

# TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE APRIL 2024

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**Town of Braintree**  
1 John F. Kennedy Drive  
Braintree, MA 02184

# TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE

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April 2024

Town of Braintree

1 John F. Kennedy Memorial Drive

Braintree, MA 02184

<https://www.braintreema.gov>

Prepared by:

**JAMIE CAPLAN CONSULTING LLC**  
Emergency Management Services

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

Phone: 413-586-0867 · Fax: 413-727-8282 · [www.jamiecaplan.com](http://www.jamiecaplan.com)

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## Acknowledgements

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

- Sharmila Biswas, Department of Elder Affairs Director, Town of Braintree
- Chrissy Brady, President of East Braintree Civic Association, Town of Braintree
- Daniel Cross, Firefighter, Town of Braintree
- Mary Howland, Department of Elder Affairs Outreach Coordinator, Town of Braintree
- Ben Hulke, Assistant Director of Public Works – Operations, Town of Braintree
- Erin V. Joyce, Mayor, Town of Braintree
- Elizabeth Maglio, Town Councilor, Town of Braintree
- Robert Millette, Director of Emergency Management, Town of Braintree
- Michael Minihane, Health Code Enforcement Officer, Town of Braintree
- Sean Murphy, Electric Operations Manager, Braintree Electric Light Dept
- Kate Naughton, Director of Community Affairs, Town of Braintree
- Kelly Phelan, Conservation Planner, Town of Braintree
- Melissa Santucci Rozzi, Planning & Community Development, Town of Braintree
- John Thompson, Assistant Director of Public Works-Engineering, Town of Braintree
- Nora Vernazza, Assistant Superintendent Braintree Schools, Town of Braintree
- Hillary Waite, Stormwater Manager, Town of Braintree
- Steve Wallace, Police Officer, Town of Braintree
- Jeff Zukowski, Hazard Mitigation Planner, Massachusetts Emergency Management Agency

# Town of Braintree, MA Hazard Mitigation Plan Update

F1. For single-jurisdictional plans, has the governing body of the jurisdiction formally adopted the plan to be eligible for certain FEMA assistance? (Requirement §201.6(c)(5))

## Local Adoption Resolution



Braintree Town Council

ORDER NO: 24 060 (renumbered from 027 24) DATE FILED: OCTOBER 28, 2024

REQUEST OF: MAYOR

**UPON THE REQUEST OF HER HONOR, THE MAYOR, THE TOWN OF BRAINTREE, THROUGH THE BRAINTREE TOWN COUNCIL, IT IS SO ORDERED:**

To Accept the Hazard Mitigation Plan as submitted.

YEAS: Boericke, Flaherty, Maglio, Morin, Quilty, Reynolds, Ringius, Ryan

NAYS: NONE

ABSENT: Hume

PASSED IN COUNCIL: NOVEMBER 6, 2024

PRESENTED TO MAYOR: NOVEMBER 7, 2024

A True Record, Attest:

11-8-24

Date Approved

  
James M. Casey, Town Clerk

  
Erin V. Joyce, Mayor

# Town of Braintree, MA Hazard Mitigation Plan Update

CERTIFICATE OF ADOPTION  
TOWN COUNCIL  
TOWN OF BRAINTREE, MASSACHUSETTS  
**A RESOLUTION ADOPTING THE  
TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE**

WHEREAS the Town of Braintree recognizes the threat that natural hazards pose to people and property within the Town of Braintree; and

WHEREAS the Town of Braintree has prepared a multi-hazard mitigation plan, hereby known as TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE in accordance with federal laws, including the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended; the National Flood Insurance Act of 1968, as amended; and the National Dam Safety Program Act, as amended; and

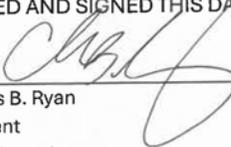
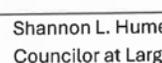
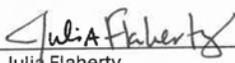
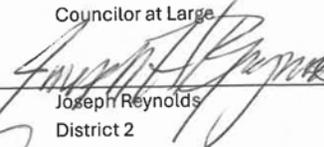
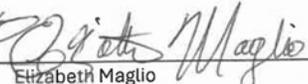
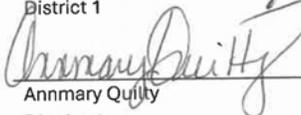
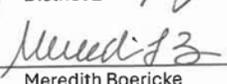
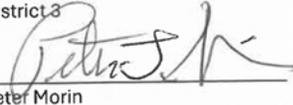
WHEREAS the TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in the Town of Braintree from the impacts of future hazards and disasters; and

WHEREAS adoption by the Town of Braintree Town Council demonstrates its commitment to hazard mitigation and achieving the goals outlined in the TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE.

NOW THEREFORE, BE IT RESOLVED BY THE TOWN OF BRAINTREE, MA, THAT:

Section 1. In accordance with M.G.L. c. 40, the Town of Braintree Town Council adopts the TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE. While content related to the Town of Braintree may require revisions to meet the plan approval requirements, changes occurring after adoption will not require Town of Braintree to re-adopt any further iterations of the plan. Subsequent plan updates following the approval period for this plan will require separate adoption resolutions.

ADOPTED AND SIGNED THIS DATE: \_\_\_\_\_

 Charles B. Ryan President Councilor at Large	 David M. Ringius, Jr. Vice President Councilor at Large	 Shannon L. Hume Councilor at Large
 Julia Flaherty District 1	 Joseph Reynolds District 2	 Elizabeth Maglio District 3
 Annmary Quilly District 4	 Meredith Boericke District 5	 Peter Morin District 6



## Chapter 1. Introduction

The Federal Emergency Management Agency (FEMA) defines hazard mitigation per the Code of Federal Regulations (CFR) 44 Section 201.2 as “any **sustained** action taken to reduce **or eliminate** the **long-term risk** to human life and property from hazards.”

“Disaster Mitigation Act (DMA) 2000 (Public Law 106-390)<sup>1</sup> provides the legal basis for FEMA mitigation planning requirements for State, local and Indian Tribal governments as a condition of mitigation grant assistance. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by repealing the previous mitigation planning provisions and replacing them with a new set of requirements that emphasize the need for State, local, and Indian Tribal entities to closely coordinate mitigation planning and implementation efforts.”<sup>2</sup>

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

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

### Purpose of the Plan

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

This plan is a result of a collaborative effort between the Town of Braintree and the surrounding communities. Throughout the development of the plan, the Hazard Mitigation Planning Committee (HMPC) consulted the public and key stakeholders for input regarding identified goals, mitigation actions, risk assessment, and mitigation implementation strategy. A sample of key stakeholders who

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<sup>1</sup> Disaster Mitigation Act of 2000, Pub. L. 106-390, as amended

<sup>2</sup> Disaster Mitigation Act of 2000. <https://www.congress.gov/106/plaws/publ390/PLAW-106publ390.pdf>

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participated, included the Massachusetts Emergency Management Agency (MEMA), Braintree Electric Light Department, and the Braintree Schools.

### Guiding principles for plan development

The HMPC adhered to the following guiding principles in the plan’s development.<sup>3</sup>

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

This plan update meets the requirements outlined 44 CFR § 201.6(d)(3). These requirements are included in the plan in the green call-out boxes, like the one below.

A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within 5 years in order to continue to be eligible for mitigation project grant funding.

Yellow call-out boxes like the one to the right, are definitions taken from the Federal Emergency Management Agency Local Policy Guide, April 2023. These are included throughout the plan for reference and explanation.

The HMPC prioritized mitigating impacts of climate change, mitigating risk to vulnerable communities, and protecting the built environment both today and in the future.

**COMMUNITY RESILIENCE** is the ability of a community to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. Activities such as disaster preparedness (which includes prevention, protection, mitigation, response and recovery) and reducing community stressors (the underlying social, economic and environmental conditions that can weaken a community) are key steps to resilience.<sup>1</sup>

The HMPC identified the following list of hazards to profile:

- Coastal Erosion
- Coastal Flooding
- Drought
- Earthquakes
- Extreme Temperatures
- Flooding

<sup>3</sup> Federal Emergency Management Agency. (April 19, 2022). Local Mitigation Planning Policy Guide, p.13.

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- Hurricanes/Tropical Storms
- Invasive Species
- Severe Weather
- Severe Winter Storms
- Tornadoes
- Wildfires or Brush Fires

### Mitigation Strategy

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

The hazard mitigation strategy is the culmination of work presented in the Planning Area Profile (Chapter 2), Risk Assessment (Chapter 4), and Capability Assessment (Chapter 5). It is also the result of multiple meetings and sustained public outreach. The HMPC developed the goals shown below. The goals from the previous Town of Braintree Local Hazard Mitigation Plan 2019 and the Braintree Climate Vulnerability and Assessment Plan 2017 were revised to develop this current list. Information about the goal development process is in Chapter 6: Mitigation Strategy. The goals are considered “broad policy-type statements”<sup>4</sup> that represent the long-term vision for mitigating risk to natural hazards in the Town of Braintree.

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<sup>4</sup> Federal Emergency Management Agency. (2013). *Local Mitigation Planning Handbook*, p. 6.

## SAVE LIVES and PROPERTY

- Reduce risk to people and property from natural hazards and climate change.

## Infrastructure

- Mitigate risk to critical facilities and infrastructure from natural hazards and climate change.

## Capacity

- Expand the Town's capacity to mitigate risk by adopting a culture of hazard mitigation through regulations, planning, and regional collaboration.

## Natural Resources

- Implement actions that minimize risk from climate change and natural hazards to preserve or restore the functions of natural systems.

## Education

- Educate all stakeholders about the value of hazard mitigation and how to implement it in their work, businesses, and homes.

Figure 1. Goal Statements.

## Land Use and Development

### Changes in Development

E1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))

Braintree's small town feel combined with its proximity and access to Boston continues to be a driving factor for development opportunities, growth pressures, and strain on environmental resources. The population has steadily increased over the past several decades, with about 5,000 new residents added over the past 25 years. From 2010 to 2020 the town experienced a 10 percent increase in population (though only a 2 percent increase in housing units), and this growth trend is expected to continue in the decades ahead. Current population projections from the UMass Donahue Institute estimate that Braintree will grow by another 22 percent by the year 2050. With this growth, Braintree is also becoming

**CHANGES IN DEVELOPMENT** means recent development (for example, construction completed since the last plan was approved), potential development (for example, development planned or under consideration by the jurisdiction), or conditions that may affect the risks and vulnerabilities of the jurisdictions (for example, climate change, declining populations or projected increases in population, or foreclosures) or shifts in the needs of underserved communities or gaps in social equity. This can also include changes in local policies, standards, codes, regulations, land use regulations and other conditions.

## Town of Braintree, MA Hazard Mitigation Plan Update

increasingly diverse. The percentage of BIPOC populations has doubled from 15 percent in 2010 to nearly 30 percent in 2020, driven mainly by an increase in the Asian population.

With all this change, significant development and redevelopment projects have occurred and continue to occur throughout town. Braintree now has several key centers of activity, including South Braintree Square, Braintree Square, and the Braintree/Weymouth Landing area. These are some of the most walkable areas in town that provide a mix of uses and opportunities for residents and visitors alike. In other ways, Braintree has remained the same. The community still has a wealth of open space and natural areas that residents want to maintain and promote, and the neighborhoods have character that residents want to preserve. Approximately 58 percent of Braintree's land is used for residential, commercial, industrial, and institutional purposes, showing little change over the years. In fact, since 1980, Braintree has increased its developed land uses by less than three percent. Open space, making up over 22 percent of the land, is protected from most development. Many of these areas overlap with lands within or adjacent to floodplains, wetlands, and coastal hazard zones which has effectively prevented changes in development from occurring in these known hazard-prone areas.

With only about 4.5 percent of the remaining undeveloped land in Braintree being unprotected open space or vacant land, much of the community is already built out. Over 40 percent of the land is used for residential purposes, with most of that being single family homes. However, there are still opportunities for redevelopment, adaptive reuse, and infill development. Industrial lands, office parks, and locally oriented developments hold the potential to accommodate growth and enhance amenities and services for residents. Future growth and development patterns will largely follow and be shaped by the direction set by the Town's Master Plan, Zoning Bylaw, and other applicable regulations.

According to the current (2023) Draft Braintree Master Plan and Future Land Use Map, the Town has identified six "transformation areas" to promote changes in development as listed below. The Town has also identified "lands of interest/protection areas" which are open space areas and key landmarks that are irreplaceable, shape the beloved character of Braintree, and tie the community to its roots. These places call for stronger preservation protections.

### Transformation Areas:

1. **Wood Road** offers the opportunity to promote more commercial uses and mixed-use developments. This area has the potential to become a vibrant area that attracts visitors.
2. **South Shore Plaza** is one of the Town's key economic assets and represents opportunities to increase commercial development and its nonresidential tax base.
3. **Granite/Pond Street Corridor** presents redevelopment and public investment opportunities to promote economic vibrancy, walkability, traffic safety, and aesthetic enhancements.
4. **Ivory Street Corridor** also offers great opportunities to increase commercial development and the Town's nonresidential tax base.

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5. **90 Pond Street** offers the opportunity for mixed-use development that incorporates commercial and residential uses.
6. **Quincy Avenue** provides opportunities for contextual infill and redevelopment for commercial, office, and mixed-use, coupled with streetscape and walking and biking safety improvements.

Fortunately, the Draft Braintree Master Plan also recognizes that in the coming years and decades, the community will face challenges due to rising temperatures, sea levels, increased precipitation, and more frequent extreme weather events. As such, the plan includes a “Sustainability and Resilience” element that has prioritized the conservation of water and other natural resources, expanded protected open space, strengthened climate resilience, preserved historic resources, and promoted the community’s social vitality. Also, as further described in Chapter 5 (Capability Assessment), future development projects in Braintree are regulated through the Town’s zoning bylaw and other regulations which prevent or restrict activities that could lead to increased hazard vulnerability. This includes preventing irresponsible development in its designated Floodplain Protection District in addition to the Town’s own wetlands protection rules and regulations and stormwater management regulations that continue to be reviewed and updated on a regular basis. All these efforts are helping Braintree to prevent changes in development from increasing future hazard vulnerability.

Lastly, since Braintree was recently classified by the Commonwealth as a “rapid transit community” under Section 3A of The Zoning Act (MGL Chapter 40), the Town recently passed a series of zoning changes to promote multi-family housing in four areas of the community. These changes were required to comply with the state’s new transit-oriented multifamily housing law which aims to provide more opportunities for housing within a half mile of public transportation. The new requirement means Braintree must allow zoning that could create nearly 3,800 housing units through by-right approvals of multifamily housing (the law only requires zoning changes, not the construction of those units). The four areas cover more than 200 acres along the MBTA’s Red Line and Greenbush commuter rail line. The zoning districts required by Section 3A encourage the development of multi-family housing projects of a scale, density and aesthetic that comport with existing surrounding uses and minimize impacts to “sensitive land.” As defined by the Zoning Act, “sensitive land” includes developable land that, due to its soils, slope, hydrology, or other physical characteristics, has significant conservation values that could be impaired, or vulnerabilities that could be exacerbated, by the development of multi-family housing.

In summary, there is no recent development or planned development in Braintree that is believed to be increasing the risks and vulnerabilities of the community to hazards. However, as noted above and described more thoroughly in Chapter 4 (Risk Assessment), it is anticipated that climate change and projected future conditions will increase the threats posed by multiple hazards. Increasing risks associated with these hazards could result in more frequent and/or more severe impacts to the community and especially those populations considered to be more vulnerable to their effects as also described in Chapter 4. Therefore, many of the Town’s current mitigation and resilience-building efforts are focused on protecting existing development in ways that can lead to aggregate decreases in future

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hazard vulnerability. Specific examples include the many ongoing improvements to stormwater drainage infrastructure, the removal of the Armstrong Dam and other riverine restoration efforts, seawall repairs at Watson Park, and community-wide efforts to prevent the loss of tree canopy and slow the increase in impervious surface area to decrease threats from flooding, extreme temperatures, and other climate hazards. Other potential long-term solutions, such as identifying ways to fund the relocation of the Town's DPW facility and exploring more opportunities to acquire flood-prone land, remain high priorities for the Town as described in Chapter 6 (Mitigation Strategy).

Along with this Hazard Mitigation Plan, the strategies and actions outlined Braintree's Master Plan, Open Space and Recreation Plan, and other key plans and regulations as described in Chapter 5 are consistent in terms aiming to reduce risk and decrease the community's overall vulnerability.

### Progress in Mitigation Efforts

E2. Was the plan revised to reflect changes in priorities and progress in local mitigation efforts?  
(Requirement §201.6(d)(3))

Priorities in the Town of Braintree have shifted since the previous plan was developed in 2019. Today the Town is more aware of climate change and has prioritized mitigating its effects. The Town is dedicated to greenhouse gas reduction. They are also pursuing a reduction in their carbon footprint through Green Communities Grants, facilities upgrades, and using electric vehicles and equipment when feasible. The HMPC reports how challenging it is to plan for the future when the current list of priorities is long. The Town's 2021 Braintree Stormwater Management Program which prioritizes low-impact development practices that are possible under Braintree ordinances.

The status of each hazard mitigation action from the Town of Braintree Local Hazard Mitigation Plan 2019 is included in Chapter 6 (Mitigation Strategy). The text in this chapter includes a designation of Completed, Completed & To Be Continued, Partially Completed/In Progress, Delayed, or Cancelled with a description. In addition, if the mitigation action has moved forward to this Plan's list of actions that is indicated.

To the extent possible information from the Town of Braintree Local Hazard Mitigation Plan 2019 was integrated into other planning mechanisms, specifically incorporating priorities and mitigation actions. Plans developed since 2019 include the 2018 Open Space and Recreation Plan (OSRP), the 2021 Braintree Stormwater Management Program, and the 2022 Phase 1 Existing Conditions Report (prepared for the Master Plan Committee detailing findings of the 2033 Master Plan). The OSRP calls for maintaining "stormwater management systems for water quality benefits and flood protection," and "evaluate areas susceptible to sea level rise and increased flooding, particularly along the Fore River" both concepts from the mitigation plan. The Stormwater Management Plan includes many concepts from the hazard mitigation plan such as public education and public involvement including updating the

## Town of Braintree, MA Hazard Mitigation Plan Update

Town’s website. It also includes a Winter Road Maintenance Program that calls for snow disposal that does not impact water bodies. The 2022 Phase 1 Existing Conditions Report has a Sustainability and Resilience chapter that includes descriptions of risks associated with rising temperatures, sea level rise, and increased precipitation consistent with findings in the 2019 Mitigation Plan and certainly included in this 2024 Hazard Mitigation Plan Update. The report includes a section titled Hazard Mitigation Plan where it lists the goals of the 2019 Mitigation Plan and strategies to meet those goals.

### Authority and Assurances

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

- Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended.
- National Flood Insurance Act of 1968, as amended.
- National Dam Safety Program Act (Pub. L. 92-367), as amended.
- 44 CFR Part 201 Mitigation Planning.
- 44 CFR, Part 60, Subpart A, including § 60.3 Flood plain management criteria for flood-prone areas.
- 44 CFR Part 77 Flood Mitigation Grants<sup>10</sup>.
- 44 CFR Part 206 Subpart N. Hazard Mitigation Grant Program.

### Plan Adoption

The Town of Braintree will adopt the Plan when it has received “approved-pending adoption” status from the Federal Emergency Management Agency (FEMA). The Certificate of Adoption is included on page 7.

### Document Overview

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

#### **Chapter 2: Planning Area Profile**

The Planning Area Profile chapter describes the Town of Braintree, including history, population, government, and infrastructure.

#### **Chapter 3: Planning Process**

## Town of Braintree, MA Hazard Mitigation Plan Update

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

### **Chapter 4: Risk Assessment**

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

### **Chapter 5: Capability Assessment**

The Capability Assessment looks at the Town's ability to mitigate risk prior to and following disaster. This chapter is structured around the following four categories: planning and regulatory, administrative, and technical, financial, as well as education and outreach. The chapter concludes with information regarding the National Flood Insurance Program (NFIP) and the Community Rating System (CRS).

### **Chapter 6: Mitigation Strategy**

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

### **Chapter 7: Plan Implementation and Maintenance**

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

### **Appendices**

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

## Chapter 2: Planning Area Profile

The Town of Braintree has a population of 39,143<sup>5</sup>, and is in Norfolk County ten miles south of Boston. Braintree is said to be the “inner ring” suburb of Boston and is a transportation hub with several access roads, commuter rails, and public transit that act as corridors to the region and beyond. With a total area of 14.56 square miles, Braintree is bordered by Quincy to its north, Holbrook to its south, Randolph to its west, and Weymouth to its east.<sup>6</sup> The figure below shows the boundaries of the Town of Braintree and its location in Massachusetts.

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<sup>5</sup> QuickFacts Braintree Town City, Massachusetts. (2022). United States Census Bureau.

<sup>6</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

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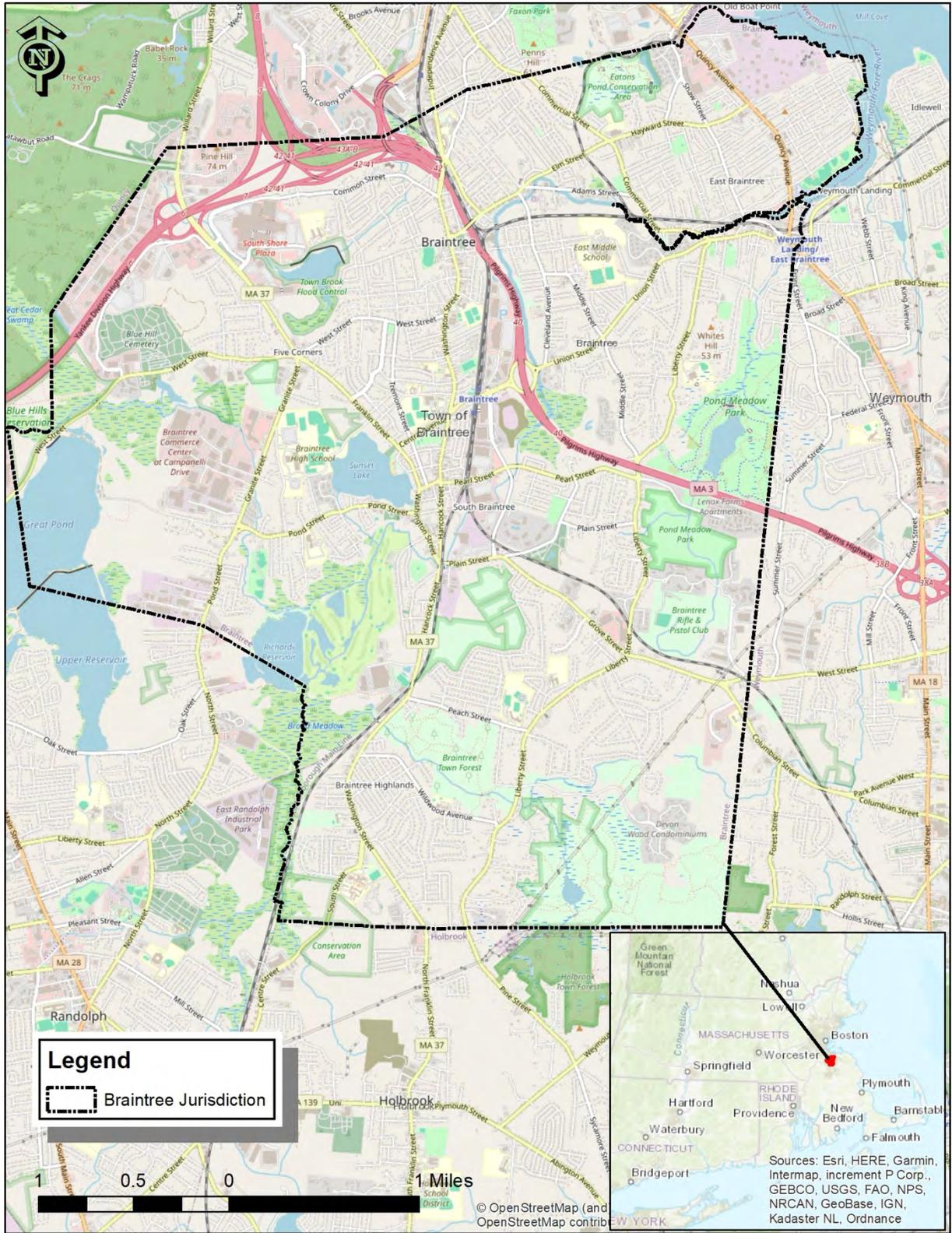


Figure 2. Town of Braintree Base Map.

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Records show that for as long as 12,000 years, Native Americans inhabited the area for settlement, resources, and transportation.<sup>7</sup> The Massachusett, Wampanoag, Pokanoket, and Pawtucket Nations were present in Braintree during this time. The Massachusett Tribe of the Algonquin people, led by Wampatuck, were within the Town prior to European settlement and the history of indigenous peoples is present in the names of historic local landmarks like the “Monatiquot River.”<sup>8</sup>

Part of Braintree was annexed to Boston in 1634 to provide lands to city residents for farming and additional agricultural purposes. Six years later, on May 13, 1640, the Town of Braintree was incorporated. The north side of the Monatiquot River was home to the earliest settlement in the Town. Braintree was established as an agricultural community with prevalent lumber, farming, and water-powered industrial activities such as the production of iron. As the population increased, the settlement spread east and west of the Monatiquot River. In the early 19<sup>th</sup> century, the Town began to have a shipbuilding industry and a growing number of mills. Shipbuilding and manufacturing defined Braintree’s economy into the late 20<sup>th</sup> century. In its industrial era, Braintree was home to a major railroad junction that connected Boston to the southeast part of Massachusetts.<sup>9</sup>

The Town has a Mayor-Town Council form of government. The Town Council has nine council members, three of which are elected as Councilors-at-Large and six that are elected as District Councilors.<sup>10</sup>

### People

As of 2020, 70.7% of the Town identified as White, 3.3% identified as Black or African American, 20.7% identified as Asian, and 2.9% identified as Hispanic or Latino. The foreign-born population in Town is 19.4%. There are approximately 14,407 households in Braintree and the median household income is \$120,593. The number of people living in poverty is 5.1%. Ninety-three percent of the Town, aged 25 years or older, have a high school or higher diploma.<sup>11</sup> Braintree’s proportion of older adults has remained consistent at 17% since 2000, but is projected to increase to 22% by 2040. The fastest growing population in the Town is adults aged 65-74.<sup>12</sup>

The Commonwealth of Massachusetts’ defines “Environmental Justice Populations” as areas of a community where at least one of the following criteria is true:

1. Annual median household income is 65% or less of the state’s annual median household income.

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<sup>7</sup> Braintree Open Space and Recreation Plan. (2018). Town of Braintree, Massachusetts.

<sup>8</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>9</sup> Braintree Open Space and Recreation Plan. (2018). Town of Braintree, Massachusetts.

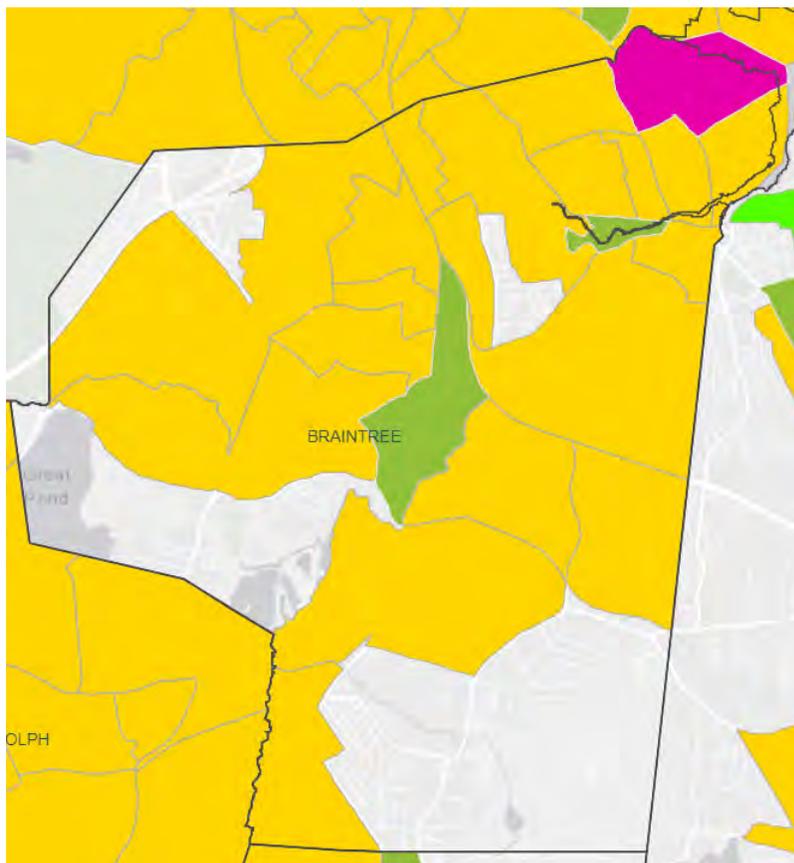
<sup>10</sup> “Government.” (n.d.). Town of Braintree, Massachusetts.

<sup>11</sup> QuickFacts Braintree Town City, Massachusetts. (2022). United States Census Bureau.

<sup>12</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

## Town of Braintree, MA Hazard Mitigation Plan Update

2. Minorities make up 40% or more of the city or town’s population.
3. Twenty-five percent or more of households speak English “less than very well.”
4. Minorities make up 25% or more of the population *and* the annual median household income of the municipality where the neighborhood is located does not exceed 150% of the statewide annual median household income.<sup>13</sup>



These populations are more vulnerable due to being disproportionately affected by the negative impacts of natural hazards nationwide. The data for identifying Environmental Justice Populations comes from the Executive Office of Energy and Environmental Affairs (EEA) who uses American Community Survey data.<sup>14</sup>

A large portion of Braintree fits at least one of the State’s Environmental Justice Criteria. In the image below, the census blocks in yellow fit the “Minority” Criteria, the census blocks in green fit the “Minority and Income” criteria, and the census block in magenta located in the northeastern part of the Town fits the “Minority and English Isolation” Criteria.<sup>15</sup>

Figure 1. Braintree Environmental Justice Communities.

### Land Use and Development (Structures)

Braintree has a “unique position” as a suburban community within proximity to a metropolitan area. This “small town” feel is supported by efforts to preserve a significant portion of Braintree’s open space and natural resources. Braintree’s land use amounts to approximately 40.7% residential, 8.2% commercial, 3.7% industrial, 4.8% institutional, and 0.7% mixed use. In the 42 years since the Town’s last

<sup>13</sup> “Environmental Justice Populations in Massachusetts.” (2024). Commonwealth of Massachusetts.

<https://www.mass.gov/info-details/environmental-justice-populations-in-massachusetts>

<sup>14</sup> “Environmental Justice Populations in Massachusetts.” (2024). Commonwealth of Massachusetts.

<https://www.mass.gov/info-details/environmental-justice-populations-in-massachusetts>

<sup>15</sup> “Massachusetts 2020 Environmental Justice Populations Map Viewer.” (2022). State of Massachusetts.

## Town of Braintree, MA Hazard Mitigation Plan Update

Master Plan, Braintree has increased its developed land uses by less than three percent. The Town has three commercial squares:

1. Braintree Square
2. South Braintree Square
3. Braintree/Weymouth Landing.<sup>16</sup>

South Shore Plaza is the most significant commercial area, but there are additional commercial areas along Route 3, Interstate 93, Granite Street, and Hancock Street. The Town continues to be home to residents who commute throughout the region. Braintree has a Zoning Bylaw that has not been “recodified (updated)” since 1987 though at least one amendment has been made in every section of the Bylaw.<sup>17</sup>

Several of Braintree’s public buildings are “old, outdated, and not sized adequately for the functions of departments today.” The Town has invested in school buildings, but the Police and Fire Department, Department of Public Works, and Department of Elder Affairs need funding to update their facilities.<sup>18</sup>

### Natural Resources

Natural resources provide habitats for plants and animals, increase biodiversity, and support various ecosystems while also providing recreational opportunities and access to the natural environment. Natural resources include features such as bodies of water like rivers and wetlands and open space like forests and parks. These features play an important part in maintaining environmental sustainability and life, but they are also threatened by natural hazards and climate change. As a result, they need to be protected and managed to mitigate risk to people and the built environment, prevent irreparable damage to the resources themselves, and lessen the impacts of major threats such as floods or drought.

#### Rivers

The Monaquot River is the primary river in Braintree. The Monaquot River becomes the Weymouth Fore River near the point of tidal influence just upstream of the Quincy Avenue bridge. Many commercial buildings are built along the Monaquot River. The Weymouth Fore River connects Braintree to the Atlantic Ocean. There is public access to the Weymouth Fore River at Smith Beach.<sup>19</sup>

#### Surface Water and Wetlands

Braintree is located within the Fore River Watershed. The Town has several lakes, ponds, and reservoirs that serve as recreation and conservation areas. These resources include:

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<sup>16</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>17</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>18</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>19</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

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- Sunset Lake
- Cranberry Pond
- Eaton Pond
- Great Pond
- Upper Reservoir
- Richardi Reservoir.<sup>20</sup>

Smaller waterways include Smelt Brook and Town Brook, though there are several other streams and creeks across Town.<sup>21</sup>

The Town has several wetland systems. Broad Meadow, Cedar Swamp, Arnold Meadow, and another unnamed large wetland area off West Street that help to filter pollutants, recharge the Town's groundwater, and offer flood protection.<sup>22</sup>

### Open Space & Recreation

Due to the Town's efforts to maintain natural resources, there are several public spaces in Braintree that comprise almost 25% of the Town's land. In addition to these public spaces, Braintree has over ten miles of trails available for public use with some paved paths to increase accessibility that can be found at Pond Meadow Park.<sup>23</sup> Braintree's Phase 1 Existing Draft Report for their 2033 Master Plan lists the following properties as "public space":

- Braintree Dam – 65 acres
- Blue Hills Reservation – 71 acres
- Conservation Lands - 454 acres
- Devon Woods Conservation Restriction – 244 acres
- Parks & Playgrounds, Golf Course – 255 acres
- Pond Meadow Park – 300 acres
- School Lands – 254 acres
- School Trust Land – 19 acres
- Town-Owned Vacant Land – 122 acres
- Town Forest – 127 acres
- Water Supply Protection – 390 acres.<sup>24</sup>

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<sup>20</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>21</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>22</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>23</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>24</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

## Critical Facilities and Infrastructure

Critical facilities and infrastructure are considered community lifelines; towns rely on these facilities before, during, and after a disaster. Critical facilities and infrastructure are important to identify and manage because of the services and access they provide daily. Mitigating risks related to natural hazards and climate change improves a town’s resilience and economic vitality.

### Water & Sewer Service

The Town has a combined Water and Sewer Division. Water is provided by Braintree’s Great Pond Water Treatment Plant which has a maximum capacity of 6.2 million gallons per day (mgd). The Town’s primary water source is Great Pond which has a capacity of 1.77 billion gallons. Braintree, alongside the neighboring communities of Holbrook and Randolph, created the Tri-Town Board of Water Commissioners in 2019. The three communities draw from the same water source and plan to update their treatment plant, with construction currently underway. The Mayor of Braintree serves as the Chair of the Tri-Town Board with representatives from Holbrook and Randolph also present on the Board. Sewer service and treatment is provided by the Massachusetts Water Resources Authority (MWRA) whose service area covers almost all of Braintree.<sup>25</sup>

### Critical Facilities

The term “critical facilities” is often used to describe structures necessary for a community to respond and recover in emergency situations. These facilities often include emergency response facilities (fire stations, police stations, rescue squads, and emergency operation centers [EOCs]), custodial facilities (jails and other detention centers, long-term care facilities, hospitals, and other health care facilities), schools, emergency shelters, utilities (water supply, wastewater treatment facilities, and power), communications facilities, and any other assets determined by the community to be of critical importance for the protection of the health and safety of the population. The adverse effects of damaged critical facilities can extend far beyond direct physical damage. Disruption of health care, fire, and police services can impair search and rescue, emergency medical care, and even access to damaged areas.

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

<sup>25</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

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The number and nature of critical facilities in a community can differ greatly from one jurisdiction to another, and usually includes both public and private facilities. Each community needs to determine the relative importance of the publicly and privately owned facilities that deliver vital services, provide important functions, and protect special populations.

A list of the critical facilities in Braintree is provided in the table below. This list was obtained from the previous edition of the hazard mitigation plan and the MVP-funded Community Resilience Building (CRB) plan; and reviewed by the HMPC throughout the planning process.

The Town of Braintree has almost one hundred critical facilities of various types. The essential and lifeline critical facilities include schools, housing establishments, community and emergency services, pump stations, sewer stations, and cable towers. Many critical facilities do not have back-up power; however, the 24 facilities that do are listed in the table below. A full list of Braintree’s critical facilities can be found in the appendix.

*Table 1. List of Critical Facilities with Back-Up Power in the Town of Braintree.*

<b>Critical Facility</b>	<b>Address</b>
Braintree Town Hall	1 John F Kennedy Memorial Drive
Braintree Police Department Headquarter/Emergency Operations Center	282 Union Street
Braintree Fire Department Headquarters	1 Union Place
Fire Station #2	1625 Washington Street
Fire Station #3	1 Hayward Street
Ross Elementary School	20 Hayward Street
Mary E Flaherty School	99 Lakeside Drive
East Middle School	305 River Street
Hollis Elementary School	482 Washington Street
Morrison Elementary School	260 Liberty Street
Braintree High School	128 Town Street
Liberty Elementary School	49 Proctor Road
South Middle School	232 Peach Street
Monatiquot School	25 Brow Avenue
Braintree Highway Dept.	245 Union Street
Commerce Park Sewer Station	Between 501 Commerce Drive & 1200 Mathew Woods Drive
Grove Street Sewer Station	Between 472 & 482 Grove Street
Plain Street Sewer Station	Corner of Plain Street & Liberty Street
Pearl Street Sewer Station	Between 304 & 320 Pearl Street
Howard Street Sewer Station	167 Howard Street

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Critical Facility	Address
Common Street Sewer Station	Between 74 & 96 Common Street
West Street Sewer Station	Between 710 & 800 West Street
Treatment Plant Water Pump	300 King Hill Road

### Critical Transportation Infrastructure

The Town’s major roadways include Interstate 93, U.S. Route 1, and State Routes 3, 37, and 53. The northeastern part of Braintree is separated from the rest of the Town by State Route 3. The Town has 150 miles of roads with 64% of those being small local roads that have lower traffic volumes and provide local access.<sup>26</sup>

The Town’s primary public transit provider is the Massachusetts Bay Transportation Authority (MBTA). The MBTA provides bus, commuter rail, rapid transit, and a paratransit service called “The RIDE” to residents in Braintree. The MBTA bus service has five bus routes that stop along Washington Street, Route 27, Route 53, and Granite Street. The Town has two MBTA rail stations (Greenbush and Red Line) which include the Braintree Station and the Weymouth Landing/East Braintree Station, providing access to neighboring cities and towns.<sup>27</sup>

Additional services outside of the MBTA include Massport which provides bus services from Braintree to Logan International Airport via the Logan Express. Senior transportation is also available through the Town’s Department of Elder Affairs. Senior citizens can receive van rides for medical appointments, shipping trips, senior center activities, and other activities.<sup>28</sup>

### Dams

The Town has four high hazard dams and no significant hazard dams. In total, there are six dams in Braintree, and they are listed in alphabetical order as follows:

1. Great Pond Dam
2. Great Pond Upper Reservoir Dam
3. Old Quincy Reservoir Dam
4. Richardi Reservoir Dam
5. Smelt Brook Dam
6. Sunset Lake Dam

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<sup>26</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>27</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>28</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

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The former high hazard Armstrong Dam and the Ames Pond Dam (aka Factory Pond Dam) were both removed in 2023 as part of the Monatiquot River Restoration project. This project includes river restoration, and a public walking trail along the restored river corridor.<sup>29</sup>

### Economy

In Braintree, the industries of Construction, Administration and Support, Transportation and Warehousing, and Health Care and Social Assistance have all added a significant number of jobs over the past decade. According to the Town, Braintree has “weathered the economic impacts of the COVID pandemic relatively well.”<sup>30</sup>

As of 2020, Braintree’s top three industries by occupation according to the United States Census include:

1. Educational services, healthcare and social assistance
2. Professional, scientific, and management, and administrative and waste management services
3. Finance and insurance, and real estate and rental and leasing.<sup>31</sup>

### Historic and Cultural Resources

Historic and cultural resources shape a community’s character and identity while also creating a sense of place for residents and visitors. Many New England cities and towns are home to significant sites and structures that capture the history and heritage of an area. Some resources may date back centuries, like burial grounds, while others can be more recent, like newly designated historic districts. Their importance lies in what they mean to a community and how they represent its people and place. Historic and cultural resources can be at risk due to the negative impacts of natural hazards and climate change. This plan identifies these resources so the HMPC may consider their vulnerability and potential need for mitigation.

Due to its “rich local history,” the Town has 780 historic resources listed on the Massachusetts Cultural Resource Information System (MACRIS).<sup>32</sup> The Town has a Historical Society called the “Braintree Historical Society” that was founded in 1938 and is in a 1720 house that serves as museum and historical center for the Town. The Historical Society hosts events, runs educational and volunteer programs, maintains a library and archives, produces a newsletter, and has a gift shop.<sup>33</sup> Braintree does not have a Historical Preservation Plan.<sup>34</sup>

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<sup>29</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>30</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>31</sup> “Industry By Occupation for the Civilian Employed Population 16 Years and Over ACS 5-Year Estimates.” (2020). United States Census Bureau.

<sup>32</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>33</sup> “About Us.” (n.d.). Braintree Historical Society.

<sup>34</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

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Braintree has fourteen historic buildings that are maintained by the Braintree Historical Society, which also teaches students about the history of the Town while preserving ratification and genealogical information. The Braintree Town Center Historic District was established in 1980 and has seventeen places and two properties overseen by the Historical Commission. The seventeen properties, many of which are part of or related to the historic Thayer Academy, a private middle school and high school.

The Blue Hills Reservation, a National Register Historic District partially located within the Town, can be accessed by a network of roads built in the 1890's called the Blue Hills Reservation Parkways.<sup>35</sup>

The Town adopted the Community Preservation Act in 2002 and has since raised over \$16 million dollars through the program. Some preservation projects include the Town Hall & Elm Street Cemetery Restoration, historic school and building improvements, historical record scanning, and an acquisition of a historic property located at Liberty and Grove.<sup>36</sup>

The Curtain Call Theatre and Beanstock Music Festival provide cultural programming in Town, along with various "well-loved festivals and events" like Braintree Day, the Braintree Beautification Day, and the Strawberry Festival that bring the community together and draw both residents and visitors to Town.<sup>37</sup>

All these historical and cultural resources must be considered in future hazard mitigation planning due to the risk of the Town's significant districts, sites, and structures being damaged or threatened by natural hazards and climate change.

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<sup>35</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>36</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

<sup>37</sup> Phase 1 Existing Conditions Draft Report (Master Plan 2033). (2022). Town of Braintree, Massachusetts.

### Chapter 3. Planning Process

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

- Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), as amended by the Disaster Mitigation Act of 2000
- Code of Federal Regulations – Title 44, Chapter 1, Part 201 (§201.6: Local Mitigation Plans)
- Federal Emergency Management Agency Local Mitigation Planning Policy Guide, (Released April 19, 2022, Effective April 19, 2023)
- In addition, the plan was prepared with the suggestions found in the Demonstrating Good Practices Within Local Hazard Mitigation Plans, FEMA Region 1, January 2017.

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

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

The planning process for this updated mitigation plan began in September 2023 and concluded in April 2024 (this does not include the months of plan review and adoption). The Town developed a Municipal Vulnerability Preparedness (MVP) Program summary of findings in 2017 which was called the “Town of Braintree Climate Vulnerability Assessment and Action Plan.” This planning effort contributed to the update of the mitigation plan. Below is a graphical display of the plan development timeline.

Table 2. Planning Process Schedule.

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
<b>Task 1. Convene Local HMPC</b>	Kick-off Meeting	HMPC Meeting	HMPC Meeting & Public Meeting		HMPC Meeting		HMPC Meeting & Public Meeting	
<b>Task 2. Update Hazard Profiles</b>								

## Town of Braintree, MA Hazard Mitigation Plan Update

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
<b>Task 3. Update Critical Facility Inventory</b>								
<b>Task 4. Update Mitigation Goals</b>								
<b>Task 5. Update Mitigation Actions</b>								
<b>Task 6. Plan Review, Evaluation, and Implementation</b>							Complete Draft for HMPC Review	
<b>Task 7. Public Review of Draft</b>							Public Review	
<b>Task 8. Review and Approval</b>								Submit Plan to MEMA

Kelly Phelan, Conservation Planner, facilitated all activities related to the mitigation Plan update, including meeting logistics, data gathering, and public outreach. The Consulting Team met with Ms. Phelan on September 18, 2023, for a kick-off meeting to review the planning process and timeline, and to discuss developing the HMPC, collecting GIS data if possible, and determining the status of previously identified mitigation actions.

The Town of Braintree participates in the NFIP Community Rating System (CRS) program. Participating in this program awards NFIP policy holders a reduction in flood insurance. Part of the Planning Process for this Hazard Mitigation Plan included making sure to optimize the number points the Town can receive, more points translate into bigger insurance discounts for policy holders. The ten CRS Planning Steps and their adjacent Mitigation Planning Elements are shown in Table 3.

Table 3. Comparison of the Planning Processes.

Mitigation Planning Elements	CRS Planning Steps
Planning Process	1- Organize to prepare the plan 2 - Involve the public 3 -Coordinate 10 - Implement, Evaluate, Revise
Hazard Identification and Risk Assessment	4- Assess the hazard 5 - Assess the problem

## Town of Braintree, MA Hazard Mitigation Plan Update

Mitigation Planning Elements	CRS Planning Steps
Mitigation Strategy	6 -Set goals 7 - Review possible activities 8 - Draft an action plan
Plan Update	10 - Implement, evaluate, revise 5-year update
Plan Adoption	9 - Adopt the plan

### Hazard Mitigation Planning Committee

The Conservation Planner, Kelly Phelan, developed the Hazard Mitigation Planning Committee (HMPC) and was the point of contact for the Consulting Team. The HMPC included Town employees and officials who represented five sectors of the community shown in the table below. A full list of HMPC members is shown in the table after that. The HMPC met four times, October 26, 2023, November 30, 2023, January 25, 2024, and March 7, 2024. All the meetings were conducted via Zoom, however sometimes Town employees gathered at their Town offices. A list of participants at each of these meetings is included in Appendix A.

Table 4. Sectors of the Community Represented On HMPC.

Sectors of the Community	HMPC Members
<ul style="list-style-type: none"> <li>Emergency Management</li> </ul>	<ul style="list-style-type: none"> <li>Emergency Management Director</li> <li>Firefighter (Fire Department)</li> <li>Police Officer (Police Department)</li> </ul>
<ul style="list-style-type: none"> <li>Economic Development</li> </ul>	<ul style="list-style-type: none"> <li>Mayor</li> <li>Planning and Community Development</li> <li>Town Councilor</li> </ul>
<ul style="list-style-type: none"> <li>Land Use and Development</li> </ul>	<ul style="list-style-type: none"> <li>Conservation Planner</li> <li>Mayor</li> <li>Planning and Community Development Director</li> <li>Stormwater Manager</li> <li>Town Councilor</li> </ul>
<ul style="list-style-type: none"> <li>Health and Social Services</li> </ul>	<ul style="list-style-type: none"> <li>Assistant Superintendent of Braintree Schools</li> <li>Department of Elder Affairs Director</li> </ul>

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Sectors of the Community	HMPC Members
	<ul style="list-style-type: none"> <li>• Department of Elder Affairs Outreach Coordinator</li> <li>• Director of Community Affairs</li> <li>• Emergency Management Director</li> <li>• Firefighter (Fire Department)</li> <li>• Health Code Enforcement Officer</li> <li>• Police Office (Police Department)</li> <li>• President of East Braintree Civic Association</li> </ul>
<ul style="list-style-type: none"> <li>• Infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>• Conservation Planner</li> <li>• Department of Public Works Assistant Director - Engineering</li> <li>• Department of Public Works Assistant Director – Operations</li> <li>• Electric Operations Manager</li> <li>• Mayor</li> <li>• Planning and Community Development Director</li> <li>• Stormwater Manager</li> <li>• Town Councilor</li> </ul>

## Town of Braintree, MA Hazard Mitigation Plan Update

Table 5. HMPC Members.

