3.5 Climate Change

Climate change may also indirectly affect dam breaches for a variety of reasons. Dams are typically designed based on historic water flows and known hydrology. Climate change projections indicate that the frequency, intensity, and amount of precipitation will increase in New England. This anticipated increase in precipitation may push dams over capacity, placing additional stress on dam infrastructure. Therefore, continuing and enhancing dam monitoring will be crucial to maintaining safe dam conditions. There are several mechanisms in place to manage increased volume in water bodies, such as slowly releasing impounded water at scheduled intervals. It is advised that these controlled events are monitored closely as they can add additional stress on the dam infrastructure.

4.3.6 Vulnerability and Risk

A dam failure could result in catastrophic impacts to both Granville and the surrounding municipalities that rely on Granville for their drinking water. Downstream communities could also be impacted by a dam failure. In addition, the breach may result in erosion on the rivers and stream banks that are inundated. These impacts can be at least partially mitigated through advance warning to communities impacted by a dam failure.

4.4 Wind Related Hazards

High winds occur during a variety of weather events, most notably during hurricanes, tropical storms, tornadoes, nor'easters, and thunderstorms, all of which affect Granville to varying degrees.

4.4.1 Severe Thunderstorms

4.4.1.1 Description

According to NOAA's National Severe Storms Laboratory, a severe thunderstorm is a rain event, accompanied by thunder and one or more of the following: hail one inch or greater, winds gusting in excess of 50 knots (57.5 mph), or a tornado (NOAA, n.d.-c). Thunderstorms in Massachusetts are usually accompanied by rainfall; however, thunderstorms with little or no rainfall have occurred, but are rare in New England (EEA and EOPSS, 2018).

4.4.1.2 Severity

Thunderstorms are typically less severe than other hazard events discussed in this section. Thunderstorms typically last for about 30 minutes and can generate winds of up to 60 mph. Winds associated with thunderstorms can knock down trees, resulting in power outages and blocked evacuation and transportation routes. Extreme rain during thunderstorms can cause inland flooding around waterbodies or due to surcharged drainage systems. During periods of drought, lightning from thunderstorm cells can result in fire ignition (EEA and EOPSS, 2018).

4.4.1.3 Probability

Based on historic occurrences, severe thunderstorms are considered high frequency events in Granville. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur more frequently than once in five years (a greater than 20% chance per year).

4.4.1.4 Location

Thunderstorms can cause local damage and are a Town-wide risk in Granville. The entire Town is equally susceptible to impacts from thunderstorms, which can include lightning, strong winds, heavy rain, hail, and sometimes tornados.

4.4.1.5 Historic Occurrences

NOAA's Storm Event Database offers thunderstorm and hail data for Hampden County (NOAA, 2020). Between 2000 and 2021, 132 thunderstorm events caused $5,139,200 in property damages in Hampden County. Three injuries and no deaths were reported. The major thunderstorm events that affected Granville caused downed trees, branches, and powerlines, leading to roadblocks and power outages in parts of the Town.

NOAA's National Centers for Environmental Information offers thunderstorm wind, high wind, and strong wind data for Hampden County. Between 2000 and Sept. 2020, 149 wind entries were uploaded into the database. Other wind events were related to low pressure cells, rains, and other hazard events. During this time period, there were no deaths, four injuries, and a total of $5,035,700 worth of damages from thunderstorm wind events in Hampden County. In some cases, winds in excess of 70 miles per hour were reported.

Many of these thunderstorm events were also accompanied by hail. Between 2000 and 2021, there were 18 hail events, but no property damage, deaths or injuries were reported. The size of hail ranged from 0.75" up to 2" (NOAA, 2020).

4.4.1.6 Climate Change

There is evidence that rising temperatures will increase convective available potential energy (CAPE) which is one of the two ingredients needed for severe thunderstorms. The other is strong wind shear. It

is projected that by warming the surface and putting more evaporation in the air CAPE will increase providing more raw fuel to produce rain and hail, and vertical wind shear, resulting in an increased amount of severe thunderstorm activity (NASA, 2021).

4.4.1.7 Vulnerability and Risk

Due to the large spatial extent, all populations and all existing infrastructure, including critical facilities, are at risk to thunderstorms. Potential impacts include damage to buildings from wind, water, and lightning strike, which could cause business interruption, loss of communications, damage to transportation networks, and power failure.

4.4.2 Hurricanes and Tropical Storms

4.4.2.1 Description

Tropical cyclones (including tropical depressions, tropical storms, and hurricanes) form over the warm waters of the Atlantic, Caribbean, and Gulf of Mexico. A tropical storm is defined as having sustained winds from 39 to 73 mph. If sustained winds exceed 73 mph, it is categorized a hurricane. The official hurricane season runs from June 1 to November 30. However, storms are more likely to occur in New England during August, September, and October (MEMA and DCR, 2013).

4.4.2.2 Severity

The Saffir-Simpson scale ranks hurricanes based on sustained wind speeds from Category 1 (74 to 95 mph) to Category 5 (156 mph or more). Category 3, 4, and 5 hurricanes are considered "Major" hurricanes. Wind gusts associated with hurricanes may exceed the sustained winds and cause more severe localized damage (MEMA and DCR, 2013). The Saffir-Simpson scale (Table 4-5) categorizes or rates hurricanes from 1 (minimal) to 5 (catastrophic) based on their intensity. This is used to provide an estimate of the potential property damage and flooding expected along the coast from a hurricane making landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on context (EEA and EOPSS, 2018).

Table 4-5. Saffir-Simpson Scale

Scale No. (Category)	Winds (mph)	Potential Damage
1	74 – 95	**Minimal**: damage is primarily to shrubbery and trees, mobile homes, and some signs. No real damage is done to structures.
2	96 – 110	**Moderate**: some trees topple, some roof coverings are damaged, and major damage is done to mobile homes.
3	111 – 130	**Extensive**: large trees topple, some structural damage is done to roofs, mobile homes are destroyed, and structural damage is done to small homes and utility buildings.
4	131 – 155	**Extreme**: extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail; and some curtain walls fail.
5	> 155	**Catastrophic**: roof damage is considerable and widespread, window and door damage are severe, there are extensive glass failures, and entire buildings could fail.

(MEMA and DCR, 2013) (table originally created by NOAA)

Potential hurricane damage in Granville was estimated using a hurricane modeling software. Hazus Multi-Hazard (Hazus) is a GIS model developed by FEMA to estimate losses in a defined area due to a specified natural hazard. The Hazus hurricane model allows users to input specific parameters in order to model a defined hurricane magnitude, which is based on wind speed. The largest hurricane ever recorded in Massachusetts was a Category 3 hurricane, which occurred in 1954.

The return period of a hurricane is the frequency at which a certain intensity of hurricane can be expected within a given distance of a given location (NHC, 2021). In Massachusetts, the return period for a Category 2 hurricane is approximately 0.01 percent. Hazus models hurricanes based on their return period; therefore, a Category 2 was modeled as a 100-year hurricane. To model the hurricane, first the study region was defined. The Census Tract modeled is 43 square miles with 1,566 people (as of 2010). An estimated 684 buildings are located in the tract with $190 million dollars value, and 91.52% of the buildings are residential.

Granville was outlined in the model using the Census Tract that represents the Town, and the probabilistic scenario was used. The census tract covers other towns beyond Granville, so the results from Hazus are given for the entire census tract and are likely greater than impacts on Granville alone. This scenario considers the impact of thousands of storms that have a multitude of tracks and intensities. The output shows the potential impact that could occur in the Census Tract if a Category 2 hurricane made landfall. Hazus is based on 2010 Census data and 2014 dollars. Table 4-6 below shows the estimated damage from a Category 2 hurricane in the census tract.

Table 4-6. Estimated Damages in Granville's Census Tract from Probabilistic Category 2 Hurricane

Building Characteristics	
Estimated total number of buildings	684
Estimated total building replacement value (Year 2014 $) (Millions of Dollars)	$190,000,000
Building Damages	
# of buildings sustaining minor damage*	4.95
# of buildings sustaining moderate damage*	0.07
# of buildings sustaining severe damage	0
# of buildings destroyed	0
Population Needs	
# of households displaced	0
# of people seeking public shelter	0
Debris	
Total debris generated (tons)*	19,151
Tree debris generated (tons)*	19,135
Brick/Wood debris generated (tons)*	16
# of truckloads to clear building debris (@25 tons/truck)*	1
Value of Damages	
Total property damage*	$2,063,090
Total losses due to business interruption*	$2,063,210

*Granville shares a census tract with other communities, so these numbers are for the entire tract and not just the Town.

In addition to the infrastructural damage, Hazus also calculated the potential societal impact of a Category 2 hurricane on the community. This calculation included lost monetary wage, capital-related rental and relocation costs, as well as expected damages to essential facilities and damages by building material type. A full Hazus risk report for the hurricane can be found in Appendix B.

4.4.2.3 Probability

Based on historic occurrences, hurricanes are considered a medium frequency event in Granville. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard can occur between once in five years to once in 50 years (a 2% to 20% chance per year).

4.4.2.4 Location

Hurricanes have a large spatial extent often spanning several hundred miles across. Due to their size, when hurricanes and tropical storms do occur, they will be a Town-wide hazard.

4.4.2.5 Historic Occurrences

The region has been impacted by hurricanes throughout its history, starting with the Great Colonial Hurricane of 1635, the first recorded hurricane in Massachusetts. Hampden County faced one major Tropical Storm, Irene, in the last 10 years. During the August 2011 Tropical Storm, strong winds occurred across Hampden County, with frequent wind gusts of 35 to 55 mph, along with localized stronger wind gusts exceeding 60 mph.

4.4.2.6 Climate Change

According to NOAA's Geophysical Fluid Dynamic Laboratory (NOAA, 2021) climate change is anticipated to impact hurricanes, although exactly how is not fully understood. A study by NOAA examined every hurricane from 1980 to 2018 and found that the buildup of greenhouse gases in the atmosphere, along with changes in other human pollution, has changed how often storms form in certain locations. Some spots, like the Atlantic basin, saw a "substantial increase" in storms. This indicates that the Atlantic Ocean is likely to experience an increase in the number of hurricanes due to climate change. Figure 4-4 provides additional information on where hurricanes have formed historically. The Atlantic East coast is highlighted in green, showing the Atlantic as a hurricane generating hotspot.

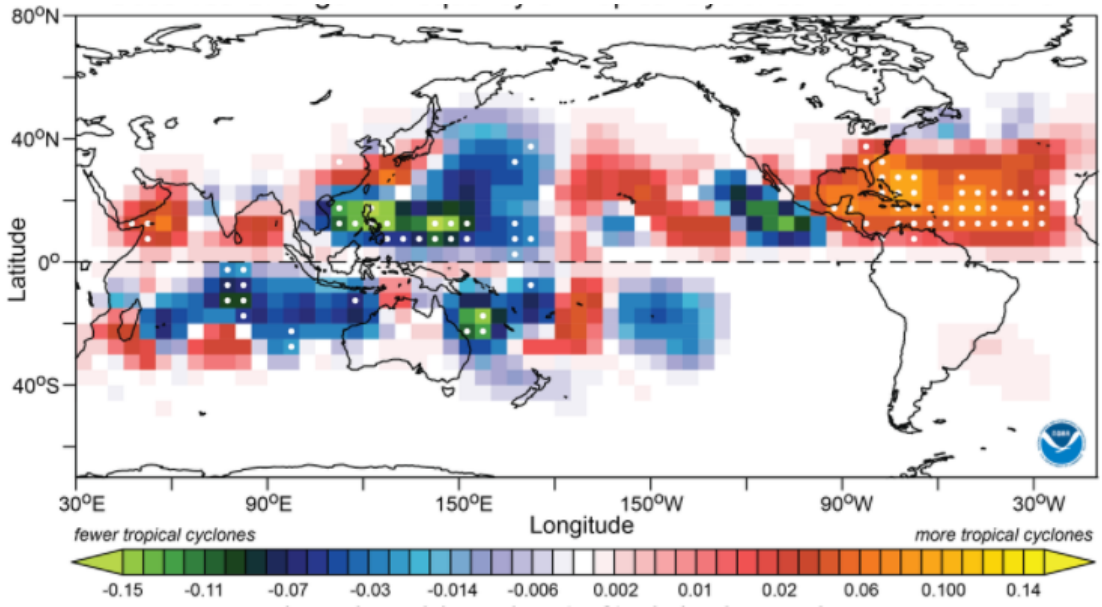


Figure 4-4. Observed Change in Frequency of Hurricanes from 1980 to 2018
(NOAA, 2020)

4.4.2.7 Vulnerability and Risk

Due to the large spatial extent, all populations and all existing infrastructure, including critical facilities, are at risk to hurricane and tropical storm hazards. Potential impacts include damage to buildings from wind and water, business interruption, loss of communications, damage to transportation networks, and power failure. Flooding is a major concern, as slow-moving hurricanes can discharge tremendous amounts of rain on an area. Figure 4-5 provides an overview of the impacts that these extreme events can have on Granville.