First Name	Last Name	Title	Affiliation	Phone	Email
Sharmila	Biswas	Department of Elder Affairs Director	Town of Braintree	781-848-1963	<a href="mailto:sbiswas@braintreema.gov">sbiswas@braintreema.gov</a>
Chrissy	Brady	President of East Braintree Civic Association	Town of Braintree	617-212-1047	<a href="mailto:cbrady1558@aol.com">cbrady1558@aol.com</a>
Daniel	Cross	Firefighter (Fire Department)	Town of Braintree	781 843-3601	<a href="mailto:dcross@braintreema.gov">dcross@braintreema.gov</a>
Mary	Howland	Department of Elder Affairs Outreach Coordinator	Town of Braintree	781-848-1963	<a href="mailto:mhowland@braintreema.gov">mhowland@braintreema.gov</a>
Ben	Hulke	Assistant Director of Public Works - Operations	Town of Braintree	781-794-8959	<a href="mailto:bhulke@braintreema.gov">bhulke@braintreema.gov</a>
Erin V.	Joyce	Mayor	Town of Braintree	781-794-8100	<a href="mailto:mayor@braintreema.gov">mayor@braintreema.gov</a>
Elizabeth	Maglio	Town Councilor	Town of Braintree	617-842-6492	<a href="mailto:emaglio@braintreema.gov">emaglio@braintreema.gov</a>
Robert	Millette	Director of Emergency Management	Town of Braintree	781-983-3233	<a href="mailto:rmillette@braintreema.gov">rmillette@braintreema.gov</a>
Michael	Minihane	Health Code Enforcement Officer	Town of Braintree	781-794-8096	<a href="mailto:mminihane@braintreema.gov">mminihane@braintreema.gov</a>
Sean	Murphy	Electric Operations Manager	Braintree Electric Light Department	781-348-1071	<a href="mailto:smurphy@beld.com">smurphy@beld.com</a>

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First Name	Last Name	Title	Affiliation	Phone	Email
Kate	Naughton	Director of Community Affairs	Town of Braintree	781-794-8026	<a href="mailto:knaughton@braintreema.gov">knaughton@braintreema.gov</a>
Kelly	Phelan	Conservation Planner	Town of Braintree	781-794-8233	<a href="mailto:kphelan@braintreema.gov">kphelan@braintreema.gov</a>
Melissa	Santucci Rozzi	Planning and Community Development	Town of Braintree	781-794-8234	<a href="mailto:msantucci@braintreema.gov">msantucci@braintreema.gov</a>
John	Thompson	Assistant Director of Public Works - Engineering	Town of Braintree	781 794-8013	<a href="mailto:jthompson@braintreema.gov">jthompson@braintreema.gov</a>
Nora	Vernazza	Assistant Superintendent of Braintree Schools	Town of Braintree	781-380-0130	<a href="mailto:nora.vernazza@braintreeschools.org">nora.vernazza@braintreeschools.org</a>
Hillary	Waite	Stormwater Manager	Town of Braintree	781-794-8945	<a href="mailto:hwaite@braintreema.gov">hwaite@braintreema.gov</a>
Steve	Wallace	Police Officer (Police Department)	Town of Braintree	781-389-5465	<a href="mailto:swallace@braintreema.gov">swallace@braintreema.gov</a>
Jeffrey	Zukowski	Hazard Mitigation Planner	MA Emergency Management Agency	508-820-1422	<a href="mailto:jeffrey.zukowski@state.mas.us">jeffrey.zukowski@state.mas.us</a>

## Town of Braintree, MA Hazard Mitigation Plan Update

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

The Planning and Community Development Department manages development in the Town of Braintree. The Planning and Community Development Department is supported by the Planning Board, Conservation Commission, and Zoning Board of Appeals who assist in development regulation in Town.

Stakeholders were invited to participate in the planning process through the HMPC, public meetings, and plan review. Appendix A includes the press releases and flyers used to announce meetings and opportunities for participation. The Conservation Planner conducted outreach specifically to local and regional agencies involved in hazard mitigation, Town boards and departments that regulate development, neighboring communities, nonprofit organization representatives that serve socially vulnerable populations, and business and academic organizations.

The first HMPC meeting, held on October 26, 2023, introduced hazard mitigation planning, plan development, and next steps for the HMPC. The benefits of hazard mitigation planning, hazard mitigation plan contents, a working timeline, and planned public engagement efforts were also discussed.

The meeting went on to identify key stakeholders. The HMPC noted that representatives from the Fire Department, School Department, local power utility, housing authority, Commission of Disabilities, Health Department, and vulnerable populations should be included in future meetings.

The HMPC and consulting team then discussed an overview of hazards and critical facilities. The main points of discussion included that Braintree has cooling and warming centers in the Town Hall and Elder Affairs Building, but attendance has been poor. An additional point made included the prevalence of coastal erosion and flooding which has closed streets and led to water pooling in areas such as Granite Street, Forbes Road, Union Street, and the Massachusetts Bay Transportation Authority (MBTA) underpass. The Town's stormwater system is mapped and is regularly updated to improve its accuracy. The HMPC also shared important information regarding their critical facilities such as their Emergency Operations Center being moved to the Police Station's Police Training Facility after the Pilgrim Nuclear Plant had closed.

The conversation then went on to the topics of capabilities, mitigation actions, and Town priorities for the plan. Main discussion points included the Town's increased awareness of climate change which led to the creation of their Vulnerability Assessment and Adaptation Plan; however, they feel that they are "stretched thin" with staff and resources which has impacted the completion of long-term goals.

## Town of Braintree, MA Hazard Mitigation Plan Update

The second HMPC meeting, held on November 30, 2023, began by summarizing the overall timeline of the project and public meeting outreach. The Town's upcoming public meeting and outreach efforts included a press release that went out to a local online paper (Patch.com) and was posted on their electronic bulletin board as well as on social media and the Town website. Additional suggestions included sending reminders and reaching out to the Braintree Chamber of Commerce due to their extensive list of contacts.

The discussion then turned to an update on the capability assessment. The HMPC stated that they have an updated Floodplain Bylaw and a Watershed Based Plan. They also shared that the Department of Environmental Protection has revised their regulations to provide for review of cumulative impact of facilities on air quality.

The meeting participants then reviewed critical facilities and identified over 100 sites that would need generator and back-up power information. Regarding the risk assessment portion of the meeting, the major takeaway was that there are four high hazard dams, Great Pond Dam, Great Pond Upper Reservoir Dam, Old Quincy Reservoir Dam, and Smelt Brook Dam. The HMPC also wanted to remove landslides from the hazard list due to no events occurring in the last 24 years. A major hazard concern was related to drought and water supply which has led to water restrictions in the past.

The third HMPC meeting, held on January 25, 2024, began with a discussion of the public meeting and how the Town wants to aim at increased attendance for the second meeting by scheduling it alongside a City Council meeting.

The meeting then turned to a project update, risk rankings, and the creation of mitigation actions. Regarding risk rankings, the major points of discussion included rating severe winter storms above hurricanes and removing dam overtopping as they have not seen that in the Town. The HMPC also shared that the Town rarely loses electricity.

The meeting then went on to discuss opportunities for improving capabilities, planning for the public meeting, prioritizing mitigation actions and drafting new actions, and discussing plan implementation. The major takeaway was that the Town has a full-time grant writer as well as a Geographic Information Systems (GIS) employee that works at the Department of Public Works. The Town also shared that they aim to meet twice a year and post disaster to support plan implementation efforts.

The fourth HMPC meeting, held on March 7, 2024, began with a project update, planning outreach for the second public meeting and additional public engagement for a review of the plan. The Town will share information with *The Patriot Ledger*, a local newspaper as well as through social media, municipal committees, their local utility homepage, and advertisements to local schools.

The meeting then went on to finalizing hazard list rankings and reviewing the list of prioritized mitigation actions. Important notes from this portion of the meeting included that the Community

## Town of Braintree, MA Hazard Mitigation Plan Update

Ranking System will continue, elementary school roofs need to be repaired, and the need to address the Fore River Basin area that houses major critical infrastructure which is impacted by flooding. The HMPC also agreed that there needs to be a systemic effort to conduct outreach to vulnerable populations like the elderly and particularly those who have limited mobility to address evacuation needs and offer necessary services.

The meeting ended with a capability assessment update and summarizing a timeline for completion. Main points included designating a Floodplain Administrator to promote new model bylaws and coordinating with neighboring communities and the Metropolitan Area Planning Council (MAPC) to go out for grant opportunities. The HMPC also shared that Braintree has a great GIS mapping portal that aids in education and outreach efforts. For the plan review, hard copies will be posted at the Town Library, Mayor's Office, and Senior Center.

The HMPC also participated in two public meetings, one on December 14, 2023, and one on March 19, 2024. Finally, the HMPC reviewed the draft Town of Braintree, MA Hazard Mitigation Plan Update prior to sending it to the Massachusetts Emergency Management Agency (MEMA) for their review in April 2024.

### Public Outreach

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

The Public Outreach Strategy was designed to involve the whole community in the mitigation planning process. The public was engaged in the planning process during the drafting of the plan and prior to plan approval through two public workshops (a flyer for the workshop is shown below). Each public meeting was held virtually. The public was also given a chance to look over the plan and provide feedback prior to its review by MEMA or FEMA. The purpose of public engagement was to:

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

Each public meeting included a PowerPoint presentation and plenty of opportunity for questions and discussion. In addition, Mentimeter was used to facilitate input from meeting participants. This has

**COMMUNITY LIFELINES** are the most fundamental services in the community that, when stabilized, enable all other aspects of society.

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proven to be an effective tool when engaging people who may not be comfortable speaking up in a virtual meeting. The HMPC participated in each meeting.



Figure 3. Community Lifelines.

Representatives from all community lifelines were included in public engagement efforts. Community lifelines are a driving force behind FEMA's strategic goals for building a culture of preparedness and readying the nation for catastrophic disasters. The eight community lifelines can be a powerful tool for local governments when evaluating risk and developing mitigation actions. The HMPC considered the eight community lifelines when conducting outreach through this planning process. The eight community lifelines and their respective components are shown in the figure below.

Outreach for the public meetings and for plan review was conducted via press release, email blasts, and posting announcements. The Town website (<https://www.braintreema.gov/>) included announcements for meetings, the press releases were sent to municipal committees, boards, and Town employees. Outreach was also conducted to vulnerable populations, and flyers were posted at frequented buildings.

Specific efforts were made to reach underserved communities and socially vulnerable populations. These efforts were led by the Department of Elder Affairs, the East Braintree Civic Association, the Department of Community Affairs, and the Braintree School District.

Information gathered during the public meetings contributed to the plan's development. The first public meeting was held via Zoom on December 14, 2023. An accurate list of participants was not gathered due to the Zoom format. The meeting included a project introduction, explaining what a hazard mitigation plan is, outlining the risk assessment process, sharing mitigation actions, and planning for public review.

The meeting asked participants a series of questions to engage them and help them understand the process of developing a hazard mitigation plan. The questions are listed below.

- Who lives and works in your community?
- What buildings and infrastructure are critical to your community?
- What weather related hazards can impact your community?
- Name specific locations in your community that flood or are vulnerable to natural hazards.

## Town of Braintree, MA Hazard Mitigation Plan Update

- What can be done to mitigate risks you have identified? Think of activities to protect the people, buildings, and infrastructure named previously.

When asked “What do you like most about Braintree?” some results included:

- Convenient Location
- Monatiquot River
- Lots of Activities
- Families

The meeting participants also discussed a few mitigation actions that could be implemented in the Town. One resident described an idea through a comment received during the session below:

“I've been thinking about the schools. I came up with the idea of a dashboard. Do you see folks use this in other towns? Keeping a list of projects, and issues to address? So, I think there's a list of items we need to address. And you explained that we have a list but it takes take to do. My idea is to build a resource for continuous planning and addressing the issues. How could Braintree not just build this plan that's updated every 4 or 5 years. But also work on continuous updates. Gathering ideas and information from citizens in the town. We've seen a lot of planning in Braintree that ends in a great plan, but it's never updated. I'd rather we build a continuous process. What I'd like to see is a better system implemented where we have continuous feedback from citizens. And create a better resource internally. Great to have you Jamie, but I believe we are only going to implement and resolve these issues really more if we have internal people doing the work. I see you as a guide and coach. I'd actually see it as an opportunity for you to help us now, but then come back every so often to adjust what we are doing.”

The second public meeting was held on March 19, 2024, and eight people were in attendance. The consulting team shared an overview of the plan contents and how to review the draft plan. In addition, the meeting included a description of the planning process, a review of the natural hazards and critical facilities identified as well as the hazard ranking list. A sample of problem statements were given as part of an effort to demonstrate how the mitigation actions were identified. A sample of mitigation actions were reviewed. Participants did not share many comments and expressed an interest in reviewing the draft plan.

Contributions from the HMPC and public engagement impacted the plan in multiple ways. The table below indicates some of the contributions, others are included above and throughout the plan.

## Town of Braintree, MA Hazard Mitigation Plan Update

Table 6. Where Public Engagement Informed the Plan.

Area of the Plan Impacted	Contributions
Planning Area Profile	<ul style="list-style-type: none"> <li>The HMPC updated the list of critical facilities, shown in Appendix B. They also contributed information regarding current land use practices and priorities.</li> </ul>
Planning Process	<ul style="list-style-type: none"> <li>Participated in every aspect of the planning process and made recommendations regarding how to engage the public and key stakeholders.</li> </ul>
Risk Assessment	<ul style="list-style-type: none"> <li>Described extent of hazard impacts based on previous events.</li> <li>Offered first-hand insight and experiences of Town residents.</li> <li>Added the qualitative review to the risk analysis for determination of the hazard risk ranking.</li> </ul>
Capability Assessment	<ul style="list-style-type: none"> <li>Contributed plans, bylaws, and reports for review.</li> <li>Completed three Capability Assessment questionnaires including the National Flood Insurance survey and the Safe Growth survey.</li> </ul>
Mitigation Strategy	<ul style="list-style-type: none"> <li>Identified and prioritized mitigation actions based on their concerns.</li> <li>Focused on the concerns raised by community members.</li> </ul>
Implementation Plan	<ul style="list-style-type: none"> <li>Committed to integrating this plan more thoroughly throughout Town government and to posting the plan on the Town’s website.</li> </ul>

### List of Key Stakeholders Invited to Public Meetings

- Members of all Braintree Committees
- Members of all Braintree Boards
- Town of Braintree Employees
- Town of Quincy
- Town of Randolph
- Town of Weymouth
- Braintree Electric Light Department
- Elder Affairs Participants

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- Metropolitan Area Planning Council (MAPC)

### Review of Draft Plan

The Town made the plan available for public review in April 2024. A press release announcing the availability to review the plan was sent and the announcement was posted to the Town website. The HMPC sent emails to specific stakeholders in Town. Hard copies of the plan were kept in the Mayor's Office, Library, and Senior Center. No comments were received via the Google Form. One comment was received via email to update the priority of the Watson Park project. The original prioritization did not give the project priority via equity; however this was an error, the project uses public space for recreation and community events, improves accessibility, and promotes equity in Braintree. In addition, the field is being upgraded comply with the Americans with Disabilities Act.

## Chapter 4. Risk Assessment

### Hazard Identification

***RISK** for the purpose of hazard mitigation planning, is the potential for damage or loss created by the interaction of natural hazards with assets, such as buildings, infrastructure, or natural and cultural resources.*

The first step in the risk assessment was to revisit and evaluate the hazards identified for study and inclusion in the Town’s previous draft hazard mitigation plan. This was a key topic of discussion at the first Hazard Mitigation Planning Committee (HMPC) meeting, along with the consideration of any additional hazards to include in the updated risk

assessment. While only natural hazards are required to be addressed by FEMA, other hazards such as technological and human-caused hazards may be included if they are of significant concern to the community and determined to be a mitigation priority.

In completing the updated hazard identification process, the HMPC considered the results of the Town’s Climate Vulnerability Assessment and Action Plan (completed in 2017), as well as the “ResilientMass Plan” (2023<sup>38</sup>) which is the formal update to the 2018 State Hazard Mitigation and Adaptation Plan (SHMCAP). As a result of this process all hazards from the prior hazard mitigation plan (adopted in 2019) remain in this updated risk assessment. For this updated assessment, some hazards have been consolidated or renamed to be consistent with the ResilientMass Plan, as further described below. The top natural hazards identified in the Climate Vulnerability Assessment and Action Plan are covered in this assessment. Invasive species as a hazard was added to reflect the concern for this becoming a more prevalent challenge with projected climate change; and to ensure that the risk assessment is aligned with the ResilientMass Plan.

Landslides were initially screened for inclusion in this plan update, but a review of landslide susceptibility revealed that only a handful of undeveloped properties were potentially at risk. Furthermore, the previous edition of this plan notes that “The town does not have records of any damages caused by landslides.” As a result of this screening exercise, landslides were dropped from further analysis.

All relevant hazards identified in the ResilientMass Plan, except landslides, were therefore carried forward and addressed in this risk assessment chapter. The profiled hazards are as follows:

- Average/Extreme Temperatures
- Coastal Erosion

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<sup>38</sup> <https://www.mass.gov/doc/resilientmass-plan-2023>

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- Coastal Flooding
- Drought
- Earthquakes
- Flooding from Precipitation
- Hurricanes and Tropical Storms
- Invasive Species
- Other Severe Weather
- Severe Winter Storms
- Tornadoes
- Wildfires

One “hazard” profiled in the ResilientMass Plan – “changes in groundwater” – is included as appropriate in the flood and drought hazard profiles in this plan.

### Massachusetts Emergency Declarations

The Town of Braintree has been subject to numerous federal disaster declarations along with the entirety of Norfolk County. Some of these disaster declarations correspond to emergency declarations in portions of Massachusetts. The following table cross-references the 13 Massachusetts emergency declarations starting in 2011 with the corresponding federal disaster declarations. All the Massachusetts emergency declarations corresponding to Braintree have involved natural hazards addressed in this plan except for the shelter capacity crisis, which is not a natural hazard and not profiled in this plan. Hazards that do not appear in this table (i.e., earthquakes) have not been subject to Massachusetts emergency declarations.

*Table 7. Massachusetts Emergency Declarations.*

<b>Massachusetts Emergency</b>	<b>Start</b>	<b>Termination</b>	<b>Corresponding Federal Disaster Declaration</b>	<b>FEMA Public Assistance Available</b>	<b>Applicable to Braintree?</b>
Storm Lee	9/15/2023	9/16/2023	Not applicable	Not applicable	Yes
Severe Weather and Flooding	9/12/2023	9/16/2023	Not applicable	Not applicable	Yes

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<b>Massachusetts Emergency</b>	<b>Start</b>	<b>Termination</b>	<b>Corresponding Federal Disaster Declaration</b>	<b>FEMA Public Assistance Available</b>	<b>Applicable to Braintree?</b>
Shelter Capacity Crisis	8/8/2023	Pending	Not applicable	Not applicable	Yes, but not a natural hazard and not a FEMA declaration for Massachusetts
COVID-19	3/10/2020	5/11/2023	DR-4496-MA	All counties	Yes
Merrimack Valley Gas Explosion	9/14/2018	10/4/2018	Not applicable	Not applicable	No
Coastal Storm	3/3/2018	3/6/2018	DR-4372-MA	Essex, Norfolk, Plymouth, Bristol, Barnstable, and Nantucket Counties	Yes
Winter Storm	2/9/2015	2/25/2015	Not applicable	Not applicable	Yes
Winter Storm	1/26/2015	1/28/2015	DR-4214-MA	Worcester County and eastward	Yes
Winter Storm	2/8/2013	2/13/2013	DR-4110-MA	All counties	Yes
Hurricane Sandy	10/27/2012	11/1/2012	DR-4097-MA	Suffolk, Bristol, Plymouth, Barnstable, Dukes, and Nantucket Counties	No
Nor'easter	10/29/2011	11/7/2011	DR-4051-MA	Berkshire, Franklin, Hampshire, Hampden, Worcester, and	No

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Massachusetts Emergency	Start	Termination	Corresponding Federal Disaster Declaration	FEMA Public Assistance Available	Applicable to Braintree?
				Middlesex Counties	
Hurricane Irene	8/26/2011	9/6/2011	DR-4028-MA	Berkshire, Franklin, Hampshire, Hampden, Norfolk, Bristol, Plymouth, Barnstable, and Dukes Counties	Yes
Tornadoes	6/1/2011	6/19/2011	DR-1994-MA	Hampden and Worcester Counties	No

### Link to Massachusetts Climate Change Assessment

The 2022 *Massachusetts Climate Change Assessment* report was issued in December 2022 (<https://www.mass.gov/info-details/massachusetts-climate-change-assessment#read-the-report->). This report provided statements about the impacts of climate change in five sectors within each of seven

## Town of Braintree, MA Hazard Mitigation Plan

designated regions of Massachusetts. Braintree is in the “Boston Harbor” region shown in yellow in Figure 4.

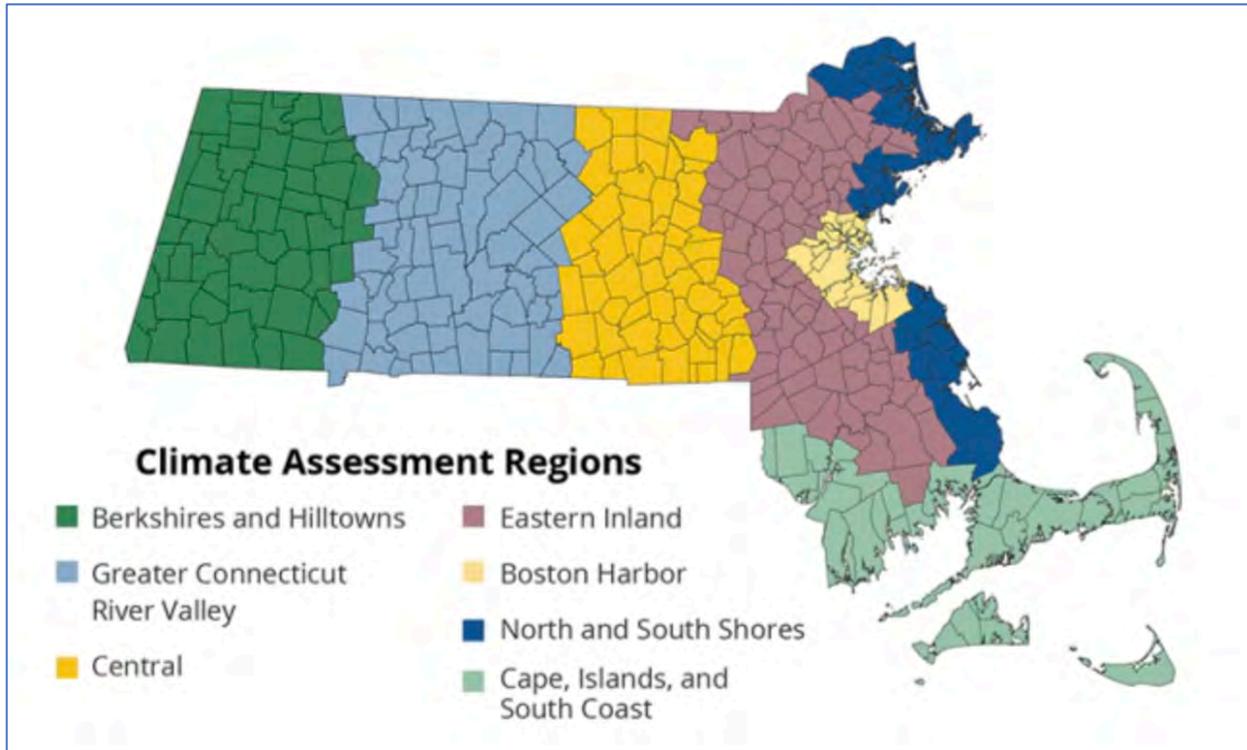


Figure 4. Climate Assessment Regions. Braintree is in the Boston Harbor Region.

The table below lists the top two or three impacts of climate change in each of the five sectors within this region.

Table 8. Top Impacts of Climate Change per Sector in Boston Harbor Region.

Sector	Top Impacts per Sector	Comments
Human	Health and cognitive effects from extreme heat	Includes premature death and learning loss
	Health effects from degraded air quality; and emergency service response disruptions and evacuation disruptions	Causes are extreme heat, flooding, etc.
	Reduction in food safety and security	Causes are production and supply chain issues as well as spoilage during outages

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Sector	Top Impacts per Sector	Comments
<b>Infrastructure</b>	Loss of urban tree cover	Causes are heat, drought, and pests
	Damage to rails and loss of rail/transit service	Causes are flooding and track buckling from heat
<b>Natural Environment</b>	Freshwater ecosystem degradation	Causes are warming waters, drought, and runoff
	Marine ecosystem degradation	Causes are warming waters and ocean acidification
<b>Governance</b>	Reduction in State and municipal revenues	Causes are reduced property tax base due to coastal floods
	Increase in demand for State and municipal services	Includes emergency response, food assistance, and health care
<b>Economy</b>	Reduction in availability of affordably priced housing	Causes are direct damage (floods) and scarcity caused by demand
	Economic losses from commercial structure damage and business interruptions	Causes are flooding and storm damage; and climate-driven supply chain issues

The Town proposes to incorporate these top climate change impacts in this edition of its plan as outlined below.

*Table 9. How This Plan Addresses the Top Impacts of Climate Change per Sector.*

Sector	Top Impacts per Sector	Approach to Incorporating Impacts
<b>Human</b>	Health and cognitive effects from extreme heat	Extreme heat is a hazard profiled in this plan.
	Health effects from degraded air quality; and emergency service response disruptions and evacuation disruptions	Hazards that affect air quality (i.e., extreme heat) and that affect disruptions in response (i.e., flooding and severe storms) are profiled in this plan.
	Reduction in food safety and security	Some of the hazards that affect food security (i.e., droughts) are profiled in this plan. However, Braintree depends on food from other regions, and

## Town of Braintree, MA Hazard Mitigation Plan

Sector	Top Impacts per Sector	Approach to Incorporating Impacts
		additional efforts beyond the scope of this plan will be needed to protect food safety and security.
<b>Infrastructure</b>	Loss of urban tree cover	Severe weather events, droughts, wildfires, and invasive species that damage urban tree cover are hazards profiled in this plan.
	Damage to rails and loss of rail/transit service	Severe weather events, floods, and extreme heat events that damage transit systems are hazards profiled in this plan.
<b>Natural Environment</b>	Freshwater ecosystem degradation	Invasive species are addressed as a hazard profiled in this plan. Additional efforts beyond the scope of this plan will be needed to protect freshwater ecosystems.
	Marine ecosystem degradation	Additional efforts in Braintree beyond the scope of this plan (for example, improving stormwater runoff quality) will be needed to protect marine ecosystems.
<b>Governance</b>	Reduction in State and municipal revenues	The capability assessment and related mitigation actions will help address increased demands for municipal revenues.
	Increase in demand for State and municipal services	The capability assessment and related mitigation actions will help address increased demands for municipal services.
<b>Economy</b>	Reduction in availability of affordably priced housing	The individual hazards addressed in this plan can reduce the availability of affordably priced housing, and the specific actions for each hazard will help protect housing options and opportunities.
	Economic losses from commercial structure damage and business interruptions	Reducing the risks and losses associated with the hazards in this plan will help reduce structure damage and business interruption.

# Town of Braintree, MA Hazard Mitigation Plan

B1. Does the plan include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction? Does the plan also include information on previous occurrences of hazard events and on the probability of future hazard events? (Requirement 44 CFR §201.6(c)(s)(i))

B2. Does the plan include a summary of the jurisdiction’s vulnerability and the impacts on the community from the identified hazards? Does the summary also address NFIP-insured structures that have been repetitively damaged by floods? (Requirement 44 CFR §201.6(c)(s)(ii))

## Hazard Profiles

The risk assessment for the ResilientMass Plan describes the natural hazards that have the potential to impact the Commonwealth and provides the underlying narrative for this hazard profile for the Town. Because this section repeats information from the ResilientMass Plan, some citations have been removed for brevity. The original citations can be found in the ResilientMass Plan.

**IMPACTS** are the consequences or effects of each hazard on the participant’s assets identified in the vulnerability assessment. For example, impacts could be described by referencing historical disaster damages with an estimate of potential future losses (such as percentage of damage vs. total exposure).

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

Table 10. Hazard Characterization.

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

## Town of Braintree, MA Hazard Mitigation Plan

Category/Method	Definition
Vulnerability Assessment	Describes potential impact on the community, including estimated potential losses and the anticipated effects of climate change.

To describe previous occurrences, this plan update highlights major events from history but relies primarily on a roughly ten-year lookback (2014 through 2023) ending with any events from the date of plan development (2023-2024). This helps maintain a concise narrative. Where applicable, narratives about warning times (i.e., floods, heat advisories, and wildfires) are incorporated into the “Extent” subsections.

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

### Average and Extreme Temperatures

According to the ResilientMass Plan, extreme heat for Massachusetts is usually defined as daily high temperatures above 90 degrees Fahrenheit (°F) which may be accompanied by high humidity. Extreme cold is also considered relative to the normal climatic lows in a region. Extreme cold is a period of excessively low temperatures, particularly with the addition of wind chill. The ResilientMass Plan notes that typically in Massachusetts the highest temperatures are experienced in the southeast while the coldest are typically in the northwest. Braintree is not in either of these areas but is susceptible to extreme temperatures.

#### Description

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

## Town of Braintree, MA Hazard Mitigation Plan

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

A heat wave is defined as three or more days of temperatures of 90°F or above. A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle, and which may have adverse health consequences for the affected population. Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. According to the EPA, more than 11,000 Americans have died from heat-related causes (EPA, 2016) since 1979.<sup>39</sup>

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

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

### Location

The Massachusetts Climate Assessment (2022) explains that recent efforts to characterize extreme heat have underscored that risks are present throughout the entire commonwealth. Therefore, the entire geography of Braintree is subject to extreme heat. As with the entire commonwealth, Braintree is also exposed to extreme cold temperatures.

### Previous Occurrences

Extreme Cold: The ResilientMass Plan notes that since 1995, there have been 120 cold weather events within the Commonwealth, ranging from Cold/Wind Chill to Extreme Cold/Wind Chill events. The NOAA Storm Events database (<https://www.ncdc.noaa.gov/stormevents/>) for Norfolk County lists only two extreme cold and/or wind chill events for the area of Braintree during the timeframe 2014-2023, in 2015 and 2016.

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<sup>39</sup> <https://www.epa.gov/climate-indicators/climate-change-indicators-heat-related-deaths#:~:text=Some%20statistical%20approaches%20estimate%20that,set%20shown%20in%20Figure%201.>

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**Extreme Heat:** The ResilientMass Plan notes that according to the NOAA’s Storm Events Database there have been 118 warm weather events (Heat to Excessive Heat events) between 2010 and 2022. Excessive heat results from a combination of temperatures well above normal and high humidity. Whenever the heat index values meet or exceed locally or regionally established heat or excessive heat warning thresholds, an event is reported in the database.

In 2012, Massachusetts temperatures broke 27 heat records. Most of these records were broken between June 20 and June 22, 2012, during the first major heat wave of the summer to hit Massachusetts and the East Coast. In July 2013, a long period of hot and humid weather occurred throughout New England. One fatality occurred on July 6, when a postal worker collapsed as the Heat Index reached 100°F. August 2022 was the hottest August on record for the Commonwealth, and 2020 and 2022 were the two hottest records for the state. Boston experienced two six-day heat waves and 17 days above 90 degrees in 2022.

The NOAA Storm Events database (<https://www.ncdc.noaa.gov/stormevents/>) for Norfolk County does not list any extreme heat events for the area of Braintree in the timeframe 2014-2023. Evidence demonstrates that several extreme heat events occurred in Braintree in July-August 2022 and July-August 2023.

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

*Table 11. USDA Disasters Events That Refer to Extreme Temperatures.*

Year	Event	Event “Begin Dates”
2016	Drought, high winds, wildfire, excessive heat, insects	8/24/2016, 9/21/2016
2016	Heat, Excessive Heat, Frost, Freeze	4/30/2016 (event date)
2014	Winter/ice storm, below normal temps	1/21/2014

### Extent

**Extreme Cold:** The extent (severity or magnitude) of extreme cold temperatures is generally measured through the Wind Chill Temperature Index. Wind Chill Temperature is the temperature that people and animals feel when they are outside, and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body loses heat at a faster rate, causing the skin’s temperature to drop. The National Weather Service (NWS) issues a Wind Chill Advisory if the Wind Chill Index is forecast to dip to –15°F to –24°F for at least 3 hours, based on sustained winds (not gusts). The NWS issues a Wind Chill Warning if the Wind Chill Index is forecast to fall to –25°F or colder for at least 3

## Town of Braintree, MA Hazard Mitigation Plan

hours. On November 1, 2001, the NWS implemented a Wind Chill Temperature Index (Figure 5) designed to more accurately calculate how cold air feels on human skin.

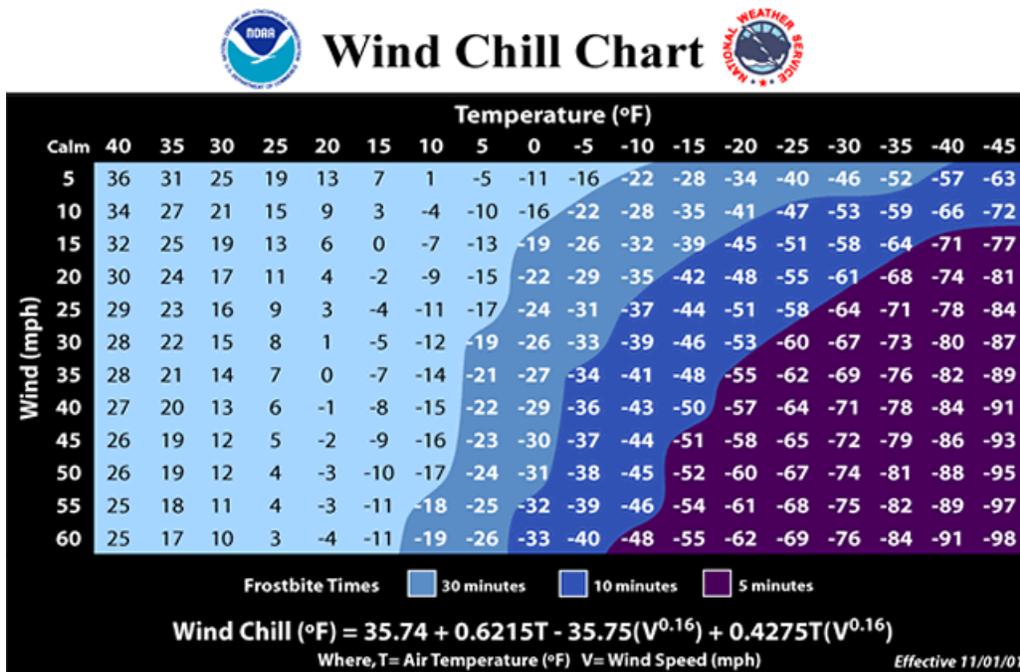


Figure 5. NWS Wind Chill Temperature Index and Frostbite Risk.

**Extreme Heat:** The NWS issues a Heat Advisory when the NWS Heat Indices are between 95 and 99 degrees for two or more hours or two consecutive days, or if they are between 100 and 104 degrees for two or more hours in a single day. The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105°F or higher for 2 or more hours. The NWS Heat Index is based both on temperature and relative humidity, and describes a temperature equivalent to what a person would feel at a baseline humidity level. It is scaled to the ability of a person to lose heat to their environment. Exposure to full sunshine can increase heat index values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can increase the risk of heat-related impacts.

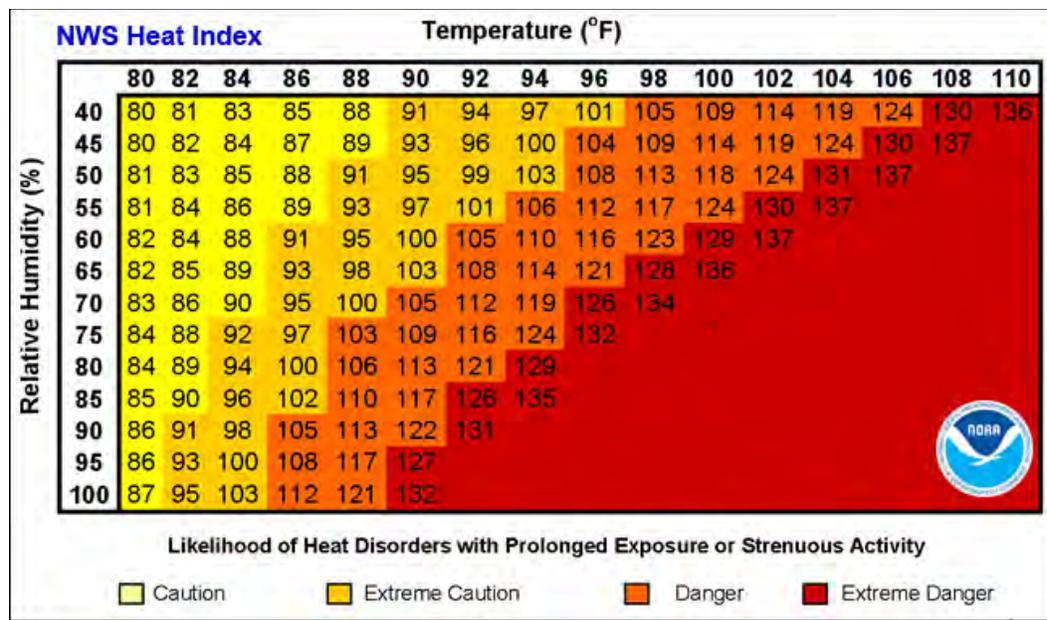


Figure 6. NWS Heat Index Chart.

The NWS advisory and warning products are applicable to all extreme temperature events that may affect Braintree, as they are used throughout Massachusetts on a routine basis and appropriately characterized the most recent extreme cold and heat events over the last few years. Extreme temperatures have not occurred that are outside of the NWS advisory/warning systems.

**Probability of Future Events**

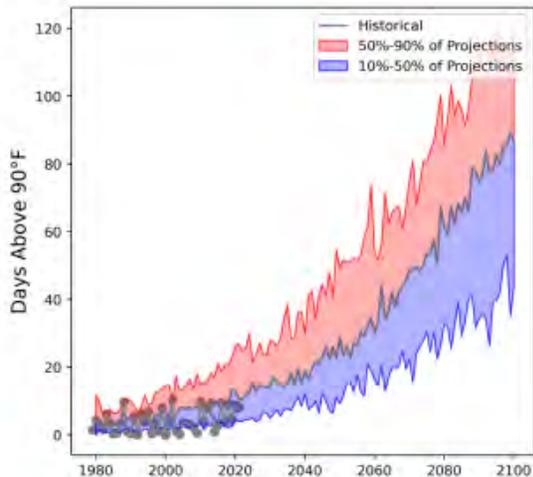
The ResilientMass Plan notes that Massachusetts averaged three declared cold weather events and two extreme cold weather events annually between January 2018 and October 2022. The years 2018 and 2019 were particularly notable, with 10 cold weather events in each year, including five extreme cold/wind chill events in 2018 and six in 2019. The ResilientMass Plan also notes that there was an average of 3.6 heat events and two excessive heat events between January 2018 and December 2022. Many practitioners believe that some heat wave related circulation patterns are occurring more frequently due to climate change.

There are a number of climatic phenomena that determine the number of extreme weather events in a specific year. However, there are significant long-term trends in the frequency of extreme hot and cold events. Since 2010, U.S. daily record high temperatures have occurred over eight times as often as record low. This is compared to a nearly 1:1 ratio in the 1950s. Models suggest that this ratio could climb to 20:1 by midcentury, if GHG emissions are not significantly reduced (C2ES, n.d.).

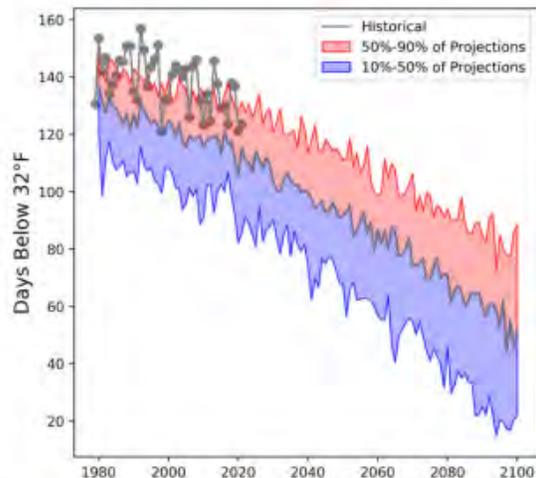
Various climate forecasts support the trends of an increased frequency of extreme hot weather events and a decreased frequency of extreme cold weather events. High, low, and average temperatures in Massachusetts are all likely to increase significantly over the next century as a result of climate change.

## Town of Braintree, MA Hazard Mitigation Plan

The graphics below (from resilient MA, 2018) show the projected annual days with maximum temperature above 90 degrees and projected annual days with minimum temperature below 32 degrees.



Source: CMIP6 downscaled projections (Thrasher et al., 2022), warming scenario SSP 5-8.5, historical data from GridMET.



Source: CMIP6 downscaled projections (Thrasher et al., 2022), warming scenario SSP 5-8.5, historical data from GridMET.

Figure 7. Projected Annual Days with Temperatures above 90 Degrees (left) and below 32 degrees (right).

### Vulnerability Assessment

#### Exposure

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

#### Built Environment Impacts

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

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

Climate change will increase the probability of extreme temperatures which may impact utilities, transportation, and especially older structures. Future development should consider keeping more mature trees, less dark asphalt areas, and more natural areas.

### ***Population Impacts***

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

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

Older adults are often at elevated risk due to a high prevalence of pre-existing and chronic conditions. In Braintree, 15.9% of the population is over age 64. People who live in older housing stock and in housing without air conditioning have increased vulnerability to heat-related illnesses. Power failures are more likely to occur during heat waves, affecting the ability of residents to remain cool during extreme heat. Individuals with pre-existing conditions and those who require electric medical equipment may be at increased risk during a power outage. Heat impacts are more likely to be felt by residents without air conditioning, by those who work outdoors, and those with underlying health conditions.

## Town of Braintree, MA Hazard Mitigation Plan

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

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

Climate change will increase the rate of heat illness and need for cool spaces. Outdoor workers and vulnerable populations will need to be considered during extreme heat events.

### ***Environment Impacts***

Extreme heat can lead to water quality issues, wildlife concerns, and impact vegetative growth when combined with drought.

### **Problem Statements for Extreme Temperatures.**

Problem statements summarize risk and vulnerability and are included following each hazard profile. The problem statements were developed to bridge the gap between identified hazard and development of the mitigation actions. Problem statements are included in each hazard profile section.

*Table 12. Problem Statements for Extreme Temperatures.*

<b>Assets</b>	<b>Problems Associated with Extreme Temperatures</b>
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"><li>• Extreme heat will be a significant public health threat to all residents, but especially for vulnerable populations living in older homes or homes without air conditioning.</li><li>• People generally are not using cooling centers; work may be needed in this area to promote public health and safety.</li></ul>

## Town of Braintree, MA Hazard Mitigation Plan

Assets	Problems Associated with Extreme Temperatures
	<ul style="list-style-type: none"> <li>• The elderly and those with mobility issues may not be able to leave their homes and travel safely.</li> <li>• People working in businesses without air conditioning may be at risk of heat illness.</li> <li>• First responders may also be impacted by extreme temperatures.</li> <li>• Pets may be adversely impacted by extreme heat.</li> </ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"> <li>• Older homes without insulation and single-pane glass are difficult to heat and cool and may not provide safe living conditions.</li> <li>• Businesses that require refrigerated trucks or refrigeration units may see business losses and increased utility costs.</li> <li>• The electric grid may become stressed and fail during extreme heat events.</li> </ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"> <li>• Extreme heat mitigation and adaptation has not been fully integrated into existing local plans and regulations for new development, though progress is being made.</li> </ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"> <li>• Extreme heat may lead to, or exacerbate, impacts to natural systems related to wildfires and invasive species (refer to those sections).</li> <li>• Extreme heat may lead to water quality concerns.</li> </ul>
Activities that have value to the community	<ul style="list-style-type: none"> <li>• Recreational activities may be adversely impacted by extreme heat.</li> </ul>

### Coastal Erosion

Coastal erosion is a persistent challenge in Braintree, though rates of erosion vary from point to point along the Fore River and its embayment.

#### Description

The ResilientMass Plan describes coastal erosion as a natural process that is perpetually affected by various factors including wind, waves, storms, and human activities; some of which are also influenced by climate change. Environmental factors such as wind, waves, currents, and storms often set the

## Town of Braintree, MA Hazard Mitigation Plan

balance between coastal accretion and erosion. Human activities such as coastal hardening and armoring, and development or changes in land use can contribute to increased coastal erosion rates. Shorelines naturally change seasonally, accreting slowly during summer when sediments are deposited by relatively low energy waves and eroding dramatically during winter when sediments are moved offshore by high-energy storm waves, such as those generated by nor'easters.

### Location

The Fore River estuary is the coastal fringe of the Town of Braintree. This fringe is exposed to coastal processes and therefore is the location of coastal erosion when it occurs. The Climate Vulnerability Assessment and Action Plan notes that Braintree hosts areas of “salt marsh, beach, coastal bank, and tidal flats along the Fore River shoreline and the tidal portion of the Monaquot River.”

### Previous Occurrences

The Braintree Open Space and Recreation Plan (2019) notes that a significant erosion problem has developed at the edge of Watson Park along the Fore River. Beginning in 2017, The Town obtained a series of grants from MA Coastal Zone Management to evaluate, design and construct a shoreline stabilization and salt marsh restoration project. Other areas of erosion were being addressed on a case by case basis.

### Extent

Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time. A number of factors determine whether a community exhibits greater long-term erosion or accretion, including the following:

- Exposure to high-energy storm waves
- Sediment size and composition of eroding coastal landforms feeding adjacent beaches
- Near-shore bathymetric variations, which direct wave approach
- Alongshore variations in wave energy and sediment transport rates
- Relative sea level rise
- Frequency and severity of storm events
- Human interference with the sediment supply (e.g., revetments, seawalls, and jetties)

Additional impacts from this hazard that may occur as a result of climate change (and municipal responses to climate change) include:

- Increased armoring of shorelines, resulting in decreases in the sediment supply to beaches and the prevented migration of coastal landforms
- A decrease in sediment, which contributes to flattening of the adjacent profile and increases wave effects
- More intense, longer-duration coastal storms

## Town of Braintree, MA Hazard Mitigation Plan

- Increases in erosion rates

The Massachusetts Coastal Erosion Viewer characterizes erosion along the ocean facing shorelines in the Commonwealth. However, the Fore River is not included in the data sets embedded in the viewer tool. Until such time that a measure of extent or severity is available, the Town of Braintree will evaluate other classification schemes to physically describe erosion hazards.