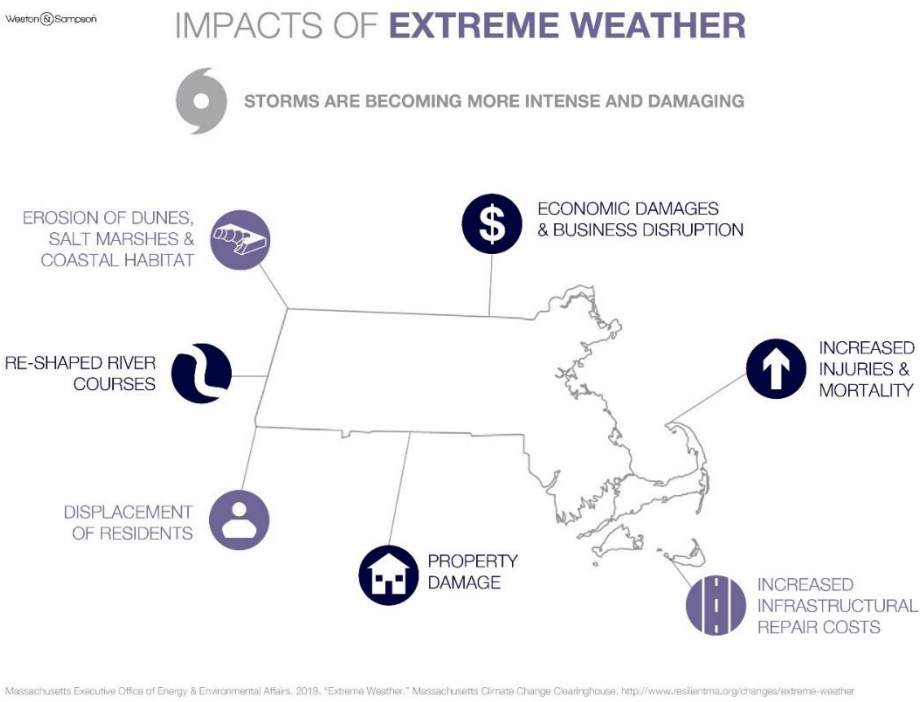


Figure 4-5. Impacts of extreme events and stronger storms on the State of Massachusetts

4.4.3 Tornados

4.4.3.1 Description

A tornado is a narrow, rotating column of air that extends from the base of a cloud to the ground. According to the 2018 SHMCAP, the following are common factors in tornado formation:

- Very strong winds in the middle and upper levels of the atmosphere.
- Clockwise turning of the wind with height.
- Increasing wind speed in the lowest 10,000 feet of the atmosphere (i.e., 20 mph at the surface and 50 mph at 7,000 feet).
- Very warm, moist air near the ground, with unusually cooler air aloft.
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity.

4.4.3.2 Severity

According to the NWS a tornado is a violently rotating column of air touching the ground, usually attached to the base of a thunderstorm (NOAA, n.d.-e). Tornadoes are the most violent of all atmospheric storms (EEA and EOPSS, 2018). They can be spawned by tropical cyclones or the remnants thereof, and weak tornadoes can even form from little more than a rain shower if air is converging and spinning upward. Tornados can cause fatalities and devastate a neighborhood in seconds. The winds of a tornado may reach 300 miles per hour with damage paths in excess of one mile wide and 50 miles long (NOAA, n.d.-e).

The Fujita Tornado Scale measures tornado severity through estimated wind speed and damage. The National Weather Service began using the Enhanced Fujita-scale (EF-scale) in 2007, which led to

increasingly accurate estimates of tornado severity. Table 4-7 provides more detailed information on the EF Scale.

Table 4-7. Enhanced Fujita Scale

Fujita Scale			Derived		Operational EF Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gust (mph)	EF Number	3-second gust (mph)
0	40 – 72	45 – 78	0	65 – 85	0	65 – 85
1	73 – 112	79 – 117	1	86 – 109	1	86 – 110
2	113 – 157	118 – 161	2	110 – 137	2	111 – 135
3	158 – 207	162 – 209	3	138 – 167	3	136 – 165
4	208 – 260	210 – 261	4	168 – 199	4	166 – 200
5	261– 318	262 – 317	5	200 – 234	5	Over 200

(MEMA and DCR, 2013)

4.4.3.3 Probability

Based on historical occurrences, tornado events in Granville are considered a low frequency event. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur once in 100 years (a 1% chance per year). Historical tornado activity around Granville is higher than the average probability in the State.

4.4.3.4 Location

Because tornados are typically generated by strong thunderstorms, the entire Town is equally susceptible, and tornadoes are considered a Town-wide hazard.

4.4.3.5 Historic Occurrences

Although no tornadoes have been reported to have touched down within the Town of Granville, Massachusetts experiences an average of 1.7 tornadoes per year. The most tornado-prone areas of the State are the central counties, which includes Hampden County. There have been 19 recorded tornadoes in Hampden County since 1950 (NOAA, 2020). In 2011, there was an EF3 tornado that touched down in Westfield and passed through southwest and south-central Massachusetts over 38 miles. Three fatalities and 200 injuries were directly attributed to the tornado. It was estimated that 1,400 houses and at least 78 businesses were either damaged or destroyed. Roughly 300 houses were completely destroyed, and three public schools were severely damaged. Total property damages were around $227,600,000.

The most common months for tornadoes to occur are June, July, and August. There are exceptions: The 1995 Great Barrington, Massachusetts tornado occurred in May; and the 1979 Windsor Locks, Connecticut tornado occurred in October (EEA and EOPSS, 2018), among others.

4.4.3.6 Climate Change

Tornadoes are typically spawned by strong thunderstorms. With climate change, storms such as this are expected to increase in frequency and severity. Tornados are difficult to simulate well in climate models because of their small size, but because they are generated by storm events that have been modeled to increase, it is predicted that the frequency of tornados in central Massachusetts will also rise in the future due to climate change.

4.4.3.7 Vulnerability and Risk

As was experienced previously in local tornadoes, if a tornado were to occur in Granville there is the potential for extensive damage. Damages would depend on the track of the tornado and would most likely be high due to the prevalence of older construction and the density of development that exists. Structures built before current building codes may be more vulnerable. Evacuation, sheltering, debris clearance, distribution of food and other supplies, search and rescue, and emergency fire and medical services may be required as part of an emergency response to a tornado event. Critical evacuation and transportation routes may be impassable due to downed trees and debris, and recovery efforts may be complicated by power outages.

4.4.4 Nor'easters

4.4.4.1 Description

A nor'easter is characterized by large counterclockwise wind circulation around a low-pressure center that often results in heavy snow, high winds, waves, and rain along the East Coast of North America. These storms usually develop in the latitudes between Georgia and New Jersey, within 100 miles east or west of the East Coast. They progress generally northeastward and typically attain maximum intensity near New England and the Maritime Provinces of Canada (NWS, 2021). The term nor'easter refers to their strong northeasterly winds blowing in from the ocean.

4.4.4.2 Severity

The storm radius of a nor'easter can be as much as 1,000 miles and sustained wind speeds of 20 to 40 mph are common, with short-term gusts of up to 50 to 60 mph or greater. Nor'easters are commonly accompanied by a storm surge equal to or greater than two feet. High storm surge and winds during a hurricane can last from 6 to 12 hours, while these conditions during a nor'easter can last from 12 hours to three days (EEA and EOPSS, 2018). These winter weather events are among the season's most ferocious storms, often causing beach erosion, flooding, and infrastructure damage (EEA and EOPSS, 2018).

4.4.4.3 Probability

Nor'easters generally occur on at least an annual basis, typically in late fall and early winter. Some years bring up to four nor'easter events. Nor'easters in Granville are high frequency events. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur more frequently than once in 5 years (a greater than 20% chance per year).

4.4.4.4 Location

Due to their large size, the entire Town and region is impacted by a nor'easter event. Nor'easters are considered a Town-wide hazard.

4.4.4.5 Historic Occurrences

Some of the historic events described in the "Flood-Related Hazards" section of this report were caused by nor'easters, including the January 2015 Winter Storm Juno. Three back-to-back nor'easters in March 2018.

4.4.4.6 Climate Change

Nor'easters along the Atlantic coast are increasing in frequency and intensity. Future nor'easters may become more concentrated during the coldest winter months when atmospheric temperatures are still low enough to result in snowfall rather than rain (EEA and EOPSS, 2018).

4.4.4.7 Vulnerability and Risk

The impacts of nor'easters can result in property damage, downed trees, coastal erosion, power service disruptions, surcharged drainage systems, and localized flooding. Nor'easters can often last several days. These prolonged conditions can impact evacuation and transportation routes and complicate emergency response efforts in Granville and throughout the state.

4.5 Winter Storms

Winter storm events are atmospheric in nature and can impact large areas at a time. All current and future buildings and populations are at risk of winter storms, which have a variety of potential impacts. Granville's rural location magnifies impacts. Snow removal becomes difficult with limited staffing and a widespread population. Heavy snow loads may cause roofs and trees to collapse, leading to structural damage. Deaths and injury are also possible impacts. Additional impacts can include road closures, power outages, business interruption, business losses (due to road closures), hazardous driving conditions, frozen pipes, fires due to improper heating, and second-hand health impacts caused by shoveling (such as a heart attack). Public safety issues are also a concern, as streets and sidewalks can become difficult to pass. This issue may be especially difficult for vulnerable populations such as elderly people who may have trouble crossing at intersections due to large accumulations of snow. Impassable streets can also complicate emergency response efforts during an extreme event.

Winter storms are a potential Town-wide hazard in Granville. These events can include wind, heavy snow, blizzards, and ice storms. Blizzards and ice storms in Massachusetts can range from an inconvenience to extreme events that cause significant impacts and require a large-scale, coordinated response. A list of previous federal disaster declarations during winter weather is shown in Table 4-8.

Table 4-8. Previous Federal Disaster Declarations – Winter Weather

Disaster Name and Date of Event	Disaster Number	Type of Assistance	Counties Under Declaration
Snowstorm December 6-7, 2003	EM-3191	FEMA Public Assistance	Middlesex, Essex, Suffolk, Norfolk, Bristol, Plymouth, Barnstable, Berkshire, Hampshire, **Hampden**, Franklin, Berkshire
Snowstorm January 22 - 23, 2005	EM-3201	FEMA Public Assistance	**All** 14 Massachusetts Counties
Severe Winter Storm and Flooding December 11-18, 2008	DR-1813	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	**All** 14 Massachusetts Counties
Severe Winter Storm December 11-18, 2008	EM-3296	None	Middlesex, Essex, Suffolk, Bristol, Berkshire, Hampshire, **Hampden**, Franklin, Berkshire

Disaster Name and Date of Event	Disaster Number	Type of Assistance	Counties Under Declaration
Severe Winter Storm and Snowstorm January 11-12, 2011	DR-1959	FEMA Public Assistance Grant	Middlesex, Essex, Suffolk, Norfolk, Hampshire, **Hampden**, Berkshire
Snowstorm October 29-30, 2011	DR-4051	FEMA Public Assistance	Middlesex, Worcester, Hampshire, **Hampden**, Franklin, Berkshire
Severe Winter Storm, Snowstorm, and Flooding February 8-9, 2013	DR-4110	FEMA Public Assistance	**All** 14 Massachusetts Counties

(FEMA, 2020)

4.5.1 Heavy Snow and Blizzards

4.5.1.1 Description

The National Weather Service defines "heavy snow" as snowfall accumulating to 4 inches or more in 12 hours or less; or snowfall accumulating to 6 inches or more in 24 hours or less (NOAA and National Weather Service, 2019). Winter storms can be combined with nor'easters discussed previously in the "Wind-Related Hazards" section. A blizzard is a winter snowstorm with sustained wind or frequent wind gusts of 35 mph or more, accompanied by falling or blowing snow that reduces visibility to or below a quarter of a mile. These conditions must be the predominant condition over a three-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of the criteria. However, the hazard created by the combination of snow, wind, and low visibility increases significantly with temperatures below 20°F. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced to near zero by snow (EEA and EOPSS, 2018).

4.5.1.2 Severity

NOAA tracks and records historic snowfall data. Table 4-9 shows maximum single day and three-day snowfall data in Hampden County.

Table 4-9. Snowfall Extremes in Hampden County

Event Type	Day	Snowfall Maximums
1- Day	February 12, 1998	26.0"
3-Day	December 13, 1992	29.2"

4.5.1.3 Probability

Blizzards are classified as high frequency events in Granville. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard can occur more than once in five years (a greater than 20% chance of occurring each year).

4.5.1.4 Location

Heavy snow and blizzards impact the entire Town of Granville equally and are considered a Town-wide hazard.

4.5.1.5 Historic Occurrences

There have been 40 winter storms recorded between 2000 and 2020 totaling $1,643,000 in damages in Hampden County (NOAA, 2020a). One of the entries was categorized as a blizzard. No injuries or deaths were reported. The "Blizzard of 1978" is a well-known winter storm that deposited more than three feet of snow and led to multi-day closures of roads, businesses, and schools.

4.5.1.6 Climate Change

Climate change will impact the types of storms Granville will be experiencing. An increase in days hovering around freezing will mean an increase in ice storms, which are discussed in Section 4.5.2 below. Additionally, frequency of blizzards may decrease due to warmer temperatures, but intensity of blizzards when they do occur may increase.

4.5.1.7 Vulnerability and Risk

Winter storms bring hazardous conditions, impacting travel and safety. Slippery roads and whiteout conditions lead to traffic accidents. Additionally, cold temperatures associated with winter storms impact vulnerable populations who may not have the means to stay inside and stay warm.

4.5.2 Ice Storms

4.5.2.1 Description

An ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations (NOAA, n.d.-g). Ice storm conditions are defined by liquid rain falling and freezing on contact with cold objects creating ice build-ups of ¼ inch or more that can cause severe damage. An ice storm warning, now included in the criterion for a winter storm warning, is issued for severe icing conditions. This is issued when ½ inch or more of accretion of freezing rain is expected.