NOAA's NWS monitors potential events and provides forecasts and information in advance of a storm through multiple means, which vary in system characteristics and time issued. The NWS provides early notification through its Hazardous Weather Outlook, which is a narrative statement produced and issued on a routine basis to provide information regarding the potential of significant weather expected during the next 1 to 5 days. Additionally, many of the standard warning products can help people prepare for erosional events:

- For nor'easters, the NWS issues Coastal Flood Advisories when minor flooding is possible; Coastal Flood Watches when flooding with significant impacts is possible; or Coastal Flood Warnings when flooding that will pose a serious threat to life and property is occurring, imminent, or highly likely.
- For tropical, subtropical, or post-tropical systems, the NWS will issue a Hurricane or Tropical Storm Warning 36 hours in advance of the anticipated onset of tropical-storm-force winds or a Hurricane or Tropical Storm Watch 48 hours in advance of the anticipated onset of tropical-storm-force winds.

The FEMA flood products and the NWS warning products are applicable to coastal floods that may occur in Braintree and cause erosion, as they are used throughout coastal Massachusetts on a routine basis. Coastal floods have not occurred that are outside of the FEMA flood characterization framework or the NWS watch/warning systems for coastal floods. As such, they are available to characterize events that may cause coastal erosion.

### Probability of Future Events

The 2022 Massachusetts Climate Change Assessment report states that climate change is expected to increase coastal erosion, primarily driven by sea level rise. Coastal erosion is predicted to be worse in areas not protected by tidal wetlands (e.g., dunes, coastal banks, and beaches). The probability of coastal erosion in Braintree is therefore expected to increase in specific area.

### Vulnerability Assessment

#### **Exposure**

Although Braintree's coastline isn't directly impacted by open Atlantic waves, shoreline erosion is occurring. As implied above, the erosion estimates recorded over time by the Massachusetts Office of Coastal Zone Management are not available for Braintree due to its relatively interior location. However,

## Town of Braintree, MA Hazard Mitigation Plan

the Town has been completing shoreline stabilization projects including one for Watson Park which concluded in 2022. Areas close to the shoreline will be identified as exposed to the coastal erosion hazard.

The electric substation #11 on Edgehill Road and Smith Beach are potentially exposed to coastal erosion hazards. The other building data was overlaid with the erodible areas to determine the exposure. Table 13 shows the result of this analysis. Nine buildings were found in areas adjacent to the coastal flood areas consisting of single-family, commercial, and government buildings.

*Table 13. Buildings in Unstable and Moderately Unstable Area.*

<b>Building Type</b>	<b>Number of Buildings (Total in City)</b>	<b>Building Value (Total in City)</b>
Single Family	5 (11,666)	\$577,000 (\$3,592,112,100)
Multi-Family	0 (1,219)	\$0 (\$4,389,337,685)
Mixed-Use	0 (40)	\$0 (\$18,419,800)
Commercial	1 (445)	\$384,500 (\$2,333,869,090)
Educational	0 (11)	\$0 (\$111,267,500)
Government	3 (228)	\$168,300 (\$575,447,000)
Religious/Non-Profit	0 (83)	\$0 (\$102,022,000)
Industrial	0 (134)	\$0 (\$230,341,800)
Garage/Outbuilding	0 (9)	\$0 (\$87,000)
Vacant	0 (54)	\$0 (\$21,192,400)
<b>Total</b>	<b>9 (13,889)</b>	<b>\$1,129,800 (\$11,374,096,375)</b>

Figure 8 shows the erosion susceptibility map for the Town. The purple areas are exposed to coastal erosion.

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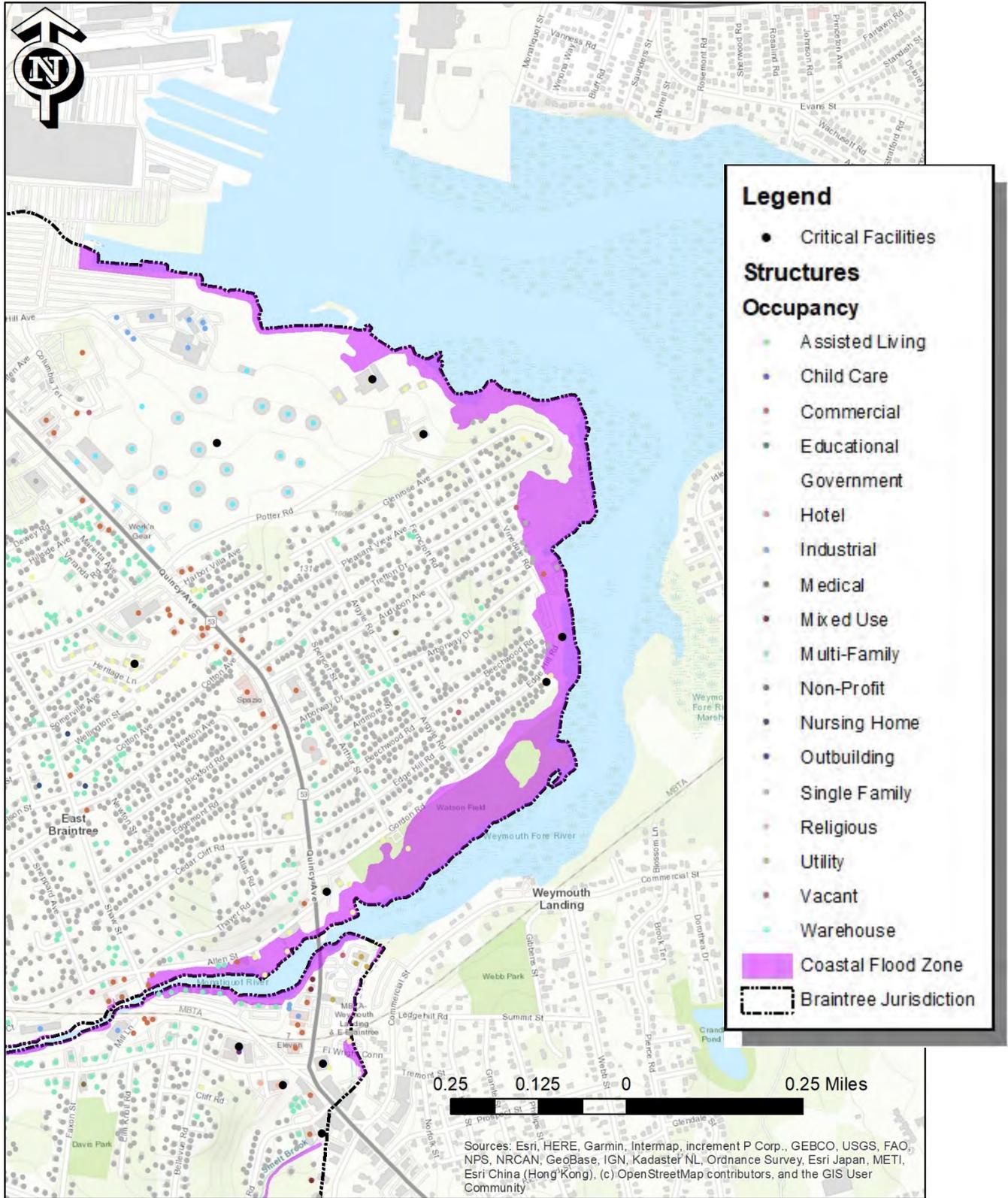


Figure 8. Erosion Susceptibility Map (FEMA, Coastal Flood Hazards, 2023).

# Town of Braintree, MA Hazard Mitigation Plan

## **Built Environment Impacts**

Historic data for erosion provides an indication of how much land is going to be lost in the future. However, the data shows the average erosion rates and these may be accelerated with sea-level rise and major storm events. This assessment assumes a total loss for the buildings exposed after 30 years of erosion. The value of the buildings in the erosion zone is \$1,129,800. This would result in an AAL of \$11,298.

## **Population Impacts**

Populations considered most vulnerable to coastal erosion impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard. The Town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

## **Environment Impacts**

The Citgo Petroleum Braintree Terminal resides in the erodible area on the shoreline. It is used to move hazardous materials and may be susceptible to impact. The site has been armored over the years with bulkheads, revetments, and sheet pile walls to prevent erosion.

## **Problem Statements for Coastal Erosion**

Table 14. Problem Statements Related to Coastal Erosion.

<b>Assets</b>	<b>Problems Associated with Coastal Erosion</b>
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"><li>• People living in some structures are at risk for erosion.</li></ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"><li>• Some single-family homes, commercial, and government structures are located within areas of direct coastal erosion risk.</li></ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"><li>• If piers are impacted by erosion, transport may be impacted as well.</li></ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"><li>• Considerable damage has reportedly occurred along Watson Park and along the Fore River shoreline.</li><li>• Beaches may be impacted and the environment may be impacted by if hazardous materials are released on the shoreline.</li></ul>

## Town of Braintree, MA Hazard Mitigation Plan

Assets	Problems Associated with Coastal Erosion
Activities that have value to the community	<ul style="list-style-type: none"><li>• Waterfront and shoreline coastal public access locations and recreational resources are impacted by coastal erosion.</li></ul>

### Coastal Flooding

The FEMA-delineated flood zones along the Fore River are primarily a reflection of coastal flood risk. Sea level rise will continue to increase the impacts of coastal flooding, increasing the depths of flooding during severe events and also increasing the frequency of nuisance flooding occurring during less severe events.

#### Description

The ResilientMass Plan adopted in 2023 describes coastal flooding as the result of a coastal storm, high tides, hurricanes, nor'easters, or extreme precipitation events that combine result in combined riverine and coastal flooding. Climate change is increasing the risks of coastal flooding as sea level rise is increasing and severe storm and precipitation events are becoming more intense and frequent.

The narratives in the ResilientMass Plan are based on the analysis in the *2022 Massachusetts Climate Change Assessment* report issued in December 2022. This report included an update to the coastal flood assessment for Massachusetts. In the section "Sea Level Rise and Coastal Flooding," the report notes that the "climate assessment followed the approach in the 2017 National Climate Assessment and the Global and Regional Sea Level Rise Scenarios (U.S. Global Change Research Program [USGCRP], 2017, 2018) by adopting a scenario for sea level rise that supports planning and decision-making, while taking into account uncertainty and future risks. For the purposes of this assessment, the Commonwealth of Massachusetts has selected from among several options the USGCRP's High scenario as the preferred scenario for assessment of vulnerability and flood risk."

The report proceeds to explain that "the relative sea level rise which Massachusetts residents may see in the future reflects both sea-level and land-level changes, as well as other regional factors which can affect the rate of sea level rise. In the northern part of Massachusetts, this scenario corresponds to approximately 21 inches (54 cm) between 2020 and 2050, and 43 inches (109 cm) between 2020 and 2070; estimates for the southern part of Massachusetts are slightly higher - 23 inches (59 cm) by 2050 and 45 inches (113 cm) by 2070."

The report also explains that the effect of sea level rise will be to cause more frequent inundation in areas in the future, compared to areas today. For example, the report notes that the area of Massachusetts inundated by the 1,000-year flood (0.1% chance per year) today will be inundated by the 20-year flood (5% chance per year) by 2050.

# Town of Braintree, MA Hazard Mitigation Plan

## Location

The Fore River shoreline and adjacent areas are within reach of the tidal influence are exposed to coastal flooding.

## Previous Occurrences

As noted earlier, this plan update relies primarily on a roughly ten-year lookback (2014 through 2023). The NOAA Storm Events database (<https://www.ncdc.noaa.gov/stormevents/>) for Norfolk County lists two coastal flood events impacting Braintree for the period 2014-2023, neither has reported losses.

Table 15. NCEI Severe Storm Database Entries Covering Coastal Floods in Braintree.

Date	Description
1/4/18	Low pressure moved north from the Florida coast and deepened, passing southeast of Nantucket on Thursday January 4. The storm reached its lowest pressure and strongest pressure gradient as it passed Southern New England. This brought heavy snow and damaging winds to Massachusetts, and caused near-blizzard conditions at Boston, Worcester, and Plymouth. The strong northeast wind also created a high storm surge along the eastern Massachusetts coast. In Braintree, flooding was reported on East Howard Street.
3/2/18	Low pressure moving out of the Ohio Valley passed south of Southern New England on the 2nd and moved out to sea on the 3rd. This storm brought heavy snow to northwest Massachusetts, heavy rain and strong winds to central and eastern Massachusetts, and coastal flooding to the coastline. Moderate to major coastal flooding took place over three tide cycles due to astronomically high tides and a persistent northeast wind. This built a storm surge of two to four feet along the Massachusetts East Coast. In Braintree Howard Street and Edgell Road were closed.

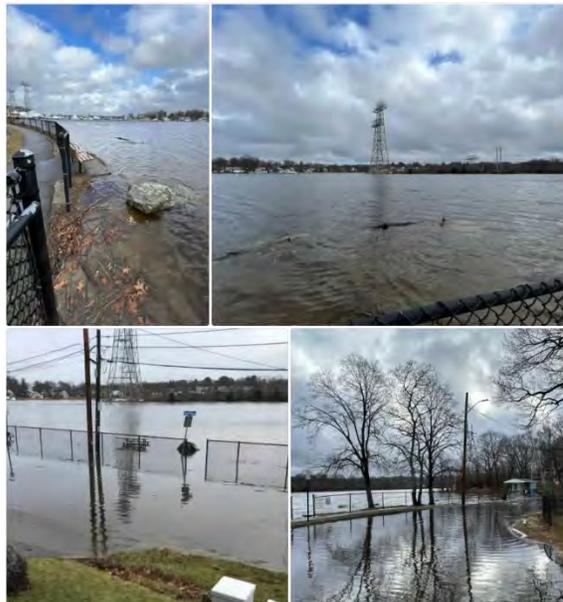
Braintree experienced coastal flooding at least twice in winter 2023-2024, including the back-to-back flood events of mid-January 2024 that caused significant damage in the Boston area:

- January 10, 2024 – The Boston tide gauge peaked about 3.5 feet above normal, causing moderate flooding; Braintree social media shows some flooding.

## Town of Braintree, MA Hazard Mitigation Plan

- January 13, 2024 – The Boston tide gauge peaked about 3.0 feet above normal (the 4th highest level recorded at this location) causing moderate to major flooding. The last time the water level was this high in Boston Harbor was in early 2018.

Braintree is sometimes featured in data and photographs uploaded to MyCoast (<https://mycoast.org>). Photographs taken during the flood event of January 13, 2024, depict flooding at Smith Beach, Edgehill Road and Watson Park. This photograph mosaic (to the right) is courtesy of MyCoast.



### Extent

As explained earlier in the section about inland flooding, the 1% annual chance flood is the standard used by most federal and state agencies. It is used by the NFIP to guide floodplain management and determine the need for flood insurance. The extent of flooding associated with a 1% annual probability of occurrence (the base flood or 100-year flood) is called the 100-year floodplain, which is used as the regulatory boundary by many agencies. Also referred to as the SFHA, this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. The term “500-year flood” is the flood that has a 0.2% chance of being equaled or exceeded each year. Base flood elevations and the boundaries of the 1% annual chance (100-year) and the 0.2% annual chance (500-year) floodplains are shown on FIRMs, which are the principal tools for identifying the extent and location of the flood hazard. Both the 100-year and the 500-year floodplains are determined based on past events. As a result, the flood maps do not reflect projected sea level rise.

FEMA defines the Coastal High Hazard Area (V Zone) as a SFHA that extends from offshore to the inland limit of a primary frontal dune along an open coast and any other portion of the SFHA that is subject to high-velocity wave action from storms or seismic sources. The boundary of a V Zone is generally based on wave heights (3 feet or greater) or wave run-up depths (3 feet or greater). V Zones can also be mapped based on the wave overtopping rate (when waves run up and over a dune or barrier).

In 2017, the Coastal A Zones and AE Zones were further divided in Massachusetts coastal areas with the limit of moderate wave action (LiMWA) line. The area between the LiMWA and the landward limit of the V Zone is often referred to as the Coastal A Zone in many building codes. This area is subject to wave heights between 1.5 and 3 feet during the base flood. The area between the LiMWA and the landward limit of the A Zone is known as the Minimal Wave Action area and is subject to wave heights less than 1.5 feet during the base flood.

## Town of Braintree, MA Hazard Mitigation Plan

In addition to providing the basis for flood insurance premiums, these flood zones are referenced in the Massachusetts State Building Code and used to ensure, among other things, that new and substantially improved structures are elevated based on the magnitude of the hazard. Under the Massachusetts State Building Code, the top of the first floor in residential structures must be located 1 foot above the base flood elevation (BFE) in A and AE Zones and the lowest horizontal structural member must be 2 feet above the BFE in V Zones.

The NWS issues a variety of coastal flood warnings and watches that are effective in Braintree when needed. The NWS issues storm surge watches and warnings to highlight coastal areas with significant risk of life-threatening inundation from an ongoing or potential tropical cyclone, subtropical cyclone, or a post-tropical cyclone during an event. A storm surge watch is issued, generally within 48 hours, for the possibility of life-threatening inundation from rising water moving inland from the shoreline. The watch is issued earlier if other conditions such as wind may limit the time to take protective actions for surge, such as evacuations. A storm warning is issued, generally within 36 hours, if there is a danger of life-threatening inundation.

The FEMA flood products and the NWS warning products are applicable to all coastal floods that may occur in Braintree, as they are used throughout coastal Massachusetts on a routine basis and appropriately characterized previous coastal floods in Braintree. Coastal floods have not occurred that are outside of the FEMA flood characterization framework or the NWS watch/warning systems for coastal floods.

### Probability of Future Events

As sea level rises, the probability of both nuisance and damaging coastal flood events will increase. For example, the Massachusetts Climate Change Assessment report notes that the area of Massachusetts inundated by the 1,000-year flood (0.1% chance per year) today will be inundated by the 20-year flood (5% chance per year) by 2050.

### Vulnerability Assessment

#### *Exposure*

The risk scenario considered in this vulnerability assessment section considers the spatial extent of damage from coastal flooding. Several hurricane surge scenarios were selected.

# Town of Braintree, MA Hazard Mitigation Plan

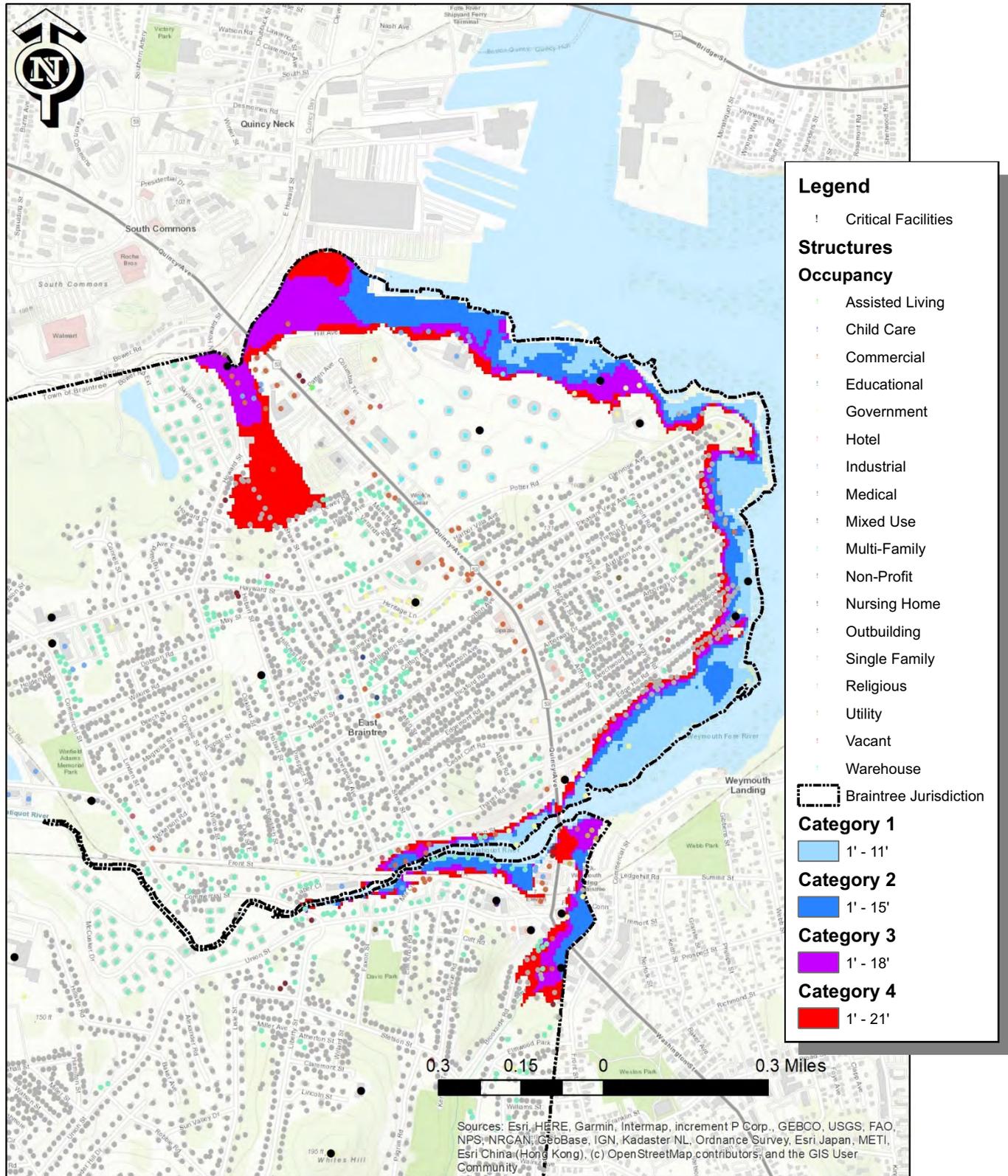


Figure 9. Hurricane Surge (NOAA, 2022).

## Town of Braintree, MA Hazard Mitigation Plan

### **Built Environment Impacts**

Hurricane surge inundation areas were modeled in Hazus to identify the impacts of today’s extreme events and events which may happen more often in the future with sea-level rise. Table 16 shows the impacts of a Category 1 storm surge while Table 17 shows the economic impacts of a Category 2 storm surge and Table 18 shows the economic impacts of a Category 3 storm.

*Table 16. Building Losses Due to Surge for a Hurricane Category 1 Scenario.*

<b>Loss Type</b>	<b>Residential (\$Million)</b>	<b>Commercial (\$Million)</b>	<b>Other Occupancy (\$Million)</b>	<b>Total (\$Million)</b>
Building Loss	0.37	0.19	0.48	<b>1.04</b>
Content Loss	0.30	0.56	1.66	<b>2.52</b>
Business Inventory Loss	0.00	0.02	0.15	<b>0.17</b>
Business Income Loss	0.00	0.54	0.29	<b>0.83</b>
Business Relocation Loss	0.19	0.11	0.36	<b>0.66</b>
Rental Income Loss	0.11	0.54	0.14	<b>0.79</b>
Wage Loss	0.00	0.64	6.16	<b>6.80</b>
<b>Total</b>	<b>0.97</b>	<b>2.60</b>	<b>9.24</b>	<b>12.81</b>

*Table 17. Building Losses Due to Surge for a Hurricane Category 2 Scenario.*

<b>Loss Type</b>	<b>Residential (\$Million)</b>	<b>Commercial (\$Million)</b>	<b>Other Occupancy (\$Million)</b>	<b>Total (\$Million)</b>
Building Loss	2.49	1.64	2.05	<b>6.18</b>
Content Loss	1.94	6.60	7.05	<b>15.59</b>
Business Inventory Loss	0.00	0.16	0.65	<b>0.81</b>
Business Income Loss	0.00	5.61	0.68	<b>6.29</b>
Business Relocation Loss	0.69	0.91	0.87	<b>2.47</b>
Rental Income Loss	0.44	0.71	0.34	<b>1.49</b>
Wage Loss	0.01	5.27	14.62	<b>19.90</b>
<b>Total</b>	<b>5.57</b>	<b>20.90</b>	<b>26.26</b>	<b>52.73</b>

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Table 18. Building Losses Due to Surge for a Hurricane Category 3 Scenario.

Loss Type	Residential (\$Million)	Commercial (\$Million)	Other Occupancy (\$Million)	Total (\$Million)
Building Loss	6.74	3.32	3.18	<b>13.24</b>
Content Loss	5.18	11.67	13.19	<b>30.04</b>
Business Inventory Loss	0.00	0.41	1.11	<b>1.52</b>
Business Income Loss	0.01	8.37	1.15	<b>9.53</b>
Business Relocation Loss	1.26	1.40	1.47	<b>4.13</b>
Rental Income Loss	0.70	1.10	0.58	<b>2.38</b>
Wage Loss	0.02	8.08	25.24	<b>33.34</b>
<b>Total</b>	<b>13.91</b>	<b>34.35</b>	<b>45.92</b>	<b>94.18</b>

These losses would be concentrated in the northeast part of Town. Sea level rise will impact the geographic extent of the surge areas in the future. The electric substation #11 on Edgehill Road, BELD Light Plant, and Smith Beach are exposed to coastal surge.

### **Population Impacts**

Population impacts from storm surge flooding will be similar to those described in the flood vulnerability assessment earlier in this chapter. The Town should be aware that senior and low-income segments of Braintree’s population may be more vulnerable to storm surges as compared to other segments of the population. Senior and low-income populations may be physically or financially unable to react and respond to a hazard event and require additional assistance. Access to information about the hazard event may be lacking, as well as access to transportation in the case of an evacuation. However, unlike a flood event accruing due to severe precipitation, the warning time may be longer for a storm surge.

### **Environment Impacts**

The environmental impacts would be similar to those caused by flooding. Specifically, the major environmental impacts would be the potential release of hazardous materials from the Citgo Pier.

### **Problem Statements for Coastal Flooding**

# Town of Braintree, MA Hazard Mitigation Plan

Table 19. Problem Statements Related to Coastal Flooding.

People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"> <li>• Older populations in the floodplain may have difficulty evacuating.</li> </ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"> <li>• Potential exposed structures include:               <ul style="list-style-type: none"> <li>○ Electrical substation</li> <li>○ BELD Light Plant</li> </ul> </li> <li>• Residential, commercial, and government structures near shoreline.</li> </ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"> <li>• The Town is currently precluded from adopting higher regulatory standards to protect against flooding (must comply with State Building Code).</li> </ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"> <li>• Smith Beach and other parks and beaches on coastline could be impacted.</li> <li>• Hazardous materials from the pier may impact coastal areas.</li> </ul>
Activities that have value to the community	<ul style="list-style-type: none"> <li>• Activities conducted on beaches and coastal parks may be disrupted in a coastal flood event.</li> </ul>

## Droughts

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

### Description

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

1. Meteorological drought is a measure of departure of precipitation from normal.
2. Hydrological drought is related to the effects of precipitation shortfalls on stream flows and on reservoir and groundwater levels.

## Town of Braintree, MA Hazard Mitigation Plan

3. Agricultural drought links various characteristics of meteorological and hydrological drought to agricultural impacts and occurs when there is not enough water available for a particular crop to grow at a particular time.
4. Socioeconomic drought is associated with the supply and demand of economic goods with elements of meteorological, hydrological, and agricultural drought.
5. Ecological drought is an episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability and impacts ecosystem services.

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

The Braintree Water Department is part of the Tri Town Water Board with Randolph and Holbrook. The three communities receive drinking water from the Great Pond/Upper Reservoir, Richardi Reservoir, and the Farm River. Water is pumped from the Richardi Reservoir to the Great Pond/Upper Reservoir when water levels in the Great Pond/Upper Reservoir are low. The Braintree Water Department and Tri Town employ water use restrictions when needed to manage droughts.

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

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

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

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

# Town of Braintree, MA Hazard Mitigation Plan

## Location

Massachusetts Drought Management Plan (DMP, 2019) assesses drought conditions in seven regions: Western, Connecticut River Valley, Central, Northeast, Southeast, Cape Cod, and Islands. A regional approach allows customization of drought actions and conservation measures to address situations in each region; and allows for the determination of a drought on a watershed basis. This approach recognizes that parts of Massachusetts can experience significantly different weather patterns due to topography, distance from coastal influence, as well as a combination of regional, national, and global weather patterns. Droughts have the potential to impact the entirety of Braintree, which is located in the Southeast region.

## Previous Occurrences

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

Although short or relatively minor droughts occurred over the 50 years following the drought of the 1960s, the next long-term event began in March 2015 when Massachusetts began experiencing widespread abnormally dry conditions. In July 2016, based on a recommendation from the Drought Management Task Force (DMTF), the Secretary of the Executive Office of Energy and Environmental Affairs (EOEEA) declared a Drought Watch for Central and Northeast Massachusetts and a Drought Advisory for Southeast Massachusetts and the Connecticut River Valley. Drought warnings were issued in five out of six drought regions of the state. Many experts stated that this drought was the worst in more than 50 years. DMTF declared an end to the drought in May 2017 with a return to wetter-than-normal conditions.

USDA declares agricultural disasters as needed for a variety of hazards. Information can be found at <https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index>. The line items related to droughts in Norfolk County are listed below, corresponding to 2015-2016, 2020, and 2022.

Table 20. USDA Disasters Events That Refer to Drought.

Year	Event	Event “Begin Dates”
2022	Drought	8/9/2022
2020	Drought	9/15/2020, 9/29/2020
2016	Drought, high winds, wildfire, excessive heat, insects	8/24/2016, 9/21/2016

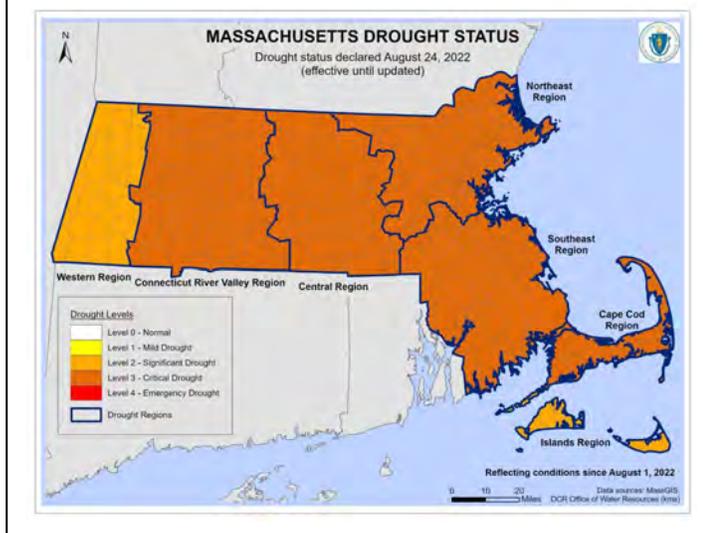
## Town of Braintree, MA Hazard Mitigation Plan

The drought of 2020, a so-called “flashy drought” that impacted southern New England, was sufficiently impactful in Norfolk County to be included in the USDA data table above. Flashy droughts are described below under *Extent*.

Applying the same ten-year lookback as the severe storms database review, USDA payments to Massachusetts agricultural sectors for drought impacts associated with events from 2012 through 2022 were reviewed. This timeframe includes the droughts of 2015-2017 and 2020. USDA reimbursements for droughts have not occurred in Braintree over the last decade.

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

*The drought of 2022 is typical of a flashy drought; it was most severe in August, but alleviated by rainfall in September 2022.*



### Extent

Drought is defined by a combined look at several indices as detailed in the Massachusetts DMP (EOEEA and MEMA, 2019). The indices are:

- **Precipitation:** The Standard Precipitation Index, which is widely used, is based on monthly precipitation totals from Massachusetts Department of Conservation and Recreation’s (DCR) Precipitation Program and the NWS.
- **Streamflow:** Is an early indicator of impacts to rivers, streams, wetlands, and other riparian habitats.
- **Groundwater:** This provides information on impacts over a longer period of time due to groundwater recharge rates.
- **Lakes and Impoundments:** Captures the effects on surface water including lakes, ponds, water supply, and flood control reservoirs.
- **Fire Danger:** The Keetch Byram Drought Index indicates fire potential and flammability of organic matter.

## Town of Braintree, MA Hazard Mitigation Plan

- Evapotranspiration: The Crop Moisture Index is used to assess short-term or current conditions of dryness or wetness relative to agricultural crops.

These indices are monitored weekly to generate a monthly hydrological conditions report and used to determine the onset, severity, and end of droughts. Five levels of increasing drought severity are defined in the DMP: *Normal*, *Mild*, *Significant*, *Critical*, and *Emergency*. The drought levels are associated with actions outlined in the DMP. Recommendations of drought levels are made by the DMTF to the Secretary of the EEA, who then declares the drought level for each region of the state.

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

The five drought levels in the 2019 DMP provide a basic framework for taking actions to assess, communicate, and respond to drought conditions. Under the “Normal” condition, data are routinely collected, assessed, and distributed. When drought conditions are identified, the four drought levels escalate moving to heightened action, which may include increased data collection and assessment, interagency communication, public education and messaging, recommendations for water conservation measures, and a state of emergency issued by the Governor. At the “Emergency” level, mandatory water conservation measures may be enacted. These regionally declared drought levels and associated state actions are intended to communicate and provide guidance to the public and stakeholders across industries to enable them to respond early and effectively and to reduce impacts. Individual public water suppliers may have their own drought management plan, drought levels, and associated actions, which they may follow at all levels except at the Emergency level when mandatory actions may be required.

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

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

The Massachusetts drought warning and characterization products are applicable to all droughts that may occur in Braintree, as they are used throughout Massachusetts on a routine basis and appropriately characterized previous droughts affecting Braintree. Droughts have not occurred that are outside of the

## Town of Braintree, MA Hazard Mitigation Plan

framework established in the Massachusetts Drought Management Plan or, more broadly, outside federal resources such as the USGS Drought Monitor.

### Probability of Future Events

Climate change will increase the probability of droughts. The Massachusetts Climate Change Assessment notes that the region will experience slight increases in the number of consecutive dry days and the number of days without rain from 2050 onward. By 2090 the number of consecutive dry days per year will increase to 33, compared to the annual statewide baseline of 31 days from 1986 to 2005. Table 21 summarizes this data and indicates the projected number of consecutive dry days according to the “high” and “low” limits of the Northeast Climate Adaptation Science Center (NE CASC) data. The Town of Braintree is represented by the Boston Harbor region.

Table 21. Number of Consecutive Dry Days (CDD) and Days without Rain (DWR) per Year.

Region	Baseline		2030		2050		2070		2090	
	CDD	DWR								
<b>Berkshire and Hilltowns</b>	29	159	29	161	30	165	30	167	31	170
<b>Greater Connecticut River Valley</b>	31	171	31	172	32	175	32	178	33	181
<b>Central</b>	32	180	32	182	32	185	33	188	33	192
<b>Eastern Island</b>	32	186	32	181	32	185	33	188	33	193
<b>Boston Harbor</b>	31	192	31	185	32	192	32	194	33	198
<b>North and South Shores</b>	31	184	31	182	32	187	32	190	33	195
<b>Cape, Islands, and South Coast</b>	31	186	31	182	32	187	32	191	33	194
<b>Statewide</b>	<b>31</b>	<b>176</b>	<b>31</b>	<b>175</b>	<b>31</b>	<b>179</b>	<b>32</b>	<b>182</b>	<b>33</b>	<b>187</b>

CDD = Consecutive Dry Days per Year (ResilientMass, Steinschneider & Najibi (2022))  
DWR = Days Without Rain per Year (MA Climate Assessment (Commonwealth of Massachusetts, 2022))

These projections suggest that the days without precipitation are likely to increase across the Commonwealth, while the number of consecutive dry days will vary across the state while increasing over the coming decades.

### Vulnerability Assessment

#### Exposure

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

# Town of Braintree, MA Hazard Mitigation Plan

## **Built Environment Impacts**

Major water users are more susceptible to drought, and these include water utilities and some commercial users.

With an increased probability of drought and drought magnitude, water utilities should consider reviewing or developing extreme drought scenarios.

## **Population Impacts**

Populations considered most vulnerable to drought impacts are identified based on multiple factors including their physical and financial ability to react or respond during a hazard. Senior and low-income populations are particularly susceptible. The Town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

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

With an increased probability of drought and increased drought magnitude, and the potential of increased water costs, vulnerable populations may be more severely impacted in the future.

## **Environment Impacts**

Although agriculture is limited in the Town, there are some natural areas which may be adversely impacted by drought. Drought amplifies the risk of loss of biodiversity and affects animal and plant species. Economic impacts include higher food and lumber prices. Drought can shrink the food supplies of animals and plants dependent on water and damage their habitats. Sometimes the environmental damage caused by a drought is temporary, and other times it is irreversible.

## **Problem Statements for Drought**

Table 22. Problem Statements for Drought.

<b>Assets</b>	<b>Problems Associated with Drought</b>
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"><li>• Vulnerable communities may have difficulty accessing potable water during an emergency drought event. If the water sources are at emergency levels, having a plan to get vulnerable people water should be considered. If rates are increased to lower water demand, this may also adversely impact underserved and vulnerable communities.</li></ul>

## Town of Braintree, MA Hazard Mitigation Plan

Assets	Problems Associated with Drought
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"><li>Water supply infrastructure may need to be shut down and water quality may become substandard. Businesses requiring water for daily operations may have their operations limited due to water restrictions.</li></ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"><li>Outdoor water use restrictions and other water conservation measures during periods of extreme drought can be challenging to enforce, even when mandated through local declaration.</li></ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"><li>Water quality may be adversely impacted by major droughts.</li></ul>
Activities that have value to the community	<ul style="list-style-type: none"><li>None applicable.</li></ul>

### Earthquakes

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

#### Description

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

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

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

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

In some places in New England, including locations in Massachusetts, small earthquakes seem to occur with some regularity. In articles appearing in 2016, John Ebel Ph.D., a Senior Research Scientist at the Weston Observatory, was quoted as saying “The Acton, Braintree and Littleton areas are actually sporadically active... We tend to get a small earthquake once every three-to-five years.” It is not clear why some localities experience such clustering of earthquakes, but clusters may indicate locations where there is an increased likelihood of future earthquake activity.

### Location

Given the above discussion, the potential exists for earthquakes to occur within Braintree or to occur elsewhere and be felt in Braintree.

### Previous Occurrences

The largest earthquake since 1900 to strike Massachusetts was a magnitude 3.9 located east of the Quabbin Reservoir in 1994. Two recent earthquakes with epicenters close to central Massachusetts included a magnitude 3.3 in the area around Westfield in 2000, and a magnitude 1.9 in the area around Northampton in 2012.

The previous edition of this plan noted that earthquakes have not occurred Braintree. To determine whether earthquakes have occurred recently near or in Braintree, all events listed by Weston Observatory were reviewed for all towns in Massachusetts since the date of last edition of this plan. Listed earthquakes above magnitude 2.0 include the following very minor earthquakes, and none were near Braintree:

- 12/21/18 – 3 km WSW of Gardner, MA, 2.1/2.1 [Mn\*/Mc\*\*]
- 8/21/19 – 2 km SSE of Wareham, MA, 1.7/2.4
- 12/3/19 – 4 km SSE of Plymouth, MA, 1.6/2.2
- 11/8/20 – 11 km SW of New Bedford, MA, 3.8/3.4
- 11/22/20 – 12 km WSW of New Bedford, MA, 1.7/2.6
- 7/25/21 – 5 km W of Peabody, MA, 1.4/2.5
- 1/1/22 – 13 km N of Rockport, MA, 2.3/3.0
- 3/4/22 – 5 km WSW of Orange, MA, 2.2/2.7

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- 3/19/22 – 36 km ENE of Rockport, MA, 1.4/2.2

\*Mn is the Nuttli Magnitude (see *Extent* below)

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

### Extent

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

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

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

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

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

Regionally, the Weston Observatory utilizes two scales to track the magnitude of earthquakes. These include the Nuttli magnitude (Mn) for North America east of the Rocky Mountains and is more appropriate for the relatively harder continental crust in Connecticut compared to California. Weston Observatory also utilizes the Coda Duration magnitude (Mc), which is based on the duration of shaking

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at a particular station. The advantages of the Coda Duration magnitude are that this method can quickly estimate the magnitude before the exact location of the earthquake is known.

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

Table 23. Modified Mercalli Intensity.

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

Source: USGS

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

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Table 24. Modified Mercalli Intensity and Moment Magnitude.

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

Source: USGS

The above earthquake characterization systems are applicable to all earthquakes that may occur in Braintree, as they are used throughout the northeastern United States on a routine basis and appropriately characterized previous earthquakes that were felt in Braintree. Earthquakes have not occurred that are outside of the Richter, Moment Magnitude, and Mercalli scales.

### Probability of Future Events

Earthquake location and magnitude probabilities are exceptionally difficult to predict in Massachusetts. Minor earthquakes are relatively common in New England, but damaging earthquakes are not. Therefore, USGS instead characterizes the probability of ground acceleration rather than estimating a probability of magnitude. The Seismic Hazard Map for the Massachusetts (USGS) shows a peak ground acceleration of 14% of gravity in Braintree having a 2% probability of being exceeded in 50 years.

### Vulnerability Assessment

#### **Exposure**

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

#### **Built Environment Impacts**

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

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To identify built environment impacts to the Town, FEMA’s risk assessment software, Hazus, was implemented. The economic loss results of the 1500-year event are shown in Table 25 while the results for the 2500-year event are shown in Table 26. **Error! Reference source not found.** The Town’s Average Annual Loss (AAL) is modeled to be \$145,713.

Table 25. Building Loss for a 1500-Year Scenario.

Loss Type	Residential (\$Million)	Commercial (\$Million)	Other Occupancy (\$Million)	Total (\$Million)
Building Loss	18.26	12.70	7.62	<b>38.58</b>
Content Loss	4.85	4.92	3.50	<b>13.27</b>
Business Inventory Loss	0.00	1.16	0.26	<b>1.42</b>
Business Income Loss	0.18	2.17	0.10	<b>2.45</b>
Business Relocation Loss	1.11	2.12	1.13	<b>4.36</b>
Rental Income Loss	0.78	1.51	0.23	<b>2.52</b>
Wage Loss	0.41	2.54	0.51	<b>3.46</b>
<b>Total</b>	<b>25.59</b>	<b>27.12</b>	<b>13.35</b>	<b>66.06</b>

Table 26. Building Loss for a 2500-Year Scenario.

Loss Type	Residential (\$Million)	Commercial (\$Million)	Other Occupancy (\$Million)	Total (\$Million)
Building Loss	35.86	24.10	14.60	74.56
Content Loss	10.69	9.99	7.08	27.76
Business Inventory Loss	0.00	2.34	0.52	2.86
Business Income Loss	0.34	3.94	0.18	4.46
Business Relocation Loss	2.10	3.82	2.10	8.02
Rental Income Loss	1.41	2.65	0.42	4.48
Wage Loss	0.79	4.57	0.91	6.27
<b>Total</b>	<b>51.19</b>	<b>51.41</b>	<b>25.81</b>	<b>128.41</b>

# Town of Braintree, MA Hazard Mitigation Plan

## Population Impacts

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

Hazus was used to model injuries and fatalities for the 1500- and 2500-year events. For the 1500-year event, there are up to 2 minor injuries requiring medical attention and no injuries requiring medical attention. For the 2500-year event there are up to 20 minor injuries not requiring medical attention with up to five injuries requiring medical attention.

## Environment Impacts

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

## Problem Statements for Earthquakes

Table 27. Problem Statements for Earthquakes.

Assets	Problems Associated with Earthquakes
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"><li>• Vulnerable populations located in unreinforced masonry structures may sustain injuries.</li><li>• Elderly people may fall during events.</li></ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"><li>• Unreinforced masonry and utility lifelines impacted.</li><li>• Utility systems impacted.</li></ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"><li>• None apparent or projected.</li></ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"><li>• Historical buildings constructed out of unreinforced masonry are susceptible and may be impacted.</li></ul>
Activities that have value to the community	<ul style="list-style-type: none"><li>• None apparent or projected.</li></ul>

### Flooding from Precipitation

Nationally, flooding causes more damage annually than any other severe weather event. Flooding in Massachusetts is often the direct result of frequent weather events such as coastal storms, nor'easters, tropical storms, hurricanes, heavy rains, and snowmelt. Increases in precipitation and extreme storm events will result in increased inland flooding. Common types of flooding are described below.

#### Description

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

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

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

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

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

Beaver Dams: Additional causes of flooding include beaver dams. Beaver dams obstruct the flow of water and cause water levels to rise. Significant downstream flooding can occur if beaver dams break.

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

Secondary Hazards: The most problematic secondary hazards for flooding are fluvial erosion, riverbank erosion, and landslides affecting infrastructure and other assets located within floodplains. Without the space required along river corridors for natural physical adjustment, such changes in rivers after flood events can be more harmful than the actual flooding. The impacts from these secondary hazards are especially prevalent in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging buildings, and structures closer to the river channel or cause them to fall in. Landslides can occur following flood events when high flows oversaturate soils on steep slopes, causing them to fail. These secondary hazards also affect infrastructure.

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

### Location

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Heavy rainfall events occur regularly in Massachusetts. As a result, inland flooding such as riverine and drainage-related flooding affect most of the communities in the Commonwealth, including Braintree. The inland waterways of Braintree include the Monatiquot River and its tributaries, and much of the inland flooding in the Town is associated with this watershed. Ice jams are likely not a risk given the stream and river profiles in Braintree. A few dams are located in and upstream of Braintree. Therefore, all flood-related hazards except for ice jams (riverine floods, stormwater flooding, dam overtopping) are believed relevant to the Town of Braintree.

“Locally Identified Areas of Flooding” were listed in the previous edition of this plan. They were identified by Town staff in 2018-2019 as areas where flooding was known to occur. These areas did not necessarily coincide with the flood zones; some were areas that flood due to inadequate drainage systems, high groundwater, or other local conditions rather than a location within a flood zone. This list is repeated below for consistency with the previous edition of this plan; a mention on this list does not mean that flooding has occurred recently.

*Table 28. Locally Identified Areas of Flooding.*

<b>Name</b>	<b>Description</b>
Braintree Highway Barn	The Union Street pump station and neighboring homes receive overflow from the Monatiquot River.
Harding Avenue	Overflow from the Monatiquot River floods homes in this area.
Hancock Street & Route 37	Overflow from the Monatiquot River floods homes in this area.
Jefferson Street at Shepherd Street	Overflow from the Monatiquot River floods homes in this area.
Jefferson Street at Ellery Street	Overflow from the Monatiquot River floods homes in this area.
Solar Avenue	Overflow from the Monatiquot River floods homes in this area.
Wayne Avenue	Overflow from a tributary to the Monatiquot River floods homes in this area.
Winter Street	Groundwater sourced flooding occurs here.
Hillside Road	Runoff from South Middle School and a high groundwater table causes flooding here.
Glendale Road	Groundwater sourced flooding occurs here.
Braintree High School	The athletic fields flood. The fields are filled former wetlands.

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Name	Description
Pearl Street near the Monatiquot River	Overflow from the Monatiquot River floods this area.
Crawford and Webb Streets and Stevens Avenue	Overflow from the Monatiquot River floods this area.
Union Street	This area can be prone to “flash flooding” as a large area of paved surface drains to this area. Overflow from the river also contributes to flooding at the rotary. Flooding can be two feet deep but dissipates quickly.
Watson Park	This area is subject to flooding from coastal storm surge.
Alida Road/Cedar Swamp	Flooding from the swamp reaches the adjacent homes.
Woodsum Drive	This is groundwater sources flooding. Short-term flash street flooding occurs here.
Adams Street	From Elm to Commercial Streets is subject to flooding due to downstream constriction in the Monatiquot River floodplain.
Allen Street	Flooding occurs when the Monatiquot River overflows its banks. Sewage overflows are also an issue in this location.
Commercial Street	Flooding from the Monatiquot River happens downstream from the bridge.
West Street/Great Pond Dam	Road flood happens here. A culvert replacement project has reduced the flooding.
Vinedale and Edgehill Roads	Flooding here is a result of coastal storm surge.
Lundquist and Campanelli Drives and Granite Street	Overflow from the Farm River causes flooding here.
Andrea and Eileen Drives, and Norfolk Road	Groundwater sourced flooding occurs here.
Trotter Green	This area is at very low elevation. Groundwater infiltrating the sewer system leads to flooding during large storms.

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Name	Description
Commercial Street and Brookside Road	Flooding comes from Pond Meadow Park and floods the pump station area. There have been some drainage improvements related to the Greenbush MBTA project.
Quincy Avenue and Brookside Road	The sewer pump station is subject to flooding.
Barstow Drive near Ida Road	The Farm River pump station area floods.
Franklin Street between Lakeview and Hollingsworth Avenues	Drainage is in need of repair here. State and town roads are both involved.

### Previous Occurrences

The previous edition of this plan includes a brief description of the floods of March 2010, which remains the most severe precipitation-related month of flooding in Braintree from the last 15 years. The Monaquot River exceeded flood stage twice. Flooding was widespread throughout Braintree including overtopping six bridges, street flooding, DPW flooding, and FEMA-reimbursed flood claims for more than 600 properties.

As noted earlier, this plan update relies primarily on a roughly ten-year lookback (2014 through 2023). The NOAA Storm Events database (<https://www.ncdc.noaa.gov/stormevents/>) for Norfolk County lists four flood events impacting the Braintree area for the period 2014-2023.

Table 29. NCEI Severe Storm Database Entries Covering Floods in Braintree.

Date	Description	Losses Reported
8/10/12	<i>Flash Flood.</i> A series of upper level disturbances rotated around a vertically stacked low pressure system in the Great Lakes. These provided a focus for showers and thunderstorms to develop across southern New England. Southerly winds drew tropical moisture over the area, resulting in very heavy rain in showers and thunderstorms that developed. In addition, strong winds in the upper levels and 30-40 knots of deep layer shear resulted in wind damage with the strongest of these storms. <b>Several feet of water on Route 37 in Braintree near the Mutual gas station closed the</b>	\$35,000 among all affected towns

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	<b>road. A car was stuck in flood waters at the intersection of Union Street and Grossman Drive.</b>	
6/7/13	<i>Flood.</i> The remnants of Tropical Storm Andrea tracked across southeastern Massachusetts bringing heavy rain (3-5 inches) to much of southern New England. This resulted in significant urban flooding, particularly across eastern Massachusetts and Rhode Island, as well as river and small stream flooding. It also contributed to record high rainfall across the area for the month of June. Three to five inches of rain fell across the south Boston metro area. <b>Grossman Drive and the underpass for the MBTA train tracks were flooded in Braintree. Also, Forbes Road near the bus terminal was flooded.</b>	---
10/23/14	<i>Flood.</i> Low pressure moving up the east coast brought a soaking rain and strong winds to much of southern New England. The strongest winds were along the east coast of Massachusetts where many trees were still fully leaved. This resulted in significant tree damage along with power outages. In addition, both downed leaves from the storm and naturally fallen leaves from before the storm clogged storm drains which resulted in street flooding, particularly across northeastern Massachusetts. <b>Route 37 was flooded near 275 Hancock Street. Traffic was diverted down Washington Street to Jefferson Street. Common Street from Granite to Washington was closed due to flooding.</b>	---
8/2/17	<i>Flood.</i> A mid-level disturbance moved across Southern New England, tapping very moist and unstable air to create showers and thunderstorms. Some showers and storms produced heavy downpours and strong wind gusts. <b>At 350 PM, Granite Street in Braintree had six to twelve inches of street flooding.</b>	---

USDA declares agricultural disasters as needed for a variety of hazards. Information can be found at <https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index>. The line item related to floods in Norfolk County is listed below. The severe precipitation-related flooding of summer 2023 is reflected in this entry.

Table 30. USDA Disasters Events That Refer to Floods.

Year	Event	Event "Begin Dates"
2023	Flood, Flash flooding, Excessive rain, moisture, humidity	7/9/2023

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Braintree has been affected by floods as recently as the winter of 2023-2024. The coastal flood event of January 10, 2024, was accompanied by significant precipitation which caused inland flooding. Braintree recorded about 2.59 inches of rain on January 10, and posts on social media from Braintree community members featured pictures of flooding in the community.

According to the previous edition of this plan, there have been no dam failures in Braintree.

### Extent

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

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

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

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

Due to the pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Flash flooding, which occurs when excessive water fills either normally

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dry creeks or riverbeds or dramatically increases the water surface elevation on currently flowing creeks and rivers, can be less predictable. However, potential hazard areas can be warned in advance of potential flash-flooding danger. Flooding is more likely to occur due to a rainstorm when the soil is already wet and/or streams are already running high from recent previous rains. NOAA's Northeast River Forecast Center provides flood warnings for Massachusetts, relying on monitoring data from the USGS stream gauge network. Notice of potential flood conditions is generally available several days in advance. State agency staff also monitor river, weather, and forecast conditions throughout the year. Notification of potential flooding is shared among state agency staff, including the Massachusetts Emergency Management Agency (MEMA) and the Office of Dam Safety. The NWS provides briefings to state and local emergency managers and provides notifications to the public via traditional media and social networking platforms.

The FEMA flood products and the NWS warning products are applicable to all floods that may occur in Braintree, as they are used throughout Massachusetts on a routine basis and appropriately characterized previous floods in Braintree. Floods have not occurred that are outside of the FEMA flood characterization framework or the NWS watch/warning systems for floods.

### Probability of Future Events

Although it can be complex to forecast, scientists expect that there will be an overall increase of precipitation on an annual basis across Massachusetts. It is expected that precipitation patterns will become more variable over time, with fewer days with precipitation, but heavier and more intense events when it does rain or snow. Most areas across the state are expected to have small increases in annual total precipitation, but a substantial change in seasonal precipitation patterns.

Climate change will increase the probability of flooding caused by intense precipitation. The National Climate Assessment and NCEI both project more fall, winter, and spring precipitation as well as more intense precipitation. As noted in the ResilientMass Plan, extreme river flow events are projected to increase, elevating the probability of damaging floods. In addition, smaller flood events are likely to occur more frequently. For example, the current 24-hour 10-year storm (about 3 inches) could double in frequency by 2050 in western and central Massachusetts and triple in frequency in coastal regions.

### Vulnerability Assessment

#### ***Exposure***

Risks in Braintree are expressed with new floodplain mapping that has preliminary status for the Town as well as the older, effective floodplain. The newer floodplain mapping depicts additional areas of flooding to the east, and slightly less flood risk in more populated areas to the west and north. The effective 1% annual chance floodplain (100-year floodplain) covers about 1,651.4 acres, or approximately 17.9 percent of the Town. The newer, preliminary floodplain covers 1,687.0 acres, or approximately 18.3 percent of the Town. Consider the following:

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- Two sewer pump stations, the sewer department and garage, two reservoir pumps, the Braintree Highway Department, a Yacht Club, Citgo Pier, and a BELD Station are exposed to flooding.
- Approximately 313 buildings are in the current floodplain and 183 buildings in the new, preliminary floodplain.
- Two structures listed on the National Register of Historic Places are in the floodplain: the Chickatawbut Road Entrance Gates and the Blue Hills Reservation Culvert System.
- According to EPA’s Toxic Release Inventory (TRI) database, 50 buildings containing hazardous materials are found in the floodplain. These buildings include gas stations, auto shops, home repair, oil companies, and other businesses. The Citgo Pier contains and transports hazardous materials in the coastal floodplain.
- There are 137 buildings in the floodplain that are part of an environmental justice community.

Table 31 shows the types of buildings exposed to the flood and their value for the current floodplain and Table 32 shows the buildings exposed to the preliminary floodplain. The number in parathesis shows the total number of buildings and building values for the Town.

*Table 31. Buildings in 100-Year Floodplain (Current).*

<b>Building Type</b>	<b>Number of Buildings (Total in City)</b>	<b>Building Value (Total in City)</b>
Single Family	177 (11,666)	\$54,670,900 (\$3,592,112,100)
Multi-Family	40 (1,219)	\$311,622,085 (\$4,389,337,685)
Mixed-Use	0 (40)	\$0 (\$18,419,800)
Commercial	42 (445)	\$25,424,800 (\$2,333,869,090)
Educational	0 (11)	\$0 (\$111,267,500)
Government	25 (228)	\$2,772,300 (\$575,447,000)
Religious/Non-Profit	6 (83)	\$3,168,000 (\$102,022,000)
Industrial	22 (134)	\$15,665,700 (\$230,341,800)
Garage/Outbuilding	1 (9)	\$6,400 (\$87,000)
Vacant	0 (54)	\$0 (\$21,192,400)
<b>Total</b>	<b>313 (13,889)</b>	<b>\$413,330,185 (\$11,374,096,375)</b>

*Table 32. Buildings in 100-Year Floodplain (Preliminary).*

<b>Building Type</b>	<b>Number of Buildings (Total in City)</b>	<b>Building Value (Total in City)</b>
Single Family	83 (11,666)	\$22,685,900 (\$3,592,112,100)
Multi-Family	26 (1,219)	\$167,885,085 (\$4,389,337,685)
Mixed-Use	0 (40)	\$0 (\$18,419,800)
Commercial	35 (445)	\$23,732,100 (\$2,333,869,090)

## Town of Braintree, MA Hazard Mitigation Plan

Building Type	Number of Buildings (Total in City)	Building Value (Total in City)
Educational	0 (11)	\$0 (\$111,267,500)
Government	18 (228)	\$2,248,900 (\$575,447,000)
Religious/Non-Profit	2 (83)	\$1,145,400 (\$102,022,000)
Industrial	18 (134)	\$12,898,300 (\$230,341,800)
Garage/Outbuilding	0 (9)	\$0 (\$87,000)
Vacant	1 (54)	\$44,000 (\$21,192,400)
<b>Total</b>	<b>183 (13,889)</b>	<b>\$230,639,685 (\$11,374,096,375)</b>

The population exposed to the preliminary 100-year floodplain is shown in Table 33. The column on the left shows the population in and around the floodplain (wherever the Census Block overlapped with the floodplain boundary) while the column on the right shows the total population numbers for the Town.

There is a large Asian population and EJ community in the floodplain.

*Table 33. Population Exposed to 100-Year Floodplain (2020 U.S. Census).*

Demographics	Population in and Adjacent to Floodplain	Total Population
<b>Population</b>	13,840	39,143
<b>Households</b>	5,802	14,510
<b>White</b>	9,577 (69.1%)	27,698 (70.8%)
<b>Black</b>	645 (4.7%)	1,330 (3.4%)
<b>American Indian</b>	13 (0.1%)	69 (0.2%)
<b>Asian</b>	2,596 (18.8%)	6,750 (17.2%)
<b>Pacific Islander</b>	0 (0.0%)	9 (0.0%)
<b>Other Race</b>	321 (2.3%)	923 (2.4%)
<b>Two or More Races</b>	688 (5.0%)	2,364 (6.0%)
<b>Hispanic or Latino:</b>	535 (3.9%)	764 (2.0%)
<b>Population under 18:</b>	3,028 (21.9%)	8,126 (20.8%)
<b>Population over 64:</b>	2,251 (16.3%)	6,211 (15.9%)
<b>Annual Income &lt; \$30K/year</b>	645 (11.1%)	1,967 (13.6%)
<b>Population in EJ Zone*:</b>	10,431 (75.4%)	30,821 (78.7%)

*\*Massachusetts Office of Energy and Environmental Affairs, 2022*

In addition to the 100- year floodplain, stormwater has the potential to cause localized flooding. Areas that experience road flooding include the Union and Ivory Street intersection, Hancock, Washington, Adams, Jefferson, West, and Union Streets, and Rex Drive.

Although dams and their associated impoundments provide many benefits to a community, such as water supply, recreation, hydroelectric power generation, and flood control, they also pose a potential risk to lives and property. Dam failure is not a common occurrence, but dams do represent a potentially disastrous hazard. When a dam fails, the potential energy of the stored water behind the dam is

## Town of Braintree, MA Hazard Mitigation Plan

instantly released, oftentimes with catastrophic consequences as the water rushes in a torrent downstream flooding an area known as an “inundation area.” The number of casualties and the amount of property damage will depend upon the timing of the warning provided to downstream residents, the number of people living or working in the inundation area, and the number of structures in the inundation area.

There are four high hazard dams and no significant hazard dams in Braintree, with an additional high hazard dam located to the west of the Town. The Armstrong Dam (formerly high hazard) was recently removed, along with the Ames Dam. Table 34 identifies the dams within the Town.

*Table 34. Dams in Vicinity.*

<b>Name</b>	<b>Ownership</b>	<b>Hazard Type</b>
Great Pond Dam	Public	High
Great Pond Upper Reservoir Dam	Public	High
Old Quincy Reservoir Dam	Public	High
Smelt Brook Dam	Public	High
Ricardi Reservoir Dam	Public	Low
Sunset Lake Dam	Public	N/A

The 100-year preliminary floodplain (FEMA), dams, and Town’s critical facilities are shown in Figure 10. The fire station is exposed to the flood hazard. Train tracks do cross the 100-year floodplain and may be vulnerable to flooding. There are two sewer pump stations, sewer department and garage, two reservoir pumps, Braintree Highway Department, Citgo Pier, BELD Station, and B.A.S.E., is exposed to flooding.

# Town of Braintree, MA Hazard Mitigation Plan

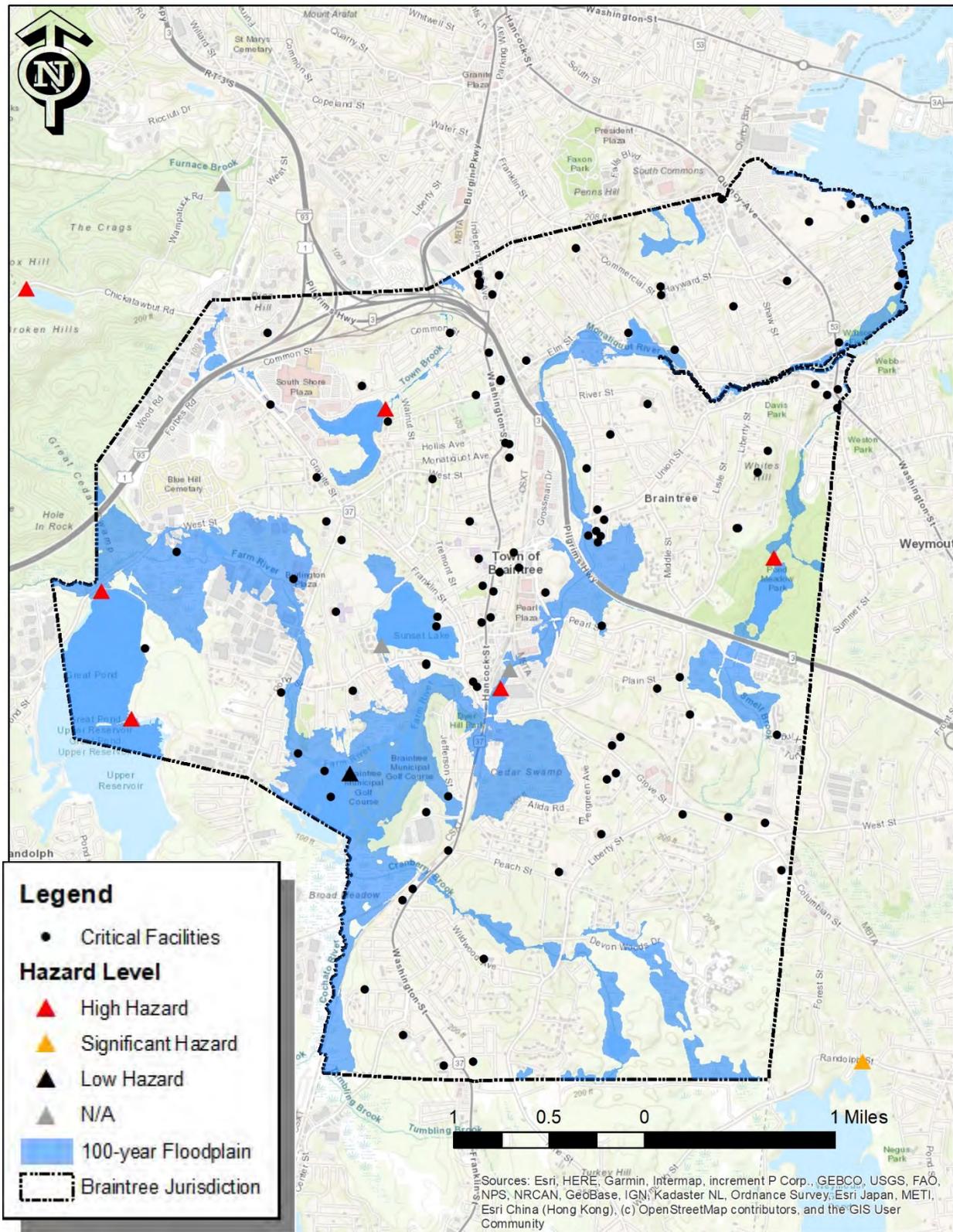


Figure 10. Braintree Critical Facilities and 100-Year Floodplain.

## Town of Braintree, MA Hazard Mitigation Plan

### **Built Environment Impacts**

To identify built environment impacts to the Town, FEMA’s risk assessment software, Hazus, was implemented. Building footprint data and parcel data was used to update the model while the latest floodplain was also integrated into the software. The economic loss results of the 100-year event are shown in Table 35. The Town’s Average Annual Loss (AAL) is calculated to be \$1,774,000.

Table 35. Building Loss for the 100-Year Flood Scenario.

Loss Type	Residential (\$Million)	Commercial (\$Million)	Other Occupancy (\$Million)	Total (\$Million)
Building Loss	5.05	1.59	0.28	<b>6.92</b>
Content Loss	3.82	5.29	1.34	<b>10.45</b>
Business Inventory Loss	0.00	0.92	0.09	<b>1.01</b>
Business Income Loss	0.18	34.48	3.67	<b>38.33</b>
Business Relocation Loss	6.99	12.02	3.95	<b>22.96</b>
Rental Income Loss	3.29	8.49	1.10	<b>12.88</b>
Wage Loss	0.43	36.61	47.81	<b>84.85</b>
<b>Total</b>	<b>19.76</b>	<b>99.4</b>	<b>58.24</b>	<b>177.40</b>

Climate change will increase the probability and magnitude of flood impacts to the built environment. Future floodplains may be larger than the current FEMA modeled floodplain and new development, including the Enclave development should consider these projected conditions. These new developments may cause additional stormwater issues which should be considered too.

### **Population Impacts**

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

Using the Hazus software, the 100-year flood scenario results showed that there would be approximately 550 displaced households and 280 people seeking public shelter.

## Town of Braintree, MA Hazard Mitigation Plan

Climate change will increase the probability and magnitude of flood impacts to the population. Future floodplains may be larger than the current FEMA modeled floodplain and new development should consider these projected conditions. Vulnerable populations should be considered when development near the current floodplain is planned.

### **Environment Impacts**

One of the major environmental impacts of a major flood would be the potential release of hazardous materials. According to EPA’s Toxic Release Inventory (TRI) database, 50 buildings containing hazardous materials are found in the floodplain. These buildings include gas stations, auto shops, home repair, oil companies, and other businesses. The Citgo Pier contains and transports hazardous materials in the coastal floodplain. There are capped landfills which could be impacted by floods too.

Climate change will increase the probability and magnitude of flood impacts which may include environmental impacts due to hazardous materials release. Facilities which contain hazardous materials should be considered when new development is planned.

### **Problem Statements for Flood**

Problem statements summarize risk and vulnerability and are included following each hazard profile. The problem statements were developed to bridge the gap between identified hazard and development of the mitigation actions. Problem statements are included in each hazard profile section.

*Table 36. Problem Statements Related to Flooding.*

<b>Assets</b>	<b>Problems Associated with Flood</b>
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"> <li>• Older populations in the floodplain may have difficulty evacuating.</li> <li>• A nursing home and schools are exposed to flooding; these have vulnerable populations in them.</li> </ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"> <li>• Potential exposed structures include: two sewer pump stations, sewer department and garage, two reservoir pumps, Braintree Highway Department, , Citgo Pier, and a BELD Station.</li> </ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"> <li>• Road closures may interrupt community systems including the following roads: Grossman, Forbes, Route 37/Hancock, Route 37/Granite, Washington, Adams, Jefferson, West, Union, Rex, the Union and Ivory Street intersection, and Forbes Road and Union Street at the MBTA underpass.</li> </ul>

## Town of Braintree, MA Hazard Mitigation Plan

Assets	Problems Associated with Flood
	<ul style="list-style-type: none"> <li>The Town is currently precluded from adopting higher regulatory standards to protect against flooding (must comply with State Building Code).</li> </ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"> <li>According to EPA’s Toxic Release Inventory (TRI) database, 50 buildings containing hazardous materials are found in the floodplain. These buildings include gas stations, auto shops, home repair, oil companies, and other businesses. The Citgo Pier contains and transports hazardous materials in the coastal floodplain.</li> <li>Two structures listed on the National Register of Historic Places are located in the floodplain: the Chickatawbut Road Entrance Gates and the Blue Hills Reservation Culvert System.</li> </ul>
Activities that have value to the community	<ul style="list-style-type: none"> <li>Several road closures and critical facilities impacted by flooding may disrupt community events.</li> </ul>

### Hurricanes and Tropical Storms

Flooding in Massachusetts is often the direct result of tropical storms and hurricanes. These powerful storms can also cause significant widespread damage due to high winds. The impacts from high winds are the primary concern of this section.

#### Description

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

Hurricane season runs from June 1 to November 30. In New England, these storms are most likely to occur in August, September, and the first half of October. The ResilientMass Plan notes that this is due in large part to the fact that it takes a considerable amount of time for the waters south of Long Island to warm to the temperature necessary to sustain the storms this far north. Also, as the region progresses into the fall months, the upper-level jet stream steering winds might flow from the Great Lakes

## Town of Braintree, MA Hazard Mitigation Plan

southward to the Gulf States and then back northward up the eastern seaboard. This pattern is conducive for capturing a tropical system over the Bahamas and accelerating it northward.

### Location

Tropical storms and hurricanes can affect the entirety of Massachusetts, including the geographic extent of Braintree.

### Previous Occurrences

The ResilientMass Plan notes that hurricanes and tropical storms occur somewhat regularly in Massachusetts. Recent notable events include Tropical Storm Isaias (2020), Tropical Depression Henri (2021), and Tropical Storm Else (2021). Historical tropical system tracks near and through are depicted on the following page. This mapping is available from NOAA and updated continuously.

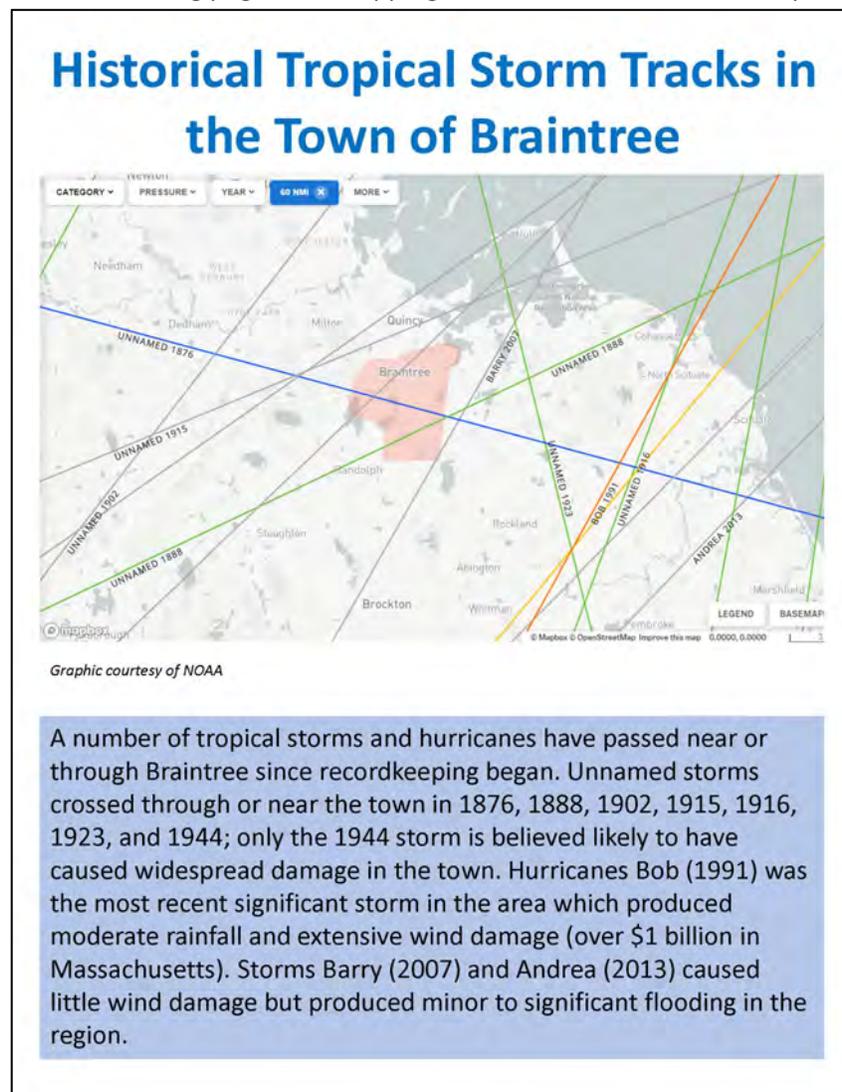


Figure 11. Historical Tropical Storm Tracks In Braintree.

## Town of Braintree, MA Hazard Mitigation Plan

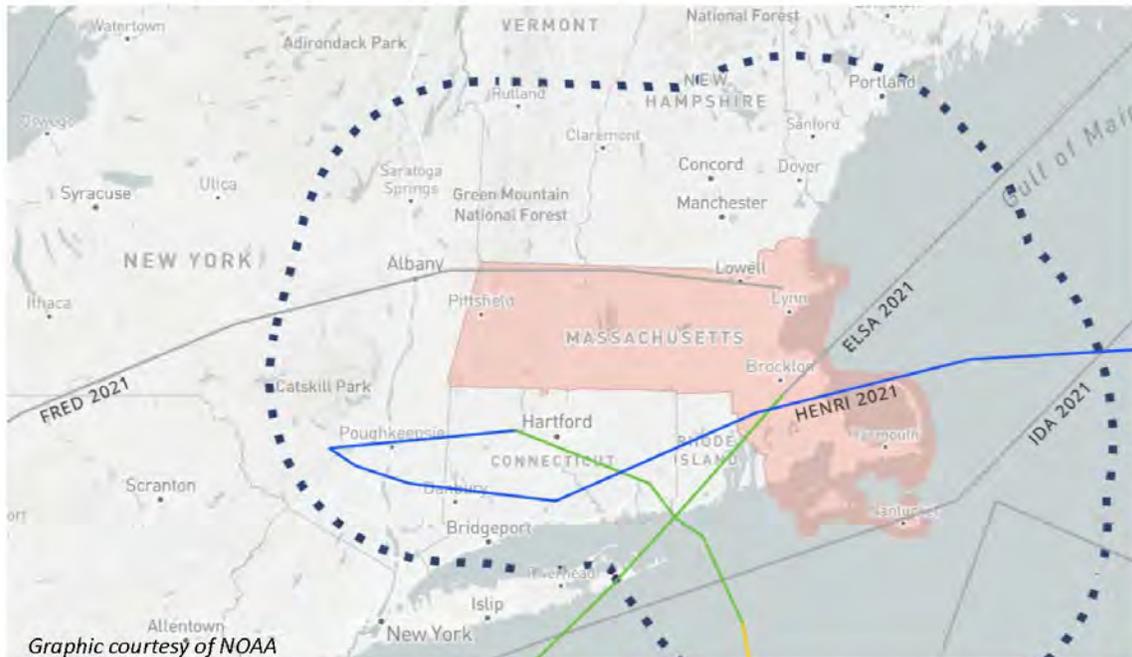
As noted elsewhere, this Plan update relies primarily on a ten-year lookback (2014 through 2023) ending with the date of plan development. During that ten-year period, only one Massachusetts emergency declaration (Storm Lee of September 2023) was associated with a tropical system, but it is not yet in the NCEI database of severe storms for Norfolk County. Three tropical storm and hurricane events appeared in the NCEI inventory for eastern Norfolk County for the last 11 years.

Table 37. NCEI Severe Storm Database Entries Covering Tropical Storms in Braintree.

Date	Description	Losses Reported
6/7/13	<i>Flood.</i> The remnants of Tropical Storm Andrea tracked across southeastern Massachusetts bringing heavy rain (3-5 inches) to much of southern New England. This resulted in significant urban flooding, particularly across eastern Massachusetts and Rhode Island, as well as river and small stream flooding. It also contributed to record high rainfall across the area for the month of June. Three to five inches of rain fell across the south Boston metro area. Grossman Drive and the underpass for the MBTA train tracks were flooded in Braintree. Also, Forbes Road near the bus terminal was flooded.	---
8/4/20	<i>Tropical Storm.</i> Tropical Storm Isaias moved from coastal Virginia eastern New York state, near the Connecticut/Massachusetts border on Tuesday, August 4. As the storm reached the New York City area, southerly winds were maximizing across southern New England, causing widespread wind damage. At 451 PM, the ASOS atop Blue Hill (KMQE) in Milton measured a wind gust to 59 mph.	---
8/22/21	<i>Tropical Storm.</i> Tropical Storm Henri made landfall in southwest Rhode Island around noon on August 22nd, then moved slowly northwestward and westward across northern Connecticut and weakened. Henri brought strong wind gusts and flash flooding. The strongest gusts (to 70 mph) occurred along the Rhode Island coast. In Braintree, a tree was down on Birch Street, near Grove Street.	\$500

Braintree was only moderately impacted by the tropical and post-tropical storm systems listed above. The storm tracks of 2021 are illustrated on the following graphic. Tropical Storm Elsa tracked very close to Braintree.

## Impacts of the 2021 Hurricane Season on Massachusetts



T.S. Elsa crossed eastern Massachusetts on July 9, delivering wind and flooding rains while transitioning to an extratropical storm later that day. Approximately 2 to 4 inches of rain were recorded in many towns. MBTA commuter rail trains were delayed on the Worcester line due to flooding, and Route 146 was flooded. About 11,000 Eversource customers in Massachusetts lost power.

Extratropical Storm Fred crossed northern Massachusetts lengthwise on August 19 and 20, delivering flooding rains to parts of southern New England. Flooding in Massachusetts was worst in the Worcester area. Approximately 2 to 4 inches of rain were recorded in many towns.

T.D. Henri crossed eastern Massachusetts on August 24, delivering flooding rains to parts of southern New England. Prior to crossing Massachusetts, the storm looped through Connecticut and New York on August 22-24. The path and slow movement of the storm contributed to widespread flooding in all three states, made worse due to the conditions caused by storm Fred only a few days before. Approximately 1 to 4.5 inches of rain were recorded in many towns. About 12,000 Eversource customers in Massachusetts lost power.

Extratropical Storm Ida passed south of New England and crossed Nantucket on September 2, delivering flooding rains to parts of southern New England. The precipitation from Ida was more intense than expected, and it caused widespread flooding. Approximately 2 to 6 inches of rain were recorded in many towns. About 4,000 people in Massachusetts lost power.

Figure 12. Tracks for Tropical Storms that Impacted Massachusetts 2021.

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Even without the presence of a catastrophic hurricane striking Braintree recently, less severe tropical storms and remnants such as those described above have created disruptions and necessitated public expenditures to deal with outages and debris.

### Extent

The Beaufort Wind Scale is reportedly one of the first scales to estimate and characterize wind speeds. It was developed in 1805 to help sailors estimate winds via visual observations. The scale ranges from zero (“seas like a mirror”) to 12 (“hurricane”). The Beaufort scale is still used today to estimate wind strengths, but is more common in coastal communities with frontage along the open ocean or large bays. The scale has been used only seldom in Braintree, but it nevertheless available for the Fore River shoreline.

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

Table 38. Saffir-Simpson Scale.

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

**Source:** National Hurricane Center, NOAA

Tropical storms and tropical depressions, while generally less dangerous than hurricanes, can be deadly. The winds of tropical depressions and tropical storms are usually not the greatest threat; rather, the rains, flooding, and severe weather associated with the tropical storms are what customarily cause more significant problems. Nevertheless, serious power outages can also be associated with these types of events.

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

## Town of Braintree, MA Hazard Mitigation Plan

tropical, subtropical, or post-tropical cyclone. A watch is issued 48 hours in advance of the anticipated onset of tropical-storm-force winds (NWS, 2013).

The Saffir-Simpson scale and the NWS watch/warning products are applicable to all tropical storms and hurricanes that may strike Braintree, as they are used throughout Massachusetts on a routine basis and appropriately characterized the previous storms that posed risks to Braintree.

### Probability of Future Events

The ResilientMass Plan explains that Massachusetts experiences a tropical storm or hurricane about once every two years on average, with NOAA estimating the recurrence of any category hurricane between 13 to 30 years, and a Category 3 hurricane occurrence every 50 to 60 years.

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

### Vulnerability Assessment

#### ***Exposure***

High winds and heavy rain and/or hail associated with hurricanes and tropical storms can cause damage to utilities, structures, roads, trees (potentially causing vehicle accidents) and injuries and death. Other associated concerns are debris management issues including debris removal and identification of disposal sites. All assets in Braintree should be considered exposed to high winds while specific areas are exposed to hurricane surge. Figure 13 shows the 100-year windspeeds identified in the ASCE 7-98 publication.

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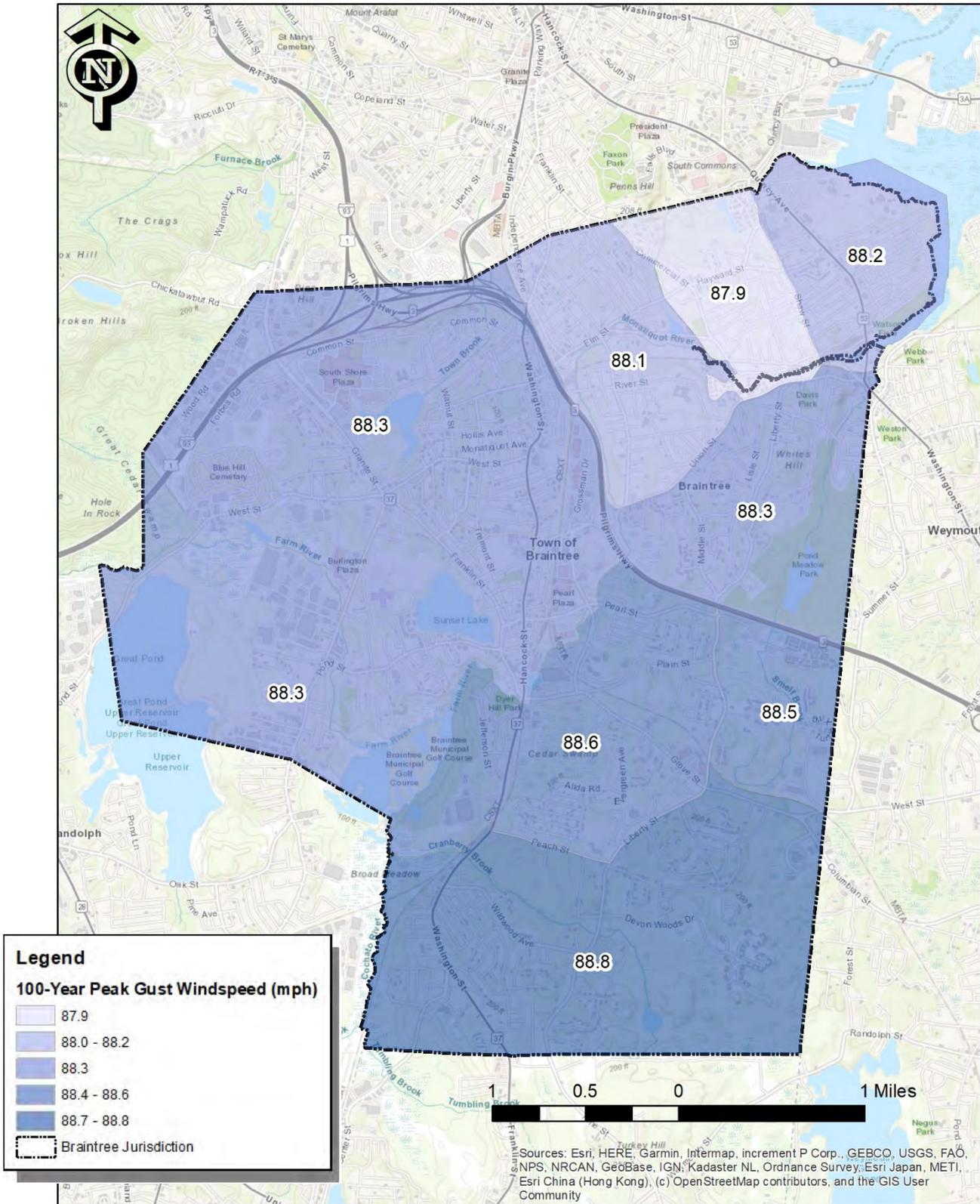


Figure 13. 100-Year Windspeeds (ASCE 7-98).

## Town of Braintree, MA Hazard Mitigation Plan

### **Built Environment Impacts**

To identify built environment impacts to the Town resulting from wind damage, FEMA’s risk assessment software, Hazus, was implemented. The economic loss results of the 500-year event are shown in Table 39 while the results for the 1000-year event are shown in Table 40. The Town’s Average Annual Loss (AAL) is calculated to be \$2,371,372. Buildings that are permanently open with bays or open sides are susceptible to wind damage since the building envelope can’t be maintained. These structures include pavilions and gazebos too.

*Table 39. Building Losses Due to Wind for a 500-Year Scenario.*

<b>Loss Type</b>	<b>Residential (\$Million)</b>	<b>Commercial (\$Million)</b>	<b>Other Occupancy (\$Million)</b>	<b>Total (\$Million)</b>
Building Loss	113.95	19.03	11.16	<b>144.14</b>
Content Loss	26.81	5.98	4.92	<b>37.71</b>
Business Inventory Loss	0.00	1.18	0.41	<b>1.59</b>
Business Income Loss	0.00	1.82	0.48	<b>2.30</b>
Business Relocation Loss	6.50	2.95	1.39	<b>10.77</b>
Rental Income Loss	3.39	1.59	0.20	<b>5.18</b>
Wage Loss	0.00	1.98	4.62	<b>5.79</b>
<b>Total</b>	<b>150.65</b>	<b>34.53</b>	<b>22.3</b>	<b>207.48</b>

*Table 40. Building Losses Due to Wind for a 1000-Year Scenario.*

<b>Loss Type</b>	<b>Residential (\$Million)</b>	<b>Commercial (\$Million)</b>	<b>Other Occupancy (\$Million)</b>	<b>Total (\$Million)</b>
Building Loss	169.27	30.97	18.87	<b>219.11</b>
Content Loss	46.70	11.46	9.41	<b>67.57</b>
Business Inventory Loss	0.00	2.25	0.74	<b>2.99</b>
Business Income Loss	0.00	1.91	0.56	<b>2.47</b>
Business Relocation Loss	12.47	4.75	2.29	<b>19.51</b>
Rental Income Loss	5.66	2.54	0.35	<b>8.55</b>
Wage Loss	0.00	2.18	4.94	<b>7.12</b>
<b>Total</b>	<b>234.10</b>	<b>56.06</b>	<b>37.16</b>	<b>327.32</b>

## **Population Impacts**

Populations considered most vulnerable to hurricane and tropical storm impacts in Braintree are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. For high windspeeds, it's important to maintain the building envelope during the event. If a window or door fails, damage to the structure will be much greater. The senior and low-income populations in Braintree are particularly susceptible to extreme winds and it should be noted that there may be overlap within the two categories. The Town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

For the 500-year event, Hazus predicts that there will be up to forty displaced households and ten people seeking public shelter from the high windspeeds. For the 1000-year event, Hazus predicts that there will be up to 85 displaced households and nearly 25 people seeking public shelter from the high windspeeds.

## **Environment Impacts**

Hurricanes can cause damage to parks, and other, natural areas. Some areas of the Town may be out of service until trees are removed.

## **Problem Statements for Hurricanes/Tropical Storms**

*Table 41. Problem Statements for Hurricanes/Tropical Storms.*

<b>Assets</b>	<b>Problems Associated with Hurricanes and Tropical Storms</b>
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"> <li>• Vulnerable populations may need to be evacuated and could be displaced from their homes.</li> </ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"> <li>• Wind may cause trees to fall into structures and infrastructure, and roadways.</li> <li>• Wind damage to wind-susceptible buildings such as carports, greenhouses, pavilions, gazebos, and open-walled buildings. Additional damage to commercial buildings with HVAC located on roofs.</li> <li>• The electric grid may go down during high wind event.</li> </ul>

## Town of Braintree, MA Hazard Mitigation Plan

Assets	Problems Associated with Hurricanes and Tropical Storms
Systems (including networks and capabilities)	<ul style="list-style-type: none"><li>• First responders may have difficulty reaching people if roads are closed due to tree debris.</li></ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"><li>• Historic buildings may experience damage during high wind events, especially the roofing and windows. Water entering these buildings could impact important historic and cultural artifacts.</li></ul>
Activities that have value to the community	<ul style="list-style-type: none"><li>• A severe hurricane wind and rain event could negatively impact outdoor activities in the Town.</li></ul>

### Invasive Species

The ResilientMass Plan defines invasive species as non-native species that cause or are likely to cause harm to ecosystems, economies, and/or public health (USDA). The focus of this section is on invasive terrestrial plants, as this is the most studied and managed type of invasive; information for invasive aquatic flora and fauna is also provided when relevant.

#### Description

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

Some examples of invasive insect species include:

- Nantucket Pine Tip Moth (native pest) is a moth with heads, bodies, and appendages covered with gray scales with mottled rusty-red markings. Larvae cause damage to young trees (up to five years old) by feeding inside growing shoots, buds, and conelets. The preferred host is the loblolly pine.
- Bark Beetles (native pest) include more than 600 species of beetles which serve in important ecological roles in small numbers where they live in dead, weakened, and dying host conifer trees.

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- Forest Tent Caterpillar (native pest) has the biggest footprint of any indigenous tent caterpillar in North America (Furniss and Carolin 1977) and is a major defoliator of a variety of deciduous hardwood trees. The caterpillars spin silken mats on the trunks and large branches of trees where they molt and feed. Forest Tent Caterpillars can reach outbreak proportions causing massive defoliation of host trees and becoming a nuisance to people.
- Pine Reproduction Weevils (native pest) is a very dark, elongate, oval insect up to 1/2 inch long with indistinct to distinct gray or pale orange spots of scales on the wings and thorax. They feed at night on the conifer seedlings or near the tips of branches of larger plants. Females lay their eggs on the roots of these trees. The weevils breed in all species of pines, hemlocks, junipers, spruces, firs, and cedars.
- Hardwood Borers (native pest) usually attack hardwoods experiencing some kind of stress although the clear-wing moths attack healthy trees. These insects attack the tree year after year and may eventually weaken it enough that it is prone to wind breakage. Some borers develop in the root system damaging young trees.
- Hemlock Woolly and Balsam Woolly Adelgid (non-native pest) is a very small, invasive, aphid-like insect that attacks North American hemlocks (Hemlock Woolly) and firs (Balsam Woolly). They can be identified by the white woolly masses that form on the underside of branches at the base of the tree's needles. They stay at this location for the rest of their lives. Their feeding disrupts the flow of nutrients to the tree twigs and needles leading to a decline in tree health and mortality in 4 to 10 years.
- Gypsy Moth (non-native pest) is an insect which feeds on a large variety of tree leaves from oak, maple, apple, crabapple, hickory, basswood, aspen, willow, birch, pine, spruce, hemlock, and others. It does prefer oak tree leaves, however. Periodically, large populations can cause defoliation damaging and killing trees they are feeding on.
- Spotted Lanternfly (non-native pest) is an invasive insect first detected in the U.S. in 2014. It feeds on a variety of fruit, ornamental, and wood trees and could seriously impact the grape, orchard, and logging industries.
- Emerald Ash Borer (non-native pest) is a small invasive beetle that is devastating to all ash tree species in Massachusetts. The species was first detected in Massachusetts in 2012 in the Town of Dalton. According to the ResilientMass Plan, the emerald ash borer can kill an ash tree in three years.
- Asian Longhorned Beetle (non-native pest) was first discovered in the United States in Brooklyn, NY in 1996 and has since been found in a handful of states. According to the ResilientMass Plan, an outbreak of Asian long-horned beetles in Worcester in 2008 destroyed nearly 30,000 trees; and the species has the potential to cause more damage than Dutch elm disease, chestnut blight and gypsy moths combined.

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- Winter Moth (non-native pest) is an invasive insect that can wreak havoc on trees. Introduced into the United States from Europe via Canada, the moth is most commonly observed in late fall and early winter as a whitish adult moth; and in spring as a tiny green caterpillar.

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### Location

The entire Commonwealth is vulnerable to invasive species. Types of species can vary by location, elevation, ecosystem, and habitat type, as well as land and water use. Furthermore, the ability of invasive species to travel distances (either via natural mechanisms or accidental human interference) allows these species to propagate rapidly over a large geographic area. Similarly, in open freshwater and marine ecosystems, invasive species can quickly spread once introduced, as there are generally no physical barriers to prevent establishment, outside of physiological tolerances, and multiple opportunities for transport to new locations (by boats, for example). The entire geographic area of Braintree is believed at risk for invasive species propagation.

### Previous Occurrences

Invasive species do not represent a singular event but rather an ongoing or emerging problem, so it is difficult to measure the frequency of occurrences. A comprehensive list of invasives can be found at <https://www.massnrc.org/mipag/invasive.htm>. Invasives of current concern to forest health (<https://www.mass.gov/service-details/current-forest-health-threats>) in Norfolk County are reportedly:

- Gypsy Moth
- Winter Moth
- Hemlock Woolly Adelgid
- Southern Pine Beetle
- Emerald Ash Borer
- White Pine Needlecast

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

Table 42. Statewide Budgets for Addressing Invasive Species.

FY Year	Budget
2022	\$277,838
2021	\$146,348
2020	\$4,150,000

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FY Year	Budget
2019	\$3,831,135
2018	\$4,347,000
2017	\$6,046,870

The Braintree Open Space and Recreation Plan (2019) notes that Sunset Lake, Eaton’s Pond, and Pond Meadow all experience problems with nuisance growth of non-native aquatic weeds. These waterbodies are shallow and provide ample opportunity for plants to root in the bottom sediment. These lakes/ponds are also eutrophic, meaning they have experienced a high level of nutrient enrichment due largely human activity such as over fertilizing lawns which fuels aquatic plant growth. Aquatic weeds require ongoing management, typically with aquatic herbicides.

The Braintree Open Space and Recreation Plan further notes that common invasive species include Japanese knotweed, multiflora rose, glossy buckthorn, *Phragmites*, and oriental bittersweet. Invasive species are believed well established in the Town’s landscape, and eradication is believed an unrealistic goal. The Open Space and Recreation Plan encourages focusing on early detection and elimination of new invasive species along with targeted management of invasive species where they threaten sensitive resources or intact ecosystems.

### Extent

MIPAG recognizes 74 plant species as "Invasive," "Likely Invasive," or "Potentially Invasive." The criteria for an “Invasive” species are listed below; the other assigned categories are associated with lower scores on the criteria checklist. The criteria for invasive animal species are less well-defined, but many of the same characteristics (including a non-Massachusetts origin and the ability to out-compete native species) are similar. In order to be considered “Invasive” by MIPAG, a plant species must meet the following complex set of criteria:

1. Be nonindigenous to Massachusetts.
2. Have the biologic potential for rapid and widespread dispersion and establishment in minimally managed habitats.
3. Have the biologic potential for dispersing over spatial gaps away from the site of introduction.
4. Have the biologic potential for existing in high numbers away from intensively managed artificial habitats.
5. Be naturalized in Massachusetts (persists without cultivation in Massachusetts).

If a species meets criteria 1–4 and criterion 5, it may be considered “invasive” or “likely invasive” in Massachusetts. If it does not meet criterion 5, it may be considered “potentially invasive” if it meets criteria 13–15 below.