4.5.2.2 Severity

Due to the nature of ice storms, the impacts can be severe and long-lasting. Maintenance and cleanup following an ice storm requires more equipment than would be needed during a snowstorm. Ice is heavy and builds up on infrastructure and natural resources, causing them to collapse or break. If an ice storm is followed by cold weather, it is difficult to melt the ice and travel can be hazardous.

4.5.2.3 Probability

Ice storms are classified as high frequency events in Granville. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard can occur at least once in five years (a greater than 20% chance of occurring each year).

4.5.2.4 Location

The entire Town is equally susceptible to ice storm conditions. Ice storms are considered a Town-wide event in Granville.

4.5.2.5 Historic Occurrences

Four ice storms were reported in Hampden County between 2000 and Sept. 2020. However, climate shifts are resulting in a greater number of days hovering around freezing temperatures, resulting in more freezing rain than has previously been seen in Granville.

4.5.2.6 Climate Change

Climate change will impact the frequency and intensity of storm events Granville will experience. An increase in days hovering around freezing will result in an increase in ice storm conditions.

4.5.2.7 Vulnerability and Risk

Ice storms may lead to dangerous walking or driving conditions and the weighing down of power lines and trees. Icy roads can also complicate emergency response efforts during an extreme event. Cities and towns in the state of Massachusetts that have experienced ice storms where they were without power for days and school were canceled.

4.6 Geological Hazards

Geologic hazards can include earthquakes, landslides, sinkholes, and subsidence.

4.6.1 Earthquakes

4.6.1.1 Description

An earthquake is the sometimes-violent vibration of the earth's surface that follows a release of energy in the earth's crust due to fault fracture and movement.

4.6.1.2 Severity

The magnitude or extent of an earthquake is a seismograph-measured value of the amplitude of the seismic waves. The Richter Magnitude Scale (Richter Scale) was developed in 1932 as a mathematical device to compare the size of earthquakes. The Richter Scale is the most widely known scale that measures earthquake magnitude. It has no upper limit and is not a direct indication of damage. An earthquake in a densely populated area, which results in many deaths and considerable damage, can have the same magnitude as an earthquake in a remote area that causes no damage. Table 4-10 summarizes Richter Scale magnitudes and corresponding earthquake effects (MEMA and DCR, 2013). Earthquakes are often so small that they are not felt in New England.

Table 4-10. Richter Scale and Effects

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

(Louie, 1996)

4.6.1.3 Probability

Earthquakes occur less frequently in New England compared to other parts of the country. Earthquakes are classified as a low frequency event in Granville. As defined by the 2013 State Hazard Mitigation Plan, these events occur from once in 50 years to once in 100 years, or 1% to 2% per year. According to the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, the probability of a magnitude 5.0 or greater earthquake centered in New England is about 10-15% in a 10-year period.

4.6.1.4 Location

There is no record of an earthquake epicenter being located in Granville. While it is possible, damaging earthquakes are not common in Massachusetts. Ground motion during an earthquake is the primary cause of damage to structures. Soft soils amplify ground motion, while hard rock reduces it. In order to measure the ground motion during an earthquake, scientists look at the maximum horizontal acceleration (peak ground acceleration). This is expressed as a "percentage of gravity" or percentage of the force we experience from gravity. It is often shorted to %g. Probability of occurrence is described as the peak ground acceleration (%g) with a 2% probability of exceedance in 50 years. Peak ground acceleration in the state ranges from 8%g to 20%g (USGS, 2016).

A serious earthquake in Massachusetts is possible. Granville is located in an area with a PGA of 6-10 %g with a 2% probability of exceedance in 50 years (Figure 4-6). This is the highest zone in the state.

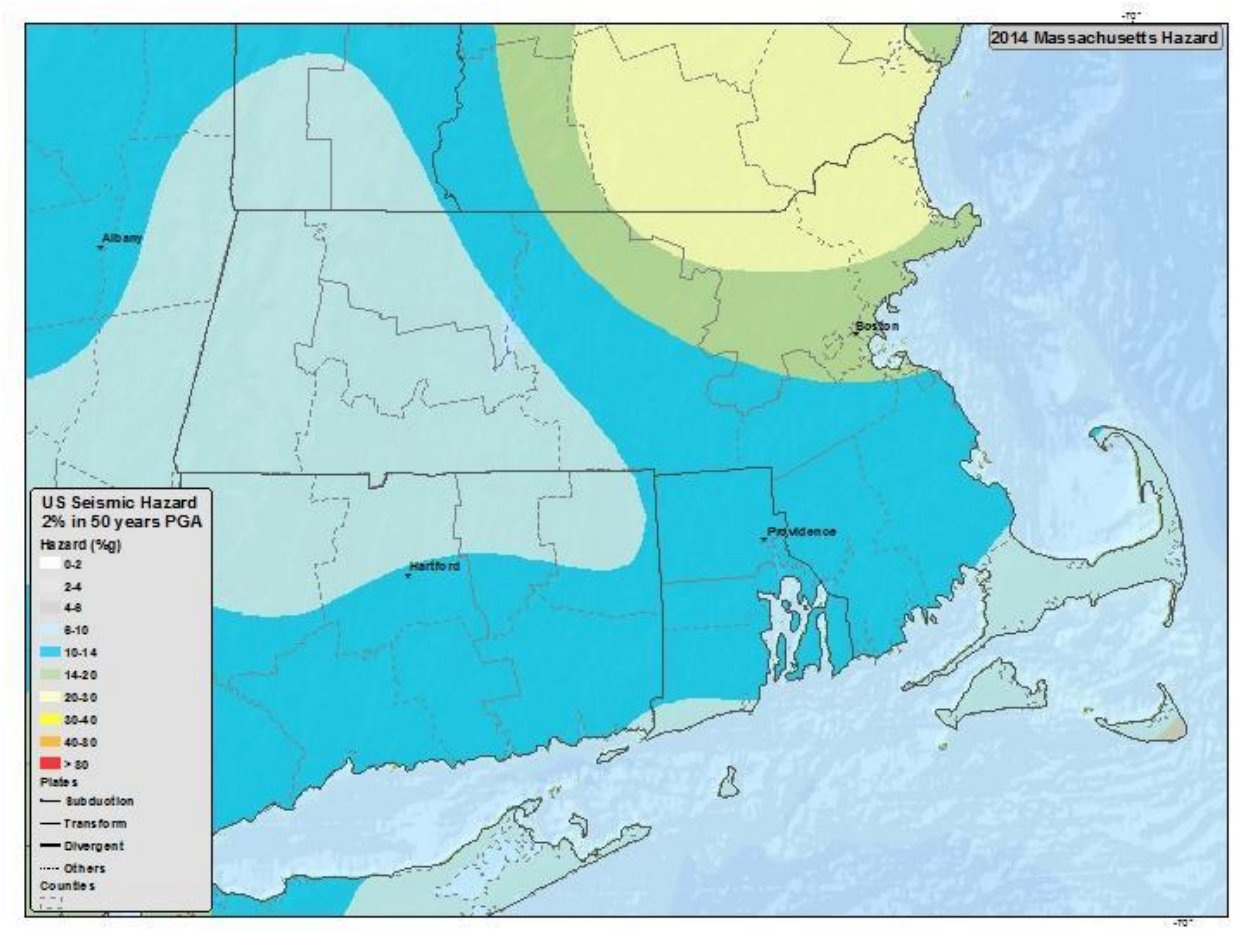


Figure 4-6. 2014 Seismic Hazard Map- Massachusetts

(USGS, 2014)

4.6.1.5 Historic Occurrences

The first recorded earthquake in MA was noted by the Plymouth Pilgrims and other early settlers in 1638. Historically, moderately damaging earthquakes strike somewhere in the region every few decades, and smaller earthquakes are felt approximately twice per year (MEMA and DCR, 2013). A summary of historic earthquakes in Massachusetts is included in Table 4-11 below.

Table 4-11. Historical Earthquakes in Massachusetts and Surrounding Area, 1727-2020

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA - Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA
MA - Boston	12/27/1974	2.3
MA - Nantucket	4/12/2012	4.5
MA – Newburyport	2/20/2013	2.3
MA – Freetown	1/9/2014	2.0
MA – Bliss Corner	2/11/2014	2.2
MA – off Northshore	8/18/2014	2.0
MA – Rockport Coast	6/1/2016	2.2
MA – Nantucket	8/18/2018	2.4
MA – Templeton	12/21/2018	2.1
MA – Gardner	12/23/2018	2.2
MA – Rockport	4/27/2019	2.1
MA – North Plymouth	12/3/2019	2.1
MA – Edgartown	7/24/2020	2.1
MA – Bliss Corner	11/8/2020	3.6

Table 4-11. Historical Earthquakes in Massachusetts and Surrounding Area, 1727-2020

Location	Date	Magnitude
MA – Bliss Corner	11/22/2020	2.0

(USGS, 2020)

4.6.1.6 Climate Change

There is no established correlation between climate change and earthquakes.

4.6.1.7 Vulnerability and Risk

Although new construction under the most recent building codes generally will be built to seismic standards, much of the development in the Town pre-dates the current building code. These events can strike without warning and can have a devastating impact on infrastructure and buildings constructed prior to earthquake resistant design considerations. It can be assumed that all existing and future buildings and populations are at risk to an earthquake hazard. If an earthquake occurs, the entire region, not just the Town of Granville, would face significant challenges.

Impacts from earthquakes can range from slight to moderate building damage, to catastrophic damage and fatalities, depending on the severity of the earthquake event. Events may cause minor damage such as cracked plaster and chimneys, or broken windows, or major damage resulting in building collapse. Based on the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, the degree of exposure "depends on many factors, including the age and construction type of the structures where people live, work, and go to school; the soil type these buildings are constructed on; and the proximity of these building to the fault location." Furthermore, the time of day exposes different sectors of the community to the hazard. Earthquakes can lead to business interruptions, loss of utilities, and road closures which may isolate populations. People who reside or work in unreinforced masonry buildings are vulnerable to liquefaction (liquefaction is the phenomenon that occurs when the strength and stiffness of a soil is reduced by earthquake). Earthquakes often trigger fires, and the water distribution system may be disrupted, thus posing a risk for public health and safety.

Potential earthquake damage was modeled for Granville using Hazus. The Hazus earthquake model allows users to input specific parameters in order to model a defined earthquake magnitude, with the epicenter located at the center of the study region. In this case, the smallest study region available was a census tract. Granville shares a census tract with multiple other small communities, and the results from the Hazus analysis show the impact on the entire census tract. While large earthquakes are rare in Massachusetts, there was a magnitude 5.0 earthquake recorded in 1963 and a Cape Ann magnitude 6.5 earthquake which was used as the basis for this modeling. The table below shows the estimated damage from a magnitude 6.5 earthquake in Granville. In addition to the infrastructural damage, Hazus also calculated the potential social impact, property damage, and business interruption loss. This calculation included a utility system inventory, building damages by construction type, damages to essential facilities and transportation systems, and casualty estimates (Table 4-12). A full Hazus risk report for each earthquake category can be found in Appendix B.

Table 4-12. Estimated Damage in Granville from Historic Magnitude 6.5 Earthquake

Building Characteristics	
Estimated total number of buildings	648

Estimated total building replacement value (Year 2014 $)	190,000,000
Building Damages	
# of buildings sustaining slight damage	0
# of buildings sustaining moderate damage	0
# of buildings sustaining extensive damage	0
# of buildings completely damaged	0
Population Needs	
# of households displaced	0
# of people seeking public shelter	0
Debris	
Building debris generated (tons)	0
# of truckloads to clear building debris (@25 tons/truck)	0
Building-Related Economic Loss	
Income Losses	$0
Capital Stock Losses	$0
Direct repairs (transportation and utility)	$1,178,790,000

4.6.2 Landslides

4.6.2.1 Description

Landslides include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors. These contributing factors can include erosion by rivers or ocean waves over steepened slopes, rock and soil slopes weakened through saturation by snowmelt or heavy rains, earthquake-created stresses that make weak slopes fail, excess weight from accumulation of rain or snow, and stockpiling of rock or ore from waste piles or man-made structures (USGS, 2019).

4.6.2.2 Severity

Landslide intensity can be measured in terms of destructiveness, as demonstrated by Table 4-13 below.