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6. The species is widespread in Massachusetts, or common in a region or habitat type(s) in the state.
7. The species has many occurrences in Massachusetts that have high numbers of individuals in minimally managed habitats.
8. The species is able to outcompete other species in the same natural plant community.
9. The species has the potential for rapid growth, for high seed or propagule production and dissemination, and for establishment in natural plant communities.

If a species meets the initial five criteria and criteria 6–9 at this time, it may be considered a “likely invasive” species in Massachusetts if it also meets at least one of the following three criteria:

10. The species has at least one occurrence in Massachusetts that has high numbers of individuals forming dense stands in minimally managed habitats.
11. The species has the potential, based on its biology, colonization history outside its native range, and likelihood of range expansion or change in biologic potential from climate change predictions, to become invasive in Massachusetts.
12. The species is acknowledged to be invasive in nearby states, but its status in Massachusetts is unknown or unclear. This may result from lack of field experience with the species or from difficulty in species determination or taxonomy.

If the species meets the basic criteria for invasiveness (criteria 1–4) but is not naturalized in Massachusetts (criterion 5), the species may be considered “potentially invasive” in Massachusetts if it meets the following three criteria (criteria 13–15):

13. The species, if it becomes naturalized in Massachusetts, based on its biology and biologic potential, would pose an imminent threat to the biodiversity of Massachusetts and
14. Its naturalization in Massachusetts is anticipated, and
15. The species has a documented history of invasiveness in other areas outside its native range including expansion of range and/or change in biological potential from climate change predictions

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

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Table 43. Early Detection Information for Addressing Invasive Species.

Species	Common Name	Current County of Distribution (November 2010)	Notes
<i>Arthraxon hispidus</i>	Hairy joint grass; jointhead; small carpetgrass	Franklin (historically)	This species is not currently known in Massachusetts; it was last collected in Deerfield in 1973. This is an annual grass that co-occurs with Japanese stilt grass further south.
<i>Butomus umbellatus</i>	Flowering rush	Essex, Norfolk	<i>Butomus umbellatus</i> is an aquatic perennial herb which reproduces by seed dispersal or vegetatively by bulbils
<i>Carex kobomugi</i>	Japanese sedge; Asiatic sand sedge	Barnstable (historically)	Native to northeastern Asia, <i>Carex kobomugi</i> is an invasive plant that invades coastal sand dunes and can outcompete native dune-binding grasses. This species was last collected in 1973.
<i>Egeria densa</i>	Brazilian waterweed; Brazilian elodea	Essex, Norfolk, Norfolk, Plymouth, Worcester	This species is often confused with Hydrilla and native <i>Elodea</i> spp. but has larger, nickel-sized flowers. This is a submerged aquatic species whose rapid growth often leads to dense mats on the water surface, which crowds out native plants and damages fish and aquatic habitat. The mats can also impede boat traffic.
<i>Glyceria maxima</i>	Tall mannagrass; reed mannagrass	Essex	This perennial grass invades low shrub-swamps and other wetland
<i>Heracleum mantegazzianum</i>	Giant hogweed	Berkshire, Franklin, Hampden, Hampshire, Norfolk, Norfolk,	Giant hogweed is a federal noxious weed that is currently being eradicated under the U.S. Department of Agriculture's authority. This is a perennial herb that can cause painful burns and permanent scarring to humans if they touch the plant.

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Species	Common Name	Current County of Distribution (November 2010)	Notes
		Suffolk, Worcester	
<b><i>Hydrilla verticillata</i></b>	Hydrilla; water-thyme; Florida elodea	Barnstable, Plymouth, Worcester	Hydrilla is an invasive non-native submerged plant. This plant grows and reproduces rapidly, displacing native species, hampering recreational uses, and slowing water flow. Hydrilla, once established, can replace native vegetation and affect fish populations.
<b><i>Myriophyllum aquaticum</i></b>	Parrot-feather; water-feather; Brazilian watermilfoil	Norfolk	Parrot-feather is a perennial aquatic plant native to South America. This plant typically grows in freshwater, with a preference for areas with high nutrient contents. Parrot-feather has been introduced worldwide for use in indoor and outdoor aquaria.
<b><i>Nymphoides peltata</i></b>	Yellow floating heart	Hampden, Norfolk, Worcester	Yellow floating heart is native to Asia and now is found in over 15 states in the U.S. This plant forms dense mats on the water surface, restricting light penetration into the water and decreasing air exchange between the water's surface and the atmosphere. Algae can be shaded out by this plant, resulting in food chain disruptions for an entire lake.
<b><i>Persicaria perfoliata syn.: Polygonum perfoliatum</i></b>	Mile-a-minute vine or weed; Asiatic tearthumb	Barnstable, Essex, Franklin, Norfolk, Plymouth, Suffolk	Mile-a-minute vine is a barbed vine that can grow up to 6 inches a day. This vine smothers other herbaceous plants, shrubs, and even trees by growing over them and blocking their access to sunlight.

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Species	Common Name	Current County of Distribution (November 2010)	Notes
<i>Peuraria montana ssp. lobata</i>	Kudzu; Japanese arrowroot	Barnstable, Bristol, Essex, Norfolk, Plymouth, County	Kudzu is native to Japan and southeast China and was introduced to the U.S. during the Philadelphia Centennial Exposition in 1876. Once established, kudzu can grow at a rate of a foot per day, with mature vines as long as 100 feet.
<i>Senecio jacobaea</i>	Tansy ragwort; stinking Willie; stinking Billy	Essex County Suffolk County Norfolk County	This biennial herb is a weedy plant that infests woodlands, pastures, and hayfields. This plant is toxic to all classes of livestock but most toxic to cattle and horses. The plant can cause chronic liver disease, and affected animals usually die within a few weeks after ingesting it
<i>Trapa natans</i>	Water chestnut	Berkshire, Bristol, Essex, Franklin, Hamden, Hampshire, Norfolk, Suffolk, Worcester	Water chestnut is an annual aquatic species with both floating and submerged leaves.

For the non-native aquatic species in Sunset Lake, Eaton’s Pond, and Pond Meadow – plus the common invasive species Japanese knotweed, multiflora rose, glossy buckthorn, *Phragmites*, and oriental bittersweet – the classification systems presented in this section such as the MIPAG early detection resources are appropriate for Braintree. Additionally, Massachusetts DCR maintains online resources and fact sheets may be useful for Braintree.

### Probability of Future Events

Once established, invasive species often escape notice for years or decades. Introduced species that initially escaped many decades ago are only now being recognized as invasives. Because these species can occur anywhere (on public or private property), new invasive species often escape notice until they

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are widespread, and eradication is impractical. As a result, early and coordinated action between public and private landholders is critical to preventing widespread damage from an invasive species.

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

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

In 2002, Massachusetts passed an Aquatic Invasive Species Management Plan, making the Commonwealth eligible for federal funds to support and implement the plan through the federal Aquatic Nuisance Prevention and Control Act. MassDEP, DCR, CZM, and Massachusetts Institute of Technology Sea Grant College Program are part of the Northeast Aquatic Nuisance Species Panel, which was established under the federal Aquatic Nuisance Species Task Force. This panel allows managers and researchers to exchange information and coordinate efforts on the management of aquatic invasive species. The Commonwealth also has several resources pertaining to terrestrial invasive species, such as the Massachusetts Introduced Pest Outreach Project, although a strategic management plan has not yet been prepared for these species. All these efforts are aimed at reducing the probability of future occurrences.

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

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## Vulnerability Assessment

### Exposure

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

### Built Environment Impacts

Although the built environment is not as susceptible to pests as the natural environment, it can help spread the invasive species. This includes trains and vehicles that could move the species from one location to another. Trees, which are damaged or killed by invasive pests, can become hazards to people, property, utility lines, and roadways when they fall. Many dead trees in one area can also become fuel for wildfires interconnecting the two hazards.

### Population Impacts

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

### Environment Impacts

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

## Problem Statements for Invasive Species

Table 44. Problem Statements for Invasive Species.

Assets	Problems Associated with Invasive Species
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"><li>• None apparent or projected.</li></ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"><li>• None apparent or projected.</li></ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"><li>• Additional DPW resources may be required in critical areas.</li></ul>

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Assets	Problems Associated with Invasive Species
Natural, historic, and cultural resources	<ul style="list-style-type: none"> <li>Invasive species are problematic throughout the Town and have been verified in Pond Meadow Park, Cranberry Pond, and on the Monatiquot River.</li> <li>Sunset Lake, Eaton’s Pond, and Pond Meadow experience problems with nuisance growth of non-native aquatic weeds.</li> </ul>
Activities that have value to the community	<ul style="list-style-type: none"> <li>Recreational activities may be adversely impacted, depending on location, and especially in parks and natural areas.</li> </ul>

### Other Severe Weather

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

#### Description

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

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

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

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

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

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

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

### Location

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

### Previous Occurrences

The NOAA Storm Events database (<https://www.ncdc.noaa.gov/stormevents/>) for Norfolk County lists numerous severe storms affecting the area of Braintree from 2014 through 2023.

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Table 45. NCEI Severe Storm Database Entries Covering Other Severe Storms in Braintree.

Date	Description	Losses Reported
11/24/13	<i>High Wind.</i> Strong pressure rises behind a cold front coupled with cold air advection resulted in strong to damaging winds across much of southern New England. Most of the damage was to trees, some of which were still at least partially leaved. The Automated Surface Observing System at Blue Hill Observatory and Science Center in Milton, MA (KMQE) recorded a wind gust of 58 mph. In Braintree, wires were downed on Liberty and Hancock Streets.	\$25,000 among all affected towns
11/27/13	<i>High Wind.</i> An anomalously strong low level jet coupled with strong pressure falls associated with a low pressure region approaching southern New England resulted in strong to damaging winds across southern New England. Damage was largely to trees. The Automated Surface Observing System at Blue Hill Observatory in Milton, MA (KMQE) recorded sustained wind speeds of 44 mph and gusts up to 63 mph. In addition, large limbs were downed onto Route 37 in Braintree.	\$2,000
10/22/14	<i>High Wind.</i> Low pressure moving up the east coast brought a soaking rain and strong winds to much of southern New England. The strongest winds were along the east coast of Massachusetts where many trees were still fully leaved. This resulted in significant tree damage along with power outages. The Automated Surface Observing System at Blue Hill Observatory in Milton, MA (KMQE) recorded a wind gust to 59 mph. In Braintree, a tree was downed onto a house breaking a skylight on the porch.	\$50,000 among all affected towns
1/5/15	<i>High Wind.</i> Low pressure intensifying in the maritimes led to blustery conditions across southern New England. While most locations remained below high wind warning criteria (40 mph sustained, 58 mph gusts), winds did damage in other parts of the state as well. The Automated Surface Observing System at Blue Hill Observatory and Science Center in Milton, MA (KMQE) recorded sustained wind speeds of 40 mph and gusts to 53 mph. A large branch was downed onto wires on Common Street in Braintree.	\$2,000
5/12/15	<i>Hail.</i> A cold front moved through southern New England sparking showers and thunderstorms. None of these storms became severe, but one produced penny size hail.	---

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Date	Description	Losses Reported
8/4/15	<i>Thunderstorm Wind.</i> This severe weather was triggered by an approaching cold front from the west. A large tree on Washington Street was downed by thunderstorm winds.	\$5,000 among all affected towns
2/25/16	<i>Thunderstorm Wind.</i> Low pressure tracked north through New York bringing a warm front through southern New England. Unseasonably deep moisture accompanied this front. This was a very complicated weather situation as a strong low level inversion was in place over the area with a very strong low level jet just above the inversion. As showers and thunderstorms developed, the storms and heavy rain allowed the stronger winds to mix down to the surface. In other areas, temperatures warmed enough at the surface to break the inversion and allow the stronger winds to mix down. This resulted in a complicated combination of severe thunderstorm winds and high winds. A tree on Russell Road in Braintree was downed by thunderstorm winds.	\$5,000
3/2/17	<i>High Wind.</i> Low pressure moving up the St Lawrence Valley swept a cold front through Massachusetts early the morning of March 2. Behind the cold front, strong west-northwest winds brought colder air to the state. At 1117 AM, the Automated Surface Observing System platform at Blue Hill in Milton reported a wind gust of 60 mph. Wires were reported down on Jefferson Street in Braintree.	\$500
9/6/17	<i>Thunderstorm Wind.</i> A cold front stalled over Southern New England with several waves of low pressure moving up along the front. The cold front then moved offshore Wednesday night. Thunderstorms moved across parts of Eastern Massachusetts during Wednesday producing damaging winds and heavy downpours. At 1024 AM, an amateur radio operator reported a tree down in the road near the Stop and Shop store in Braintree.	\$1,000
12/5/17	<i>High Wind.</i> A cold front moved across Southern New England the night of the 5th. Warm air ahead of the front allowed strong south wind gusts to develop across Eastern Massachusetts. These winds diminished after the cold front moved through. At 948 PM, the Automated Surface Observing System at Blue Hill in Milton recorded a wind gust of 62 mph. At 1138 PM, a tree and wires were down on	\$5,000 among all affected towns

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Date	Description	Losses Reported
	Daniel Road in Braintree. At 1240 AM, a tree was down on wires on Central Street in Braintree.	
3/2/18	<i>High Wind.</i> Low pressure moving out of the Ohio Valley passed south of Southern New England on the 2nd and moved out to sea on the 3rd. This storm brought heavy snow to northwest Massachusetts, heavy rain and strong winds to central and eastern Massachusetts, and coastal flooding to the coastline. Moderate to major coastal flooding took place over three tide cycles due to astronomically high tides and a persistent northeast wind. This built a storm surge of two to four feet along the Massachusetts East Coast. At 6:05 AM a tree was blocking Commercial Street in Braintree.	\$35,000 among all affected towns
6/30/19	<i>Hail.</i> A pool of cold air above the surface moved over Southern New England during June 30. This created sufficient instability to cause thunderstorms with large hail and damaging wind. The cold air moved off to the southeast that night. At 2:09 PM, three-quarter inch diameter hail was reported at Braintree.	---
2/7/20	<i>High Wind.</i> Powerful low pressure moved from eastern Pennsylvania across central Connecticut and central Massachusetts on February 7, 2020. A southerly jet of 85 to 95 mph was just above the surface at 925 mb. Damaging winds occurred across much of eastern Massachusetts and Rhode Island with some damage reported farther to the west. There were widespread power outages and numerous trees down, some falling on homes and vehicles. Late in the evening, as of 11 PM, more than 66,000 residents remained without power. The ASOS atop Blue Hill (KMQE) in Milton recorded a wind gust to 69 mph at 3 PM. At 247 PM, a CWOP site also in Milton, MA recorded a wind gust to 66 mph. CBS Boston reported that a tree fell on multiple cars in Braintree (time unknown), fortunately without injuries.	\$7,000 among all affected towns
10/7/20	<i>Thunderstorm Wind.</i> A squall line formed in New York State then raced eastward in the late afternoon and early evening, gathering strength as it raced across Massachusetts, northeast Connecticut, and northern Rhode Island. Hundreds of thousands of people were left without power in southern New England, as there was widespread tree and power line damage from winds generally gusting to between 50 and 80 mph. The Storm Prediction Center officially classified it as a derecho. Along the line, an isolated brief tornado touched down in Millis. Prior to the derecho, strong	\$1,000

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Date	Description	Losses Reported
	southwest winds gusted to 40-50 mph in the early afternoon. In Braintree at 605 PM, a resident reported a 64 mph wind gust on their home anemometer. Damage in the immediate area was mostly downed tree limbs.	
12/25/20	<i>High Wind.</i> An anomalously deep, full-latitude mid-level trough over the Mississippi Valley caused a strong frontal system to move up the Appalachians. It brought strong to damaging winds, heavy rain with minor flooding, and well above normal temperatures to southern New England. Winds generally gusted to 40 to 60 mph, except 65 to 70 mph along the southeast coast. In Braintree at 831 AM, a tree was down on Pearl Street.	\$1,000 among all affected towns

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

Table 46. USDA Disasters Events That Refer to Severe Storms.

Year	Event	Event “Begin Dates”
2016	Drought, high winds, wildfire, excessive heat, insects	8/24/2016, 9/21/2016

### Extent

The strength of thunderstorms is typically measured in terms of its effects, namely the speed of the wind, the presence of significant lightning, and the size of hail. High winds are defined by the NWS as sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer, or gusts of 50 knots (58 mph) or greater for any duration (NCDC, 2018). A thunderstorm is classified as “severe” when it produces damaging wind gusts in excess of 58 mph (50 knots), hail that is 1 inch in diameter or larger (quarter size), or a tornado (NWS, 2013).

Hailstorms are not typically characterized by intensity or duration; instead, the size of hailstones is described. NOAA provides a range from “bb” (<0.25 inch) to “softball” (4.5 inches) with common sizes reported in Massachusetts ranging from pea to nickel-sized (0.25 inch to 0.875 inch).

The NOAA/NWS classification systems coupled with the NWS warning systems are appropriate for severe storms and hail events in Braintree, as they have been used for many of the severe storms that

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have occurred in the eastern part of Massachusetts. Severe storms have not occurred that are outside of these systems of classification.

### Probability of Future Events

According to the NWS, an average of 100,000 thunderstorms per year occur in the United States. The ResilientMass Plan notes that over the 15-year period between January 1, 2008, and December 31, 2022, a total of 911 high wind events occurred in Massachusetts on 198 days, and an annual average of 61 events occurred per year. Southern New England typically experienced 10 to 15 days a year with severe thunderstorms, with Massachusetts experiencing between nine and 27 thunderstorm days per year. Climate models show projections that the frequency and intensity of severe thunderstorms (which include tornadoes, hail, and winds) will increase (USGCRP, 2017). Furthermore, the ResilientMass Plan reports that, according to the Localized Constructed Analog's climate change models, thunderstorm event frequency is expected to slightly increase as a result of climate change.

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

An average of 21 people per year died from lightning strikes in the United States from 2013 to 2023. Most lightning deaths and injuries occur outdoors, with 45% of lightning casualties occurring in open fields and ballparks, 23% under trees, and 14% involving water activities. The ResilientMass Plan notes that 8 fatalities and 148 injuries have occurred in Massachusetts as a result of lightning events between 1990 and 2022 (NOAA, 2022). Given that thunderstorm event frequency is expected to slightly increase as a result of climate change, it is likely that risks associated with lightning may increase.

According to NOAA's National Weather Service, hail caused two deaths and an average of 27 injuries per year in the United States from 2004 to 2013. Given that thunderstorm event frequency is expected to slightly increase as a result of climate change, it is likely that risks associated with hail may increase.

### Vulnerability Assessment

#### ***Exposure***

The entire built environment of Braintree is vulnerable to the high winds and/or flooding from a severe weather event.

#### ***Built Environment Impacts***

Severe thunderstorms, and their associated hail and lightning events, brought about property damage in Braintree and adjacent towns in previous years. From 2014 until 2022, there was \$750,800 in property damage to Braintree and adjacent towns. This equates to an AAL of \$75,080.

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### **Population Impacts**

Some traffic accidents associated with storm events include injuries and deaths. However, the number of injuries and deaths reported for accidents is generally low. Populations considered most vulnerable to tornado, microburst and thunderstorm impacts in Braintree are identified based on a number of factors including their physical and financial ability to react or respond during a hazard. Senior and low-income populations in Braintree are particularly susceptible to storms. The Town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

### **Environment Impacts**

Thunderstorms and microbursts can cause damage to parks and other, natural areas. Some areas of the Town may be out of service until trees are removed.

### **Problem Statements for Other Severe Weather**

*Table 47. Problem Statements for Other Severe Weather.*

<b>Assets</b>	<b>Problems Associated with Other Severe Weather</b>
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"> <li>• People in Braintree have been frequently disrupted by severe weather events and other more frequent wind and thunderstorm events. Vulnerable populations may be isolated if roads are closed.</li> </ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"> <li>• The individual damages for frequent severe weather events appear nominal, but given the frequency of events in and around Braintree, the impacts occur often and can occur anywhere in the Town.</li> </ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"> <li>• First responders may have difficulty reaching people if roads are closed due to tree debris.</li> </ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"> <li>• These can be adversely impacted depending on the specific locations of damage.</li> </ul>
Activities that have value to the community	<ul style="list-style-type: none"> <li>• These can be adversely impacted depending on the specific locations of damage.</li> </ul>

### Severe Winter Storms

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

#### Description

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

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

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

**Nor'easters:** A nor'easter is a storm that occurs along the East Coast of North America. A nor'easter is characterized by a large counterclockwise wind circulation around a low-pressure center that often results in heavy snow, high winds, and rain. A nor'easter gets its name from its continuously strong northeasterly winds blowing in from the ocean ahead of the storm and over the coastal areas.

Nor'easters are among winter's most ferocious storms. These winter weather events are notorious for producing heavy snow, rain, and oversized waves that crash onto Atlantic beaches, often causing beach

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erosion and structural damage. These storms occur most often in late fall and early winter. The storm radius is often as much as 100 miles, and nor'easters often sit stationary for several days, affecting multiple tide cycles and causing extended heavy precipitation. Sustained wind speeds of 20 to 40 mph are common during a nor'easter, with short-term wind speeds gusting up to 50 to 60 mph.

### Location

Although the entire Commonwealth may be considered at risk to the hazard of severe winter storms, higher snow accumulations appear to be prevalent at higher elevations in Western and Central Massachusetts, and along the coast where snowfall can be enhanced by additional ocean moisture. Ice storms occur most frequently in the higher-elevation portions of Western and Central Massachusetts. Coastal communities of the Commonwealth are more susceptible to the impacts of a Nor'easter, which can bring heavy snow. Overall, winter storms can affect the entirety of Massachusetts, including the geographic extent of Braintree.

### Previous Occurrences

Winter storms occur somewhat regularly in Massachusetts. Five of the disasters declared in Massachusetts from 2012 through 2022 and effective in Norfolk County were associated with winter storms:

- Massachusetts Severe Winter Storm and Snowstorm (DR-4651-MA)  
Incident Period: January 28, 2022 – January 29, 2022  
***Public Assistance (PA) reimbursements eligible for Norfolk County***
- Massachusetts Severe Winter Storm and Snowstorm (DR-4379-MA)  
Incident Period: March 13, 2018 - March 14, 2018  
***PA reimbursements eligible for Worcester County and eastward***
- Massachusetts Severe Winter Storm and Snowstorm (DR-4372-MA)  
Incident Period: March 2, 2018 - March 3, 2018  
***PA reimbursements eligible for Norfolk, Essex, Bristol, Plymouth, Cape and Islands***
- Massachusetts Severe Winter Storm, Snowstorm, and Flooding (DR-4214-MA)  
Incident Period: January 26, 2015 - January 28, 2015  
***PA reimbursements eligible for Worcester County and eastward***
- Massachusetts Severe Winter Storm, Snowstorm, and Flooding (DR-4110-MA)  
Incident Period: February 8, 2013 – February 9, 2013  
***PA reimbursements eligible for entire state***

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These were likewise subject to concurrent emergency declarations in Massachusetts. The PA assistance reimbursements associated with the above declarations totaled approximately \$1,345,200 for the Town of Braintree. This indicates that severe winter storms comprise a very significant public expenditure.

The NOAA Storm Events database (<https://www.ncdc.noaa.gov/stormevents/>) for Norfolk County lists many severe winter storm events impacting the Braintree area for the period 2014-2023. A selection of events is provided below, including some of the disasters listed above. Slightly more detail is provided for the events corresponding to the winter storm disasters.

Table 48. NCEI Severe Storm Database Entries Covering Winter Storms in Braintree.

Date	Description
2/8/13	<i>Blizzard.</i> An historic winter storm deposited tremendous amounts of snow over all of southern New England, mainly from the mid-afternoon on Friday, February 8 and lasting into the daylight hours of Saturday, February 9. Most locations received 2 to 2.5 feet of snow. The Blizzard of 2013 also produced a prolonged period of very strong winds Friday night along the MA and RI coasts. Gusts exceeded hurricane force (74 mph) at a few locations. Gale force gusts (to 50 mph) continued on the MA coast through Saturday afternoon. In addition, moderate to major coastal flooding occurred, most notably during the time of the high tide Saturday morning along the Massachusetts east coast. At the storm's height near the early morning low tide, the storm surge reached 3 to 4 feet along much of the MA east coast from Boston south. At the time of the mid-morning high tide, the winds had shifted from northeast to north and the surge had dropped to 1.5 to 2.5 feet for most MA east coast locations. However, this was an astronomically high tide. Twenty-three to 26 inches of snow fell across eastern Norfolk County.
3/7/13	<i>Heavy Snow.</i> This storm brought heavy snow and significant coastal flooding to the forecast area. In addition, the Massachusetts east coast was hit by widespread moderate and pockets of major coastal flooding for two high tide cycles and beach erosion for at least 5 high tide cycles. Twelve to nearly 30 inches of snow fell across eastern Norfolk County.
1/2/2014	<i>Heavy Snow.</i> Eleven to 15 inches of snow in eastern Norfolk County.
1/21/2014	<i>Heavy Snow.</i> Eight to 17 inches of snow in eastern Norfolk County.
2/5/2014	<i>Heavy Snow.</i> Eight to 10 inches of snow in eastern Norfolk County.
1/26/2015	<i>Blizzard.</i> Anywhere from eighteen to thirty-one inches of snow fell across eastern Norfolk County.

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Date	Description
2/2/2015	<i>Heavy Snow.</i> Ten to 17 inches of snow in eastern Norfolk County.
2/8/2015	<i>Heavy Snow.</i> Seventeen to 20 inches of snow in eastern Norfolk County.
2/4/15	<i>Heavy Snow.</i> Twelve to 19 inches of snow in eastern Norfolk County.
1/7/17	<i>Winter Storm.</i> Nine to 17 inches of snow in eastern Norfolk County.
2/9/17	<i>Winter Storm.</i> Ten to 13 inches of snow in eastern Norfolk County.
1/4/18	<i>Winter Storm.</i> Twelve to 17 inches of snow in eastern Norfolk County.
3/2/18	<i>High Wind.</i> Low pressure moving out of the Ohio Valley passed south of Southern New England on the 2nd and moved out to sea on the 3rd. This storm brought heavy snow to northwest Massachusetts, heavy rain and strong winds to central and eastern Massachusetts, and coastal flooding to the coastline. Moderate to major coastal flooding took place over three tide cycles due to astronomically high tides and a persistent northeast wind. This built a storm surge of two to four feet along the Massachusetts East Coast. At 6:05 AM a tree was blocking Commercial Street in Braintree.
3/13/18	<i>Winter Storm.</i> Low pressure along the Carolina coast March 12 moved up the coast and passed offshore of Southern New England on March 13, moving off through the Maritimes on March 14. The storm brought snow accumulations of one to two feet across Eastern Massachusetts and wind gusts of seventy to eighty miles per hour to Cape Cod and the Islands. Blizzard conditions were observed at Logan International Airport, Marshfield, Plymouth, Hyannis, and Martha's Vineyard. From ten to twenty inches of snow fell on Eastern Norfolk County. At 6:32 AM a tree was reported down on Abbott Street in Braintree.
1/19/19	<i>Winter Weather.</i> Low pressure from the Deep South moved along the South Coast of New England on January 20. This brought snow and rain to Southeast Massachusetts, while Northern Massachusetts received snow and freezing rain. A trained spotter in Braintree reported three-tenths inch accumulation of ice.
3/3/19	<i>Winter Storm.</i> From 14 to 16 inches of snow in eastern Norfolk County.
10/30/20	<i>Heavy Snow.</i> This was a rapidly moving upper level low and its associated upper jet max, which moved northeastward from the Mississippi Valley and low pressure again

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Date	Description
	passed to the south of New England. Cold air was streaming into the region from the north. The result was some heavy, wet snow across the region, with many areas receiving 3 to 6 inches. The weight of the snow caused scattered tree and power line damage. Snowfall ranged from 5 to 6.5 inches in eastern Norfolk County. Reports included 6.5 inches in Braintree from a trained spotter.
12/16/20	<i>Heavy Snow.</i> A storm system produced heavy snow, strong to damaging winds, and minor coastal flooding in southern New England. Its precipitation shield was expansive because of a broad 700 mb low over southeast New England, abundant moisture, and a very cold air mass in place. Snow amounts ranged from 10 to 20 inches across much of southern New England. There was some minor coastal flooding at the time of high tide and also a flash freeze in eastern Massachusetts as the storm pulled away to the northeast. Heavy snow generally ranged from 12.0 to 16.5 inches in eastern Norfolk County. Some specific amounts included 13.0 inches in Braintree.
1/7/22	<i>Heavy Snow.</i> Snowfall generally ranged from 9 to 15 inches with the highest amount (15.2 inches) coming from the Blue Hill Observatory.
1/28/22	<i>Winter Storm.</i> Snowfall generally ranged from 21 to 27 inches. The highest amount reported was 27.6 inches at the Blue Hill Observatory.

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

Table 49. USDA Disasters Events That Refer to Winter Storms.

Year	Event	Event "Begin Dates"
2014	Winter/ice storm, below normal temps	1/21/2014

### Extent

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

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

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

Table 50. RSI Scale.

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

Source: NOAA

Prior to the use of the RSI, the Northeast Snowfall Impact Scale, developed by Paul Kocin of The Weather Channel and Louis Uccellini of the NWS, was used to characterize, and rank high- impact northeast snowstorms with large areas of 10-inch snowfall accumulations and greater. In contrast to the RSI, which is a regional index, NESIS is a quasi-national index that is calibrated to Northeast snowstorms. NESIS has five categories. The RSI and NESIS approaches do not include separate scales for ice storms; in general, ice storm extent is expressed on a case-by-case basis, and forecasts will provide the information needed to determine how to prepare and respond.

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

The RSI and NESIS classification systems coupled with the NWS warning systems are appropriate for Braintree, as they have been used for many of the severe winter storms that have occurred in the region and the community. Storms have not occurred that are outside of these systems of classification.

According to some resources, the Sperry-Piltz Ice Accumulation Index (SPIA® Index) is becoming a resource for addressing ice events. The index is a copyright product with controlled distribution, according to its developers (refer to <https://spia-index.com/>). The SPIA® Index is "a forward-looking, ice accumulation and ice damage prediction index that uses an algorithm of researched parameters that,

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when combined with National Weather Service forecast data, predicts the projected footprint, total ice accumulation, and resulting potential damage from approaching ice storms. It is a tool to be used for risk management and/or winter weather preparedness.” The index ranges from 0 (“minimal risk of damage to exposure utility systems”) to 5 (“catastrophic damage to entire exposure utility systems”). To date, this type of system has not been needed in Braintree.

### Probability of Future Events

The ResilientMass Plan notes that Massachusetts experiences high-impact snowstorms at approximately the rate of three per year over the past 50 years, although there is significant interannual variability in the frequency and severity of winter storms. The Town of Braintree should assume that winter storms are likely, even if the impacts of climate change will shift the timing to a shorter winter season. Heavy wet snowfall may be more common in the future. The overall probability of winter storms of all kinds, including blizzards and ice storms, is believed high.

### Vulnerability Assessment

#### ***Exposure***

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

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

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

#### ***Built Environment Impacts***

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

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Since Hazus doesn't support severe winter storms and there aren't other readily available severe winter storm models, historical data was used to determine potential losses and probabilities. From 2014 until 2023, there was \$464,900 in storm damage in and around Braintree. This equates to an AAL of \$46,490.

### **Population Impacts**

As discussed above, some traffic accidents associated with storm events include injuries and in limited cases, deaths. However, the number of injuries and deaths reported for accidents is generally low. Populations considered most vulnerable to severe winter storm impacts are identified based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Senior and low-income populations in Braintree are particularly susceptible and the Town should be aware of the potential needs of residents within these population segments in the event of a hazard occurrence.

### **Environment Impacts**

Severe winter storms can cause damage to parks and other, natural areas. Some areas of the Town may be out of service until roads are cleared and trees are removed.

### **Problem Statements for Severe Winter Storms**

*Table 51. Problem Statements for Severe Winter Storms.*

<b>Assets</b>	<b>Problems Associated with Severe Winter Storms</b>
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"> <li>• Vulnerable populations may be stranded during a winter storm event and may not be able to travel to emergency services.</li> </ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"> <li>• Roof ice dams may cause damage to structures.</li> <li>• Severe winter storms comprised a substantial expenditure for Braintree over the course of the last decade.</li> <li>• The electrical grid and roadways are susceptible to failure and loss of use during storms.</li> </ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"> <li>• First responders may have difficulty reaching people if roads are closed due to road closures.</li> </ul>

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Assets	Problems Associated with Severe Winter Storms
Natural, historic, and cultural resources	<ul style="list-style-type: none"> <li>Severe storms may damage trees in natural areas, and historical and cultural sites.</li> </ul>
Activities that have value to the community	<ul style="list-style-type: none"> <li>Outdoor activities may be adversely impacted by severe winter storms.</li> </ul>

### Tornadoes

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

#### Description

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

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

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

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

#### Location

The U.S. experiences an average of 1,230 tornadoes per year from 1991 to 2020, more than any other country (NOAA, n.d.). Because Massachusetts experiences fewer tornadoes than other parts of the country, residents may be less prepared to react to a tornado. The ResilientMass Plan notes that Massachusetts is located within the FEMA Wind Zone II, with Zone IV typically experiencing the greatest number and strongest tornadoes. According to the FEMA National Risk Index most of the state has a

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“relatively low” risk of strong wind. The ResilientMass Plan notes that the area at greatest risk for a tornado touchdown runs from central to northeastern Massachusetts. Braintree is inside of this area.

### Previous Occurrences

The most devastating tornado to occur in New England was the Worcester Tornado of July 9, 1953, a category F4 tornado. The tornado passed through Barre, Rutland, Holden, Worcester, Shrewsbury, Westborough, and Southborough causing 90 deaths and over 1,300 injured. Damage estimates were placed at more than \$52 million. The National Storm Prediction Center has ranked this as one of the deadliest tornadoes in the nation's history. Braintree was not directly impacted by this tornado, but the proximity is notable.

The most recent severe tornado (F3 or stronger) to impact Massachusetts occurred June 1, 2011, affecting communities in Hampden and Worcester Counties. The EF3 tornado touched down in Westfield and traveled through West Springfield, Springfield, Wilbraham, Monson, Brimfield, and Sturbridge. The tornado caused extensive property damage and resulted in a FEMA disaster declaration.

The NOAA Storm Events database (<https://www.ncdc.noaa.gov/stormevents/>) for Norfolk County lists four tornadoes in Norfolk County during the period 2014-2023 including an EF-0 in Stoughton in 2013, an EF-0 in Wrentham in 2015, an EF-0 in Millis in 2020, and an EF-0 in Foxborough. The database provides damage figures of \$20,000, \$20,000, \$6,000, and \$5,000 (respectively) for these four storms.

A series of storms on August 19, 2023 caused an EF-1 tornado in Weymouth and an EF-0 tornado in Stoughton. Localized damage occurred from both tornadoes. These two tornadoes are not yet captured in the Storm Events database.

### Extent

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

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Table 52. Enhanced Fujita Scale.

EF Rating	Wind Speeds	Expected Damage
<b>EF-0</b>	65-85 mph	<p>'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.</p> 
<b>EF-1</b>	86-110 mph	<p>'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.</p> 
<b>EF-2</b>	111-135 mph	<p>'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.</p> 
<b>EF-3</b>	136-165 mph	<p>'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.</p> 
<b>EF-4</b>	166-200 mph	<p>'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.</p> 
<b>EF-5</b>	> 200 mph	<p>'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.</p> 

Source: National Weather Service

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

The EF scale and the NWS warning products are applicable to all tornadoes that may strike Braintree, as they are used throughout Massachusetts on a routine basis and appropriately characterized the tornadoes that passed through adjacent communities. Tornadoes have not occurred that are outside of the EF scale or the NWS watch/warning system.

### Probability of Future Events

According to the ResilientMass Plan, the Commonwealth experienced 190 tornadoes from 1950 to 2021, or an average annual occurrence of 2.6 tornado events per year. From 1995 to 2021, the average frequency of these events has been 2.06 events per year (NOAA, 2018). Massachusetts experienced an average of 1.4 tornadoes per 10,000 square feet annually between 1991 and 2010, less than half of the national average of 3.5 tornadoes per 10,000 square feet per year (NOAA, n.d.). As highlighted in the National Climate Assessment, tornado activity in the U.S. has become more variable, and increasingly so

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in the last two decades. While the number of days per year that tornadoes occur has decreased, the number of tornadoes on these days has increased. Climate models show projections that the frequency and intensity of severe thunderstorms (which include tornadoes, hail, and winds) will increase (USGCRP, 2017). Overall, it is unclear if tornado frequency will increase with climate change given the difficulty to draw conclusions based on thunderstorm statistics and the difficulty in identifying long-term trends.

### Vulnerability Assessment

#### **Exposure**

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

#### **Built Environment Impacts**

Since Hazus doesn't support tornadoes and there aren't other readily available tornado models, historical data will be used to determine potential losses and probabilities. From 1953 until 2023, there was no property damage to Braintree due to tornadoes. However, there were eleven events in Norfolk County which produced \$4.106M in property damage, one death, and twenty-one injuries. The county's average annual loss would be \$58.7K.

#### **Population Impacts**

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

#### **Environment Impacts**

Tornadoes can cause damage to parks, and other, natural areas. Some areas of the Town may be out of service until trees are removed.

### Problem Statements for Tornadoes

Table 53. Problem Statements for Tornadoes.

Assets	Problems Associated with Tornadoes
People (including underserved communities)	<ul style="list-style-type: none"><li>Vulnerable populations may need support seeking protected shelter. Those without cell phones may not get weather alerts.</li></ul>

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Assets	Problems Associated with Tornadoes
and socially vulnerable populations)	<ul style="list-style-type: none"> <li>• People without basements are susceptible to tornado impacts.</li> </ul>
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"> <li>• Structures and critical infrastructure can all be impacted by tornadoes.</li> <li>• Roadways may be blocked due to downed trees and other debris.</li> </ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"> <li>• The electric grid may be impacted by winds and downed trees.</li> </ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"> <li>• Historic and cultural resources may be impacted by tornado winds.</li> <li>• Winds may damage trees and cause natural areas to close for cleanup.</li> </ul>
Activities that have value to the community	<ul style="list-style-type: none"> <li>• Outdoor events could be impacted by potential tornado activity.</li> </ul>

### Wildfires/Brushfires

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

#### Description

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

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

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

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susceptibility to wildfires. According to the Forest Encyclopedia Network, four types of fuel are present in wildfires:

- Ground Fuels: organic soils, forest floor duff, stumps, dead roots, buried fuels
  - Surface Fuels: the litter layer, downed woody materials, dead and live plants to 2 meters tall
  - Ladder Fuels: vine and draped foliage fuels
  - Canopy Fuels: tree crowns
- Heat: Without sufficient heat, a fire cannot begin or continue. Heat can be removed through the application of a substance, such as water, powder, or certain gasses, that reduces the amount of heat available to the fire. Scraping embers from a burning structure also removes the heat source.
  - Oxygen: Without oxygen, a fire cannot begin or continue. In most wildland fires, this is commonly the most abundant element of the fire triangle and is therefore not a major factor in suppressing wildfires.
  - Uninhibited Chain Reaction: The chain reaction is the feedback of heat to the fuel to produce the gaseous fuel used in the flame. In other words, the chain reaction provides the sustained heat necessary to maintain the fire. Fire suppression techniques, such as dry chemical extinguishers, break up the uninhibited chain reaction of combustion to stop a fire.

### Location

The ResilientMass Plan identified areas in Barnstable, Essex, and Plymouth counties with the highest wildfire potential in the state. The ecosystems that are most susceptible to the wildfire hazard include pine barrens in the Connecticut River Valley, marshes inundated with *Phragmites*, pine barrens and maritime grasslands in Martha's Vineyard, Nantucket, and Cuttyhunk, and the Myles Standish State Forest. Other portions of the Commonwealth are also susceptible to wildfire, particularly at the urban-wildland interface. Notwithstanding the location of Braintree in central Massachusetts, the presence of wildland interface and vast rural areas makes Braintree a location with wildfire risk.

### Previous Occurrences

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

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Table 54. Statewide Brush Fire Counts.

Year	Total # of Events	Injuries/deaths (civilians and fire service)	Losses
2019	2,974	12/0	\$136,357
2018	3,253	1/5	\$493,145
2017	4,206	20/0	\$215,156
2016	7,834	40/0	\$1,526,654
2015	6,962	35/0	\$323,211
2014	4,627	25/0	\$209,857
2013	4,968	31/3	\$297,854
2012	5,857	38/0	\$705,457

According to this statewide data set, fire event counts back to 2012 were as follows for Braintree:

Table 55. Outdoor and Total Fire Event Figures for Braintree.

Year	Total Outdoor Fires	Total Fire Events	Reported Losses for Outdoor Fires
2012	58	102	\$1,839,589
2013	46	90	\$556,168
2014	80	128	\$758,031
2015	69	115	\$1,906,680
2016	57	89	\$463,532
2017	51	90	\$526,745
2018	35	70	\$253,925
2019	43	69	\$26,112
2020	55	90	\$0
2021	29	69	\$0

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Applying the fraction of outdoor fire incidents that are typically brush fires in Massachusetts (52%) and the fraction of fire losses that are typically from brush fires in Massachusetts (0.2%), an alternate set of figures for brush fires in Braintree is presented below.

Table 56. Estimated Brush Fire Event Figures for Braintree.

Year	Estimated Brush Fires	Estimated Brush Fire Losses
2012	30	\$6,147
2013	24	\$2,067
2014	42	\$2,304
2015	36	\$6,038
2016	30	\$1,375
2017	27	\$1,766
2018	18	\$965
2019	22	\$80
2020	29	\$360*
2021	15	\$449*

\*Estimated from Countywide figures

The above estimates compare reasonably well to the figures reported in the previous edition of this plan. According to the previous edition, “wildfire extent in Braintree consists of 10 to 99 acres burned, with 51 to 100 recordable fires from 2001 to 2009. Less 1% of fires results in significant property damage. There have been no deaths as a result of brush fires.”

USDA declares agricultural disasters as needed for a variety of hazards. Information can be found at <https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index>. The single line item related to wildfires in Norfolk County is listed below; this line corresponds to the drought of 2016.

Table 57. USDA Disasters Events That Refer to Wildfires.

Year	Event	Event “Begin Dates”
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## Town of Braintree, MA Hazard Mitigation Plan

2016	Drought, high winds, wildfire, excessive heat, insects	8/24/2016, 9/21/2016
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### Extent

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

Fires can be classified by physical parameters such as their fireline intensity, or Byram's intensity, which is the rate of energy per unit length of the fire front (BTU [British thermal unit] per foot of fireline per second) (NPS, n.d.). Following a fire event, the severity of the fire can be measured by the extent of mortality and survival of plant and animal life aboveground and belowground and by the loss of organic matter (NPS, n.d.).

The National Wildfire Coordinating Group defines seven classes of wildfires:

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

Early detection of wildfires is a key part of the overall efforts of the Massachusetts Bureau of Forest Fire Control. Early detection is achieved by trained Bureau observers who staff 22 of the 42 operating fire towers statewide. During periods of high fire danger, the Bureau conducts county-based fire patrols in forested areas. These patrols assist cities and towns in prevention efforts and allow for the quick deployment of mobile equipment for suppression of fires during their initial stage. If a fire breaks out and spreads rapidly, residents may need to evacuate within days or hours. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

The various wildfire classification systems coupled with the detection and warning systems are believed appropriate for Braintree, despite the fact that extensive wildfires have not occurred in the community. Wildfires have not occurred that are outside of these systems of classification.

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### Probability of Future Events

It is difficult to predict the likelihood of wildfires in a probabilistic manner because a number of factors affect fire potential and because some conditions (e.g., ongoing land use development patterns, location, and fuel sources) exert changing pressure on the wildland-urban interface zone. The Massachusetts Climate Change Assessment report suggests that wildfire risk will increase over time in association with extreme heat events and changing precipitation and droughts. The following discussion helps characterize the risk further for Braintree.

### Vulnerability Assessment

#### ***Exposure***

To help identify potential wildfire areas for Braintree, the U.S. Forest Service's Wildfire Risk to Communities spatial data was downloaded. This data was developed in 2020 using the vegetation and wildland fuels from the LANDFIRE 2014 model with the burn probability coming from the Forest Service Fire Simulation System (FSim). To create a product with a finer resolution, the data was upsampled to the native 30m resolution of the LANDFIRE fuel and vegetation data spreading the values of the modeled burn probability into developed areas represented in LANDFIRE fuels as non-burnable.

The Town identified areas of concern and these areas were used to extract the probability of wildfire to better quantify the impacts. The areas of higher wildfire/brushfire potential included:

- Town Forest
- Pond Meadow Park
- Gun Club
- South Street Conservation Land
- Cranberry Pond Area
- Smith Beach Marsh
- Great Pond Treatment Plan Area
- Skyline Drive/Eaton's Pond Area (campfires)
- South Braintree Office Park Area
- Wooded Area South of South Shore Plaza
- Blue Hills Reservation

In the areas of higher susceptibility, there is an electric substation (#11) on Edgehill Road, water treatment plant pumps on 300 King Hill Road, and Smith Beach. There were 253 structures located within 50 meters of the wildfire areas of concern. These areas have a .01% chance of burning each year. Table 58 shows the types of buildings exposed identified during this analysis.

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Table 58. Buildings in 0.01% Annual Chance Area.

Building Type	Number of Buildings (Total in City)	Building Value (Total in City)
Single Family	214 (11,666)	\$65,349,300 (\$3,592,112,100)
Multi-Family	9 (1,219)	\$44,799,300 (\$4,389,337,685)
Mixed-Use	0 (40)	\$0 (\$18,419,800)
Commercial	9 (445)	\$10,022,900 (\$2,333,869,090)
Educational	0 (11)	\$0 (\$111,267,500)
Government	19 (228)	\$14,032,600 (\$575,447,000)
Religious/Non-Profit	4 (83)	\$1,351,600 (\$102,022,000)
Industrial	5 (134)	\$4,944,600 (\$230,341,800)
Garage/Outbuilding	0 (9)	\$0 (\$87,000)
Vacant	3 (54)	\$459,100 (\$21,192,400)
<b>Total</b>	<b>313 (13,889)</b>	<b>\$140,959,400 (\$11,374,096,375)</b>

The population exposed to the 0.01% probability areas of concern is shown in Table 59. The column in the left shows the population in and around the 0.01% probability wildfire area (wherever the Census Block overlapped with the wildfire area) while the column on the right shows the total population numbers for the Town. The percentage of Black and Hispanic or Latino populations is larger in the wildfire areas than it is for the Town as a whole.

Table 59. Population Exposed to 0.01% Annual Chance Wildfire (2020 U.S. Census).