Table 4-13. Landslide Volume and Velocity

Estimate Volume (m^3)	Expected Landslide Velocity		
	Fast moving (rock fall)	Rapid moving (debris flow)	Slow moving (slide)
<0.001	Slight intensity	--	--
<0.5	Medium intensity	--	--
>0.5	High intensity	---	--
<500	High intensity	Slight intensity	--
500-10,000	High intensity	Medium intensity	Slight intensity
10,000 – 50,000	Very high intensity	High intensity	Medium intensity
>500,000	--	Very high intensity	High intensity

Estimate Volume (m^3)	Expected Landslide Velocity		
	Fast moving (rock fall)	Rapid moving (debris flow)	Slow moving (slide)
>>500,000	--	--	Very high intensity

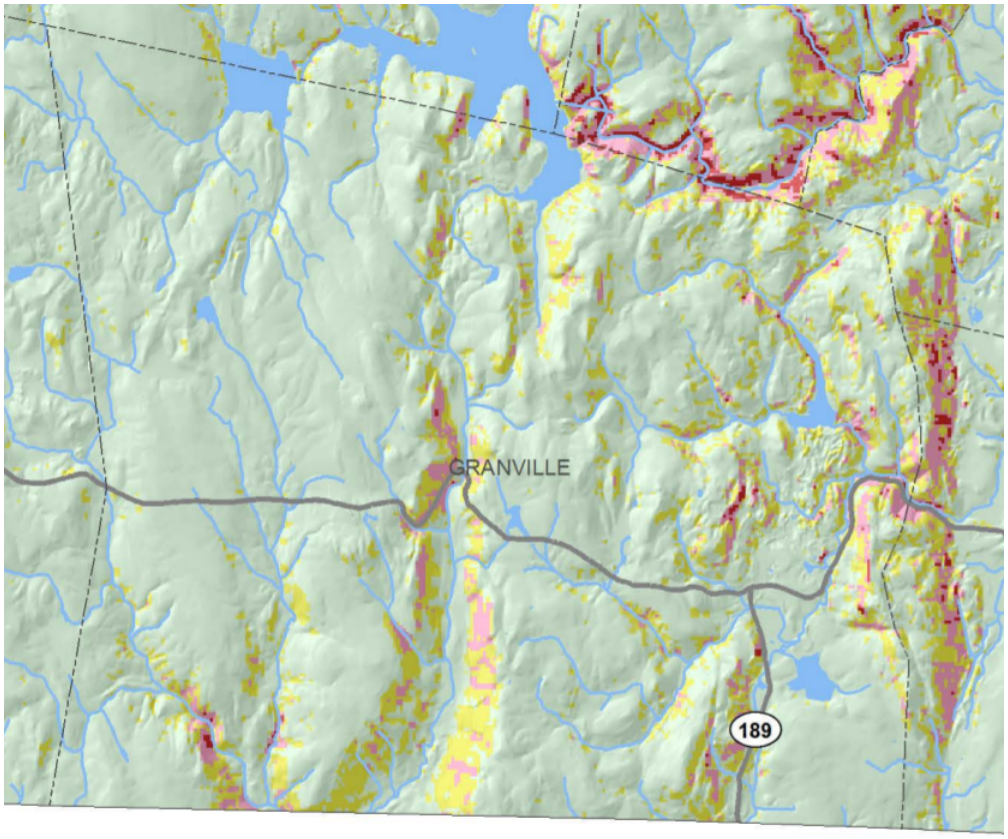
(Cardinali et al., 2002)

4.6.2.3 Probability

Landslides are classified as low frequency events in Granville. According to the 2013 State Hazard Mitigation Plan, these events occur from once in 50 years to once in 100 years, or one percent to two percent per year.

4.6.2.4 Location

Granville is classified as stable and therefore having a low risk for landslides, except for a few locations that are unstable in the northeast and central portions of the town (Figure 4-7). Local officials indicate some erosion occurring along the Tennessee Gas Pipeline, due in part to clearing of vegetation as well as off road vehicles.



Map Color Code	Predicted Stability Zone	Relative Slide Ranking[1]	Stability Index Range[2]	Factor of Safety (FS)[3]	Probability of Instability[2]	Predicted Stability With Parameter Ranges Used in Analysis	Possible Influence of Stabilizing or Destabilizing Factors[5]
	Unstable	High	0	Maximum FS<1	100%	Range cannot model stability	Stabilizing factors required for stability
	Upper Threshold of Instability		0 - 0.5	>50% of FS1	>50%	Optimistic half of range required for stability	Stabilizing factors may be responsible for stability
	Lower Threshold of Instability	Moderate	0.5 - 1	≥50% of FS>1	<50%	Pessimistic half of range required for instability	Destabilizing factors are not required for instability
	Nominally Stable	Low	1 - 1.25	Minimum FS=1	_	Cannot model instability with most conservative parameters specified	Minor destabilizing factors could lead to instability
	Moderately Stable		1.25 - 1.5	Minimum FS=1.25	_	Cannot model instability with most conservative parameters specified	Moderate destabilizing factors are required for instability
	Stable	Very Low	>1.5	Minimum FS=1.5	_	Cannot model instability with most conservative parameters specified	Significant destabilizing factors are required for instability

Figure 4-7. Slope Stability Map of Massachusetts focusing on Granville

(The Massachusetts Geological Survey, 2013)

4.6.2.5 Historic Occurrences

No significant landslides have been recorded for Granville or Hampden County (Appendix B of EEA and EOPSS, 2018).

4.6.2.6 Climate Change

As rainfall increases in both magnitude and intensity, unstable slopes are at a greater risk of landslides. Prolonged droughts, thunderstorms, and strong winds due to climate change create an environment for brushfires. Losing vegetation due to fire reduces the stability of a slope, and when followed by heavy rain the soils have a more difficult time staying in place if located on a slope. This type of environment feeds landslides and erosion, even in areas that have not previously experienced these hazards.

4.6.2.7 Vulnerability and Risk

Landslides occur throughout the United States, causing an estimated $1 billion in damages and 25-50 deaths each year. Any area composed of very weak or fractured materials resting on a steep slope will likely experience landslides.

Although the physical cause of many landslides cannot be eliminated, geologic investigations, good engineering practices, and effective enforcement of land-use management regulations can reduce landslide hazards (USGS, 2019). Landslides can damage buildings and infrastructure and cause sedimentation of water bodies.

4.7 Fire Related Hazards

4.7.1 Description

Granville is more likely to experience a brushfire compared to a wildfire (or a fire with a large impact area). Brushfires can occur in the vegetative wildland, including grass, shrub, leaf litter, and forested tree fuels. Fires can be caused by natural events such as lightning strike, human activity or in an intentional controlled manner, as in the case of prescribed fire (MEMA and DCR, 2013, 252).

4.7.2 Severity

Fire severity is influenced by fuel (the type of material), terrain, and weather. Strong winds can exacerbate extreme fire conditions, especially wind events that persist for long periods, or those with significant sustained wind speeds that quickly promote fire spread through the movement of embers or exposure within tree crowns. Fires can spread quickly into developed areas.

4.7.3 Probability

Brush fires are classified as medium frequency events in Granville. As defined by the 2013 State Hazard Mitigation Plan, brushfires occur between once in five years to once in 50 years (a 2% to 20% chance of occurring per year) across the state.

4.7.4 Location

The State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPPS, 2018) states:

> Portions of the Commonwealth susceptible to wildfire, particularly at the urban-wildland interface…, are defined as those in the vicinity of contiguous vegetation, with more than one house per 40 acres and less than 50 percent vegetation, and within 1.5 miles of an area of more than 500 hectares (approximately 202 acres) that is more than 75 percent vegetated."

The areas of Granville most vulnerable to brush fire are primarily heavily wooded areas and forests directly adjacent to developed areas. The majority of Granville is forested and the Town works to clear Town-owned land to reduce the spread of brushfires. The town also maintains access roads. Much of the land in Granville is owned by neighboring municipalities, therefore it is difficult for Granville to regulate clearing and fire management in these areas. As seem in Figure 4-8, the southeast corner of Granville is most vulnerable to brushfires.

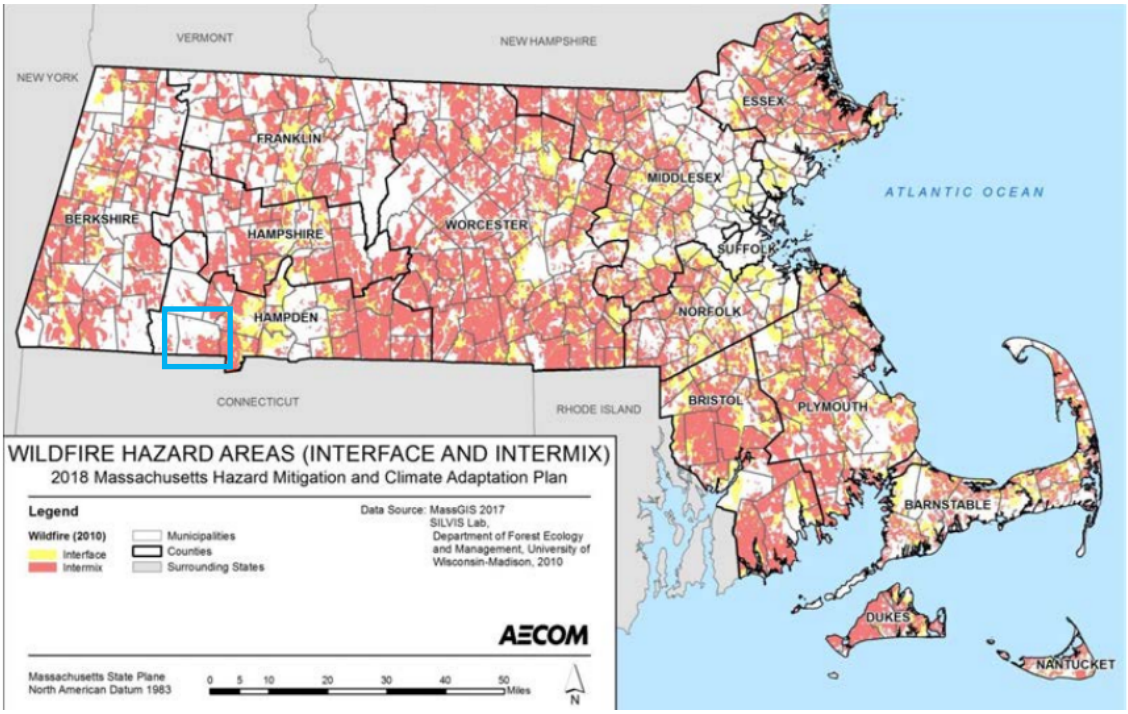


Figure 4-8. Wildfire related hazard areas in Massachusetts, Granville is outlined in light blue

Source: (EEA and EOPSS, 2018)

4.7.5 Historic Occurrences

The Granville Fire Department requires that residents apply for a burn permit when burning brush during the designated burn season. The Fire Department reported that there are occasionally unauthorized burns in one of the Town's forests, but there have not been recent issues with those fires spreading and creating larger brush fires.

4.7.6 Climate Change

Brush fires are often caused by lightning strike. A 2014 study found that the frequency of lightning strikes could increase by more than 10% for every degree Celsius of warming (EEA and EOPSS, 2018). This projected increase in lighting strikes will likely result in more naturally ignited brush and wildfires.

4.7.7 Vulnerability and Risk

Brushfires can lead to injury, death, and property damage. All homes or workplaces located in brush fire hazard zones are at risk. The most vulnerable members of this population are those who would be unable to evacuate quickly, including those over the age of 65, households with young children under the age of five, people with mobility limitations, and people with low socioeconomic status (EEA and EOPSS, 2018). Secondary effects from brush fire include contamination of reservoirs, and destroyed power, gas, water, broadband, and oil transmission lines. Brush fires can also contribute to flooding as they strip slopes of vegetation, thereby exposing them to greater amounts of runoff which may cause soil erosion and ultimately increase the likelihood of flooding. Additionally, subsequent rain events can worsen erosion on bare slopes.

4.8 Extreme Temperatures

Massachusetts has four clearly defined seasons. Extreme temperatures are considered outliers, or temperatures that fall outside the typical range for each season. In this section, we are focused on days with extremely cold and hot temperatures. Extreme temperatures can last from an afternoon to a few days. Day and nighttime temperature fluctuations also factor into the overall effects of temperature. For example, when the temperature does not cool off at night during an extreme heat wave, the risk of heat related illnesses is intensified.

NOAA gathers weather data from Westfield, MA, directly adjacent to Granville. The following table shows temperature averages over the latest three-decade at the Westfield 3 SW weather station (NOAA, 2010).

Table 4-14. Seasonal Temperatures Normals in Granville, MA from 1981-2010

SEASON	MIN TEMP (°F)	AVG TEMP (°F)	MAX TEMP (°F)
Annual	37.8	48.1	58.5
Winter	17.5	26.5	35.5
Summer	58.0	68.9	79.7
Spring	35.5	46.4	57.4
Autumn	39.7	50.4	61.1

4.8.1 Extreme Cold

4.8.1.1 Description

Extreme cold is generally defined as an extended period of excessively cold weather. Expose to extreme cold for extended periods of time or without the proper equipment can result in frostbite or hypothermia, and has the potential to be life threatening.

4.8.1.2 Severity

Extremely cold temperatures are measured using the Wind Chill Temperature Index provided by the National Weather Service (NWS). The updated index was implemented in 2001 and helps explain the impact of cold temperatures on unexposed skin. Figure 4-9 below provides more information.