Demographics	Population in and Adjacent to 0.01% Wildfire Area	Total Population
<b>Population</b>	5,818	39,143
<b>Households</b>	2,478	14,510
<b>White</b>	3,998 (68.7%)	27,698 (70.8%)
<b>Black</b>	546 (9.4%)	1,330 (3.4%)
<b>American Indian</b>	6 (0.1%)	69 (0.2%)
<b>Asian</b>	865 (14.9%)	6,750 (17.2%)
<b>Pacific Islander</b>	0 (0.0%)	9 (0.0%)
<b>Other Race</b>	165 (2.8%)	923 (2.4%)
<b>Two or More Races</b>	238 (4.1%)	2,364 (6.0%)
<b>Hispanic or Latino:</b>	252 (4.3%)	764 (2.0%)
<b>Population under 18:</b>	1,207 (21.9%)	8,126 (20.8%)
<b>Population over 64:</b>	973 (16.7%)	6,211 (15.9%)
<b>Annual Income &lt; \$30K/year</b>	375 (15.1%)	1,967 (13.6%)
<b>Population in EJ Zone*:</b>	3,924 (67.4%)	30,821 (78.7%)

\*Massachusetts Office of Energy and Environmental Affairs, 2022

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

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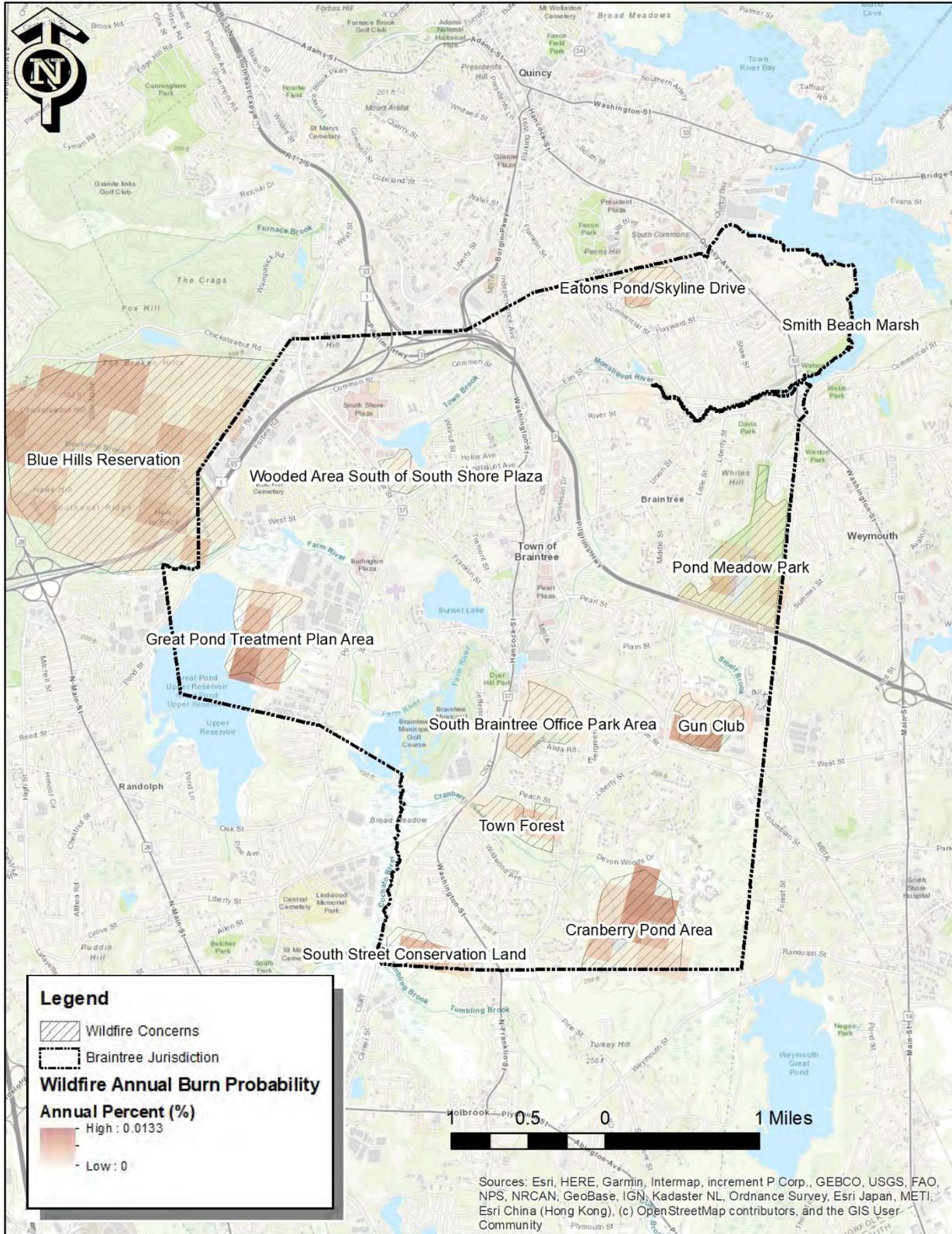


Figure 14. Wildfire Burn Probability Map.

# Town of Braintree, MA Hazard Mitigation Plan

## **Built Environment Impacts**

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

No property damage, injuries or deaths have been recorded for the reported for major wildfires in Braintree between 2004 and 2022. Using the wildfire probabilities and building values, a loss estimate was produced for the 0.01% scenario. The losses are \$140,959,400 for the .01% event and the AAL will be \$14,096.

Climate change will increase the probability of brushfires which could lead to additional property damage. Future development in forested and other high-fuel areas also could lead to additional increases in the probability of brushfires.

## **Population Impacts**

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

With the increased probability of brushfires outside of the Town in the future due to climate change, populations may be impacted more often due to air quality issues.

## **Environment Impacts**

Many of the natural features in the Town are susceptible to wildfire including the trees and parks.

## **Problem Statements for Wildfires**

Table 60. Problem Statements for Wildfires.

<b>Assets</b>	<b>Problems Associated with Wildfires</b>
People (including underserved communities and socially vulnerable populations)	<ul style="list-style-type: none"><li>• Populations with severe asthma may be adversely impacted by wildfires in the vicinity.</li></ul>

## Town of Braintree, MA Hazard Mitigation Plan

Assets	Problems Associated with Wildfires
Structures (including facilities, lifelines, and critical infrastructure)	<ul style="list-style-type: none"> <li>Several residential structures are found in the higher probability burn areas. Structures without defensible zones are more susceptible to wildfires and brush fires.</li> </ul>
Systems (including networks and capabilities)	<ul style="list-style-type: none"> <li>Wildfires often cause roads to be closed requiring detours impacting emergency services.</li> <li>The Town should assess existing capabilities to fight wildfires and identify deficiencies to increase capacity.</li> </ul>
Natural, historic, and cultural resources	<ul style="list-style-type: none"> <li>Wildfires may adversely impact forested and other vegetated areas of Braintree.</li> </ul>
Activities that have value to the community	<ul style="list-style-type: none"> <li>Recreational activities may be adversely impacted by wildfires, depending on location.</li> </ul>

## National Flood Insurance Repetitive Loss Properties

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

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

**REPETITIVE LOSS STRUCTURE** means a structure covered under an NFIP flood insurance policy that (1) has incurred flood-related damage on two occasions, in which the cost of repair, on average, equaled or exceeded 25% of the value of the structure at the time of each such flood event; and (2) at the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.

- According to data provided by MEMA, 18 repetitive loss properties collectively have experienced 53 loss events, with \$743,488.17 total building payments and \$615,955.91 total content payments. These properties included ten single family homes, two 2-to-4 family homes, one non-residential, and five other non-residential.

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- Two severe repetitive loss properties have experienced nine loss events, with \$420,397.50 total building payments and \$540,826.03 total content payments. These properties included one non-residential and one other non-residential property.

**SEVERE REPETITIVE LOSS** structure means a structure that is covered under an NFIP flood insurance policy and has incurred flood-related damage (1) for which four or more separate claims have been made under flood insurance coverage, with the amount of each claim (including building and contents payments) exceeding \$5,000 and with the cumulative amount of such claims payments exceeding \$20,000; or (2) for which at least two separate flood insurance claims payments (building payments only) have been made, with cumulative amount of such claims exceeding the value of the insured structure.

A summary of the Town's participation and compliance with the NFIP, including current policy and historical claims statistics, is provided in Table 7 of Chapter 5 (Capability Assessment).

### Hazard Ranking

Ranking hazards helps the Town set goals and mitigation priorities. To compare the risk of different hazards, and prioritize which are more significant, requires a scoring system for equalizing the units of analysis. As not all hazards assessed in this plan have precisely quantifiable probability or impact data, a scoring system based on multi-criteria decision analysis (MCDA) methodology was developed to rank all the hazards. This multi-criteria ranking analysis

approach prioritizes hazard risk based on a blend of quantitative factors from the available data, such as historical data, local knowledge, public survey, and Hazus assessment. This hazard ranking analysis assigns varying degrees of risk to five categories for each of the hazards, including: probability (how often it can occur), impact (economic, social, and environmental loss), spatial extent (the size of the area affected), warning time (how long does a community have to prepare for the event), and duration. Each degree of risk was assigned a value ranging from 1 to 4. The weighting factor derived from a review of best practice plans. Some of these hazard characteristics, like probability and impact, are more important than others and are weighted more heavily.

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

$$\text{Hazard Score Value} = [(Probability \times 30\%) + (Impact \times 30\%) + (Spatial Extent \times 20\%) + (Warning Time \times 10\%) + (Duration \times 10\%)]$$

Table 61 provides the hazard characteristic, level description, level criteria, level index value, and weighting value.

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Table 61. Hazard Ranking Criteria

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

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Table 62 provides the final hazard ranking for Braintree. Each hazard characteristic is assigned a value between 1 (lowest value) and 4 (highest value). When the risk values were calculated, if the value was greater than 2.7, it was assigned as a high risk hazard. If the value was greater than 2 and less than or equal to 2.7, it was assigned as a moderate risk. If the value was less than or equal to 2, it was assigned as a low risk hazard. The coastal flooding, flooding from precipitation, severe winter storms, average and extreme temperatures, and hurricanes/tropical storms hazards were ranked highest. The coastal erosion, wildfires/brushfires, other severe weather, invasive species, droughts, landslides, and tornadoes were all ranked as moderate. The earthquake hazard is ranked as low.

Table 62. Final Hazard Ranking of Hazards for Braintree.

Hazards	Probability	Impact	Spatial Extent	Warning Time	Duration	Value	Rank
Coastal Flooding	3	4	2	3	2	3	High
Flooding from Precipitation	4	3	2	3	2	3	High
Severe Winter Storms	4	2	4	1	3	3	High
Average and Extreme Temperatures	4	2	4	1	2	2.9	High
Hurricanes and Tropical Storms	3	3	4	1	2	2.9	High
Coastal Erosion	4	2	2	1	4	2.7	Mod.
Invasive Species	3	2	2	3	4	2.6	Mod.
Other Severe Weather	3	2	4	2	1	2.6	Mod.
Droughts	2	2	4	1	4	2.5	Mod.
Tornadoes	2	4	1	3	1	2.4	Mod.
Wildfires/Brushfires	2	2	3	3	3	2.4	Mod.
Earthquakes	1	1	4	4	1	1.9	Low

The following table summarizes changes in population patterns and land use and development and how those impact hazards.

## Town of Braintree, MA Hazard Mitigation Plan

Table 63. Impacts from Population and Land Use.

Hazards	Changes in Population Patterns	Changes in Land Use and Development
Flooding from Precipitation	<p>There is a growing elderly population exposed to the floodplain:</p> <ul style="list-style-type: none"> <li>• Along Devon Woods Dr.</li> <li>• Around Sunset Lake</li> <li>• Along Echo Creek</li> </ul>	<p>Existing codes and regulations in the SFHA will help to keep flood impacts low.</p> <p>New development areas may produce additional flooding due to the addition of impervious surfaces.</p>
Droughts	<p>The Town’s elderly population has increased from 16.5% in 2010 to 16.7% in 2020. The number of people living below the poverty line has decreased from 2010 to 2020.</p>	<p>All new developments will create more demand for limited water resources.</p>
Coastal Flooding	<p>There is a growing elderly population exposed to coastal flooding in East Braintree.</p>	<p>Existing codes and regulations in the SFHA will help to keep flood impacts low.</p>
Coastal Erosion	<p>There is a growing elderly population exposed to coastal erosion around the southern part of Vinedale Rd. towards the river.</p>	<p>Limiting development along areas of eroding shoreline will help reduce risks.</p>
Extreme Temperatures	<p>The Town’s elderly population has increased from 16.5% in 2010 to 16.7% in 2020. The number of people living below the poverty line has decreased from 2010 to 2020.</p>	<p>All new developments will exacerbate heat island effect if the development includes tree removal and adding black surfaces such as asphalt and roofs.</p>
Wildfires	<p>There is a growing elderly population around Pond Meadow Park with a moderate wildfire susceptibility.</p>	<p>Development in or adjacent to a forested or brushland area can lead to a higher risk of wildfire.</p>

## Town of Braintree, MA Hazard Mitigation Plan

Hazards	Changes in Population Patterns	Changes in Land Use and Development
Infectious Diseases	The Town’s elderly population has increased from 16.5% in 2010 to 16.7% in 2020. The number of people living below the poverty line has decreased from 2010 to 2020.	Shouldn’t be impacted by changes in land use and development.
Invasive Species	Shouldn’t be impacted by population changes.	Shouldn’t be impacted by changes in land use and development.
Hurricanes and Tropical Storms	The Town’s elderly population has increased from 16.5% in 2010 to 16.7% in 2020. The number of people living below the poverty line has decreased from 2010 to 2020.	Shouldn’t be impacted by changes in land use and development.
Severe Winter Storms	The Town’s elderly population has increased from 16.5% in 2010 to 16.7% in 2020. The number of people living below the poverty line has decreased from 2010 to 2020.	Shouldn’t be impacted by changes in land use and development.
Tornadoes	The Town’s elderly population has increased from 16.5% in 2010 to 16.7% in 2020. The number of people living below the poverty line has decreased from 2010 to 2020.	Shouldn’t be impacted by changes in land use and development.
Other Severe Weather	The Town’s elderly population has increased from 16.5% in 2010 to 16.7% in 2020. The number of people living below the poverty line has decreased from 2010 to 2020.	Shouldn’t be impacted by changes in land use and development.
Earthquakes	Not considered.	Not considered.

## Problem Statements Summary

The following problem statements reflect a summary of the problem statements included at the end of each hazard profile. They were designed to briefly summarize the key hazard risks and vulnerabilities to the community based on potential impacts and losses from future events. They are among the issues of greatest concern and were used to assist in the identification and analysis of potential mitigation actions for Chapter 6 (Mitigation Strategy). These problem statements will be reviewed and revised as needed during plan updates to reflect the most current information resulting from the risk assessment.

Table 64. Problem Statements Summary.

Hazard	Problem Summary
Coastal Flooding	<ul style="list-style-type: none"> <li>• Potential exposed structures include the Electrical substation and BELD Light Plant</li> <li>• Residential, commercial, and government structures near shoreline.</li> <li>• Smith Beach and other parks and beaches on coastline could be impacted.</li> <li>• Hazardous materials from the pier may impact coastal areas.</li> </ul>
Flooding from Precipitation	<ul style="list-style-type: none"> <li>• Older populations in the floodplain may have difficulty evacuating.</li> <li>• There are two sewer pump stations, sewer department and garage, two reservoir pumps, Braintree Highway Department, Citgo Pier, and a BELD Station exposed to flooding.</li> <li>• Road closures may interrupt community systems including the following roads: Grossman, Forbes, Route 37/Hancock, Route 37/Granite, Washington, Adams, Jefferson, West, Union, Rex, the Union and Ivory Street intersection, and Forbes Road and Union Street at the MBTA underpass.</li> <li>• According to EPA’s Toxic Release Inventory (TRI) database, 50 buildings containing hazardous materials are found in the floodplain. These buildings include gas stations, auto shops, home repair, oil companies, and other businesses. The Citgo Pier contains and transports hazardous materials in the coastal floodplain.</li> <li>• Two structures listed on the National Register of Historic Places are located in the floodplain: the Chickatawbut Road Entrance Gates and the Blue Hills Reservation Culvert System.</li> </ul>

## Town of Braintree, MA Hazard Mitigation Plan

Hazard	Problem Summary
Severe Winter Storms	<ul style="list-style-type: none"> <li>• Vulnerable populations may be stranded during a winter storm event and may not be able to travel to emergency services.</li> <li>• The electrical grid and roadways are susceptible to failure and loss of use during storms.</li> <li>• First responders may have difficulty reaching people if roads are closed due to road closures.</li> </ul>
Average and Extreme Temperatures	<ul style="list-style-type: none"> <li>• Extreme heat will be a significant public health threat to all residents, but especially for vulnerable populations living in older homes or homes without air conditioning.</li> <li>• People generally are not using cooling centers; work may be needed in this area to promote public health and safety.</li> <li>• The electric grid may become stressed and fail during extreme heat events.</li> <li>• The elderly and those with mobility issues may not be able to leave their homes and travel safely.</li> <li>• People working in businesses without air conditioning may be at risk of heat illness.</li> </ul>
Hurricanes/Tropical Storms	<ul style="list-style-type: none"> <li>• Wind may cause trees to fall into structures and infrastructure, and roadways.</li> <li>• Wind damage to wind-susceptible buildings such as carports, greenhouses, and open-walled buildings. Additional damage to commercial buildings with HVAC located on roofs.</li> <li>• The electric grid may go down during high wind event.</li> </ul>
Coastal Erosion	<ul style="list-style-type: none"> <li>• Some single-family homes, commercial, and government structures are located within areas of direct coastal erosion risk.</li> <li>• Considerable damage has reportedly occurred along Watson Park and along the Fore River shoreline.</li> <li>• If piers are impacted by erosion, transport may be impacted as well.</li> </ul>

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Hazard	Problem Summary
Invasive Species	<ul style="list-style-type: none"> <li>• Invasive species are problematic throughout the Town and have been verified in Pond Meadow Park, Cranberry Pond, and on the Monatiquot River.</li> <li>• Sunset Lake, Eaton’s Pond, and Pond Meadow experience problems with nuisance growth of non-native aquatic weeds.</li> <li>• Additional DPW resources may be required in critical areas.</li> </ul>
Other Severe Weather	<ul style="list-style-type: none"> <li>• First responders may have difficulty reaching people if roads are closed due to tree debris.</li> <li>• Storm damage to wind-susceptible buildings such as carports, greenhouses, and open-walled buildings. Additional damage to commercial buildings with HVAC located on roofs.</li> <li>• The electric grid may go down during high wind event.</li> </ul>
Droughts	<ul style="list-style-type: none"> <li>• Vulnerable communities may have difficulty accessing potable water during an emergency drought event.</li> <li>• Water supply infrastructure may need to be shut down and water quality may become substandard. Businesses requiring water for daily operations may have their operations limited due to water restrictions.</li> <li>• Outdoor water use restrictions and other water conservation measures during periods of extreme drought can be challenging to enforce, even when mandated through local declaration.</li> </ul>
Tornadoes	<ul style="list-style-type: none"> <li>• Vulnerable populations may need support seeking protected shelter. Those without cell phones may not get weather alerts.</li> <li>• Structures and critical infrastructure can all be impacted by tornadoes.</li> <li>• Roadways may be blocked due to downed trees and other debris.</li> <li>• The electric grid may be impacted by winds and downed trees.</li> </ul>
Wildfires/Brushfires	<ul style="list-style-type: none"> <li>• Populations with severe asthma may be adversely impacted by wildfires in the vicinity.</li> </ul>

# Town of Braintree, MA Hazard Mitigation Plan

Hazard	Problem Summary
	<ul style="list-style-type: none"> <li>• Several residential structures are found in the higher probability burn areas. Structures without defensible zones are more susceptible to wildfires and brush fires.</li> <li>• Wildfires often cause roads to be closed requiring detours impacting emergency services.</li> <li>• The Town should assess existing capabilities to fight wildfires and identify deficiencies to increase capacity.</li> </ul>
Earthquakes	<ul style="list-style-type: none"> <li>• Elderly population falls during event.</li> <li>• Unreinforced masonry and utility lifelines impacted.</li> <li>• Fire Station impacted.</li> </ul>

## Chapter 5: Capability Assessment

### Overview

The capability assessment is an evaluation of the existing tools and resources available to the Town of Braintree for increasing its resilience to hazards, with the primary purpose of identifying opportunities to improve or enhance these capabilities. Coupled with the risk assessment, the capability assessment serves as the foundation for designing an actionable and effective hazard mitigation strategy.

As in any planning process, it is important to establish which goals or actions are feasible based on the organizational capacity of those agencies or departments tasked with plan implementation. This capability assessment helps determine which types of mitigation actions are practical and likely to be completed over time based on Braintree’s existing authorities, policies, programs, and resources available to support them. It also helps identify any critical capability gaps or limitations to address through corrective actions, as well the key strengths or positive measures in place that should continue to be supported or expanded upon to improve local mitigation capabilities.

This capability assessment was completed to not only help establish the goals and actions for the Town of Braintree’s hazard mitigation plan, but to also help ensure that those goals and actions are realistically achievable under current local conditions. As highlighted in FEMA’s 2022 Local Mitigation Planning Policy Guide, *“describing the current capabilities provides a rationale for which mitigation projects can be undertaken to address the vulnerabilities identified in the Risk Assessment.”*<sup>40</sup>

The capability assessment for the Town of Braintree includes a comprehensive examination of several components as summarized in Table 65. It was prepared using the latest guidance and worksheets provided in FEMA’s 2023 Local Mitigation Planning Handbook.<sup>41</sup>

Table 65. Capability Assessment Components.

Components	Description
Planning and Regulatory Capabilities	Local plans, policies, codes, and ordinances that are relevant to reducing the potential impacts of hazards.
Administrative and Technical Capabilities	Local human resources and their skills/tools that can be used to support mitigation activities.
Financial Capabilities	Fiscal resources the community has access to for helping to fund hazard mitigation projects.

<sup>40</sup> Local Mitigation Planning Policy Guide. FEMA. April 2022. P. 25.

<sup>41</sup> Local Mitigation Planning Handbook. FEMA. May 2023. PP. 79-92 and Worksheets 4-5.

## Town of Braintree, MA Hazard Mitigation Plan

Components	Description
Education and Outreach Capabilities	Local programs and methods already in place that can be used to support mitigation activities.
NFIP Participation and Compliance	Summary of information relevant to the community's participation in the NFIP and continued compliance with NFIP requirements.

### Review and Incorporation of Existing Plans, Studies, and Reports

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

The first step in completing the updated capability assessment was to gather and review any relevant local plans, studies, or reports completed or updated since the previous hazard mitigation plan was adopted in 2019. This information was used to help gain a current understanding of the Town's current ability to mitigate risk, and how local capabilities may have changed over the past five years. The 2023 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (the "ResilientMass" Plan), as well as other plans adopted by the Town of Braintree in the recent past, were reviewed for consistency as well as opportunities for plan integration. The goal of this review was to support updates to this plan that easily align with and possibly incorporate key aspects of relevant plans at the state and local level.

Table 66 provides a summary of the most relevant plans, studies, reports, or sources of other technical information consulted as part of this process and how they were incorporated into this plan update.

*Table 66. Relevant Plans, Studies, and Reports for Incorporation.*

Plan / Study / Report	Summary Description / Incorporation
ResilientMass Plan: The Massachusetts State Hazard Mitigation and Climate Adaptation Plan (2023)	The 2023 ResilientMass Plan is an update to the Commonwealth's innovative State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) that was developed in a highly collaborative manner to fully integrate a hazard mitigation plan and a climate change adaptation plan. The ResilientMass Plan identifies strategies and specific, measurable actions that state agencies can take—individually or through interagency partnerships—to address risks to the human health and safety, communities, critical assets and infrastructure, natural resources, governance, and economy of the Commonwealth. The ResilientMass Plan aims to ensure the Commonwealth is prepared to withstand, rapidly recover from, adapt to, and mitigate natural hazard events.

## Town of Braintree, MA Hazard Mitigation Plan

Plan / Study / Report	Summary Description / Incorporation
	<p>Through the ResilientMass Plan, the Commonwealth is advancing its mission to increase its capacity for addressing natural and other hazards and climate impacts through preparation, mitigation, adaptation, and risk reduction. The ResilientMass Plan includes six (6) overarching goals which were developed through a collaborative process involving the interagency ResilientMass Action Team (RMAT) and local, regional, and community partners. It also integrates the findings of the 2022 Climate Assessment with additional analysis on all current hazards that may impact the Commonwealth, as well as future risks that will increase the likelihood, frequency, and duration of hazards. Of perhaps most relevance to local communities, the ResilientMass Plan identifies the most urgent priority impacts of these risks to various regions across the Commonwealth.</p> <p>The ResilientMass Plan was incorporated as a key source of information for this plan update. This included the integration and consideration of the latest climate data and information for 15 hazards impacting the Commonwealth now and, in the future, with particular emphasis on those unique impacts determined for the Boston Harbor region. In addition, the goals and actions included in Chapter 7 (State Strategy, Actions, and Implementation Plan) were reviewed and considered as part of the update process for Braintree’s Hazard Mitigation Plan to help ensure the Town’s own goals and objectives are in alignment with and can be mutually supportive of the Commonwealth’s overall strategy. As can be seen in Chapter 6 of this plan, several of the goals and actions identified for Braintree’s updated plan address the key themes identified in the ResilientMass Plan.</p>
<p>Town of Braintree Climate Vulnerability Assessment and Action Plan (2017)</p> <p><i>* Designated MVP community through prior work</i></p>	<p>This plan includes a climate vulnerability assessment that addresses expected impacts from flooding (due to increased precipitation and rising sea level), drought, and extreme heat. The assessment considers impacts to vulnerable populations, public health, natural resources, the built environment including public and private infrastructure and utilities, and the local economy. Action items include a process for ensuring that implementation is monitored, as well as strategies to address the vulnerabilities identified. Upon the plan’s completion, the Commonwealth’s Executive Office of Energy and Environmental Affairs (EEA) awarded the Town with a Municipal Vulnerability Preparedness (MVP) community designation in 2018. Communities with this designation become eligible for MVP Action Grant funding and other opportunities to support the implementation of priority climate adaptation actions.</p>

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Plan / Study / Report	Summary Description / Incorporation
	<p>The Climate Vulnerability Assessment and Action Plan was incorporated into the plan update process as a key source for informing the risk assessment and mitigation strategy. Data inputs for the updated risk assessment included information on projected climate impacts and future conditions for various sectors of the community that were not addressed in the previous plan. It also included more information on the Town’s socioeconomic conditions and vulnerabilities to the impact of climate-driven natural hazards. Data inputs for the updated mitigation strategy included the review and updating the status of nearly 50 specific actions as recommended in the plan.</p>
<p>Master Plan (2023 Draft) and Existing Conditions Report (2022)</p>	<p>The Braintree Master Plan will be a 10-year vision and roadmap for Braintree's future. The Plan will be the foundational policy document for the Town – guiding local decisions about future growth, preservation, and change. Although not considered final or adopted by the Town at the time of this assessment, a draft version of the plan (dated 10/11/23) was reviewed along with the Phase I <i>Existing Conditions Report</i>, which had been prepared in 2022 for the Town’s Master Plan Committee (MPC) to detail the findings of a preliminary review and data collection phase to help define current trends, challenges, and issues faced by the community. The Town’s last Master Plan update was completed in 1998, but these two new documents build on more recent planning work and have helped establish a meaningful vision with strategies that are considered realistic and fiscally responsible.</p> <p>These Master Plan documents served as primary sources for current information and data that were reviewed and integrated into the hazard mitigation plan update. This included content relating to the physical, environmental, cultural, and demographic characteristics of Braintree, as well as the community’s collective vision for the future and the key goals and strategies to achieve that vision. Chapter 6 focuses on the core theme of “A Sustainable Community with Strong Connections,” including “strengthened climate resilience” as part of the theme’s overall vision. It identifies several complementary goals in support hazard mitigation, such as those focused on open space and nature resource preservation, resiliency and sustainability, and capacity building. All the relevant goals and strategies included in the draft plan were reviewed and incorporated into the updated Mitigation Strategy of this plan as deemed appropriate by the HMPC.</p>
<p>Open Space and Recreation Plan (2018)</p>	<p>The Town’s Open Space and Recreation Plan is intended to be a comprehensive source of information on Braintree’s natural and recreational resources and to inform the Town’s decision making about open space and</p>

## Town of Braintree, MA Hazard Mitigation Plan

Plan / Study / Report	Summary Description / Incorporation
	<p>recreation land and opportunities over the next five to seven years. It is designed to continue ongoing efforts by the Town to enhance and protect its natural areas and maintain accessible parks and recreational areas, while reflecting the Town’s priorities for potential land acquisition and land management. The Plan includes a community vision along with the identification of resource protection and management needs, followed by specific goals, objectives, and actions to be pursued under a seven-year action plan.</p> <p>The OSRP served as a key source of information related to Braintree’s history, demographics, growth and development patterns, and the natural environment, with specific content regarding natural hazards and mitigation activities also being incorporated into this updated plan. This includes details on environmental challenges such as climate change, stormwater, chronic flooding, erosion, and invasive species for the risk assessment, and information on existing goals and recommended or planned activities that will help the community to mitigate hazards or adapt to climate change for the mitigation strategy.</p>
<p>Town of Braintree Monatiquot River Watershed Study (2011)</p>	<p>Prepared for the Town by UMass-Amherst’s Department of Landscape Architecture and Regional Planning, this document provides a comprehensive study of stormwater management, water quality improvement and river access, and recreation along the Monatiquot River. The main goals of this project were to provide stormwater management strategies, improve water quality management, and to evaluate accessibility and recreation opportunity of the Monatiquot River within the Town of Braintree, and the recommendations put forward in this report were developed to enhance long term sustainability of the community.</p> <p>Although somewhat dated, key recommendations indicated in this report were revisited and integrated into the process of updating the Mitigation Strategy. As noted in the study, a combination of short-term and long-term flood mitigation and risk management in coping with extreme events should be integrated into long-range planning considering floodplain acquisition, floodplain and wetlands restoration, disaster preparedness, response and recovery plans, and climate change mitigation and adaptation plans.</p>
<p>FEMA Flood Insurance Study for</p>	<p>Last revised by FEMA on April 7, 2023, this report constitutes the revised preliminary Flood Insurance Study (FIS) report for Norfolk County. This latest FIS revises and updates information from the currently effective (2021) FIS</p>

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Plan / Study / Report	Summary Description / Incorporation
Norfolk County (2023)	<p>report on the existence and severity of flood hazards for the study area, which includes the Town of Braintree. The studies described in this report provide flood hazard data that will, once formally adopted as final/effective, be used to establish actuarial flood insurance rates and to assist communities in efforts to implement sound floodplain management.</p> <p>The FIS and accompanying Flood Insurance Rate Maps (FIRMs) include relevant data and information on flood hazards for Braintree, including but not limited to descriptions of principal flood problems, flooding sources, FEMA flood zone designations, base flood elevations, and discharge rates of flooding sources. This data and information were reviewed and incorporated into the plan update process by informing the risk assessment, especially as it relates to the hazard profile and GIS-based vulnerability assessment that was prepared for the flood hazard.</p>

In addition to the above plans which were determined to be most relevant for incorporation into the hazard mitigation plan update, the following plans, studies, reports, and other technical documents were reviewed to gain a clearer understanding of local capabilities and their existing or potential effects on hazard risk reduction. More information on some of these documents is provided in Table 67 in the next section.

- Local Rapid Recovery Plan (2021)** – The Local Rapid Recovery Plan (LRRP) was prepared for South Braintree Square as part of the Massachusetts Rapid Recovery Plan (RRP) Program. The RRP was intended to provide every municipality in Massachusetts the opportunity to develop actionable, project-based recovery plans tailored to the unique economic challenges and COVID-19 related impacts to downtowns, town centers, and commercial areas across the Commonwealth. The Braintree LRRP examines market and physical conditions, as well as feedback from the business community, to identify strategic projects that support a sustainable and equitable recovery from the COVID-19 pandemic.
- Stormwater Management Plan (2019)** – The Town’s Stormwater Management Plan (SWMP) is maintained in compliance with MS4 permit requirements as administered by the U.S. Environmental Protection Agency and Massachusetts Department of Environmental Protection (MassDEP). The SWMP describes and details the activities and measures that will be implemented to meet the terms and conditions of the MS4 permit. It is focused on reducing pollutants in stormwater runoff versus mitigating flood hazards. The main elements of the Town’s stormwater management program are (1) a public education program in order to affect public behavior causing stormwater pollution, (2) an opportunity for the public to participate and provide comments on the stormwater program, (3) a program to effectively find and eliminate illicit discharges within the MS4 (4) a program to effectively control construction site

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stormwater discharges to the MS4, (5) a program to ensure that stormwater from development projects entering the MS4 is adequately controlled by the construction of stormwater controls, and (6) a good housekeeping program to ensure that stormwater pollution sources on municipal properties and from municipal operations are minimized.

- Comprehensive Emergency Management Plan (outdated but update in process)*** – The Town’s Comprehensive Emergency Management Plan (CEMP) provides a framework for a community-wide emergency management system to ensure a coordinated response to emergencies and coordinated support of certain pre-planned events. The CEMP addresses the roles and responsibilities of all community departments, agencies, government organizations, volunteers, and other community partners that may be involved in response operations, and identifies how regional, state, federal, private sector, and other resources may be activated to address disasters and emergencies in the community. Although the plan is focused on actions and activities in response to an emergency or disaster event, it does provide general guidance on the roles and responsibilities of Town departments and partners for the prevention and mitigation of anticipated incidents.

### Planning and Regulatory Capabilities

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

Table 67 is based off Worksheet 4 from FEMA’s Local Mitigation Planning Handbook. It was used by the HMPC to document and review the current planning and regulatory capabilities of the Town including local plans, policies, codes, and ordinances that are relevant to reducing the potential impacts of hazards. Some additional information on how effectively these plans and regulatory tools are being used for hazard mitigation purposes can be found under the Safe Growth Survey and NFIP Participation and Compliance sections of this chapter.

*Table 67. Planning and Regulatory Findings.*

Planning/Regulatory Tool	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
<b><i>Plans</i></b>		
Master/Comprehensive Plan	Yes	The Town updated Master Plan (2023 draft) includes protection of open space and natural resources among its key goals related to hazard risk reduction. Chapter 6 focuses on the core theme of “A Sustainable Community with Strong Connections,” including

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Planning/Regulatory Tool	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		<p>“strengthened climate resilience” as part of the theme’s overall vision. It identifies several complementary goals in support hazard mitigation and will be an effective tool for supporting the implementation of strategies and actions identified in this Hazard Mitigation Plan. See Table 66 for more information on the Town’s Master Plan update process.</p>
Open Space & Recreation Plan	Yes	<p>Notes flood hazard areas and includes implementation of items from the Climate Vulnerability Assessment and Action Plan (see below) as well as Armstrong Dam removal. The OSRP was last updated in 2018. See Table 66 for more information.</p>
Climate Adaptation Plan	Yes	<p>The Town’s Climate Vulnerability Assessment and Action Plan addresses several hazards (drought, extreme heat, flooding, sea level rise). Although completed back in 2017 the plan was considered and integrated into the Hazard Mitigation Plan update process and may be used to support plan implementation. See Table 66 for more information.</p>
Floodplain Management Plan	No	<p>No stand-alone plan, but floodplain management is addressed as a component of this Hazard Mitigation Plan (including the Floodplain Management Plan requirements of CRS Activity 510).</p>
Stormwater Management Plan	Yes	<p>Plan addresses compliance with MS4 permit. Includes maintenance of drainage system but not focused on hazards. Updated in 2019. More details on the SWMP are provided in the previous section following Table 66.</p>
Capital Improvements Plan	Yes	<p>Does not address hazards. Includes new DPW facility (current one is in the floodplain). Updated in 2022. The Town is also addressing many of its planned capital improvements through its Master Plan (Chapter 10 is focused on “Expanding and Modernizing Town Facilities, Services, and Infrastructure”).</p>
Housing Production Plan	No	<p>The Town had adopted an Affordable Housing Plan in 2004 but is now addressing many current issues related</p>

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Planning/Regulatory Tool	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		to housing through its updated Master Plan (Chapter 9 is focused on “Residential Neighborhoods and Housing Options”).
Transportation Plan	No	The Town had adopted a Townwide 10-Year Transportation Management Plan in 2001 but is now addressing many current issues related to transportation through its updated Master Plan (Chapter 8 is focused on “A Safe and Connected Transportation Network”).
Economic Development Plan	No	No current plan, however, the Town is addressing many current issues related to economic development through its updated Master Plan (Chapter 7 is focused on “Strategic Economic Development & Vibrant Local Businesses”).
Historic Preservation Plan	Yes	The Town maintains plans for specific properties (for example, Elm Street Cemetery), but these do not address hazards. The Braintree Town Center Historic District, established in 1980, encompasses and safeguards 19 historical structures managed by the Braintree Historical Commission.
Emergency Operations Plan	Yes	The Town’s Comprehensive Emergency Management Plan (CEMP) addresses response to hazards. Currently being updated. More details on the CEMP are provided in the previous section following Table 66.
Continuity of Operations Plan	No	N/A
Community Wildfire Protection Plan	No	N/A
<b><i>Building Code, Permitting, and Inspections</i></b>		
Building Code	Yes	Version/Year: MA State Building Code (780 CMR), Ninth Edition, 2017
ISO Building Code Effectiveness Grading Schedule (BCEGS®) Classification	Yes (2020)	BCEGS Commercial Class: 4 BCEGS Residential Class: 4

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Planning/Regulatory Tool	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
ISO Public Protection Classification (PPC©)	Yes (2018)	PPC Grade (Community Classification): Class 02
Special Permit / Site Plan Review Requirements	Yes	Article V of the Town’s Zoning Bylaw and administered by the Braintree Planning Board, acting as the Special Permit Granting Authority (SPGA). The SPGA reviews all proposals for compliance with the general purpose and intent of the Braintree Zoning Bylaw while considering a range of factors including but not limited to public safety, access in case of a fire or other catastrophe, and the adequacy of drainage methods at the proposed site. All applications for a special permit shall include a site plan review. Very effective in terms of supporting hazard risk reduction through existing procedures.
<b>Zoning, Land Use, and Development Regulations</b>		
Zoning Bylaw	Yes	The Town’s Zoning Bylaw (Chapter 135) was established for many purposes that include but are not limited to promoting the health and safety of the Town’s inhabitants, securing safety from fire, panic, and other dangers, conserving natural resources, and to encourage the most appropriate use of land throughout the Town. Very effective at supporting hazard risk reduction through multiple articles and sections and in combination with other rules or regulations as further described in this table.
Subdivision Regulations	Yes	The Town’s Rules and Regulations Governing the Subdivision of Land, adopted in 2002, requires that no person, firm, or corporation shall subdivide any lot, tract, or parcel of land or construct streets or utilities in such land until definitive plans have been approved by the Planning Board. The regulations include design standards, stormwater drainage and erosion control requirements, environmental protection requirements, and other specifications that all help reduce the risk of creating hazards during the subdivision process.
Floodplain Regulations	Yes	Section 135-608 of the Town’s Zoning Bylaw establishes and regulates activities within the Floodplain Protection

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Planning/Regulatory Tool	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		<p>District with the purpose of protecting the health and safety of persons and property against flooding, eliminating new hazards to emergency response officials, regulating the development of land and construction of buildings within the district, and avoiding the loss of utility services due to flooding. These regulations have continuously been updated to include higher standards based on FEMA's recommended best practices and the State's Model Floodplain Bylaw as further described in this chapter. Very effective in reducing the long-term risk of flood hazards throughout the Town's identified special flood hazard areas as depicted on the latest Flood Insurance Rate Map for Norfolk County (2021).</p>
Wetlands Protection Regulations	Yes	<p>The Town's Wetland Bylaw (Chapter 12.20 of the Zoning Bylaw) and Rules and Regulations are strictly enforced by the Conservation Commission to protect wetlands, water resources, groundwater quality, and adjoining areas in Braintree. The rules and procedures are adequately administered and effectively help to reduce flood hazards by prohibiting certain activities and uses within protected resource areas, while also considering the impacts of any proposed activity as it relates to flood control, tree protection, stormwater management, erosion and sedimentation control.</p>
Stormwater Management Regulations	Yes	<p>Chapter 13.14 of the Town's General Bylaws was adopted to implement stormwater management requirements in compliance with State (Mass DEP) and Federal (US EPA) standards and works in conjunction with the Town's own Stormwater Management Regulations established and enforced by the Department of Public Works. The regulations address prohibited activities and specific requirements for all stormwater discharges, permit procedures, and post-development stormwater management criteria that include low impact design and green infrastructure. Very effective in terms of reducing the adverse effects</p>

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Planning/Regulatory Tool	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		of increased post-development stormwater runoff and supporting the safe operation of the Town’s existing stormwater management facilities.
Other hazard-specific regulations or ordinances?	Yes	Wetlands protection rules and regulations have been adopted and are adequately enforced under Chapter 12.20 of the Town’s Zoning Bylaw, last amended in 2019. Erosion control and grading regulations have been adopted under Article XII of the Town’s Zoning Bylaw. A Grading Permit is required for cuts or fills 2 feet or more to ensure that unstable slopes are not created and that impacts to abutters are not created.

### Massachusetts State Building Code

All municipalities in the state must adopt and enforce the current Massachusetts State Building Code (MSBC). The MSBC consists of a series of international model codes and any state-specific amendments adopted by the Board of Building Regulations and Standards (BBRS). The BBRS regularly updates the state building codes as new information and technology becomes available and change is warranted.

The MSBC is separated into two distinct volumes: The Residential volume regulates all one- and two-family structures and townhouses that are three stories or less, as well as their accessory structures. The Base volume regulates all structures that are not covered by the Residential regulations.

The current version of the MSBC is the Ninth Edition, which became effective on October 20, 2017. The Town of Braintree began enforcing the Ninth Edition for all applicable projects as required by January 1, 2018. The Ninth Edition code is based on modified versions of the following 2015 codes as published by the International Code Council (ICC). \*

- The International Building Code (IBC)
- International Residential Code (IRC)
- International Existing Building Code (IEBC)
- International Mechanical Code (IMC)
- International Energy Conservation Code (IECC)
- International Swimming Pool and Spa Code (ISPSC)
- Portions of the International Fire Code (IFC)

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*\* Although the Ninth Edition of the code is still in effect, members of the BBRS have voted that the next edition of the MSBC will be based on modified versions of the 2021 International Codes. The content of these codes is still under review by the BBRS, but it is anticipated that the Tenth Edition of the code will be available for use in 2024.*

The Commonwealth of Massachusetts requires mandatory enforcement of the MSBC and does not allow local amendments to the residential code. In addition, the Commonwealth adopts a plumbing and electrical code. The Commonwealth also has a program in place for code official certification, which includes taking code classes prior to examination and certification, requires continuing education, and allows consumers to file complaints against inspectors. Massachusetts also requires licensing of general, plumbing, electrical, and roofing contractors; requires licensing candidates to pass an examination prior to licensing; and requires continuing education.

Massachusetts continues to perform well in terms of objective assessments of the MSBC. For example, in its most recent “Rating the States” report, the Insurance Institute for Business and Home Safety (IBHS) ranked Massachusetts 9th (scoring 78 out of a possible 100 points on the IBHS scale). Now in its fourth edition, IBHS’s 2021 report evaluates the 18 states along the Atlantic and Gulf coasts, all vulnerable to catastrophic hurricanes, based on building code adoption, enforcement, and contractor licensing.

Lastly, as noted in the table above, the MSBC contains a series of requirements for flood-resistant design and construction that are in accordance with the ASCE 24 standard, which incorporates—and in certain areas exceeds—FEMA’s NFIP construction standards. Highlights of ASCE 24 that complement the NFIP minimum requirements include requirements for building performance; flood-damage-resistant materials, utilities and service equipment, and siting considerations. Specific requirements for design flood elevations and the use of flood-resistant materials may be found in the ASCE Tables included in 780 CMR Section 1612.4.

Higher regulatory standards that affect development and redevelopment in flood hazard areas include: (1) new or substantially improved buildings in A Zones have to be elevated so that the lowest floor surface is at least 1 foot above the FEMA base flood elevation; and new or substantially improved buildings in V Zones must be elevated so that the lowest floor is at least 2 feet above the FEMA base flood elevation; and (2) for new or substantially improved buildings in V Zones, utilities can no longer be located below the FEMA base flood elevation.

Additional state-specific higher standards for flood-resistant construction in coastal dunes may be found in Appendix G of the MSBC. For example, the State requires the use of pilings in coastal dune areas, even if the areas are not in a mapped Velocity flood zone (V Zone) and has higher elevation requirements than the NFIP (the lowest floor must be built to at least 2 feet above a dune).

# Town of Braintree, MA Hazard Mitigation Plan

## Safe Growth Survey

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

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

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

The results of the Safe Growth Survey are summarized in Table 68. This includes describing how strongly the Town’s planning staff agrees or disagrees with 25 statements as they relate to Braintree’s current plans, policies, and programs for guiding future community growth and development, according to the following scale:

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

Table 68. Safe Growth Survey Results.

MASTER/COMPREHENSIVE PLAN					
<i>Land Use</i>					
1.	The master/comprehensive plan includes a future land use map that clearly identifies natural hazard areas.	1	2	3	4 5

## Town of Braintree, MA Hazard Mitigation Plan

<p>2. Current land use policies discourage development and/or redevelopment within natural hazard areas.</p>	<p>1    2    3    <input checked="" type="checkbox"/>4    5</p>
<p>3. The master/comprehensive plan provides adequate space for expected future growth in areas located outside of natural hazard areas.</p>	<p>1    2    3    <input checked="" type="checkbox"/>4    5</p>
<p><b>Transportation</b></p>	
<p>4. The transportation element limits access to natural hazard areas.</p>	<p>1    2    3    4    <input checked="" type="checkbox"/>5</p>
<p>5. Transportation policy is used to guide future growth and development to safe locations.</p>	<p>1    2    3    <input checked="" type="checkbox"/>4    5</p>
<p>6. Transportation systems are designed to function under disaster conditions (e.g., evacuation, mobility for fire/rescue apparatus, etc.).</p>	<p>1    2    3    <input checked="" type="checkbox"/>4    5</p>
<p><b>Environmental Management</b></p>	
<p>7. Environmental features that serve to protect development from hazards (e.g., wetlands, riparian buffers, etc.) are identified and mapped.</p>	<p>1    2    <input checked="" type="checkbox"/>3    4    5</p>
<p>8. Environmental policies encourage the preservation and restoration of protective ecosystems.</p>	<p>1    2    3    <input checked="" type="checkbox"/>4    5</p>
<p>9. Environmental policies provide incentives to development that is located outside of protective ecosystems.</p>	<p>1    2    <input checked="" type="checkbox"/>3    4    5</p>
<p><b>Public Safety</b></p>	
<p>10. The goals and policies of the master/comprehensive plan are related to and consistent with those in the hazard mitigation plan.</p>	<p>1    2    3    <input checked="" type="checkbox"/>4    5</p>

## Town of Braintree, MA Hazard Mitigation Plan

11. Public safety is explicitly included in the master/comprehensive plan's growth and development policies.	1   2 <input checked="" type="checkbox"/> 3   4   5
12. The monitoring and implementation section of the master/comprehensive plan covers safe growth objectives.	1   2   3 <input checked="" type="checkbox"/> 4   5
<b>ZONING BYLAWS</b>	
13. The zoning bylaws conform to the master/comprehensive plan in terms of discouraging development and/or redevelopment within natural hazard areas.	1   2   3 <input checked="" type="checkbox"/> 4   5
14. The bylaws contain natural hazard overlay zones that set conditions for land use within such zones.	1   2   3 <input checked="" type="checkbox"/> 4   5
15. The bylaws require or encourage resilient development through density bonuses, flexibility with setback requirements, or other incentives for projects outside of natural hazard areas.	<input checked="" type="checkbox"/> 1   2   3   4   5
16. The bylaws prohibit development within, or filling of, wetlands, floodways, and floodplains.	<input checked="" type="checkbox"/> 1   2   3   4   5
<b>SUBDIVISION REGULATIONS</b>	
17. The subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas.	1   2   3 <input checked="" type="checkbox"/> 4   5
18. The regulations provide for conservation subdivisions or cluster subdivisions to conserve environmental resources.	1   2   3   4 <input checked="" type="checkbox"/> 5
19. The regulations allow density transfers where natural hazard areas exist.	<input checked="" type="checkbox"/> 1   2   3   4   5
<b>CAPITAL IMPROVEMENT PROGRAM AND INFRASTRUCTURE POLICIES</b>	

## Town of Braintree, MA Hazard Mitigation Plan

20. The capital improvement program limits expenditures on projects that would encourage development and/or redevelopment in areas vulnerable to natural hazards.	1	2	3	4	5
21. Infrastructure policies limit the extension of existing facilities and services that would encourage development in areas vulnerable to natural hazards.	1	2	3	4	5
22. The capital improvements program provides funding for hazard mitigation projects identified in the hazard mitigation plan.	1	2	3	4	5
<b>OTHER</b>					
23. Economic development and/or redevelopment strategies include provisions for mitigating natural hazards or otherwise enhancing social and economic resiliency to hazards.	1	2	3	4	5
24. Local plans, policies, or regulations promote the use of green infrastructure, low impact development, or other nature-based solutions for managing stormwater and other climate hazards.	1	2	3	4	5
25. The community considers and addresses potential impacts of its plans, policies, or regulations on Environmental Justice (EJ) neighborhoods or other socially vulnerable populations.	1	2	3	4	5

### Administrative and Technical Capabilities

Table 69 is based off Worksheet 4 from FEMA’s Local Mitigation Planning Handbook. It was used by the HMPC to document and review the current administrative and technical capabilities of the Town. These include staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions.