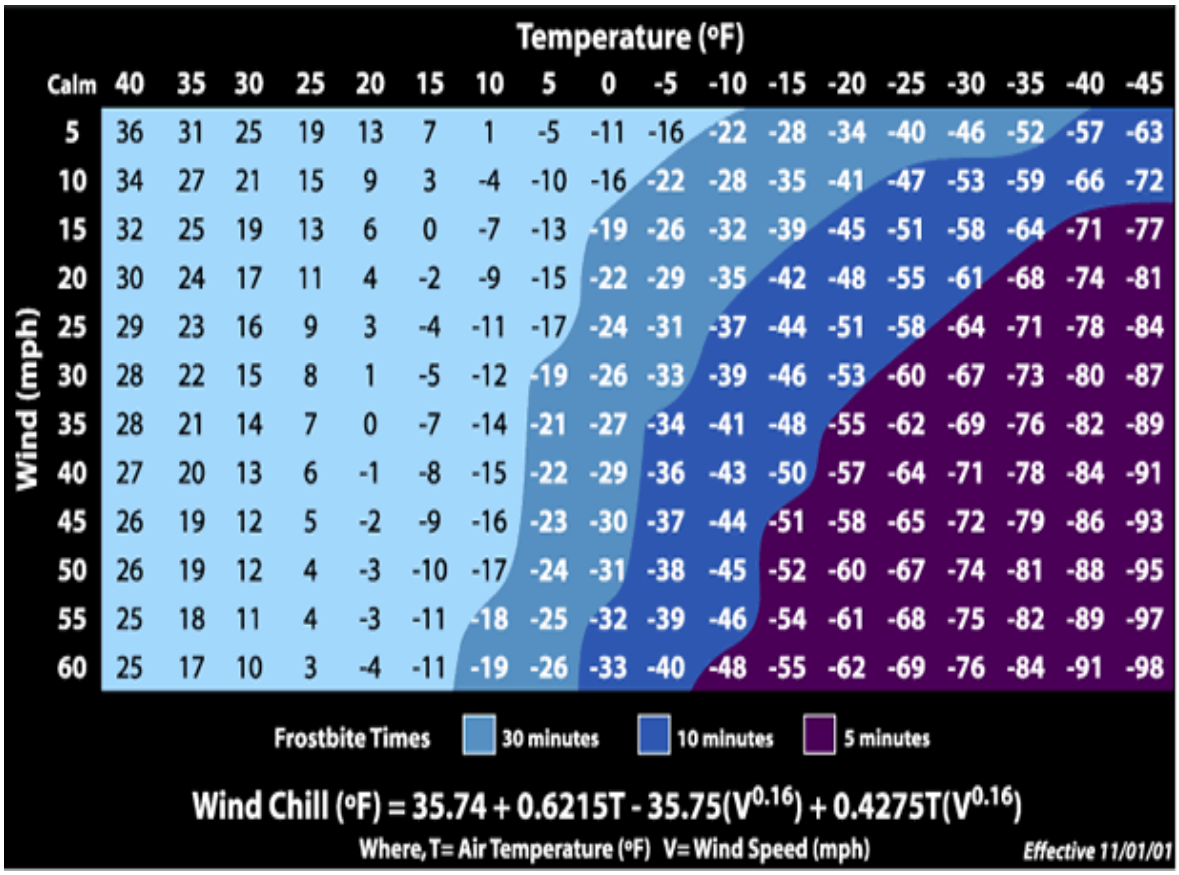


Figure 4-9. Windchill Temperature Index and Frostbite Risk
(NOAA, 2001)

4.8.1.3 Probability

An average of 1.5 extreme cold weather events per year have occurred over the last two decades in Massachusetts. This number could increase due climate change affecting extreme temperatures.

4.8.1.4 Location

Extreme cold temperatures impact large geographic areas and are considered a Town-wide hazard in Granville.

4.8.1.5 Historic Occurrences

NOAA's National Centers for Environmental Information Storm Events Database records data for extreme cold events. Between 2000 and September 2020, Hampden County experienced seven extreme cold and wind chill events, which caused no injuries or property damage, but one death was recorded in February of 2007.

4.8.1.6 Climate Change

With climate change it is anticipated that winters will become warmer, but the risks of extreme cold temperatures will continue to pose a risk in Granville and the region.

4.8.1.7 Vulnerability and Risk

During extreme cold, pipes may freeze and burst in many buildings with unreinforced masonry and improperly insulated buildings.

Extremely cold temperatures can create dangerous conditions for homeless populations, stranded travelers, and residents without sufficient insulation or heat. The homeless, the elderly, and people with disabilities are often most vulnerable. In Granville, 17% of the population is over 65 years old and 9% of the population has a disability (US Census Bureau, 2019). Cold weather events can also have significant health impacts such as frostbite and hypothermia. Furthermore, power outages during cold weather may result in inappropriate use of combustion heaters, cooking appliances, and generators in poorly ventilated areas, which can lead to increased risk of carbon monoxide poisoning.

4.8.2 Extreme Heat

4.8.2.1 Description

Extreme heat is when the maximum temperature reaches above 90°F during the day. July is the hottest month in Granville, with the temperature averaging 73°F from 2000 to 2020 (NOAA, 2020b).

4.8.2.2 Severity

The NWS issues a Heat Advisory when the Heat Index (Figure 4-10) is forecast to reach 100-104˚ F for two or more hours (NOAA, n.d.). The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105˚F or higher for two or more hours. Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. From 1979-2012, excessive heat exposure caused in excess of 8,000 deaths in the United States (MEMA and DCR, 2013). During this period, more people in this country died from extreme heat than from hurricanes, lightning, tornadoes, floods, and earthquakes combined.

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

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

Figure 4-10. Heat Index Chart

(NOAA, n.d.-a)

4.8.2.3 Probability

As defined by the 2013 State Hazard Mitigation Plan, these events occur from once in five years to once in 50 years, or a 2% to 20% chance of occurring per year. According to the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, between four and five heat waves (two or more consecutive days of 90˚F temperatures or higher) occur annually in Massachusetts.

4.8.2.4 Location

Extreme heat impacts a large geographic area and is a Town-wide hazard in Granville.

4.8.2.5 Historic Occurrences

NOAA's National Centers for Environmental Information Storm Events Database provides data on excessive heat. Between 2000 and 2021, Hampden County experienced seven heat or excessive heat days.

4.8.2.6 Climate Change

Between 2000 and 2021, Hampden County experienced seven extreme heat days. Both the average temperature and number of extreme heat days are predicted to increase in future climate conditions. Under these conditions, by the end of the century, Massachusetts's climate could more closely resemble that of Maryland or the Carolinas (refer to Figure 4-11 below).

These changes in temperature would also have a detrimental impact on air quality and public health concerns, including asthma and other respiratory conditions (Frumhoff et al., 2007). Increased temperatures can lead to a longer growing season, which in turn leads to a longer pollen season. Warmer weather can also support the migration of invasive species and lead to an increase in vector-borne diseases. Increasing temperatures can also exacerbate air pollution, which can lead to negative health impacts such as respiratory problems.

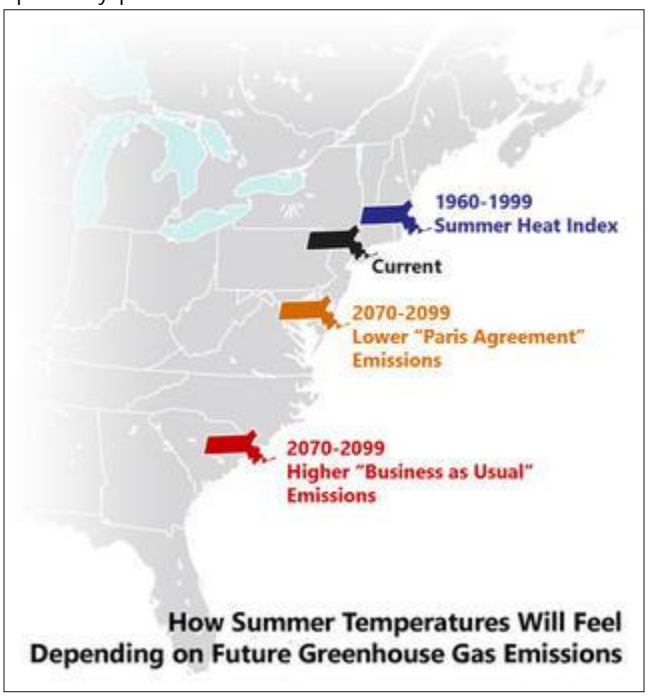


Figure 4-11. Massachusetts Extreme Heat Scenarios.

(Frumhoff et al., 2007)

4.8.2.7 Vulnerability and Risks

Because most heat-related deaths occur during the summer, people should be aware of those at greatest risk and what actions can be taken to prevent a heat-related illness or death. According to the Centers for Disease Control and Prevention, the populations most vulnerable to extreme heat impacts include the following:

- People over the age of 65.
- Children under the age of five.
- Individuals with pre-existing medical conditions that impair heat tolerance.
- Individuals without proper cooling.
- Individuals with respiratory conditions.
- Individuals that overexert themselves during extreme heat events.

Homeless individuals are increasingly vulnerable to extreme heat. The capacity of homeless shelters is typically limited. In Granville, children under five years old make up 6% of the population, and 17% are over 65 years old; however, even young, and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. Some behaviors also put people at greater risk, including drinking alcohol, taking part in strenuous outdoor physical activities in hot weather, and taking medications that impair the body's ability to regulate its temperature or that inhibit perspiration (MEMA and DCR, 2013; ACS 2014-2018).

The Massachusetts Department of Public Health Bureau of Environmental Health provides a community profile related to public health metrics (MA DPH, 2021). Granville's largest concern during heat waves is likely to be older adults (over 65) that make up 17% of the population and are more likely to have pre-existing health conditions. Impacts from heat stress can also exacerbate pre-existing respiratory and cardiovascular conditions.

4.9 Drought

4.9.1 Description

Drought is an extended period of deficient precipitation and occurs in virtually all climatic zones. In Granville, the annual average rainfall from 1981-2010 was 49.87 inches, equating to between approximately 11.5 and 13.25 inches each season, or between 3.5 and 4.5 inches every month, as shown in table 4-15 (NOAA, 2010).

Table 4-15. Average Rainfall Per Season 1981-2010

SEASON	PRECIP (IN)
Annual	49.87
Winter	11.51
Summer	12.34
Spring	12.75
Autumn	13.27

Two types of droughts are likely to occur in Granville: flash droughts and prolonged droughts. A flash drought is a rapidly occurring or intensifying drought. They can happen because of low rates of precipitation, often accompanied by high temperatures, winds, and radiation. These conditions together can intensify the climate in an area (NOAA, 2020c). A prolonged drought has a slower evolution and is caused by a long period of dry weather caused by a lack of precipitation. These two types of drought are not differentiated within this section because location is not variable, and historic occurrences are not differentiated. The primary difference between the two drought types is the severity, which is determined on a month-by-month basis.

4.9.2 Severity

According to the Massachusetts Drought Management Plan (EEA and MEMA, 2019), the Drought Management Task Force provides recommendations to the Secretary of Energy & Environmental Affairs about the location and severity of drought in the Commonwealth. The Drought Management Task Force uses seven indices to determine the severity of a drought, such as groundwater levels, stream flow levels, and crop moisture.

Drought severity is categorized into five levels and data is collected and distributed monthly. The end of a drought is determined by precipitation and groundwater levels, since these have the greatest long-term impact on streamflow, water supply, reservoir levels, soil moisture and potential for forest fires (EEA and MEMA, 2019). Table 4-16 below provides more information on drought levels and varying degrees of action.

Table 4-16. Drought Levels

Level	Severity	Action
0	Normal	No action required
1	Mild Drought	Increased assessment, proactive education, communication, and planning
2	Significant Drought	Water restrictions might be appropriate depending on the capacity of each individual water supply system
3	Critical Drought	Many water suppliers may be relying on mandatory conservation measures and preparation for emergency conditions begins
4	Emergency Drought	The Governor may exercise authority to require mandatory water restrictions

4.9.3 Probability

The probability of a drought occurring varies depending on the severity. A mild drought has between a 20-30% frequency, while and emergency drought has a less than 2% frequency. The overall frequency of being in a Drought Watch is eight percent on a monthly basis over the 162-year period of record (EEA and MEMA, 2019).

4.9.4 Location

Drought levels can be declared on a regional, county, or watershed-specific basis. The Massachusetts Drought Management Plan (2019) divides the state into seven regions: Western, Central, Connecticut River Valley, Northeast, Southeast, Cape, and Islands. Granville is located within the Connecticut River Valley Region (EEA and MEMA, 2019).

4.9.5 Historic Occurrences

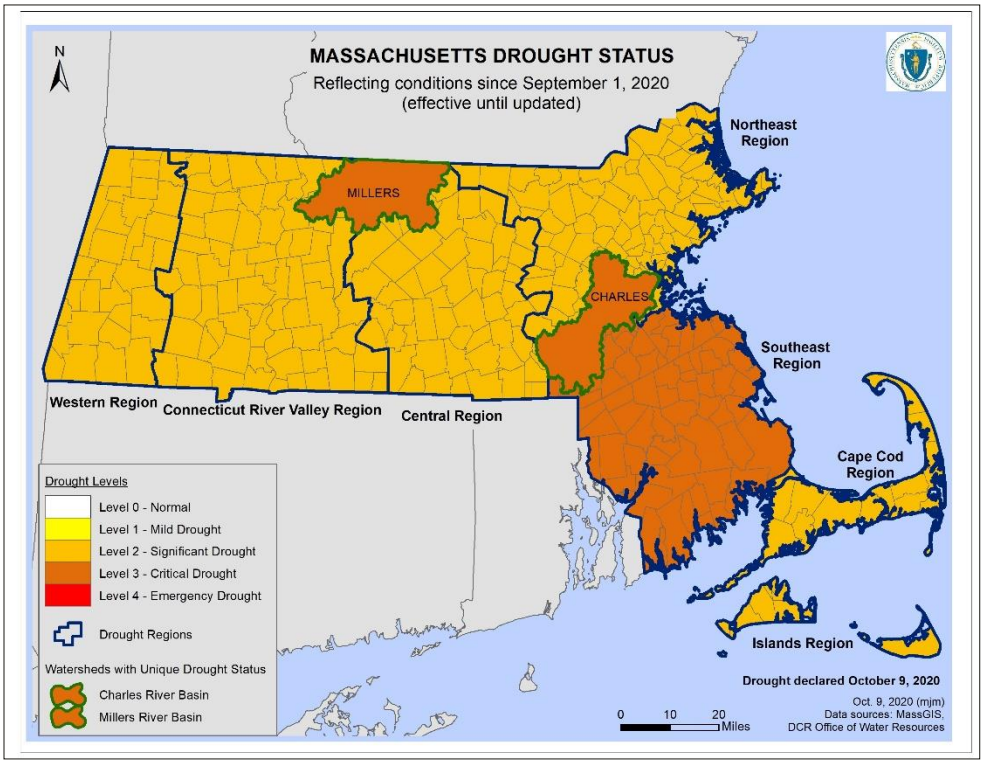


Figure 4-12. Massachusetts Drought Status, September 2020

(DCR, 2020)

Hampden County experienced one recorded drought period from 2000 to 2020, according to the National Center for Environmental Information Storm Events Database. Figure 4-12 illustrates statewide drought levels in Massachusetts from 1850 to 2012, using the Standardized Precipitation Index (SPI). The historical data available for the severity and geographic extent of droughts is not comprehensive, although some data is provided in the Drought Management Plan for the following historical drought occurrences across the state:

- 1879-1883
- 1908-1912
- 1929-1932
- 1939-1944
- 1957-1959
- 1961-1969
- 1980-1983
- 1995
- 1998-1999

The nine-year drought from 1961-1969 is widely considered the most severe drought of record in Massachusetts. The length and severity of this drought forced public water suppliers to implement water-use restriction, and numerous communities utilized emergency water supplies (EEA and MEMA, 2019). More accurate records have been kept since the development of the first Massachusetts Drought Management Plan in 2000 that was developed in response to a period of deficient precipitation that began in 1999.