Table 69. Administrative and Technical Findings.

Administrative/Technical Resource	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
<b>Local Boards/Committees</b>		
Planning Board		The Planning Board focuses on minimizing and regulating the impacts the Town faces relating to land use and development, particularly those conditions

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Administrative/Technical Resource	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		affecting quality of life, public welfare, traffic, and public safety. The Planning Board considers applications for Site Plan Review and those pertaining to the Rules and Regulations Governing the Subdivision of Land and serves as the Special Permit Granting Authority (SPGA). Very effective in terms of updating and enforcing numerous bylaws, regulations, and procedures and making recommendation to the Town Council as it relates to promoting sustainable and resilient development, protecting natural resources, and other measures that align with hazard risk reduction.
Conservation Commission	Yes	The Conservation Commission focuses on protection of resource areas such as wetlands and vernal pools, rivers and streams, and the wildlife that inhabits these areas. The Commission is supported by Town staff, including a full-time Conservation Planner, who helps administer state and local wetlands protection regulations and other related activities within the Commission’s jurisdiction. Very effective, especially in terms of flood hazard risk reduction and protection of the natural and beneficial functions of floodplains, wetlands, and other protective natural resources.
Capital Planning Committee	No	N/A – The five-year CIP is developed and updated annually by the Mayor and presented to Town Council for their approval.
Climate Action Committee	No	N/A
Other relevant boards/committees?	Yes	Braintree Historical Commission (BHC), Community Preservation Committee (CPC), DPW Advisory Board
<b>Staff</b>		
Community Planner	Yes	Planning and Community Development Director. Department staff routinely provide technical and administrative support to the Planning Board and remain an excellent resource for residents and developers regarding existing regulations and the Town’s permitting process. Staffing is adequate to

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Administrative/Technical Resource	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		administer programs and enforce regulations that are effective in supporting hazard risk reduction.
Chief Building Official	Yes	Building Division Director. In the construction, alteration or change in use of buildings and structures, the Building Division (Building, Electrical, Plumbing, and Gas) inspects all properties within the Town at pre-determined intervals to ensure compliance with all applicable regulations controlling such development. Division staffing is adequate to administer programs and enforce regulations that are effective in supporting hazard risk reduction.
Civil Engineer	Yes	Public Works Director. The Department of Public Works is responsible for the care and maintenance of all public buildings, facilities, vehicles, etc. The Department includes the Engineering Division, Highways and Grounds Division, Stormwater Division, Recreation Department, and Water and Sewer Department. Staffing is adequate to administer programs and enforce regulations that are effective in supporting hazard risk reduction.
Emergency Manager	Yes	Director of Braintree Emergency Management Agency (BEMA). BEMA has, in part, the following responsibilities: prepare and maintain Local, State and Federally approved Emergency Disaster plans; assist businesses and other departments within the town with developing contingency emergency plans; help locate and secure resources from within and outside the state; regularly execute and encourage drills to ensure the highest possible state of readiness; develop and maintain a volunteer group with appropriate training to assist in situations and disseminate information regarding disaster and emergency preparedness. Very effective in administering programs and activities that support hazard risk reduction.
Floodplain Administrator	Yes	The duties of floodplain management are effectively shared and administered by the Town's Planning and

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Administrative/Technical Resource	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		Community Development Director and Conservation Planner. These include overseeing implementation of the commitments and requirements of the NFIP and FEMA's Community Rating System (CRS).
Sustainability/Climate Coordinator	No	N/A
GIS Coordinator	Yes	Full-time position was recently filled by the Town.
Public Information Officer/Specialist	No	N/A
Other relevant staff resources?	Yes	The Town's Conservation Planner manages the Community Rating System (CRS) program and several hazard mitigation and restoration initiatives, in addition to providing routine duties in support of the Conservation Commission.
<b>Technical</b>		
Grant writing	Yes	The Town's Conservation Planner has obtained funding for a coastal resilience project and dam removal project. The Stormwater Manager has obtained funding for stormwater projects. There is also a Contract Administrator/Grant Writer.
GIS mapping and analysis	Yes	Not in the past, but with the hiring of a dedicated GIS Coordinator the Town anticipates this capability will be an effective tool in support of associated hazard risk reduction activities.
Hazard data and information	Yes	No stand-alone data repository, however most relevant hazard information is maintained and regularly updated in this Hazard Mitigation Plan.
Maintenance programs to reduce risk (e.g., tree trimming, drainage clearance)	Yes	BELD and DPW conduct removal or trimming of hazardous trees. DPW and Stormwater Division maintain Town drainage system.
Acquisition of land for open space, recreation, and other public use	Yes	Planning and Community Development Department staff identify opportunities for acquisition (either fee ownership or easement/Conservation Restriction) and

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Administrative/Technical Resource	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		work with owners to complete transactions. The Town’s Community Preservation Committee (CPC) also helps study the needs, possibilities, and resources of the Town’s open space, historic, and outdoor recreation assets through Community Preservation Act (CPA) projects as further described in Table 70.
Warning systems/services (e.g., Reverse 911, outdoor warning signs)	Yes	Braintree Alerts, powered by Smart911, is the Town’s official emergency notification system to communicate with community residents during emergencies. Braintree Alerts is a free service to for residents that allows them to sign up to receive customized alerts via text, email, and voice messages.
Mutual Aid Agreements	Yes	Both Police and Fire have mutual aid compacts, and both participate in mutual aid regularly.

### Financial Capabilities

Table 70 is based off Worksheet 4 from FEMA’s Local Mitigation Planning Handbook. It was used by the HMPC to identify and review the Town’s eligibility and access to funding sources that can be used to support the implementation of hazard mitigation projects.

Table 70. Financial Findings.

Financial Tool/Source	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
General funds	Yes	Funds have been and may continue to be used for hazard risk reduction activities such as tree planning (mitigate heat), CRS activities, BEMA activities, etc.
Capital Improvement Program (CIP) funding	Yes	Funds have been used and may continue to be used as a source for hazard mitigation projects and improvements to Town facilities and infrastructure assets. The Town’s new DPW Highway Barn (relocated out of the floodplain) is in the capital plan but unlikely to be funded in the near term.
Special purpose taxes	Yes	Community Preservation Fund – see below (Massachusetts CPA funds) for more info.

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Financial Tool/Source	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
Fees for water, sewer, gas, or electric services	Yes	Electric – tree trimming to prevent power outages.
Stormwater utility fee	Yes	Stable source of funding based on user (property owner) fees for hardened or impervious surface that cause stormwater runoff on each parcel. Funds are limited to only drainage maintenance and retrofits, but this remains an effective tool for improving stormwater infrastructure in ways that can reduce flooding impacts.
Development impact fees	No	N/A
General obligation bonds and/or special purpose bonds	Yes	Not used in the past but a possible source of funding for larger capital projects that can support hazard mitigation efforts.
FEMA Hazard Mitigation Assistance (HMA) funds	Yes	FEMA’s current HMA grant programs (BRIC, FMA, HMGP) remain a good source of external funding for implementing eligible and cost-effective mitigation projects in coordination with MEMA.
HUD Community Development Block Grant (CDBG) funds	No	N/A
Other federal funding programs	Yes	NOAA, EPA, USACE, and other federal agencies do make grant funding available for a variety of resilience-themed projects and initiatives that the Town may be eligible to pursue in the future. This includes both pre- and post-disaster funding programs that can be very effective in supporting the implementation of cost-effective hazard mitigation projects, many of which are described in FEMA’s Mitigation Resource Guide. <sup>42</sup> The Town has been successful in drawing down federal funds to support its risk reduction efforts. For example, the Town recently secured funding from NOAA in support of stormwater management improvements and the Armstrong Dam removal project.

<sup>42</sup> Mitigation Resource Guide. FEMA. March 2021.

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Financial Tool/Source	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
Massachusetts Municipal Vulnerability Preparedness (MVP) Action Grant funds		The MVP Action Grant offers financial resources to communities that are seeking to advance priority climate adaptation actions to address climate change impacts resulting from extreme weather, sea level rise, inland and coastal flooding, severe heat, and other climate impacts. As a designated “MVP Community” the Town is eligible to apply for grants on its own, or as part of a regional partnership of multiple municipalities provided that the lead applicant is MVP-designated. MVP Action Grant funding has recently been awarded to the Town in support of the Armstrong Dam Removal project and stormwater BMPs.
Massachusetts Community Preservation Act (CPA) funds	Yes	In 2002 the Town of Braintree passed the Community Preservation Act (CPA). Passage of CPA allowed the Town to establish a Community Preservation Fund to support open space, historic preservation, outdoor recreation, and community housing. Monies for the fund come from a 1% property tax surcharge and matching dollars from the state. Effective tool for hazard risk reduction as funds have been and can continue to be used for the acquisition of undeveloped land in the floodplain.
Other state funding programs		The Commonwealth makes a variety of funding programs available on a routine basis to support local risk reduction projects. Some of the most applicable opportunities for the Town include MVP Action Grants and other annual grant programs through EEA, such as the Culvert Replacement Municipal Assistance Grant Program. Others may include Community Compact grants, Green Communities grants, Coastal Resilience Grants, etc. depending on the scope and scale of specific projects. Very effective sources of funding that the Town has used in the past to support risk reduction projects, such as a CZM Coastal Resilience Grant for Watson Park, dam and seawall repairs, and the removal of Armstrong Dam.

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Financial Tool/Source	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
Private or non-profit grants, loans, or funding	No	N/A

### Education and Outreach Capabilities

Table 71 is based off Worksheet 4 from FEMA’s Local Mitigation Planning Handbook. It was used by the HMPC to identify and review existing education and outreach programs that can be used or expanded upon to support local mitigation activities.

Table 71. Education and Outreach Findings.

Education & Outreach Program/Method	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
Community newsletter(s)	No	N/A
Web-based / social media	Yes	Mayor’s Office manages web-based and social media mechanisms which can be used in support of future outreach or community engagement activities in support or hazard risk reduction efforts.
Public Access TV, radio, etc.	Yes	BCAM TV is an educational non-profit organization dedicated to the creation and delivery of local television programming to the residents of Braintree. BCAM is funded by cable TV subscribers to provide community television. Although not operated by the Town, BCAM covers government meetings, town events, and more and is considered an effective tool for supporting community outreach and education.
Community gatherings, festivals, celebrations, or other events	Yes	The Town’s 4 <sup>th</sup> of July Celebration event could be used as a method to support community outreach and education.
Hazard awareness campaigns (e.g., <i>Severe Weather Awareness Week</i> )	No	N/A
Organizations that represent, advocate for, or interact with underserved or vulnerable populations		The Town’s Department of Elder Affairs, the Braintree Housing Authority, and the Marge Crispin Center are all effective organizations that could be used in support of

## Town of Braintree, MA Hazard Mitigation Plan

Education & Outreach Program/Method	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		education and outreach to underserved or vulnerable populations throughout the community.
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, etc.	Yes	<p>The Community Emergency Response Team (CERT), which is a program that educates people about disaster preparedness for hazards that may impact their area and trains them in basic disaster response skills, such as fire safety, light search and rescue, team organization, and disaster medical operations. Using the training learned in the classroom and during exercises, CERT members can assist their family and others in their neighborhood or workplace following an event, when professional responders are not immediately available to help. BEMA encourages CERT members to support emergency response agencies by taking a more active role in emergency preparedness projects in Braintree.</p> <p>Sustainable Braintree is a community advocacy group committed to helping Braintree residents, community groups, businesses and local government, conserve energy, promote clean and renewable energy, protect, and restore the environment and live healthy, sustainable lifestyles. Could be used in support of hazard risk awareness and outreach/education activities that support community resilience building.</p>
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness)	Yes	Ongoing CRS outreach activities (in support of flood risk reduction), Fire Department programs (in support of fire prevention and safety), BEMA's Community Emergency Response Team (CERT) as described above, etc. Very effective methods for increasing public awareness and education on the preparedness and mitigation measures they can take to reduce hazard risks.
Natural disaster or safety-related school programs	No	N/A
StormReady® certification	Yes	The Town became certified by the National Weather Service as a StormReady Community in 2011. BEMA

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Education & Outreach Program/Method	In Place? (Yes/No)	General Description / Effectiveness for Hazard Risk Reduction
		manages this program and is currently in the process of recertifying. Very effective at helping the Town to improve and maintain hazardous weather operations through a variety of activities.
<i>Firewise USA</i> ® certification	No	N/A
Public-private partnership initiatives addressing disaster-related issues	No	N/A

## National Flood Insurance Program (NFIP) Participation and Compliance

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

The National Flood Insurance Program (NFIP) is a program created by the United States Congress in 1968. The NFIP has two purposes: to share the risk of flood losses through flood insurance and to reduce flood damages by restricting floodplain development. The program enables property owners in participating communities to purchase insurance protection, administered by the government, against losses from flooding, and requires flood insurance for all federally backed loans or lines of credit that are secured by existing buildings, manufactured homes, or buildings under construction, that are in FEMA-mapped special flood hazard areas in a community that participates in the NFIP. The availability of NFIP policy coverage is limited to communities that adopt adequate land use and control measures with effective enforcement provisions to reduce flood damages by restricting development in areas exposed to flooding. There are now more than 20,000 participating communities across the United States and its territories.

The Town of Braintree has participated in the NFIP since 1978. As summarized in Table 72, the HMPC used Worksheet 5 from FEMA’s *Local Mitigation Planning Handbook* to collect information regarding the Town’s participation in and compliance with the NFIP. This worksheet, in addition to a separate *NFIP Survey* for the Conservation Planner, helped the HMPC to identify areas for improvement and other ideas that could be potential mitigation actions.

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Table 72. NFIP Participation and Compliance Findings.

NFIP Topic	Source of Information	Comments
<b>Insurance Summary</b>		
How many NFIP policies are in the community? What is the total premium and coverage?	FEMA NFIP Services, Flood Insurance Data and Analytics; State NFIP Coordinator	As of December 31, 2023, a total of 196 NFIP policies are in force. The total premium is \$289,982 for a total of \$61,162,000 in coverage. The average premium paid per policy is \$1,480.
How many claims have been paid in the community? What is the total amount of paid claims? How many of the claims were for substantial damage?	FEMA NFIP Services, Flood Insurance Data and Analytics (HUDEX report)	There has been a total of 167 claims paid since 1978, totaling \$2,020,521 in losses. The average claim amount paid is \$12,099. There have been no claims paid for substantial damage.
How many structures are exposed to flood risk within the community?	GIS analysis (FEMA FIRMs + building footprint data)	It is estimated that 183 structures are at risk to the 1-percent annual chance flood, and 388 are at risk to the 0.2 percent annual chance flood for a combined total of 571 structures exposed to flood risk.
Are there any repetitive or severe repetitive loss structures in the community?	MEMA / FEMA	Yes, there are 18 repetitive loss properties and 2 severe repetitive loss properties in Braintree. See Chapter 4 for more details.
Describe any areas of flood risk with limited NFIP policy coverage	HMPC	No address-specific data has been made available by FEMA, but it is generally assumed that owners of property located in special flood hazard areas are underinsured when it comes to flood insurance coverage (based on only 196 current policies under the NFIP in comparison to 571 structures estimated to be exposed to moderate to high flood risk).
<b>Staff Resources</b>		
Who is responsible for floodplain management in the community? Do they serve	Conservation Planner	The duties of floodplain management and implementation of the commitments and requirements of the NFIP are shared through

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NFIP Topic	Source of Information	Comments
any roles other than Community Floodplain Administrator (FPA)?		auxiliary functions performed by the Town’s Planning and Community Development Director and Conservation Planner.
Is the Community FPA or NFIP Coordinator a Certified Floodplain Manager?	Conservation Planner	No
Is floodplain management an auxiliary function?	Conservation Planner	Yes, for the Town’s Planning and Community Development Director and Conservation Planner.
Explain NFIP administration services (e.g., permit review, GIS, inspections, engineering capability).	Conservation Planner	All development within the Town’s Floodplain Protection District, including structural and non-structural activities, are reviewed for compliance with the Town’s Zoning Bylaws and other applicable rules or regulations. 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. The Planning and Community Development Department provides information on flood insurance, floodplains, past flooding events, property protection and other flood safety measures. Braintree also participates in FEMA’s Community Rating System (CRS) and conducts regular outreach on flood risk topics in addition to other CRS credited activities.
What are the barriers to running an effective NFIP program in the community, if any?	Conservation Planner	Additional staff to work on floodplain management would be helpful.
<b>Compliance History</b>		
Is the community in good standing with the NFIP?	Conservation Planner, FEMA	Yes
Are there any outstanding compliance issues (i.e., current violations)?	Conservation Planner	No

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NFIP Topic	Source of Information	Comments
When was the most recent Community Assistance Visit (CAV) or Community Assistance Contact (CAC)?	State NFIP Coordinator, FEMA (CIS)	Last CAC was 8/10/1995 Last CAV was 4/22/2021
Is a CAV or CAC scheduled or needed?	Conservation Planner	No
<b>Regulation</b>		
When did the community enter the NFIP?	State NFIP Coordinator, FEMA (CIS)	6/1/1978 (Regular Entry) 11/10/1972 (Emergency Entry)
Are the FIRMs digital or paper?	Conservation Planner	Digital
Do floodplain development regulations meet or exceed FEMA or State minimum requirements? If so, in what ways?	Conservation Planner	Floodplain regulations are administered through the enforcement of the Town's Zoning Bylaws which exceed current FEMA/NFIP minimum requirements. Examples include the following: (1) No development permitted in the floodway; (2) critical facilities may not be constructed in the special flood hazard area or within the 500-year floodplain; and (3) for new building constructed on fill, the fill must extend five feet beyond building walls before dropping to the base flood elevation. As described earlier in this chapter, higher regulatory standards are also met through the Town's enforcement of the Massachusetts State Building Code (780 CMR). Other floodplain development requirements are included in the Town's administration of the Commonwealth's Wetlands Protection Act Regulations (310 CMR 10).
How does the community enforce local floodplain regulations and monitor compliance. Explain the permitting process.	Conservation Planner	The Planning Board reviews proposed developments for compliance with Section 135-608 of the Braintree Zoning Bylaw (Floodplain Protection District). The Conservation Commission reviews proposed development for

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NFIP Topic	Source of Information	Comments
		compliance with MA Wetlands Protection Act performance standards for Bordering Land Subject to Flooding (310 CMR 10.57) and the Braintree Wetland Bylaw. The Building Inspector reviews proposed or improved structures for compliance with the State Building Code (780 CMR).
<b>Community Rating System (CRS)</b>		
Does the community participate in CRS? If so, what is the community's CRS Class?	Conservation Planner	Yes – Class 7.
What categories and activities provide CRS points and how can the class be improved?	Verisk/ISO	The Town receives credit points across a range of CRS activities including public information, mapping and regulations, flood damage reduction, and warning and response. It received 160 points for the previous Hazard Mitigation Plan (Activity 510: Floodplain Management Planning). Improving beyond Class 7 will require the Town to take on more activities that may go beyond existing staff capabilities and resources to implement, but this will continue to be routinely explored in the future.
Does the plan include CRS planning requirements	Yes	Yes, many of the planning requirements under CRS Activity 510 are included in the plan update.

Table 73 provides some additional information in response to the updated requirements included in FEMA's 2022 Local Mitigation Planning Policy Guide (Element C2-a):<sup>43</sup>

*Table 73. Additional NFIP Participation and Compliance Information.*

Required Information	Response
Adoption of NFIP minimum floodplain management criteria via local regulation.	Adopted under Braintree Zoning Bylaw Section 135-608, as amended by Town Council Order 22 073 on January 3, 2023.

<sup>43</sup> Local Mitigation Planning Policy Guide. FEMA. April 2022. P. 26.

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Required Information	Response
Adoption of the latest effective Flood Insurance Rate Map (FIRM), if applicable.	Adopted under the Town’s Zoning Bylaw at Section 135-608, Part G (Floodplain District), which establishes the general boundaries of the Floodplain District to include all special flood hazard areas within the Town of Braintree as designated on the FEMA Flood Insurance Rate Map (FIRM) dated July 6, 2021.
Implementation and enforcement of local floodplain management regulations to regulate and permit development in SFHAs.	See explanation of the Town’s permitting process provided in Table 72.
Appointment of a designee or agency to implement the addressed commitments and requirements of the NFIP.	Currently the Town’s Planning and Community Development Director and Conservation Planner are tasked with implementing the commitments and requirements of the NFIP. The Town’s Building Division Director also helps to ensure that Braintree remains in compliance with all relevant codes and standards for floodplain management per the State Building Code (780 CMR).
Description of how participants implement the substantial improvement/substantial damage provisions of their floodplain management regulations after an event.	The Town’s Building Division implements the SI/SD provisions of its floodplain management regulations as required per the NFIP (CFR Title 44, Parts 59 through 65) and Massachusetts State Building Code (780 CMR). The Town will also coordinate with State Flood Hazard Management Program staff to assure that proper practices are followed and that a post-disaster plan will be in place to implement all SI/SD provisions.

### Summary and Conclusions

The Town of Braintree is a suburban community with a strong residential character, and with strong capabilities and resources to support the implementation of hazard mitigation actions. This chapter provides documentation on the existing local authorities, policies, programs, and resources to support hazard mitigation.

## Town of Braintree, MA Hazard Mitigation Plan

Some of the strongest hazard mitigation capabilities for the Town of Braintree are found through the adoption and maintenance of local plans, such as its recently updated Master Plan, and the routine administration and enforcement of strong codes and regulations. Braintree was among the first municipalities in the Commonwealth to prepare a Climate Vulnerability Assessment and Action Plan, completed in partnership with the Metropolitan Area Planning Commission (MAPC) back in 2017. It has also been an active participant in FEMA's Community Rating System (CRS) since 1992 and is currently recognized among the highest rated CRS communities (Class 7) in the state for floodplain management activities that go above the minimum federal standards of the National Flood Insurance Program (NFIP). The Town has adopted and routinely updates regulations and procedures that can help reduce natural hazard risks, such as the Town's general and zoning bylaws which continue to be reviewed and improved along with other local rules and regulations, such as those governing floodplain management, stormwater management, wetlands protection, and slope stability. The Town's special permit and site plan review regulations are triggered and enforced under many circumstances and are considered very effective in terms of supporting the Town's goals and purposes as adopted through these local regulations.

The Town employs skilled and committed staff across numerous departments to administer existing local programs, regulations, and other activities, who are supported by an active citizenry and volunteers that serve on numerous local boards and committees. The Town benefits from effective collaboration and interdepartmental coordination across these various entities. Although the Town's administrative and technical capabilities are generally considered strong, existing staff resources do occasionally get stretched thin with department staff often working on multiple projects or other priorities that can take time and/or possible focus away from hazard mitigation and other longer-term resilience initiatives. Staffing for most departments is considered adequate, and while some services are handled on a part-time basis, contracted out, or done in cooperation with the support of the Metropolitan Area Planning Commission (MAPC), these human resources are skilled and very supportive in meeting the Town's day-to-day administrative and technical needs.

The Town's financial capabilities are also strong in terms of its ability to leverage local and external funding sources to support hazard mitigation projects. Examples include the Town's ability to appropriate local funds for investments in stormwater improvements, tree planting (heat mitigation), open space acquisition and conservation, CRS activities, and other emergency preparedness or community resilience building initiatives. Funding can come from a variety of local financing mechanisms including the Town's General Fund, Capital Plan, Stormwater Utility, and Community Preservation Fund. The Town has been successful in leveraging these funds in the past in combination with a variety of external grant programs focused on hazard mitigation, including federal grants from FEMA and NOAA as well as state grants such as EEA's MVP Action Grants and CZM's Coastal Resilience Grants. While Town staff have been successful in seizing these grant opportunities for their respective programs, the recent appointment of a full-time grant writer/administrator to work across departments has enhanced its ability to pursue financing more aggressively for larger capital projects, including those addressing hazard mitigation and long-term climate adaptation.

## Town of Braintree, MA Hazard Mitigation Plan

The Town is also fortunate to have many methods and tools to support public education and outreach initiatives that can support hazard mitigation, such as a regularly maintained website (including a dedicated Flood Hazard Mitigation page), social media, cable access TV and community gathering events, in addition to several organizations that routinely engage with and advocate for underserved or socially vulnerable populations. These resources can be used to help with increasing risk awareness and promoting emergency preparedness and hazard mitigation activities that can be accomplished on community, neighborhood, and site-specific scales.

Although the Town of Braintree has relatively high capabilities and is well-positioned to mitigate the natural hazard risks faced by the community, it can expand and improve on the capabilities described in this chapter. Some general and specific opportunities to address existing gaps or limitations in local capabilities to reduce risk have been identified for each capability type and are further described below. Each of these opportunities were then considered by the HMPC during the plan update process as potential new mitigation actions to be included in the Mitigation Strategy.

### Opportunities to Expand and Improve on Capabilities to Reduce Risk

#### Planning and Regulatory Capabilities

- Integrate hazard mitigation/resilience into future updates of the Town's other key plans (Master Plan, Open Space and Recreation Plan, Community Preservation Plan, etc.) in alignment with this Hazard Mitigation Plan.
- Update the Town's Comprehensive Emergency Management Plan (CEMP) and integrate the risk assessment information from this Hazard Mitigation Plan for CEMP's Threat, Hazard and Vulnerability Summary.
- Conduct bylaw/regulatory reviews and updates for hazard mitigation, climate resilience and adaptation opportunities (incorporating LID, GI, and other nature-based solutions to mitigate the effects of extreme heat, heavy precipitation, and flooding). Leverage existing methods such as Mass Audubon's Bylaw Review Tool.

#### Administrative and Technical Capabilities

- Increase the number of staff available to support CRS and other local floodplain management activities.
- Formally designate/appoint a local Floodplain Administrator (by position).
- Build staff capacity for mitigation activities through increased training and professional development opportunities for FT and PT staff.
- Develop systems or practices that can help the Town to better cope with staff turnover and the resulting loss of institutional knowledge.

## Town of Braintree, MA Hazard Mitigation Plan

- Enhance in-house GIS capabilities to support CRS, hazard mitigation and other resilience planning/project initiatives.
- Develop system/process for maintaining hazard impact/loss data.

### **Financial Capabilities**

- Integrate long-term risk reduction/resilience as a key principle and/or screening and prioritization criterion for the annual Town Budget and Capital Plan process.
- Leverage the Community Preservation Fund to support acquisition and preservation of floodplains and other high-risk areas.
- Expand use of Stormwater Utility funds to support flood mitigation projects and related activities, including as local match for state/federal grants.
- Continue to coordinate with MAPC, neighboring communities, non-profits organizations, and others on regional risk reduction projects.

### **Education and Outreach Capabilities**

- Create an interactive flood zone mapping tool (via MapsOnline), with links directly to/from the Town's Flood Hazard Mitigation site.
- Leverage the Town's website, social media, and community events to promote risk awareness and low-cost/DIY mitigation activities.
- Identify and seek to address any unmet needs related to targeted outreach/education for the community's more vulnerable populations.
- Expand BEMA's and Fire Department's ongoing public outreach programs to address natural hazards and mitigation topics.

### **Possible New Actions Related to NFIP Participation and Compliance**

- Evaluate permit application forms to determine possible modifications focused on flood hazard prevention. Develop a checklist for review of building/development plans and for inspection of development and all activities in floodplains.
- Establish a goal to have each plan reviewer and building inspector attend a related training periodically (for example, ASFPM's Annual National Conference, MassFM or other chapter conferences, webinars, etc.).
- Encourage or require certain local staff positions to obtain and maintain Certified Floodplain Manager (CFM) certification.
- Maintain a map of areas that flood frequently (including repetitive loss areas) and prioritize them for inspection immediately after flood events. If outside FEMA special flood hazard areas, consider requiring existing regulatory standards (compliance with Floodplain Protection District) through extended overlay zoning, etc.

## Town of Braintree, MA Hazard Mitigation Plan

- Review the State's *Local Floodplain Action Guide* (forthcoming in 2024) for possible zoning or administrative improvements.

## Chapter 6. Mitigation Strategy

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

### Mitigation Goals

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

Mitigation goals represent broad statements that are achieved through the implementation of more specific mitigation actions. These actions include both hazard mitigation policies (such as land use regulations) and hazard mitigation projects (such as structure or infrastructure projects). To develop goals for this Town of Braintree, MA Hazard Mitigation Plan the HMPC reviewed the Hazard Mitigation Plan 2019 Update, the Town of Braintree Climate Vulnerability Assessment and Action Plan 2017 (MVP) plan goal statements, and the goals of the State’s Hazard Mitigation and Climate Adaptation Plan (SHMCAP).

**GOALS** are broad, long-term policy and vision statements that explain what is to be achieved by implementing the mitigation strategy.

The HMPC developed the goal statements in Figure 15 to represent their vision and priorities for the Town of Braintree in terms of hazard mitigation. All the hazards identified in this plan, while not named specifically in the goals, are implied and many are named specifically in the mitigation actions. When achieved by way of implementing the mitigation actions identified in this plan, the Town will mitigate risk posed by all identified hazards.

## Save Lives and Property

- Reduce risk to people and property from natural hazards and climate change.

## Infrastructure

- Mitigate risk to critical facilities and infrastructure from natural hazards and climate change.

## Capacity

- Expand the Town's capacity to mitigate risk by adopting a culture of hazard mitigation through regulations, planning, and regional collaboration.

## Natural Resources

- Implement actions that minimize risk from climate change and natural hazards to preserve or restore the functions of natural systems.

## Education

- Educate all stakeholders about the value of hazard mitigation and how to implement it in their work, businesses, and homes.

Figure 15. Goal Statements.

The Hazard Mitigation Plan 2019 Update included 24 mitigation actions. For the purposes of this plan, all the actions were reviewed for their status and relevance. Table 74 shows the previous plan's seventeen actions and the status of each. In addition to their status, if an action was moved forward to this plan the final column indicates the title of the new action.

E2-b. Was the plan revised to reflect changes in priorities and progress in local mitigation efforts?  
(Requirement §201.6(d)(3))

## Town of Braintree, MA Hazard Mitigation Plan

Table 74. Status of Previous Hazard Mitigation Actions.

Action #	Action Title	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
1	Complete upgrade of Great Pond Dam	Completed	An inspection of the dam from August 2020 continues to report the condition of the dam as “fair”. The Town will continue its annual scheduled maintenance and will also update the Emergency Action Plan and create a more formal Operations and Maintenance plan as identified in the inspection report. Lower reservoir dam was replaced. Continues to receive Fair evaluation.	NO - explanation provided at left	
2	West Street / Pond Street Roadway Flooding Elevation Assessment	Completed	The Town continues to monitor this area. Culverts on upper West Street reconstructed.	NO - explanation provided at left	
3	Repetitive Loss Area Property Owner Outreach	Partially Completed / In Progress	The Town continues to send information to residents in repetitive loss areas with targeted suggestions.	YES - updated/revised description provided at right, if applicable	Educate residents in repetitive loss areas with targeted suggestions.
4	Relocate Braintree Highway Department Barn	Partially Completed / In Progress	Relocation of the Highway Barn remains a priority and it has been included by the Department of Public Works in capital requests each year. Funding has not been available for construction; however, the Town is currently performing an updated feasibility study. Feasibility	YES - updated/revised description provided at right, if applicable	Build a new Department of Public Works facility outside the floodplain.

## Town of Braintree, MA Hazard Mitigation Plan

Action #	Action Title	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
			study completed, estimated cost 60-70 million. Cost prohibitive in the near future. Continue to carry forward for future funding opportunities		
5	Enhance Drainage at Union Street and Route 3	Cancelled	The Town has determined that the culvert is owned by MassDOT. We will refer the culvert to the state for additional evaluation for flooding and emergency preparedness. Area has been dredged and DPW monitors area. Floods in heavy storms. Will notify MassDOT as necessary for additional cleanings.	NO - explanation provided at left	
6	Promote Low Impact Development Techniques and Encourage Reduction of Impervious Pavement	Completed	Comprehensive stormwater regulations were adopted in June 2019 and updated in June 2021, with an update scheduled for late 2023. These regulations mandate a consideration of Low Impact Development (LID) in any new projects that meet the applicability thresholds. Updates to the regulations are planned for 2023 to clarify permitting requirements. Public outreach materials to residents on our website and in our publications include information on LID Best Management Practices (BMPs) including rain gardens and rain barrels.	YES - updated/revised description provided at right, if applicable	Do public outreach and education on natural hazard mitigation, climate adaptation, and Low Impact Development (LID).
7	Continue Participation in CRS Program	Partially Completed / In Progress	The Town continues to participate in the Community Rating System program.	YES - updated/revised description	Continue Participation in CRS Program

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Action #	Action Title	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
				provided at right, if applicable	
8	Map Storm Drain System	Completed	Storm drain system mapping is much more robust and continues to improve as new structures and sub-systems are discovered and added to the GIS. Stormwater personnel use GPS driven tablets to input information and modify GIS layers as discrepancies are found in the field. Stormwater personnel also map privately owned and managed stormwater systems for the purpose of compliance inspection. Mapping generally complete. Mapping of private systems is done ad-hoc to add to overall map.	NO - explanation provided at left	
9	Restore Riverfront and Floodplain to Natural Conditions	Partially Completed / In Progress	The Town requires restoration and mitigation during the redevelopment permitting process. This is a capability of the Town's.	NO - explanation provided at left	
10	Continue Public Education on Flood Mitigation	Partially Completed / In Progress	The Town continues outreach efforts, including mailings, flyers and resources which are available on the Town website and local library.	YES - updated/revised description provided at right, if applicable	Educate residents in repetitive loss areas with targeted suggestions. Do public outreach and education on natural hazard mitigation, climate adaptation,

## Town of Braintree, MA Hazard Mitigation Plan

Action #	Action Title	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
					and Low Impact Development (LID).
11	Continue to enforce the Floodplain Zoning District Requirements	Partially Completed / In Progress	The Town updated the Floodplain Zoning Ordinance to adopt pertinent sections of the FEMA model bylaw. Additional revisions were required, and the ordinance is currently being reviewed by FEMA, prior to local adoption.	NO - explanation provided at left	
12	Acquire Vacant Flood Prone Lands	Partially Completed / In Progress	The Town continues to explore opportunities for acquisition of flood-prone land.	YES - updated/revised description provided at right, if applicable	Acquire vacant flood prone lands.
13	Update Rainfall Rates in Stormwater and Wetlands Bylaws	Completed	The change to NOAA Atlas 14 has been in place since 2018 for the Stormwater Regulation and 2019 for the Braintree Wetland Regulations.	NO - explanation provided at left	
14	Acquire Brushfire Truck	Cancelled	Deemed not relevant for this plan.	NO - explanation provided at left	
15	Replace Elementary School Roofs with Wind Resistant Materials	Completed + To Be Continued		YES - updated/revised description provided at right, if applicable	Replace School Roofs with Wind Resistant Materials

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Action #	Action Title	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
16	Develop Opportunities for Additional Surface Water Storage	Cancelled	Not considered feasible.	NO - explanation provided at left	
17	Municipal building assessment	Cancelled	No written building assessment but Department has a general understanding of needs.	NO - explanation provided at left	
18	Identify areas of potential landslide risk	Cancelled	Not considered to be a major concern at this time.	NO - explanation provided at left	
19	Investigate opportunities to increase availability of battery storage.	Cancelled	Deemed not relevant for this plan.	NO - explanation provided at left	Batteries have limited power and duration and are not suitable for emergency power for critical facilities. Fuel/Gas fed generators are the preferred emergency power supply for critical infrastructure.
20	Upgrade Doherty Gym shelter	Cancelled	Daughraty Gym has been determined to be unsuitable for use as a shelter.	NO - explanation provided at left	
21	Purchase sidewalk plows	Completed	Two purchased (2022/2023).	NO - explanation provided at left	

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Action #	Action Title	Current Status	Current Status Description/Explanation	Keep for Updated Plan?	Updated Action Title/Description (if applicable)
22	Do public outreach and education on frozen pipe risk	Partially Completed / In Progress	Will continue as part of a larger outreach effort.	NO - explanation provided at left	Do public outreach and education on natural hazard mitigation, climate adaptation, and Low Impact Development (LID).
23	Upgrade generators	Partially Completed / In Progress	Sewer pump stations have received upgrades, mobile pumps available for sewer pump stations. Town Hall and High School have old generators and need to be upgraded. All other municipal buildings would be candidates for installs or upgrades with the exception of three which have newer systems (Police, South Middle School, East Middle School).	YES - updated/revised description provided at right, if applicable	Town Hall and High School have old generators and need to be upgraded. All other municipal buildings would be candidates for installs or upgrades with the exception of three which have newer systems (Police, South Middle School, East Middle School).
24	Upgrade social media outreach and education	Partially Completed / In Progress	DPW - Stormwater Splash and related outreach	YES - updated/revised description provided at right, if applicable	Upgrade generators

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The Municipal Vulnerability Preparedness (MVP) plan, called the Town of Braintree Climate Vulnerability Assessment and Action Plan was developed in 2017 and includes 61 recommendations. The MVP is part of a Massachusetts state-wide initiative through the Executive Office of Energy and Environmental Affairs (EEA) to provide support to cities and towns to plan for resiliency and implement climate change adaptation actions. The recommendations identified in Braintree’s MVP were reviewed and considered when developing mitigation actions for this plan update.

The following represents a summary of the status from the 2017 MVP. The Town has implemented several action items from the 2017 Climate Vulnerability Assessment and Action Plan Implementation. These actions help increase resilience to natural hazards such as flooding and drought.

- Stetson St. Culvert Replacement Design meets MA Department of Environmental Protection (MADEP) Stream Crossing Standards. This is beneficial for wildlife but also helps to prevent roadway flooding associated with undersized culverts.
- Installed water meters which inform users about usage and employ advanced leak detection to reduce water demand and conserve water.
- Completed the coastal resilience project at Watson Park. This project restores salt marsh, protects the eroding bank, and includes a flood protection berm to help protect the park from flooding.
- Began construction on the Monatiquot River Restoration Project including removal of the high-hazard Armstrong Dam.
- Adopted a Stormwater Bylaw and Regulations.
- Assessed municipal properties for stormwater retrofits.
- Assessed zoning bylaws and planning requirements for the allowability of green infrastructure.
- Sewer Dept. purchased additional back-up pumps to mitigate impact of infiltration into sewer pipes during storm events.

### Comprehensive Range of Mitigation Actions

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

**A MITIGATION ACTION** is a measure, project, plan or activity proposed to reduce current and future vulnerabilities described in the risk assessment.

Identifying a range of mitigation actions was a process that included identifying and analyzing problem statements developed in Chapter 4 (Risk Assessment) for each hazard profiled. The HMPC considered 5 key

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assets when defining problem statements for the Town of Braintree. These are:

1. People (including underserved communities and socially vulnerable populations)
2. Structures (including facilities, lifelines, and critical infrastructure)
3. Systems (including networks and capabilities)
4. Natural, historic, and cultural resources
5. Activities that have value to the community

In addition to problem statements, Chapter 4 (Risk Assessment) considered Changes in Population Patterns and Changes in Land Use and Development for each hazard profiled.

Chapter 5 (Capability Assessment) included potential actions in each of FEMA’s mitigation action categories (plans and regulations, structure and infrastructure, natural resources protection, and education and awareness).

The HMPC considered the problem statements, changes in population and land use, Capability Assessment recommendations and the status of previously identified mitigation actions and MVP recommendations to develop a list of mitigation actions for this plan update. The HMPC sought to solve problems identified with the mitigation actions.

This process is illustrated in the figure below. The first column Hazards, indicates the natural hazards considered in the plan in the order of High, Medium, or Low Risk, as reviewed in the Risk Assessment (Chapter 4). The second column, Problems to Assets, indicates that the hazards caused problems in the categories of people, structures, systems, natural, historic, and cultural resources, and activities that have value to the community. The third column, Mitigation Actions, shows the four categories of mitigation action.



Figure 16. Process of Identifying a Range of Mitigation Actions.

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The HMPC and the public considered four mitigation action categories defined in Figure 17 below when considering solutions to identified problems.

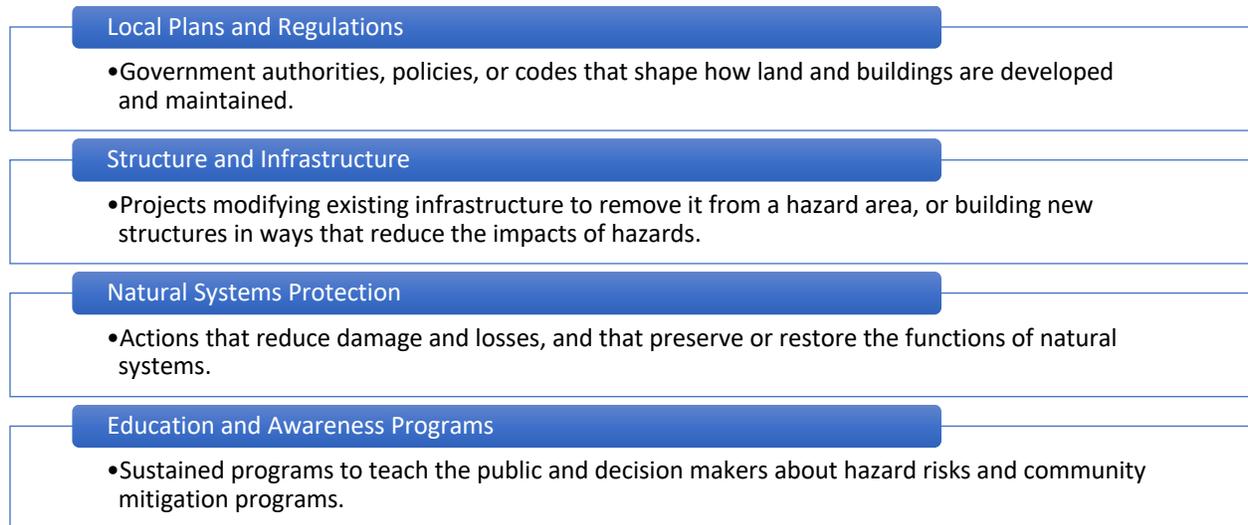


Figure 17. Four Types of Mitigation Actions.

Examples of actions in each of the above categories are shown in the table below.

Table 75. Examples of Mitigation Actions.

Mitigation Action Category	Examples of Mitigation Actions
Local Plans and Regulations	<ul style="list-style-type: none"> <li>• Comprehensive plans</li> <li>• Land use ordinances</li> <li>• Subdivision regulations</li> <li>• Development review</li> <li>• Building codes and enforcement</li> <li>• NFIP Community Rating System</li> <li>• Capital improvement programs</li> <li>• Open space preservation</li> <li>• Stormwater management regulations and master plans</li> </ul>
Structure and Infrastructure Projects	<ul style="list-style-type: none"> <li>• Acquisitions and elevations of structures in flood-prone areas</li> <li>• Utility undergrounding</li> <li>• Structural retrofits</li> <li>• Floodwalls and retaining walls</li> <li>• Detention and retention structures</li> </ul>

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Mitigation Action Category	Examples of Mitigation Actions
	<ul style="list-style-type: none"> <li>• Culverts</li> </ul>
Natural Systems Protection	<ul style="list-style-type: none"> <li>• Sediment and erosion control</li> <li>• Stream corridor restoration</li> <li>• Forest management</li> <li>• Conservation easements</li> <li>• Wetland restoration and preservation</li> </ul>
Education and Awareness Programs	<ul style="list-style-type: none"> <li>• Radio or television spots</li> <li>• Websites with maps and information</li> <li>• Real estate disclosure</li> <li>• Presentations to school groups or neighborhood organizations</li> <li>• Mailings to residents in hazard-prone areas</li> </ul>

In addition to this quantitative approach to identifying mitigation actions, the HMPC took a qualitative approach through the public outreach and engagement process to identify mitigation actions. Mitigation actions supporting underserved communities and environmental justice communities were specifically considered by the HMPC. They also focused on actions to the built environment both buildings and infrastructure as well as future development or redevelopment. The resulting list of mitigation actions includes at a minimum one action for hazard identified. In several instances multiple actions address an identified hazard and problem.

Potential mitigation actions for each identified hazard and problem identified in the Risk Assessment are shown Table 76 below. Hazards are listed in order of risk. Some of these mitigation actions are included in the Action Plan; some were not included because of cost-benefit-analysis outcomes or inconsistency with Town priorities. The HMPC considered the pros and cons of all possible mitigation actions.

*Table 76. Possible Mitigation Actions.*

Hazard	Possible Mitigation Actions
Coastal Flooding	<ul style="list-style-type: none"> <li>• Promote the availability of flood insurance to all property owners and renters.</li> <li>• Restore Riverfront and Floodplain to Natural Conditions.</li> </ul>
Flooding from Precipitation	<ul style="list-style-type: none"> <li>• Conduct a repetitive loss analysis and detailed mitigation plan for properties that repetitively flood.</li> </ul>

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Hazard	Possible Mitigation Actions
	<ul style="list-style-type: none"> <li>Sewer Pump Station Evaluation &amp; Implement Recommendations.</li> </ul>
Severe Winter Storms	<ul style="list-style-type: none"> <li>Upgrade Generators.</li> </ul>
Average and Extreme Temperatures	<ul style="list-style-type: none"> <li>Seek Funding for Urban Tree Inventory.</li> </ul>
Hurricanes and Tropical Storms	<ul style="list-style-type: none"> <li>Replace School Roofs with Wind Resistant Materials.</li> </ul>
Coastal Erosion	<ul style="list-style-type: none"> <li>Consider Long-Term Options for Watson Park Seawall &amp; Smith Beach Seawall</li> <li>Restore Riverfront and Floodplain to Natural Conditions</li> </ul>
Invasive Species	<ul style="list-style-type: none"> <li>Seek Funding for Urban Tree Inventory</li> </ul>
Other Severe Weather Events	<ul style="list-style-type: none"> <li>Create a Hazard Mitigation Planning dashboard.</li> <li>Outreach on Extreme Weather</li> </ul>
Droughts	<ul style="list-style-type: none"> <li>Integrate Resilience Into Other Plans.</li> </ul>
Tornadoes	<ul style="list-style-type: none"> <li>Replace School Roofs with Wind Resistant Materials</li> </ul>
Wildfires/Brushfires	<ul style="list-style-type: none"> <li>Do Public Outreach and Education on Natural Hazard Mitigation, Climate Adaptation, and Low Impact Development (LID).</li> </ul>
Earthquakes	<ul style="list-style-type: none"> <li>Develop an Educational Campaign to Notify Residents of Potential Earthquake Hazards and Mitigation and Safety Measures.</li> </ul>

The HMPC considered each of the hazard risks and problems identified in terms of the following CRS categories:

- a. Preventive Activities
- b. Floodplain Management Regulatory/current & future conditions
- c. Property Protection Activities
- d. Natural Resource Protection Activities
- e. Emergency Services Activities

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- f. Structural Projects
- g. Public Information Activities

The HMPC reviewed a comprehensive range of specific mitigation actions to reduce the effects of hazards as described in the risk assessment, with emphasis on addressing the vulnerability of new and existing buildings and infrastructure. This systematic review also included the consideration of numerous opportunities to expand and improve the Town’s capabilities to reduce risk as identified in the capability assessment. The actions and opportunities explored by the HMPC covered a variety of mitigation measures including preventive activities, property protection, natural resource protection, structural projects, public information activities, and emergency services.