4.9.6 Climate Change

Under climate change, drought conditions will be exacerbated with projected increasing air temperatures and changes in precipitation. Between 1970 and 2000, the median number of consecutive dry fall days in Massachusetts was 11.4 days. This is in comparison to a projected median of 13.5 consecutive days by the end of the century (EEA, 2018a). The same report also mentions that the occurrence of droughts lasting 1 to 3 months could go up by as much as 75% over existing conditions by the end of the century, under the high emissions scenario in the Northeastern States.

4.9.7 Vulnerability and Risk

Agriculture, water supply, aquatic ecosystems, wildlife, and the economy are vulnerable to the impacts of drought (EEA and EOPSS, 2018).The Town of Granville's drinking water is supplied exclusively by private wells. Reservoirs within the town provide drinking water for three surrounding communities. During a drought, water tables lower and wells do not recharge as quickly, especially for households with shallow wells. A long-term drought could impact Granville's wetlands, rivers, and streams, and the surrounding towns' drinking water reservoirs. Commercial, municipal, and residential water conservation is important during times of drought or low water levels.

Additionally, there is the potential for a severe drought to increase the risk of brush fires. Vegetative fuel for brush fires is more abundant when drought conditions dry out vegetation and make it more susceptible to burning.

5.0 EXISTING MITIGATION MEASURES

The Town of Granville is already undertaking measures to mitigate local hazards. Chapter 5 documents the Town's current operations and discusses potential improvements. FEMA's *Local Mitigation Planning Handbook* categorizes hazard mitigation measures into four types, as displayed in Table 5-1 below (FEMA, 2013). As this chapter will demonstrate, Granville uses many of these tools.

Table 5-1. FEMA's Types of Mitigation Actions

Measure	Action	Examples
Local Plans and Regulations	These actions include government authorities, policies, or codes that influence the way land and buildings are developed and built.	• Comprehensive plans • Land use ordinances • Subdivision regulations • Development review • Building codes and enforcement • NFIP Community Rating System • Capital improvement programs • Open space preservation • Stormwater management regulations and master plans
Structure and Infrastructure Projects	These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.	• Acquisitions and elevations of structures in flood prone areas • Utility undergrounding • Structural retrofits • Floodwalls and retaining walls • Detention and retention structures • Culverts • Safe rooms
Natural Systems Protection	These are actions that minimize damage and losses and preserve or restore the functions of natural systems.	• Sediment and erosion control • Stream corridor restoration • Forest management • Conservation easements • Wetland restoration and preservation
Education and Awareness Programs	These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential mitigation strategies. A greater understanding and awareness of hazards and risk among local officials, stakeholders, and the public is more likely to lead to direct actions.	• Radio or television spots • Websites with maps and information • Real estate disclosure for properties in the floodplain • Presentations to school groups or neighborhood organizations • Mailings to residents in hazard-prone areas.

Measure	Action	Examples
		• Participation in the National Weather Service's StormReady community preparedness program • Participation in Firewise Communities through the National Fire Protection Association's community preparedness program

(*FEMA*, 2013)

There are numerous existing natural hazard mitigation measures already in place in Granville. These were identified through feedback from the Core Team, CRB Workshop participants, interviews with local experts, and additional research by the project team. The hazard mitigation measures outlined below are organized by hazard type, including multi-hazards, floods, dam mitigation, wind, winter weather, drought, fire, extreme temperatures, and geologic hazards.

5.1 Existing Multi-Hazard Mitigation Measures

	Recommended Improvements
Granville Local Emergency Planning Committee – Under the Emergency Planning and Community Right to Know Act of 1986, communities are required to establish Emergency Planning Committees to develop a response plan for chemical emergencies. Granville has a Local Emergency Planning Committee lead by the Emergency Management Director. In accordance with this legislation, the Town of Granville has identified locations where hazardous materials are stored, used, and transported.	Continue to update materials and provide resources for the community. Start a Certified Emergency Response Team (CERT).
Comprehensive Emergency Management Plan (CEMP) – Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. This plan addresses mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. Included in this plan is important information regarding flooding, hurricanes, tornadoes, dam failures, earthquakes, and winter storms.	None at this time.
List of Critical Facilities – The list of critical facilities was updated during this planning process. PVPC has the capacity to digitize this map through an interactive mapping application to update critical infrastructure online.	Work with PVPC to digitize map if needed.
Regional Support from Surrounding Communities – Granville has provided and received additional support from surrounding communities. The support is informally structured. The Granville Emergency Management Director maintains contact with surrounding communities.	Work with neighboring communities to hire regional EMTs, create a regional Council on Aging, collaborate with regional food pantry.

FEMA Deployment – FEMA can deploy vehicles in the case of an emergency.	None at this time.
Salvation Army Emergency Assistance and Disaster Services – Assistance is offered by Salvation Army Emergency Assistance for families and individuals experiencing financial hardships, including food, clothing, and utility/heating assistance. Additionally, Service Units volunteers act as first responders and assist those impacted by fires, flood and other disasters using mobile kitchen truck, as part of the Salvation Army Disaster Services.	None at this time.
Greater Westfield and West Hampton County Medical Reserve Corp – A non-profit organization providing medical care, counseling, and other social services in north Worcester County.	None at this time.
CodeRED – The Town of Granville has the CodeRED system, which provides Town officials the ability to deliver messages to targeted areas or the entire Town quickly through a reverse calling system. Residents may update their CodeRED information on the Town website.	Expand outreach to increase the number of residents receiving alerts.
Emergency Shelters – The Village School is the Town's designated FEMA shelter. If needed, the Town Hall could be used as a shelter, and is sometimes used as a warming and cooling shelter.	Expand resources at the Village School as an emergency shelter.
Backup Generators – The only backup generator in Town is located at the Town Hall.	Install backup generators at critical facilities.
Buried Utilities – Buried utilities are not required but are recommended for new development to reduce power outages and damages to the grid.	Amend bylaws to require underground utilities for new developments.
Permits for Construction – Permits are required from the Building Department to ensure the building code and utility connections are properly made. Public Works requires permits to ensure safe excavation, sewer connections and other stormwater regulations are met. The Fire Department inspects certain aspects of all new construction for fire prevention safety.	None at this time
Multi-Department Review of Developments – Depending upon the type of development, extent of construction, and location, multiple departments, including the Planning Board, Building Department, Board of Health, Department of Public Works, Conservation Commission, the Fire Department, and Zoning Board of Appeals, may review site plans prior to approval.	None at this time

Massachusetts State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads.	None at this time.
Open Space and Recreation Plan (OSRP) 2004 – The Town has a wealth of open space, conservation areas, and recreation spaces that reduce heat island effect and provide flood storage, among other climate resilient co-benefits. The OSRP aims to maintain, promote use, and increase the number of these spaces.	Update the OSRP years with climate resilience and hazard mitigation in mind.
Zoning Bylaws – Zoning regulates the land use of new and redeveloped parcels. Zoning allows, regulates, or guides landscaping, the siting of small energy systems, environmental performance, and safety standards for various land use types. The Zoning Code includes a Floodplain Protection Overlay District which is further described in the following sections.	None at this time.
Rules and Regulations for Special Permits – Procedures and guidelines are set forth in the Zoning Ordinance. Special permits may be issued or approved by the zoning board of appeals.	None at this time.

5.2 Existing Town-Wide Mitigation for Flood Related Hazards

Granville employs a number of practices to help minimize potential flooding, reduce impacts from flooding, and proactively maintain existing drainage infrastructure. Existing Town-wide mitigation measures include the following.

	Recommended Improvements
Participation in the NFIP – Granville participates in the National Flood Insurance Program (NFIP) (FEMA, 2019c). The NFIP is a Federal program administered by FEMA enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. NFIP offers flood insurance to communities that comply with the minimum standards for floodplain management. Granville participates in the NFIP with three policies in force as of December 10th, 2020 (DCR, 2020). FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website. The Town complies with the NFIP by enforcing floodplain regulations, maintaining up-to-date floodplain maps, and providing information to property owners and builders regarding floodplains and building requirements.	Continue participation in the National Flood Insurance Program to enable property owners to purchase insurance protection against flood losses. Increase outreach to property owners with the floodplain. Consider partipation in the CRS.

NFIP uses a Community Rating System (CRS) to award communities that go beyond the minimum standards with lower flood insurance premiums for property owners. The incentives are awarded upon a credit system for various activities. Points are awarded to communities that prepare, adopt, implement, and update a comprehensive flood hazard mitigation plan using a standard planning process. As of December 2020, Granville is not currently participating in the CRS Program (CRS, 2020).	
FEMA FIRMS – Flood Insurance Rate Maps (FIRMs) denote areas of the 100-year and 500-year floodplain, which is used for the NFIP and other regulatory controls. For example, the Building Inspector and the Granville Conservation Commission enforce a federal law requiring elevation above the 100-year flood level of new and substantially improved residential structures in the floodplain. These floodplains are also used in wetland protection and floodplain control regulation. Granville's FEMA FIRMs were last updated in 2013.	Once the new FEMA FIRMs are finished, update regulations referencing the old map. Consider requiring regulatory controls out to the 500-year floodplain to account for climate change.
Stormwater System Maintenance– The Department of Public Works regularly clears debris from its catch basins, storm drains, and culverts across the Town. Catch basins that regularly have more debris and manage more stormwater (like at the bottom of hills) are prioritized. The Department of Public Works also inspects culvert annually and conducted maintenance and upgrades as needed.	None at this time
Maintenance of Public Water Bodies – Debris removal, cleanup in surrounding areas, and maintenance of public water bodies is ongoing in Granville.	None at this time.
Massachusetts Stormwater Management Standards and Handbook – Massachusetts administers stormwater standards through provisions of the Wetlands Protection regulations, 310 CMR 10.00 for wetland notices of intent and surface water discharge permits. The local Conservation Commission and Planning Board regulates this at the local level. The Massachusetts Stormwater Handbook provides guidance on how to meet the regulations and manage stormwater pollution.	The Massachusetts Stormwater Handbook is currently being updated by MassDEP.
Floodplain Protection Overlay District (FPOD) – The Town's FPOD is defined by the 100-year floodplain as designated by FEMA. The Floodplain Overlay District regulates certain activities within a flood zone enhancing federal/state laws. The Floodplain Overlay District is enforced by the Building Inspector (municipal staff) and regulated by Board of appeals.	Considering increased the FPOD to the 500-year floodplain to accommodate the anticipated impacts of climate change.

Massachusetts Wetlands Protection Act and Local Wetlands Protection – The Commonwealths' Wetlands Protection Act (Chapter 131, Section 40 MGL) regulates the protection of resource areas in and around wetlands, including land subject to flooding. This regulates development and activity within a 100-foot buffer around wetlands, and a 200-foot buffer around riverfront areas. The Wetlands Protection Act is locally enforced by the Conservation Commission.	Consider incorporating climate change into local wetlands protection.
Town Assistance and Grants – The Town of Granville, often lead by the Department of Public Works, regularly researches and applies for grants to support the implementation of climate resiliency and hazard mitigation projects.	Apply for flood mitigation related funding opportunities

5.3 Existing Dam Mitigation Measures

	Recommended Improvements
DCR Dam Safety Regulations and Inspections (2017) – All jurisdictional dams are subject to the Division of Conservation and Recreation's dam safety regulations (302 CMR 10.00). The dams must be inspected regularly, and reports filed with the DCR Office of Dam Safety.	Develop a new process for streamlining and completing inspections, possibly with the help of a consultant.
Permits Required for Construction – State law requires a permit for the construction of any dam.	None at this time.
Emergency Action Plans (2017) – DCR requires that all dams classified or reclassified as high hazard potential and significant hazard potential have an Emergency Action Plan. Through the MVP planning grant program, Granville received funding to develop an emergency action plan template.	None at this time.

5.4 Existing Town-Wide Mitigation for Wind-Related Hazards

	Recommended Improvements
Massachusetts State Building Code (Ninth Edition, 2018) – The Town enforces the Massachusetts State Building Code whose provisions are generally adequate to protect against most wind damage. The code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence. If a tornado were to occur, damages would depend on the track of the tornado and would most likely be high due to the prevalence of older construction and the density of development.	None at this time.
Tree Maintenance – The Department of Public Works conducts aggressive removal of hazard trees in the right of way as part of a multi-year project to increase sight line and sun exposure, and decrease power outages and the impacts of severe weather.	Continue hazard tree removal and maintenance.

5.5 Existing Town-Wide Mitigation for Winter-Related Hazards

	Recommended Improvements
Winter Storm Policy – The town has a winter storm policy related to clearing of snow and ice following a winter storm.	None at this time.
Snow Plowing and De-icing Operations – The DPW provides standard snow plowing operations on main arterials, including salting. Certain roads in the Town are subject to ice build-up and require additional attention during cold weather, regardless of snowfall.	The DPW is proposing the constriction of a new Public Works Facility that will be more centrally located for DPW operations including plowing and deicing.
Fuel Assistance – Available to renters and homeowners meeting income guidelines through the New England Farm Workers' Council.	Expand programs to assist low-income households by providing fuel assistance.

5.6 Existing Town-Wide Mitigation for Drought-Related Hazards

	Recommended Improvements
Water Conservation – Most residents in Granville are on private drinking water wells. The Town provides educational materials to residents to assist in individual water conservation.	None at this time.

5.7 Existing Town-Wide Mitigation for Fire-Related Hazards

	Recommended Improvements
Open Burning Permits Required – The Town allows controlled open burning of agricultural products (not construction or building materials) in accordance with state regulations from January 15 to May 1st. The Granville Fire Department requires a permit.	Move permit system online.
Review of Construction – The Fire Department and Building Department review buildings for proper fire protection systems.	None at this time.
Public Education – The Fire Department educates residents about home fire prevention through a variety of avenues, including the development and distribution of pamphlets.	Continue public education efforts and update materials, as necessary. Expand outreach into new forms.
Fire Department Services – There are currently two fire stations in Granville, the Fire Headquarters located in downtown Granville and the West Granville Fire Station.	None at this time
Statewide Fire Mobilization Plan (Massachusetts Fire and EMS Mobilization Plan, 2018)– The state has a fire mobilization plan for brush fires. Granville is prepared to respond to small brushfires.	None at this time.

"Senior SAFE" program – Granville received grant funding for the Senior SAFE Program, which aids in providing fire safety to seniors through the fire department. It also aims to improve safety in senior housing.	Look to secure other grants for continued outreach to vulnerable populations.
Brush Clearing - Brush clearing to provide access to Emergency Service vehicles	None at this time.

5.8 Existing Town-Wide Mitigation for Extreme Temperature-Related Hazards	Recommended Improvements
Tree Maintenance by Town – The Town maintains trees in the right-of-way and numerous trees on public grounds, historic sites, conservation areas, park areas and cemeteries.	None at this time
Heating and Cooling Shelter – The Granville Town Hall can be used as a heating or cooling facility.	Investigate expanding sheltering capacity at the Village School.

5.9 Existing Town-Wide Mitigation for Geologic Hazards	Recommended Improvements
Massachusetts State Building Code – The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is "to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake". This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be "prudent and economically justified" for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, is not economically achievable for most buildings. Section 1612.2.5 establishes seismic hazard exposure groups and assigns all buildings to one of these groups according to a Table 1612.2.5. Group II includes buildings which have a substantial public hazard due to occupancy or use and Group III are those buildings having essential facilities which are required for post-earthquake recovery, including fire, rescue and police stations, emergency rooms, power-generating facilities, and communications facilities.	None at this time.

5.10 Existing Town-Wide Sustainability Measures

Subdivision Regulations – The Town has subdivision regulations designed to protect the natural and built environment from natural hazards.

Recommended Improvements

Update subdivision regulations with floodplain overlay.

5.11 Mitigation Capabilities and Local Capacity for Implementation

Under the Massachusetts system of "Home Rule," the Town of Granville is authorized to adopt and, from time to time amend, a number of local ordinances and regulations that support the Town's capabilities to mitigate natural hazards. These include the Zoning Bylaws and Subdivision Regulations. Local bylaws may be amended to improve the Town's capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission. The Town of Granville has recognized several existing mitigation measures that require implementation or improvements, and has the capacity based on these Home Rule powers within its local boards and departments to address them. The Town also has the ability to expand on and improve the existing policies and programs listed above.

6.0 STATUS OF MITIGATION MEASURES FROM THE 2012 PLAN

6.1 Implementation Progress on the Previous Plan

The Town of Granville has taken steps to implement the 2016 Hazard Mitigation Plan by integrating the findings into the Zoning Bylaws, currently being updated.

Additionally, the 2016 Granville Hazard Mitigation Plan listed several priority actions items. Granville staff and Core Team members reviewed these previous mitigation measures for completion and to determine if the measures were still a priority. As indicated in Table 6-1, the Town completed several mitigation measures. Some of the measures have become continual operation and maintenance and are captured in Chapter 5. Some actions were deferred because of the lack of funding or capacity. The measures that were not completed were evaluated with the Core Team. The decision on whether to remove or retain a particular measure was based on the team's assessment of continued relevance or effectiveness. Table 6-1 summarizes the status of the mitigation measures and their priority.

Table 6-1. Status of Mitigation Measures from the 2016 HMP

Description of Action	Implementation Responsibility	Carry forward in 2021 Plan?
Incorporate risk assessment and hazard mitigation principles into local planning efforts.	Town Administration, Planning Board	Yes
Evaluate all bridges and culverts situated along evacuation routes – Main Road (Route 57), Granby Road (Route 189), and Old Westfield Road to determine need for increased dimensions of drainage culverts in flood prone areas.	Department of Public Works	Yes. All culverts and bridges are inspected annually.
Increase dimensions of drainage culverts in flood prone areas – Replacement of the culvert at Pond Brook crossing of Main Road (Route 57)	Department of Public Works	Yes. Pond Brook culvert was stabilized in an emergency stabilization effort; however, drainage culverts in flood prone areas should continue to be increased in size to accommodate larger rain events and allow for fish and wildlife passage.
Increase dimensions of drainage culverts in flood prone areas – replacement of the culvert at Potash Brook crossing of Main Road (Route 57)	Department of Public Works	Yes. Emergency repair was completed at Potash Brook crossing; however, drainage culverts in flood prone areas should continue to be increased in size to accommodate larger rain

Table 6-1. Status of Mitigation Measures from the 2016 HMP

Description of Action	Implementation Responsibility	Carry forward in 2021 Plan?
		events and allow for fish and wildlife passage.
Procure and install a generator to power Emergency Shelter and Granville Village School	Emergency Management Director	Yes
Recruit residents to serve as volunteer emergency personnel and first responders	Emergency Management Director	Yes. There has been a great improvement in volunteers since 2016 but this in an ongoing measure.
Replacement of existing fire 4x4 brush truck equipment	Fire Department	No. Brush truck is getting a rehab instead of replacement in FY23.
Develop an Emergency Action Plan for high risk dams in coordination with downstream communities of Southwick and Westfield.	Department of Public Works, Emergency Management Director, Fire Department	No.
Implement improvements for all previously identified flooding problem areas.	Department of Public Works	Yes.
Education for homeowners in floodplain.	Council on Aging	Yes, expand education for all residents to reduce and manage localized flooding.

7.0 HAZARD MITIGATION AND CLIMATE ADAPTATION STRATEGY

7.1 Identification of Hazard Mitigation and Climate Adaptation Strategies

The Town developed a list of priority hazard mitigation and climate adaptation strategies through a multi-faceted approach. Strategies were discussed and developed upon review of the:

- Community profile, including the Town's strengths and vulnerabilities
- Hazard and climate change risk assessment
- Existing mitigation measures and the capacity of the Town to respond to extreme events
- Updates from the previous HMP
- Input from stakeholders

Stakeholders were engaged through Core Team meetings, the CRB Workshop, expert interviews, and the Public Listening session. The full list of action items from the CRB Workshop are available in Appendix C and were integrated into the final list of action items vetted by the Core Team. Table 7-1 below represents the Town's high and medium priority action items. Each of these action items was analyzed for its overall benefit, estimated cost, timeframe, and implementation responsibility, which informed prioritization. A description of each prioritization category is included below.

General Objective – An overarching aim related to one or several mitigation actions. The general objective may be achieved through a combination of mitigation actions.

Mitigation Action - A brief description of each mitigation measure identified in this plan.

Primary Implementation Responsibility – Most mitigation measures will require a multi-department approach where several Town departments share responsibility. The designation of implementation responsibility in the table was assigned based on general knowledge of the responsibilities of each municipal department. The lead department for each action item is bolded. Some action items may require collaboration with State departments or private entities. Section 7.2 specifically addresses regional collaboration.

Implementation Time Frame – The time frames represented below are assigned based on the length of time necessary to complete the project. The timeframe is noted in years.

Estimated Implementation Cost – Approximate implementation costs are provided as an estimate for all mitigation measures. All cost data would need to be updated at the time of design and construction.

• $: <$10,000 • $$: $10,000-$100,000 • $$$: $100,000-$250,000	• $$$$: $250,000-$500,000 • $$$$$: $500,000+

Priority – Designation of high, medium, or low priority was based on overall potential benefits. A High Priority action is very likely to have political and public support and necessary maintenance can occur following the project. A Medium Priority action may have political and public support and necessary maintenance had potential to occur following the project. A Low Priority action may not have political and public support for implementation or the necessary maintenance support following the project.

Residents were asked how Granville should prioritize climate adaptation and hazard mitigation measures. Most residents felt the impact to public safety should be considered first, followed by funding and time frame (see Appendix D for more details).

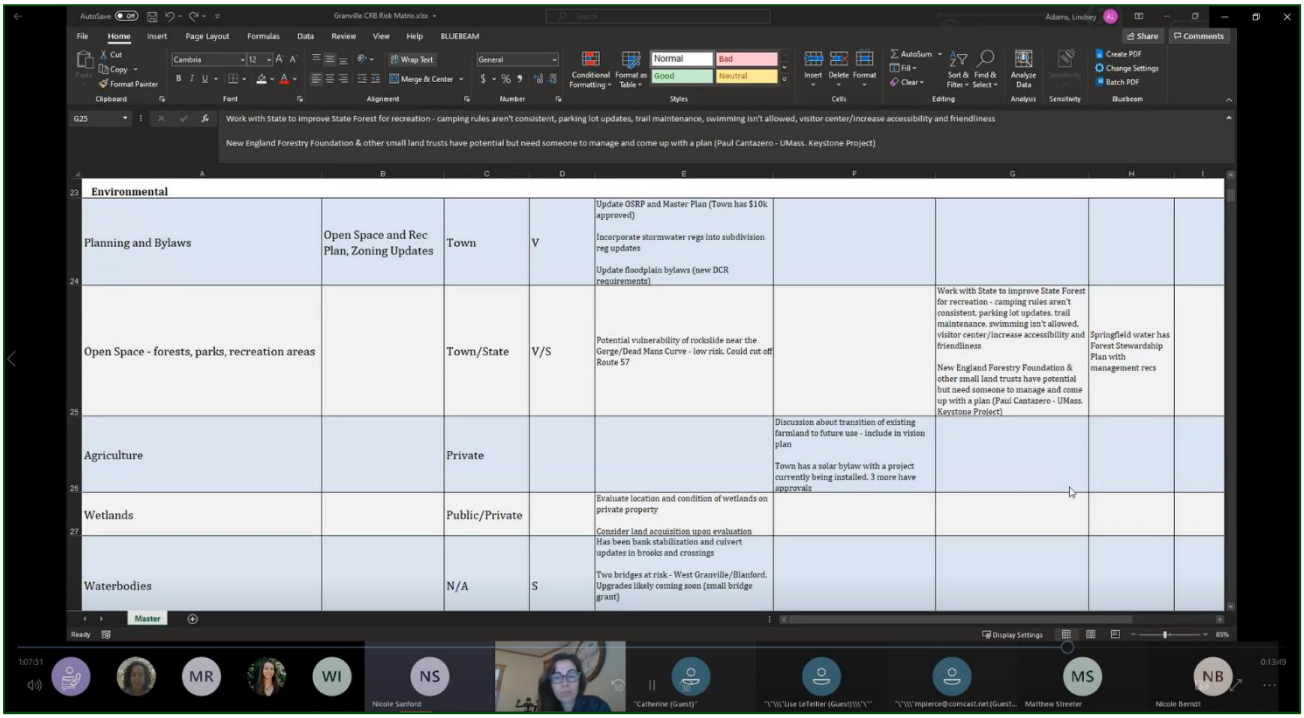


Figure 7-1. Participants Developed and Prioritized Mitigation Actions

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Mitigation Action	Implementation Responsibility	Time Frame (years)	Estimated Cost	Priority	Potential Funding Source
Drainage Infrastructure	Evaluate culverts and repair or increase dimensions as necessary to reduce flooding, accommodate larger rain events, and allow for fish and wildlife passage.*	• **Department of Public Works**	3-5	$$$	H	Culvert Replacement Municipal Assistance Grant Program, MVP
Water Infrastructure	Create a designated location at Fire Station and/or Town Hall where residents can access potable water during power outages	• **Water Department** • Town Administrator • Fire Department	1-3	$	H	Staff Time
	Add a cistern for fire fighting on the western side of town	• **Fire Department**	3-5	$$$$	M	Emergency Management Performance Grant (EMPG), MVP
	Implement a Regional Drinking Water Plan	• **Water Department**	3-5	$	M	Staff Time
Bridges	Feasibility study to update bridges for natural hazard and projected rainfall data	• **Department of Public Works**	5-10	$	M	Small Bridge Program, MVP
	Continue annual inspection of bridges and culverts*	• **Department of Public Works**	1-3	$	M	Staff Time

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Mitigation Action	Implementation Responsibility	Time Frame (years)	Estimated Cost	Priority	Potential Funding Source
Dams	Coordinate with dam owners to acquire dam tracking and inspection information	• Department of Public Works	3-5	$	M	Staff Time
	Investigate private dam ownership and use	• Department of Public Works	3-5	$	M	Staff Time
Gas and electric utilities	Work with gas company (Tennessee Gas Company) to revegetate eroding slope in gas line easement	• Department of Public Works	1-3	$	H	Tennessee Gas Company
	Conduct a feasibility study for solar and battery backups at municipal buildings	• Department of Public Works	1-3	$	H	MVP
	Install generators at Fire Station and Emergency Shelter	• Department of Public Works • Fire Department	3-5	$$	H	HMGP
	Revamp tree trimming program to reduce power outages	• Department of Public Works	3-5	$	M	MVP
Roadways	Conduct public education to reduce storm drain blockages and resulting flooding	• Department of Public Works	1-3	$	H	Staff Time
Communications	Investigate possibility of adding a cell tower in town	• Department of Public Works	1-3	$	H	BRIC

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Mitigation Action	Implementation Responsibility	Time Frame (years)	Estimated Cost	Priority	Potential Funding Source
	Increase outreach by further utilizing CodeRed, local cable, Country Caller, etc. for both emergency and non-emergency situations	• Town Administrator	1-3	$	H	Staff Time
	Add redundancies to emergency communications infrastructure	• Department of Public Works • Fire Department • Police Department	1-3	$$	H	BRIC
Vector-Borne Diseases	Create and distribute public education on ticks and mosquitos.	• Health Department	1-3	$	M	Staff Time
Emergency Services and Volunteers	Start a CERT team	• Emergency Management	1-3	$	H	MEMA Citizen Corps Program (CCP) Grant
	Work with neighboring communities to hire additional regional EMTs	• Emergency Management	1-3	$	H	Staff Time
People with possible barriers to building resilience	Create a designated heating and cooling shelter at Town Hall	• Town Administrator	1-3	$	H	BRIC
	Increase communications to vulnerable populations	• Health Department	1-3	$	H	Staff Time
	Work regionally to create a Council on Aging	• Health Department	1-3	$	H	Staff Time

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Mitigation Action	Implementation Responsibility	Time Frame (years)	Estimated Cost	Priority	Potential Funding Source
Regional Services	Collaborate with regional food pantry to provide services more efficiently to residents in need	• Health Department • Town Administrator	1-3	$	M	Staff Time
Planning and Bylaws	Create a master plan to investigate updating bylaws to protect and preserve Granville while expanding development	• Planning Department	3-5	$	H	Conservation Assistance Grant Program
	Create a housing authority to oversee updating housing bylaw updates	• Planning Department • Town Administrator	3-5	$	H	Staff Time
	Update OSRP, incorporate stormwater regulations into subdivision regulation update	• Conservation Commission	5-10	$	M	Conservation Assistance Grant Program
	Update floodplain bylaws	• Conservation Commission	5-10	$	M	Conservation Assistance Grant Program
Open Space	Monitor Gorge/Dead Man's Curve for potential stabilization to prevent rockslide	• Department of Public Works	1-5	$	M	Staff Time
	Work with the State to improve Granville State Forest for recreation	• Conservation Commission	3-5	$	M	Federal Land & Water Conservation Fund, MassTrails Program
	Develop a plan to partner with small land trust for recreation improvements	• Conservation Commission • Planning Department	3-5	$	M	Federal Land & Water Conservation Fund, MassTrails Program

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Mitigation Action	Implementation Responsibility	Time Frame (years)	Estimated Cost	Priority	Potential Funding Source
	Coordinate with Springfield Water on forest management and recreation	• Conservation Commission	3-5	$	M	Staff Time
Wetlands	Evaluate location and conditions of wetland on private property	• Conservation Commission	1-3	$	M	
	Evaluate potential for land acquisitions	• Conservation Commission	1-3	$	M	Federal Land & Water Conservation Fund, LAND Grant Program
Waterbodies	Continue monitoring bank stabilization at Transfer Station	• Department of Public Works	1-3	$	H	Staff Time
Invasive Species	Conduct public education on invasive species alongside Green Committee	• Conservation Commission	1-3	$	M	Staff Time

*Note: *Carryover from 2016 HMP*

Note: "Emergency Management" refers to both the Granville Fire Department and the Police Department

7.2 Regional Partnerships

Mitigating natural hazards is not confined to a local issue. The drainage systems that serve these communities are often complex systems of storm drains, roadway infrastructure, pump stations, dams, and other facilities owned and operated by a wide variety of agencies, including Massachusetts Department of Transportation (MassDOT), Massachusetts Emergency Management Association (MEMA), and the Department of Conservation and Recreation (DCR). The planning, construction, operation, and maintenance of these structures are integral to the hazard mitigation and climate adaptation efforts of communities. Granville State Forest is maintained by DCR. The Town will strive to share and obtain vulnerability data in coordination with these agencies. These agencies also operate with the same budgetary and staffing constraints as communities. Similarly to municipalities, they must make decisions about numerous competing priorities. In order to implement many of the mitigation

measures identified by the Town, all parties will need to work together towards a mutually beneficial solution.

7.3 Potential Funding Sources

The identification of funding sources is preliminary and may vary depending on numerous factors. These factors include, but are not limited to, if a mitigation measure is conceptual or has been studied, evaluated, or designed. In most cases, the measure will require a combination of funding sources. The funding sources identified are not a guarantee that a specific project will be eligible for, or receive, funding. Upon adoption of this plan, the local representatives responsible for implementation should begin to explore potential funding sources in more detail.

Traditional funding sources within the Town of Granville, such as funding from the operating and capital budgets, may be able to cover some of the costs associated with the action items detailed in Table 7-1. State revolving funds and other no- or low-interest loans may also be of interest. There is a great variety of funding available for Massachusetts municipalities, both through the state and federal governments. A full list of funding opportunities can be found on the Community Grant Finder webpage. The Community Grant finder provides a streamlined interface where municipalities can easily learn about grant opportunities. Specific funding options related to action items developed by Granville are listed in Table 7-2 below.

Table 7-2. Potential Funding Sources

Category	Grant	Description	Limitations & Stipulations
Community Development	MassWorks Infrastructure Program	Provides grants to communities to help them prepare for success and contribute to the long-term strength and sustainability of the Commonwealth.	None
Emergency Management and Planning	Flood Mitigation Assistance Grant Program (FMA)	Implement cost-effective measures that reduce or eliminate the long-term risk of flood damage.	For buildings and other structures insured under the National Flood Insurance Program (NFIP).
Emergency Management and Planning	Hazard Mitigation Grant Program (HMGP)	Provides funding after a disaster to significantly reduce or permanently eliminate future risk to lives and property from natural hazards.	None
Emergency Management and Planning	Building Resilient Infrastructure & Communities (BRIC)	Provides funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event, with a focus on infrastructure projects and "community lifelines." Replaced FEMA's Pre-Disaster Mitigation (PDM) Program.	None

Table 7-2. Potential Funding Sources

Category	Grant	Description	Limitations & Stipulations
Emergency Management and Planning	MEMA Citizen Corps Program (CCP) Grant	Supports local Community Emergency Response Teams (CERT) and Volunteers in Police Service (VIPS) in preparing for all-hazards. Can be used for planning activities, equipment, training, and exercises.	None
Emergency Management and Planning	Pre-Disaster Mitigation (PDM) Grant Program	Provides funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event.	None
Energy	DOER	The DOER provides grant funding for clean energy-related programs.	None
Energy	Green Communities Designation and Grant Program	Provides a road map along with financial and technical support to municipalities that pledge to cut municipal energy and meet other criteria.	None
Environment	Community Forest Grant Program	Funding to establish community forests.	None
Environment	Culvert Replacement Municipal Assistance Grant Program	Grant to replace undersized, perched, and/or degraded culverts located in an area of high ecological value.	None
Environment	US Forest Service Community Forest Grant Program	Funding to acquire private forest land threatened by conversion and establish community forests.	None
Environment	Conservation Assistance Grant Program	Provides funding for property appraisals, OSRPs, other land conservation planning.	Towns with 6,000 residents or fewer
Environment	604b Grant Program	Water quality assessment and management planning.	None
Environment	Land Use Planning Grants	Support effort to plan, regulate, and act to conserve and develop land consistent with the Massachusetts' Sustainable Development Principles.	None
Environment	LAND Grant Program	Helps cities and towns acquire land for conservation and passive recreation.	Reimbursement rate: 52-70%

Table 7-2. Potential Funding Sources

Category	Grant	Description	Limitations & Stipulations
Environment	Federal Land & Water Conservation Fund	Funding for the acquisition, development, and renovation of parks, trails, and conservation areas.	Municipality must have an OSRP
Environment	MassTrails Program	Trail protection, construction, and stewardship projects.	None
Environment	Municipal Vulnerability Preparedness (MVP) Program	Provides support to implement climate change resiliency priority projects.	None
Environment	Natural Resource Damages Program	Funding for restoration projects. Funding comes from settlements, so it is does not follow a set schedule.	None
Public Safety	Emergency Management Performance Grant (EMPG)	Reimbursable grant program to assist local emergency management departments to build and maintain an all-hazards emergency preparedness system.	Reimbursable
Public Safety	Public Assistance Program	The state reimburses governments and other applicants for disaster related costs.	75% reimbursable
Public Works & Transportation	Chapter 90 Program	Reimbursable grants on approved projects.	None
Public Works & Transportation	Community Transit Grant Program	Funding to meet the transportation and mobility needs of seniors and people with disabilities.	Depends on project type
Public Works & Transportation	Municipal Small Bridge Program	Funding for small bridge replacement, preservation, and rehab projects.	Bridges with spans between 10' and 20'
Transportation	Transportation Alternatives (TA)	Funding for smaller-scale transportation projects such as pedestrian and bicycle facilities, recreational trails, safe routes to school projects, community improvements such as historic preservation and vegetation management, and environmental mitigation related to stormwater and habitat connectivity.	None

8.0 PLAN ADOPTION AND MAINTENANCE

8.1 Plan Adoption

The Town of Granville's 2021 MVP-HMP was adopted by the Board of Selectmen on *[ADD DATE]*. See Appendix E for documentation. The plan was approved by FEMA on [*ADD DATE*] for a five-year period that will expire on [*ADD DATE*].

8.2 Plan Implementation

The Core Team will use Table 7.1 as a guide for taking action to mitigate hazards and improve the Town's climate resilience. The time frame, responsible department, and funding mechanisms in Table 7.2 present an implementation plan for the Core Team. The Core Team will be held accountable through the tracking mechanisms explained in the following sections. The 2021 MVP-HMP will also inform future planning and budgeting processes.

8.3 Plan Maintenance

8.3.1 Tracking Progress and Updates

FEMA's initial approval of this plan is valid for five years. During that time, the Town will continue to track progress, document hazards, and identify future mitigation efforts. This can be achieved through a combination of two methods:

1. Meetings: The Core Team, coordinated by the Town Administrator's Office, will meet once a year during regularly scheduled staff meetings to monitor plan implementation. The Core Team will be amended as needed but will likely include representatives from the Fire Department, Highway Department, Planning Board, and the Conservation Commission. These meetings will provide an opportunity for regular implementation updates and to identify capital planning needs related to hazard mitigation.

2. Surveys: The coordinator of Core Team will prepare and distribute a survey every year. The survey will be made available to all Core Team members and any other interested local stakeholders. The questions in the survey will reference the tables of existing and proposed action items listed in the MVP-HMP. The survey will assist in determining any necessary changes or revisions to the plan. In addition, it will provide written documentation of status updates, accomplishments, and progress related to the action items listed in the MVP-HMP. The surveys will help document new hazards or problem areas that have been identified since the 2021 MVP-HMP. The information collected through the survey will be used to formulate an update and/or addendum to the plan.

8.3.2 Continuing Public Participation

The adopted plan will be posted on the Town's website with a mechanism for citizen feedback, such as an e-mail address, for questions and comments. The Town will encourage local participation whenever possible during the next five-year planning and implementation cycle. The Core Team will also incorporate engagement into the implementation of the priority action items. All updates to the plan, including implementation progress, will be placed on the Town's website.

8.3.3 Integration of the Plans with Other Planning Initiatives

Upon approval of the Town of Granville's 2021 MVP-HMP by FEMA, the Core Team will make the plan available to all interested parties and all departments with an implementation responsibility.

The group will initiate a discussion with those various departments regarding how the plan can be integrated into their ongoing work. At a minimum, the plan will be reviewed and discussed with the Core Team's departments.

Appropriate sections of the MVP-HMP will be integrated into other plans, policies and documents as those are updated and renewed, including the writing of, or updates to, the Town's Master Plan, Open Space Plan, Comprehensive Emergency Management Plan, and Capital Improvement Program. Coordination with the Pioneer Valley Planning Commission and adjacent communities, local organizations, businesses, watershed groups, and state agencies will be required for successful implementation and continued updating.

8.4 Process of Updating

By maintaining the 2021 MVP-HMP as described above, the Town will have a competitive application when applying to FEMA for funding to update the plan. Once the resources have been secured to update the plan, the Core Team will need to determine whether to undertake the update itself or hire a consultant. If the Core Team decides to update the plan itself, the group will need to review the current FEMA hazard mitigation plan guidelines for any change in the requirements. The update to the Town of Granville's 2021 MVP-HMP will be forwarded to MEMA for review and to FEMA for ultimate approval. The Core Team will begin drafting the full update of the plan in four years. This will help the Town avoid a lapse in its approved plan status and grant eligibility when the current plan expires at the end of year five.

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Appendix A

Core Team Materials

Appendix B

Additional Hazard Data

Appendix C

Workshop Materials

Appendix D

Public Engagement

Appendix E

Plan Adoption

Appendix F

FEMA Approval