The HMPC considered the protection of existing properties and natural resources a top priority, along with limiting risk to new development and redevelopment. Although much of Braintree has been developed, the community still has a wealth of open space and environmentally sensitive areas that the Town wants to preserve in their natural state, and many of these areas overlap with lands with subject to coastal and inland flooding. Actions to support these goals and priorities as expressed in other community plans, including the Town’s recently updated Master Plan, received considerable support during the review of possible mitigation activities. Examples include acquiring vacant flood prone lands, restoring riverfront and floodplain areas to natural conditions, and integrating Low Impact Development and other nature-based solutions into existing bylaws and regulations. Additional actions to build upon and enhance these efforts were incorporated into the mitigation strategy following committee discussion and the general consideration of the pros and cons of each activity.

The HMPC also reviewed a range of structural projects and public information activities designed to help reduce the vulnerability of existing buildings and populations to potential hazard impacts. These actions included new hazard mapping activities, site-specific building and infrastructure improvements, community education initiatives, and more targeted outreach campaigns to vulnerable populations. Although not the focus of the Town’s mitigation strategy, actions related to improving emergency preparedness and response activities, such as shelter and generator upgrades, were also considered for incorporation into the plan as new actions for the Town to pursue.

*Table 77. Mitigation Actions with Corresponding CRS Categories.*

Action #	Action Title	CRS Category
1	Replace School Roofs with Wind Resistant Materials	Property Protection
2	Integrate Resilience Into Other Plans	Preventive
3	Consider Long-Term Options for Watson Park Seawall & Smith Beach Seawall	Structural Projects
4	Sewer Pump Station Evaluation & Implement Recommendations	Structural Projects
5	Upgrade Generators	Emergency Services
6	Continue Participation in CRS Program	Preventive
7	Outreach on Extreme Weather	Public Information

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Action #	Action Title	CRS Category
8	Review Capacity for Wildfires - Capacity to Mitigate Risk to Areas Prone to Wildfire and Educate Residents About How to Prevent Brushfires on Their Properties	N/A
9	Bylaw and Regulatory Review	Natural Resource Protection
10	Seek Funding for Urban Tree Inventory	Natural Resource Protection
11	Restore Riverfront and Floodplain to Natural Conditions	Natural Resource Protection
12	Educate Residents in Repetitive Loss Areas with Targeted Suggestions	Public Information
13	Culvert Assessment and Reconstruction or Replacement of Inadequate Culverts	Structural Projects
14	Create Interactive Flood Map	Public Information
15	Outreach on Water Restriction	N/A
16	Outreach on Invasive Species	N/A
17	Do Public Outreach and Education on Natural Hazard Mitigation, Climate Adaptation, and Low Impact Development (LID)	Public Information
18	Acquire Vacant Flood Prone Lands	Property Protection / Natural Resource Protection
19	Develop an Educational Campaign to Notify Residents of Potential Earthquake Hazards and Mitigation and Safety Measures	N/A
20	Build a New Department of Public Works Facility Outside the Floodplain	Property Protection
21	Reconstruct the Stetson St. Culvert	Structural Projects

### Mitigation Action Plan

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

The HMPC considered each of the types of mitigation actions for each of the identified problems. Mitigation actions supporting underserved communities and environmental justice communities were specifically considered by the HMPC. They also focused on actions to the built environment both buildings and infrastructure as well as future development or redevelopment. The resulting list of mitigation actions includes at a minimum one action for hazard identified. In several instances multiple actions address an identified hazard and problem.

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The HMPC then had the job to create a cost-effective mitigation action plan that included projects to address the identified hazards, areas of risk and vulnerable assets. An online Mitigation Action Tracker was developed for the Town to track the implementation of each mitigation action. The Mitigation Action Tracker was an online spreadsheet with separate cells showing each action’s essential details. These column labels (essential details) listed below are included to facilitate the Town’s ability to sort through the actions as well as to apply for grant funding.

*Table 78. Essential Details for Mitigation Actions.*

<b>Essential Details</b>	<b>Detail Description</b>
Action Title	Typically, a short description of the mitigation action.
Action Description	A detailed description of the action that includes the purpose or what natural hazard or problem may be mitigated by implementing the mitigation action.
Action Lead	A position in Town government responsible for implementing the action.
Supporting Organizations	A possible list of supporting partners, these may be Town departments, regional organizations, state agencies or adjacent communities.
Potential Funding Source(s)	A list of possible grant sources or the location in the Town’s budget for the funding necessary to implement the mitigation action.
Implementation Schedule	A timeline within 5 years (the life of the plan) that the Town hopes to implement the action.
Estimated Cost	An estimated cost designated as high, medium, or low. The Town considered these cost “buckets” because it is impossible to identify an exact cost for each mitigation action.
Hazard(s) Addressed	All the natural hazards that the action may mitigate are listed.

The priority order was chosen based on weighing costs versus benefits. It was imperative for the Town to determine if the costs associated with an action were reasonable compared to the corresponding benefits. To do this, the HMPC developed a prioritization table that included eight categories of criteria; these are detailed in the table below. Each category was assigned points with priority criteria given the highest points. The most points an action could earn was 22. Actions that scored 17 points or higher were ranked as High priority. Actions that scored between 13-15 points were considered Medium, and actions that scored under 12 points were considered low priority.

## Town of Braintree, MA Hazard Mitigation Plan

Table 79. Priority Ranking System.

	Criteria Category	Description	Detailed Ranking and Associated Points
1	Hazards Addressed	What level of hazards does the measure provide protection against?	High (Flood, Severe Winter Storms, Extreme Temperatures) = 3  Medium (Wildfires/Brush Fires, Hurricanes/Wind, Thunderstorms, Earthquakes, Drought, Infectious Disease, Invasive Species, Hazardous Materials) = 2  Low (Landslide, Tornadoes) = 1
2	Approximate Cost	How much will the measure cost to implement?	Low (Under \$50k) = 3  Medium (\$50k - \$250k) = 2  High over \$250k) = 1
3	Implementation Timeline	How long will it take for the measure to convey its benefits from the start of implementation efforts?	1-2 Years= 3  3-4 Years= 2  5 or More Years= 1
4	Equity Focus	Does the measure provide support to Environmental Justice (EJ) and other Vulnerable Populations?	Direct Support = 3  Indirect Support = 2  No Support = 0
5	Protection of Lives	How effective is the measure in protecting lives and mitigating injuries resulting from the targeted hazard(s)?	Direct Support = 3  Moderate Indirect Support = 2  Minor Indirect Support = 1  None = 0
6	Protection of Critical Facilities or Infrastructure	Does the measure provide protection of critical facilities and infrastructure?	Yes = 3  No = 0
7	Natural Resource Protection	Does the measure provide protection of natural resources?	Yes = 2  No = 0

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	Criteria Category	Description	Detailed Ranking and Associated Points
8	Alignment with Objectives	Does the measure align with the HMP objectives?	Yes =2 No =0

All the actions are listed in Table 80 in order of priority with the actions corresponding details. Additional tables are included in Appendix B. The breakdown of priority ranking points for each action is included in Appendix B. Readers of this Plan must understand that the mitigation action list is aspirational, it does not mean that the HMPC is confident that all actions may be implemented in the span of five years.

Table 80. Braintree Hazard Mitigation Actions.

<b>1</b>	<b>Replace School Roofs with Wind Resistant Materials</b>		
<b>High</b>	<b>Action Description</b>	Replace roofs at the following Monatiquot School, Morrison School, Foster School, Colbert Admin Building, School Maintenance Building at East Middle School	
	<b>Lead Position</b>	Facilities Director	
	<b>Supporting Agencies</b>		
	<b>Cost</b>	Medium	
	<b>Potential Funding Sources</b>	Capital Improvement Funding, FEMA BRIC	
	<b>Hazards</b>	Severe Winter Storms, Hurricanes & Tropical Storms, Tornadoes	
	<b>Implementation Schedule</b>	2027-2028	
<b>2</b>	<b>Integrate Resilience Into Other Plans</b>		
<b>High</b>	<b>Action Description</b>	Incorporate resilience to natural hazards into next Open Space and Recreation Plan Update	
	<b>Lead Position</b>	Conservation Planner	
	<b>Supporting Agencies</b>		
	<b>Cost</b>	Low	
	<b>Potential Funding Sources</b>	Planning & Community Development Budget	
	<b>Hazards</b>	Severe Winter Storms, Average and Extreme Temperatures, Hurricanes & Tropical Storms, Invasive Species, Droughts, Tornadoes	
	<b>Implementation Schedule</b>	2026	

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<b>3</b>	<b>Consider Long-Term Options for Watson Park Seawall &amp; Smith Beach Seawall</b>	
<b>High</b>	<b>Action Description</b>	Consider options for financial feasibility and alignment with long-term goals for the Park. Make recommendation for future action based on review.
	<b>Lead Position</b>	Mayor's Office
	<b>Supporting Agencies</b>	Department of Public Works, Planning & Community Development
	<b>Cost</b>	Medium
	<b>Potential Funding Sources</b>	MA Executive Office of Energy & Environmental Affairs: Dam & Seawall Repair and Removal Grant Program
	<b>Hazards</b>	Coastal Flooding
	<b>Implementation Schedule</b>	2025-2026
<b>4</b>	<b>Sewer Pump Station Evaluation &amp; Implement Recommendations</b>	
<b>Medium</b>	<b>Action Description</b>	Assess sewer pump stations for operation, performance and reliability; make recommendations for improvements.
	<b>Lead Position</b>	Water and Sewer Superintendent
	<b>Supporting Agencies</b>	Department of Public Works
	<b>Cost</b>	Medium
	<b>Potential Funding Sources</b>	Capital/SRF grant (fully funded)
	<b>Hazards</b>	Flooding from Precipitation
	<b>Implementation Schedule</b>	2024
<b>5</b>	<b>Upgrade Generators</b>	
<b>Medium</b>	<b>Action Description</b>	Town Hall and High School have old generators and need to be upgraded. All other municipal buildings would be candidates for installs or upgrades with the exception of three which have newer systems (Police, South Middle School, East Middle School).
	<b>Lead Position</b>	Facilities Director
	<b>Supporting Agencies</b>	
	<b>Cost</b>	Medium
	<b>Potential Funding Sources</b>	Capital Improvement Funding, FEMA BRIC
	<b>Hazards</b>	Flooding from Precipitation, Severe Winter Storms, Average and Extreme Temperatures, Hurricanes and Tropical Storms, Other Severe Weather, Droughts, Tornadoes, Earthquakes
	<b>Implementation Schedule</b>	2025-2028

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6	Continue Participation in CRS Program	
Medium	<b>Action Description</b>	Continue participating in FEMA's CRS program as a Class 7 community while building local capacity to advance to Class 6 in the future (if/when resources allow).
	<b>Lead Position</b>	Conservation Planner
	<b>Supporting Agencies</b>	Planning & Community Development
	<b>Cost</b>	Low
	<b>Potential Funding Sources</b>	Planning & Community Development Budget
	<b>Hazards</b>	Coastal Flooding, Flooding from Precipitation
	<b>Implementation Schedule</b>	2024-2025
7	Outreach on Extreme Weather	
Medium	<b>Action Description</b>	Increase outreach on resources available during emergencies to elders and residents with critical power needs
	<b>Lead Position</b>	Elder Affairs Director
	<b>Supporting Agencies</b>	BELD
	<b>Cost</b>	Low
	<b>Potential Funding Sources</b>	Elder Affairs Budget
	<b>Hazards</b>	Severe Winter Storms, Average and Extreme Temperature, Hurricanes & Tropical Storms, Tornados
	<b>Implementation Schedule</b>	2025-2026
8	Review Capacity for Wildfires - Capacity to Mitigate Risk to Areas Prone to Wildfire and Educate Residents About How to Prevent Brushfires on Their Properties	
Medium	<b>Action Description</b>	Assess existing capabilities to fight wildfires and identify any deficiencies.
	<b>Lead Position</b>	Fire Chief
	<b>Supporting Agencies</b>	
	<b>Cost</b>	Low
	<b>Potential Funding Sources</b>	Fire Dept Budget
	<b>Hazards</b>	Wildfires and Brushfires
	<b>Implementation Schedule</b>	2024-2025

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9	<b>Bylaw and Regulatory Review</b>	
<b>Medium</b>	<b>Action Description</b>	Conduct review of bylaws to incorporate for opportunities to incorporate LID, GI and other Nature Based Solutions to mitigate the effects of natural hazards
	<b>Lead Position</b>	Planning & Community Development Director
	<b>Supporting Agencies</b>	DPW/Stormwater
	<b>Cost</b>	Low
	<b>Potential Funding Sources</b>	Planning & Community Development Budget, MA MVP Action Grant
	<b>Hazards</b>	Flooding from Precipitation, Average and Extreme Temperatures, Severe Winter Storms, Drought
	<b>Implementation Schedule</b>	2024
10	<b>Seek Funding for Urban Tree Inventory</b>	
<b>Medium</b>	<b>Action Description</b>	Seek grant funding for inventory (species, location & condition) of street trees and landscape trees on municipal property
	<b>Lead Position</b>	DPW Director/Tree Warden
	<b>Supporting Agencies</b>	
	<b>Cost</b>	Medium
	<b>Potential Funding Sources</b>	MA Department of Conservation and Recreation: Urban and Community Forestry Grant
	<b>Hazards</b>	Average and Extreme Temperatures, Drought, Invasive Species, Wildfires and Brushfires
	<b>Implementation Schedule</b>	2025-2026
11	<b>Restore Riverfront and Floodplain to Natural Conditions</b>	
<b>Medium</b>	<b>Action Description</b>	The Town requires restoration and mitigation during the redevelopment permitting process.
	<b>Lead Position</b>	Conservation Planner
	<b>Supporting Agencies</b>	
	<b>Cost</b>	Medium
	<b>Potential Funding Sources</b>	MA MVP Action Grant
	<b>Hazards</b>	Coastal Flooding
	<b>Implementation Schedule</b>	2024-2028

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<b>12</b>	<b>Educate Residents in Repetitive Loss Areas with Targeted Suggestions</b>	
<b>Medium</b>	<b>Action Description</b>	The Town continues to send information to residents in repetitive loss areas with targeted suggestions.
	<b>Lead Position</b>	Conservation Planner
	<b>Supporting Agencies</b>	
	<b>Cost</b>	Low
	<b>Potential Funding Sources</b>	FEMA FMA
	<b>Hazards</b>	Coastal Flooding, Flooding from Precipitation
	<b>Implementation Schedule</b>	2024-2028
<b>13</b>	<b>Culvert Assessment and Reconstruction or Replacement of Inadequate Culverts</b>	
<b>Low</b>	<b>Action Description</b>	Assess condition of Town culverts and plan to implement findings.
	<b>Lead Position</b>	Stormwater Manager
	<b>Supporting Agencies</b>	Department of Public Works
	<b>Cost</b>	Medium
	<b>Potential Funding Sources</b>	Capital/SRF grant (fully funded)
	<b>Hazards</b>	Flooding from Precipitation, Severe Winter Storms, Hurricanes and Tropical Storms, Other Severe Weather
	<b>Implementation Schedule</b>	2024-2025
<b>14</b>	<b>Create Interactive Flood Map</b>	
<b>Low</b>	<b>Action Description</b>	Create interactive flood mapping tool and link from Town's Flood Hazard Mitigation page.
	<b>Lead Position</b>	GIS Coordinator
	<b>Supporting Agencies</b>	Planning
	<b>Cost</b>	Low
	<b>Potential Funding Sources</b>	Department of Public Works Budget
	<b>Hazards</b>	Coastal Flooding, Flooding from Precipitation
	<b>Implementation Schedule</b>	2024
<b>15</b>	<b>Outreach on Water Restriction</b>	
<b>Low</b>	<b>Action Description</b>	Increase outreach on water restrictions through social media
	<b>Lead Position</b>	Mayor's Office
	<b>Supporting Agencies</b>	DPW
	<b>Cost</b>	Low
	<b>Potential Funding Sources</b>	Mayor's Office Budget
	<b>Hazards</b>	Droughts
	<b>Implementation Schedule</b>	2024

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<b>16</b>	<b>Outreach on Invasive Species</b>	
<b>Low</b>	<b>Action Description</b>	Increase outreach on invasive species by adding information page to Town website and sharing on social media
	<b>Lead Position</b>	Conservation Planner
	<b>Supporting Agencies</b>	
	<b>Cost</b>	
	<b>Potential Funding Sources</b>	Planning & Community Development Budget
	<b>Hazards</b>	Invasive Species
	<b>Implementation Schedule</b>	2024
<b>17</b>	<b>Do Public Outreach and Education on Natural Hazard Mitigation, Climate Adaptation, and Low Impact Development (LID)</b>	
<b>Low</b>	<b>Action Description</b>	Update website and social media with current mitigation information.
	<b>Lead Position</b>	Conservation Planner
	<b>Supporting Agencies</b>	
	<b>Cost</b>	Low
	<b>Potential Funding Sources</b>	FEMA BRIC
	<b>Hazards</b>	All hazards
	<b>Implementation Schedule</b>	2024-2029
<b>18</b>	<b>Acquire Vacant Flood Prone Lands</b>	
<b>Low</b>	<b>Action Description</b>	The Town will explore opportunities for acquisition of flood-prone land.
	<b>Lead Position</b>	Conservation Planner
	<b>Supporting Agencies</b>	
	<b>Cost</b>	Medium
	<b>Potential Funding Sources</b>	Community Preservation Fund, FEMA FMA
	<b>Hazards</b>	Flooding from Precipitation, Severe Winter Storms, Hurricanes and Tropical Storms, Other Severe Weather
	<b>Implementation Schedule</b>	2024-2028

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<b>19</b>	<b>Develop an Educational Campaign to Notify Residents of Potential Earthquake Hazards and Mitigation and Safety Measures</b>	
<b>Low</b>	<b>Action Description</b>	Provide links on the Town website and brochures in the Building Department regarding best building practices to mitigate earthquake risk.
	<b>Lead Position</b>	Municipal License & Inspections Director & Building Inspector
	<b>Supporting Agencies</b>	MEMA
	<b>Cost</b>	Low
	<b>Potential Funding Sources</b>	FEMA BRIC
	<b>Hazards</b>	Earthquakes
	<b>Implementation Schedule</b>	2024
<b>20</b>	<b>Build a New Department of Public Works Facility Outside the Floodplain</b>	
<b>Low</b>	<b>Action Description</b>	Feasibility study completed, estimated cost 60-70 million dollars. This may be cost prohibitive in the near future however, it is a necessary action and the Town will continue to include it in the mitigation plan and work to secure funding.
	<b>Lead Position</b>	Public Works Director
	<b>Supporting Agencies</b>	
	<b>Cost</b>	High (\$75 million)
	<b>Potential Funding Sources</b>	Capital Improvement Funding, FEMA BRIC
	<b>Hazards</b>	Flooding from Precipitation, Severe Winter Storms, Hurricanes and Tropical Storms, Other Severe Weather
	<b>Implementation Schedule</b>	2028
<b>21</b>	<b>Reconstruct the Stetson St. Culvert</b>	
<b>Low</b>	<b>Action Description</b>	Pursue funding for reconstruction of culvert to prevent failure and achieve stream crossing standards.
	<b>Lead Position</b>	Stormwater Manager
	<b>Supporting Agencies</b>	
	<b>Cost</b>	High ~2 million
	<b>Potential Funding Sources</b>	FEMA BRIC, MA Division of Ecological Restoration: Culvert Replacement Municipal Assistance Grant
	<b>Hazards</b>	Flooding from Precipitation, Severe Winter Storms, Hurricanes and Tropical Storms, Other Severe Weather
	<b>Implementation Schedule</b>	2024-2028

Table 81 shows the mitigation actions that specifically target vulnerable populations and Table 82 shows the mitigation actions that specifically target buildings and infrastructure. Each table lists the actions in order of priority.

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Table 81. Actions that Target Vulnerable Populations.

Action #	Action Title
1	Replace School Roofs with Wind Resistant Materials
7	Outreach on Extreme Weather

Table 82. Actions that Target Buildings and Infrastructure.

Action #	Action Title
1	Replace School Roofs with Wind Resistant Materials
4	Sewer Pump Station Evaluation & Implement Recommendations
5	Upgrade Generators
13	Culvert Assessment and Reconstruction or Replacement of Inadequate Culverts
20	Build a New Department of Public Works Facility Outside the Floodplain
21	Reconstruct the Stetson St. Culvert

### Possible Funding Sources

All the mitigation actions included in this plan have identified one or more potential funding sources. The HMWG focused on projects eligible for MVP Grant funding and FEMA BRIC funding. Below is a list of some of the federal and state funding mechanisms that may assist in implementing mitigation actions.

#### Federal Emergency Management Agency (FEMA) Mitigation Grants

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

- **Building Resilient Infrastructure and Communities (BRIC)**

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

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- **Hazard Mitigation Grant Program (HMGP)**

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

- **Flood Mitigation Assistance (FMA) Program**

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

### **Municipal Vulnerability Preparedness Action Grants<sup>44</sup>**

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

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

- Completed application template
- Project budget and deliverables

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<sup>44</sup> State of Massachusetts. *MVP Action Grant*. <https://www.mass.gov/service-details/mvp-action-grant>.

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

Project types include:

- **Detailed Vulnerability and Risk Assessment** – In-depth vulnerability or risk assessment of a particular sector, location, or other aspect of the municipality.
- **Public Education and Communication** – Projects that increase public understanding of climate change impacts within and beyond the community and foster effective partnerships to develop support.
- **Local Bylaws, Ordinances, Plans, and other Management Measures** – Projects to develop, amend, and implement local ordinances, bylaws, standards, plans, and other management measures to reduce risk and damages from extreme weather, heat, flooding, and other climate change impacts.
- **Redesigns and Retrofits** – Engineering and construction projects to redesign, plan, or retrofit vulnerable community facilities and infrastructure (e.g., wastewater treatment plants, culverts, and critical municipal roadways/evacuation routes) to function over the life of the infrastructure given projected climate change impacts.
- **Energy Resilience Strategies** – Projects that incorporate clean energy generation, such as micro grids, and that are paired with resilience enabling technology to maintain electrical and/or heating and cooling services at critical facilities.
- **Chemical Safety and Climate Vulnerabilities** – Projects that seek to engage the business and manufacturing community through assistance or training on identifying vulnerabilities to chemical releases due to severe weather events, reducing use of toxic or hazardous chemicals, outreach to improve operations and maintenance procedures to prevent chemical releases and accidents, outreach to improve emergency and contingency planning, and/or identifying existing contaminated sites that pose chemical dispersion risks during flood events.
- **Nature-Based Storm-Damage Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques** – Projects that utilize natural resources and pervious surfaces to manage coastal and inland flooding, erosion, and other storm damage, such as stormwater wetlands and bio-retention systems, and other Smart Growth and Low Impact Development techniques.
- **Nature-Based, Infrastructure and Technology Solutions to Reduce Vulnerability to Extreme Heat and Poor Air Quality** – Projects that utilize natural resources, vegetation, and increasing

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pervious surface to reduce ambient temperatures, provide shade, increase evapotranspiration, improve local air quality, and otherwise provide cooling services within the municipality.

- ***Nature-Based Solutions to Reduce Vulnerability to other Climate Change Impacts*** – Nature-based projects that address other impacts of climate change such as extreme weather, damaging wind and power outages, and increased incidence of pests and vector-borne illnesses and other public health issues.
- ***Acquisition of Land to Achieve a Resiliency Objective*** — Land purchases are eligible for grant funding if the parcel has been identified through a climate vulnerability assessment as an appropriate location for a specific eligible adaptation activity to occur, such as accommodating an infrastructure or facility redesign or retrofit project, providing natural flood storage to reduce downstream flooding, or removal of pavement and planting of trees to reduce flooding and heat island effects.
- ***Ecological Restoration and Habitat Management to Increase Resiliency*** — Projects that repair or improve natural systems for community and ecosystem adaptation, such as right-sizing culverts, dam removal, restoration of coastal wetlands, etc.
- ***Subsidized Low Income Housing Resilience Strategies*** — Investments in resiliency measures for affordable housing to protect vulnerable populations that may not have the resources to recover from an extreme climate event.
- ***Mosquito Control Districts*** — Projects to reduce the risk to public health from mosquito-borne illness and to increase mosquito surveillance and control capacity by incentivizing municipalities not in an organized mosquito control project or district to form a new mosquito control district or join an existing mosquito control district. Also funding for municipalities currently in a mosquito control district for new or proactive mosquito control measures.

## Chapter 7. Plan Integration and Maintenance

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

### Continued Public Participation

D1. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))

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

- Advertising on the Town's website and through standard meeting laws.
- Posting news and announcements on the Town's social media pages.
- Conducting outreach to local community organizations and businesses.
- Hosting public presentations and meetings throughout the plan's process to acquire feedback and input from stakeholders.
- Record all meetings to play on the Town's cable channel and add links to the Town's website.
- Post copies of the plan on the Town's website and keep a hard copy in the Mayor's Office, Library, and Senior Center for public review.
- Continue to work with vulnerable populations, local organizations, private industry, regional agencies, and adjacent communities as this plan is implemented.

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## Method and Schedule for Keeping the Plan Current

D2. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))

The HMPC and the Town of Braintree recognize the importance of keeping the mitigation plan up to date. The HMPC will meet twice a year for the purposes of implementing and maintaining the Hazard Mitigation Plan. They will notify the public prior to meetings. This work includes monitoring, evaluating, and updating the plan over a five-year period. Overall, the responsibility for monitoring the Plan rests with the Conservation Planner.

### Process to Track Actions

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

**MONITORING** means tracking the implementation of the plan over time.

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

### Process to Evaluate Effectiveness of the Plan

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

**EVALUATING** means assessing the effectiveness of the plan at achieving its stated purpose and goals.

At the first meeting (July 2024), the HMPC will review the effectiveness of the planning process, public and stakeholder engagement, risk analysis, and the mitigation strategy, including its implementation. It is recommended that the HMPC use the worksheet provided in Appendix C. Beyond considering the planning process, the HMPC will seek to answer the following questions to determine if the plan is effective at mitigating risk to Town residents, the built environment, and the natural environment.

- Can the HMPC identify success stories of losses avoided because of hazard mitigation measures implemented? Can the HMPC identify political, social, and economic successes?
- Have the mitigation actions implemented achieved benefits beyond the cost of mitigation?

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- Have the implemented mitigation actions saved lives or protected property?
- Does the list of mitigation actions coincide with the Town's priorities? Do additional actions need to be added?

### Process to Update the Plan

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

**UPDATING** means reviewing and revising the plan at least once every five years.

They will brief the Town Council as requested and post any significant updates to the Plan to the Town's website. The HMPC recognizes the value in keeping the public and key stakeholders informed about the implementation and status of the mitigation plan.

HMPC members will continue to participate in regional and state-based meetings to stay current with best risk-mitigation practices. Such meetings may include the Massachusetts Emergency Management Agency (MEMA), Metropolitan Area Planning Council (MAPC), Braintree Electric Light Department (BELD), and Massachusetts Department of Conservation and Recreation (DCR). The HMPC will also participate in land use planning and mitigation planning meetings with their neighbors, Quincy, Holbrook, Randolph, and Weymouth.

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

## Town of Braintree, MA Hazard Mitigation Plan

Year 1	Year 2	Year 3	Year 4	Year 5
<ul style="list-style-type: none"> <li>• Seek grant funding for mitigation actions</li> <li>• Gather the HMPC in January and July</li> </ul>	<ul style="list-style-type: none"> <li>• Seek grant funding for mitigation actions</li> <li>• Gather the HMPC in January and July</li> </ul>	<ul style="list-style-type: none"> <li>• Seek FEMA BRIC funding for plan update</li> <li>• Seek grant funding for mitigation actions</li> <li>• Gather the HMPC in January and July</li> </ul>	<ul style="list-style-type: none"> <li>• Begin the plan update process</li> <li>• Seek grant funding for mitigation actions</li> <li>• Gather the HMPC in January and July</li> </ul>	<ul style="list-style-type: none"> <li>• Complete the plan update process - adopt the new plan</li> <li>• Seek grant funding for mitigation actions</li> <li>• Gather the HMPC in January and July</li> </ul>

Figure 20. Plan Update and Implementation Schedule.

The National Dam Safety Program Act has authorized FEMA to provide High Hazard Potential Dams (HHPD) Rehabilitation Grant Program assistance for the rehabilitation of dams that do not meet minimum safety standards and pose substantial risk to life and property.<sup>45</sup> Towns interested in accessing the HHPD grant must have an approved local hazard mitigation plan and meet criteria outlined in Element G: High Hazard Potential Dams. Element G is optional for local governments. While this Plan update did not address Element G requirements, the Town of Braintree will consider adding Element G during the next Plan update. Meeting the requirements of Element G include answering the following questions:

- Did the plan describe the incorporation of existing plans, studies, reports and technical information for HHPDs?
- Did the plan address HHPDs in the risk assessment?
- Did the plan include mitigation goals to reduce long-term vulnerabilities from HHPDs?
- Did the plan include actions that address HHPDs, and prioritize mitigation actions to reduce vulnerabilities from HHPDs?

<sup>45</sup> Local Mitigation Planning Policy Guide, FEMA, Effective April 19, 2023, p.32.

# Town of Braintree, MA Hazard Mitigation Plan

## Responsible Parties for Plan Implementation and Maintenance

Braintree, MA

Kelly Phelan, Conservation Planner

Town of Braintree

Planning and Community Development Department

1 JFK Memorial Drive, Braintree, MA 02184

Phone: 781-794-8233

Email: [kphelan@braintreema.gov](mailto:kphelan@braintreema.gov)

For State resources:

Massachusetts Emergency Management Agency:

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

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

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

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

For Federal resources:

Federal Emergency Management Agency:

Address: 220 Binney Street, Cambridge, MA 02142

Phone: 877-336-2734

Email: [fema-r1-info@fema.dhs.gov](mailto:fema-r1-info@fema.dhs.gov)

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

## System to Integrate this Plan with Existing Planning Mechanisms

D3. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))

For the Town of Braintree to succeed in reducing hazard risks over the long term, the information, ideas, conclusions, and strategic recommendations of this hazard mitigation plan should be integrated throughout government operations. Effective integration means to include mitigation principles, vulnerability information, and mitigation actions into

**INTEGRATE** means to include hazard mitigation principles, vulnerability information and mitigation actions into other existing community planning to leverage activities that have co-benefits, reduce risk and increase resilience.

## Town of Braintree, MA Hazard Mitigation Plan

other existing community planning mechanisms to leverage activities that have co-benefits, reduce risk, and increase resilience. Many other local plans and processes will present opportunities to address hazard mitigation in a way that can support multiple community objectives, so an important part of maintaining and implementing this hazard mitigation plan will be to identify and capitalize on these opportunities to leverage activities that have co-benefits (including but not limited to risk reduction). The Town’s integration of hazard mitigation and climate adaptation content into its draft 2023 Master Plan update, including a specific goal for “Resiliency and Sustainability,” demonstrates this type of integration by stressing the importance of community hazard risk reduction strategies across various elements of this separate planning document.

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

- Climate Vulnerability Assessment and Action Plan (2017)
- Master Plan (2023)
- Climate Action Plan (2022)
- Open Space and Recreation Plan (2018)

**PLANNING MECHANISMS** refers to the governance structures used to manage local land use development and community decision-making, such as budgets, comprehensive plans, capital improvement plans, economic development strategies, climate action plans or other long-range plans.

Additional opportunities to integrate the requirements of this plan into other local planning mechanisms shall continue to be identified through future meetings of the HMPC and through the five-year review process described in this chapter. Other planning mechanisms include local regulations and existing code enforcement procedures (i.e., zoning bylaws, site plan review, etc.), internal municipal policies, special projects or initiatives, and other

routine government or community decision-making activities such as capital improvement planning and the Town’s annual budget process. Emphasis for identifying these integration opportunities will be placed on those governance structures used to manage local land use and community development in both the pre-disaster and post-disaster environment. Also, as it relates to implementing specific mitigation actions identified in this plan, it will be the responsibility of each assigned lead department to determine additional measures that can support action completion or enhancement. This includes integrating mitigation actions from this plan into other local planning documents, processes, or mechanisms as deemed appropriate and most effective.

## Town of Braintree, MA Hazard Mitigation Plan

While it is recognized that there are many possible benefits to integrating components of this plan into other local planning mechanisms, the routine maintenance of this stand-alone plan is considered by the Town to be the most effective and appropriate method to identify, prioritize, and implement local hazard mitigation actions. In moving forward, however, the Town will consider the incorporation of some other plan documents into the hazard mitigation plan, such as any future iterations of the Town's Climate Vulnerability Assessment and Action Plan, Climate Change Plan (as proposed in the draft 2023 Master Plan), or related climate adaptation planning efforts.

# Town of Braintree, MA Hazard Mitigation Plan

## Appendix A. Planning Process Supporting Materials

### Hazard Mitigation Planning Committee Meetings

#### HMPC Meeting Participants

First Name	Last Name	Title	Affiliation	Phone	Email	HMPC #1 10/26/2023	HMPC #2 11/30/2023	HMPC #3 1/25/2024	HMPC #4 3/7/2024
Sharmila	Biswas	Department of Elder Affairs Director	Town of Braintree	781-848-1963	sbiswas@braintreema.gov	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Chrissy	Brady	President of East Braintree Civic Association	Town of Braintree	617-212-1047	cbrady1558@aol.com	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Daniel	Cross	Firefighter (Fire Department)	Town of Braintree	781 843-3601	dcross@braintreema.gov	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mary	Howland	Department of Elder Affairs Outreach Coordinator	Town of Braintree	781-848-1963	mhowland@braintreema.gov	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Ben	Hulke	Asst. Director of Public Works - Operations	Town of Braintree	781-794-8959	bhulke@braintreema.gov	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Erin V.	Joyce	Mayor	Town of Braintree	781-794-8100	mayor@braintreema.gov	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Elizabeth	Maglio	Town Councilor	Town of Braintree	617-842-6492	emaglio@braintreema.gov	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Robert	Millette	Director of Emergency Management	Town of Braintree	781-983-3233	rmillette@braintreema.gov	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Michael	Minihane	Health Code Enforcement Officer	Town of Braintree	781-794-8096	mminihane@braintreema.gov	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Sean	Murphy	Electric Operations Manager	Braintree Electric Light Dept	781-348-1071	smurphy@beld.com	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Kate	Naughton	Director of Community Affairs	Town of Braintree	781-794-8026	knaughton@braintreema.gov	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Kelly	Phelan	Conservation Planner	Town of Braintree	781-794-8233	kphelan@braintreema.gov	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Melissa	Santucci Rozzi	Planning & Community Development	Town of Braintree	781-794-8234	msantucci@braintreema.gov	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
John	Thompson	Asst. Director of Public Works- Engineering	Town of Braintree	781 794-8013	jthompson@braintreema.gov	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Nora	Vernazza	Asst. Superintendent Braintree Schools	Town of Braintree	781-380-0130	nora.vernazza@braintreeschools.org	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Hillary	Waite	Stormwater Manager	Town of Braintree	781-794-8945	hwaite@braintreema.gov	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Steve	Wallace	Police Officer (Police Department)	Town of Braintree	781-389-5465	swallace@braintreema.gov	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Jeff	Zukowski	MEMA Hazard Mitigation Planner	Massachusetts Emergency Management Agency	508-820-1422	jeffrey.zukowski@mass.gov	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

HMPC Meeting Agendas

JAMIE CAPLAN CONSULTING LLC  
Emergency Management Services

## KICK-OFF MEETING

TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE

**DATE:** 9/18/2023  
**TIME:** 12:00-1:00PM  
**ZOOM:** <https://us02web.zoom.us/j/87137518608?pwd=YzBqSy9ZcEJmZkVBVDFFnU2swVk1lQT09>  
Meeting ID: 871 3751 8608  
Passcode: 464480

### AGENDA ITEMS

- I. Project Introduction
- II. Timeline and Tasks
- III. Developing a Hazard Mitigation Planning Committee (HMPC)
- IV. Sharing GIS Data
- V. Updating Mitigation Actions
- VI. Scheduling a HMPC Meeting for October

---

### ACTION ITEMS

- I. Develop the HMPC
- II. Share GIS Data & Relevant Resources
- III. Update Mitigation Action Tracker with Action Status
- IV. Schedule a HMPC Meeting for October

JAMIE CAPLAN CONSULTING LLC  
Emergency Management Services

# HMPC MEETING #1

TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE

**DATE:** 10/26/2023  
**TIME:** 10:00-11:30AM  
**ZOOM:** <https://us02web.zoom.us/j/82536738199?pwd=THlxSm9tSGZlSzMzF0K1NlMktLVGY3dz09>  
Meeting ID: 825 3673 8199  
Passcode: 696614

## AGENDA ITEMS

- I. Introductions
  - i. HMPC Members and Consulting Team
- II. Introduction to Hazard Mitigation Planning
  - i. What's in a Hazard Mitigation Plan?
  - ii. Planning Timeline
  - iii. HMPC Responsibilities
- III. Plan Development
  - i. Plans and Policies
  - ii. Public and Stakeholder Engagement
  - iii. Hazard Identification
  - iv. Critical Facilities
  - v. Capability Assessment
  - vi. Mitigation Strategy

---

## ACTION ITEMS

- I. HMPC Meeting #2 Week of November 27<sup>th</sup>
- II. Capability Assessment Surveys
- III. Mitigation Action Tracker
- IV. Stakeholder Engagement
- V. GIS and Critical Facilities

JAMIE CAPLAN CONSULTING LLC  
Emergency Management Services

## HMPC MEETING #2

TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE

**DATE:** 11/30/2023

**TIME:** 9:00-10:30AM

**ZOOM:** <https://us02web.zoom.us/j/87553930189?pwd=eFQwY2c4UWxta2N>

[WbUFYSFZ0bEpLZz09](https://us02web.zoom.us/j/87553930189?pwd=eFQwY2c4UWxta2N)

Meeting ID: 875 5393 0189

Passcode: 950408

### AGENDA ITEMS

- I. Project Update and Loose Ends
- II. Public Meeting Outreach
  - i. Outreach Efforts
  - ii. Website and Social Media
- III. Capability Assessment Update
  - i. Key Plans Reviewed
  - ii. Survey Status
  - iii. Where are Strengths and Challenges Discussion
- IV. Risk Assessment
  - i. Hazards and Critical Facilities Identified
  - ii. Hazus Impacts
  - iii. Problems Identified Including High Hazard Areas
  - iv. Mitigation Actions Discussion
- V. Mitigation Strategy
  - i. Goal Statements
  - ii. Developing New Mitigation Actions
- VI. Town Priorities and Changes in Development

---

### ACTION ITEMS

- |                       |                                 |
|-----------------------|---------------------------------|
| I. HMPC Meeting #3    | IV. Outreach for Public Meeting |
| II. Tie Up Loose Ends | V. New Mitigation Actions       |
| III. Pictures         |                                 |

## HMPC MEETING #3 AGENDA

### TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE

**DATE:** 1/25/2024  
**TIME:** 9:00-10:30AM  
**ZOOM:** <https://us02web.zoom.us/j/86356723557?pwd=UWpYOTthRXRVqV3MxUk9lN3hSdHB1UT09>  
Meeting ID: 863 5672 3557  
Passcode: 848451

### AGENDA ITEMS

- I. **Project Update and Loose Ends**
- II. **Risk Assessment**
  - i. Risk Ranking
  - ii. Problem Statements
- III. **Capability Assessment Update**
  - i. Opportunities Identified
- IV. **Public Meeting**
  - i. Date and Outreach Efforts
- V. **Mitigation Strategy**
  - i. Essential Details for New Actions
  - ii. Action Prioritization
- VI. **Plan Implementation**

---

### ACTION ITEMS

- I. Public Meeting Date and Outreach
- II. HMPC #4 Date
- III. Pictures
- IV. New Mitigation Actions

## HMPC MEETING #4 AGENDA

### TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE

**DATE:** THURSDAY, 03/07/2024

**TIME:** 9:30-11:00AM

**ZOOM:** <https://us02web.zoom.us/j/89290027193?pwd=azFLYmtOTUpkK3dhcWRFNk9SQ2t6QT09>

MEETING ID: 892 9002 7193

PASSCODE: 615656

### AGENDA ITEMS

- I. **Project Update and Loose Ends**
- II. **Public Engagement**
  - i. Outreach for Public Meeting and Plan Review
- III. **Final Hazard List Ranking**
- IV. **CRS Points**
- V. **Mitigation Actions**
  - i. List Review Including Prioritization
- VI. **Plan Review**
  - i. Essential Details for New Actions
  - ii. Action Prioritization
- VII. **Timeline for Completion**

---

### ACTION ITEMS

- I. Public Meeting Outreach
- II. Plan Review

Public Outreach

JAMIE CAPLAN CONSULTING LLC  
Emergency Management Services

## PUBLIC MEETING

TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE

**DATE:** 12/14/2023  
**TIME:** 6:00-7:00PM  
**ZOOM:** <https://us02web.zoom.us/j/87926771918?pwd=bGpUK2l5bmFaczU0UWp2cVNmYWNoQT09>  
Meeting ID: 879 2677 1918  
Passcode: 393008

### AGENDA ITEMS

- I. Introductions
- II. What is Hazard Mitigation? What is a Hazard Mitigation Plan?
- III. Identify Natural Hazards
- IV. Identify Critical Facilities
- V. Brainstorm Possible Mitigation Actions
- VI. Next Steps

TOWN OF BRAintree, MA



# PUBLIC MEETING

## SHARE YOUR IDEAS FOR REDUCING RISK TO NATURAL HAZARDS AND CLIMATE CHANGE

Do you wonder if Braintree can flood, experience a tornado, or have an earthquake? What can prevent those natural hazards and climate change from wreaking havoc in our community?

Join the meeting to learn about this important project and to share your ideas for making Braintree more resilient to natural hazards and climate change.



Braintree has formed a Hazard Mitigation Planning Committee to identify risks and projects to mitigate those risks. The Town is working with a consultant hired by the Massachusetts Emergency Management Agency to develop a Hazard Mitigation Plan that will be approved by the Federal Emergency Management Agency and adopted by the Town. This plan allows Braintree to apply for pre- and post-disaster mitigation funds.



**12/14/2023**

**6:00 pm – 7:00 pm  
on Zoom**

<https://us02web.zoom.us/j/87926771918?pwd=bGpUK2l5bmFaczU0UWp2cVNmYWVtQT09>  
Meeting ID: 879 2677 1918  
Passcode: 393008

[HTTPS://WWW.BRAINTREEMA.GOV](https://www.braintreema.gov) FOR MEETING DETAILS OR CONTACT KELLY PHELAN, CONSERVATION PLANNER 781-794-8233 OR [kphelan@braintreema.gov](mailto:kphelan@braintreema.gov)

## PUBLIC MEETING #2 AGENDA

### TOWN OF BRAINTREE, MA HAZARD MITIGATION PLAN UPDATE

**DATE: TUESDAY, MARCH 19, 2024**

**TIME: 6:00-7:00PM**

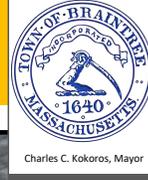
**ZOOM: <https://us02web.zoom.us/j/85418172152>**

Meeting ID: 854 1817 2152

### AGENDA ITEMS

- I. **Project Introduction**
- II. **What is Hazard Mitigation?**
  - i. Benefits of Hazard Mitigation
  - ii. How the Plan was Developed
- III. **Risk Assessment Process**
  - i. Critical Facility Identification
  - ii. Hazard Identification
  - iii. Where are the hazards experienced?
  - iv. What are your biggest concerns?
- IV. **Hazard Mitigation Strategy**
  - i. Types of Mitigation Actions
  - ii. What are your recommendations for hazard mitigation?
  - iii. Review of actions
- V. **Plan Review**
  - i. What to expect and how to review
- VI. **Timeline for Completion**

TOWN OF BRAINTREE, MA



# PUBLIC MEETING

## SHARE YOUR IDEAS FOR REDUCING RISK TO NATURAL HAZARDS AND CLIMATE CHANGE

Do you wonder if Braintree can flood, experience a tornado, or have an earthquake? What can prevent those natural hazards and climate change from wreaking havoc in our community?

Join our **second public meeting** to learn about this important project and to **share your ideas** for making Braintree **more resilient** to natural hazards and climate change.



Braintree has formed a Hazard Mitigation Planning Committee to identify projects to mitigate the risks caused by natural hazards and climate change.

The Town is working with a consultant hired by the Massachusetts Emergency Management Agency to develop a Hazard Mitigation Plan that will be approved by the Federal Emergency Management Agency and adopted by the Town. This plan allows Braintree to apply for pre- and post-disaster mitigation funds.



**03/13/2024**

6:00 pm – 7:00 pm

Join via Zoom!

<https://us02web.zoom.us/j/86157306161?pwd=WkZ4L2o2OFIam8ra1B0OVIncjBaZz09>

[HTTPS://WWW.BRAINTREEMA.GOV](https://www.braintreema.gov) FOR MEETING DETAILS OR CONTACT KELLY PHELAN, CONSERVATION PLANNER 781-794-8233 OR [kphelan@braintreema.gov](mailto:kphelan@braintreema.gov)

FOR IMMEDIATE RELEASE

## **The Town of Braintree Welcomes Community Input on Hazard Mitigation Plan Update**

*Braintree, Massachusetts – March 13, 2024*

Do you wonder if Braintree can flood, experience a tornado, or have an earthquake? What is the worst that can happen in Braintree? What can prevent those natural hazards and others from wreaking havoc?

The Town is extending an invitation to the community to participate in a public meeting as it develops an update to the Hazard Mitigation Plan. This plan details the natural hazard risks that may impact the Town and includes potential actions to mitigate those risks.

### **Meeting Information:**

- Tuesday, March 19, 2024
- 6:00 pm – 7:00 pm
- <https://us02web.zoom.us/j/85418172152>
- Meeting ID: 854 1817 2152

The Town encourages all residents and business owners to attend this public meeting to share ideas and offer feedback on which hazards present the greatest risks, which areas of Town are most susceptible to damage, and what you would like to see done to mitigate these risks.

The Hazard Mitigation Planning Committee, in partnership with Jamie Caplan Consulting LLC, a Northampton, MA-based firm, is developing the plan with a grant from the Massachusetts Emergency Management Agency (MEMA). FEMA approval, coupled with Town adoption, will enable Braintree to access pre- and post-disaster hazard mitigation grant funds.

### **For Further Inquiries:**

- *Kelly Phelan, Conservation Planner*
- *Phone: 781-794-8233*
- *Email: [kphelan@braintreema.gov](mailto:kphelan@braintreema.gov)*

Public participation is essential to a Hazard Mitigation Plan. This Plan needs to represent the interests of community members while working to mitigate risk to natural hazards and the impacts of climate change.

*The Town looks forward to a collaborative effort in building a resilient and secure future!*

# THE TOWN OF BRAINTREE WELCOMES COMMUNITY INPUT ON HAZARD MITIGATION PLAN UPDATE

Join Us in Building a Resilient Future for Braintree, MA!

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## WHAT?

Review and provide feedback on the Hazard Mitigation Plan Update drafted by Braintree's Hazard Mitigation Planning Committee.

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## HOW?

- For Online Access: <https://www.braintreema.gov/> to read the draft plan.
- In-Person Viewing: Hard copies available at the Library, Mayor's Office, & Senior Center.
- Complete the Google Form on the Town's website or at designated locations to provide feedback.

---

## WHEN?

- Commentary Period: **April 22, 2024 – May 6, 2024**

---

## WHY?

- Strengthen our community's resilience to natural hazards and climate change impacts, such as flooding, snowstorms, high winds, and extreme temperatures.

---

## CONTACT FOR INQUIRIES

- Kelly Phelan, Conservation Planner
- Phone: 781-794-8233
- Email: [kphelan@braintreema.gov](mailto:kphelan@braintreema.gov)

TOWN OF BRAINTREE, MA  
HAZARD MITIGATION PLAN UPDATE  
APRIL 2024



Town of Braintree  
1 John F. Kennedy Drive  
Braintree, MA 02184

FOR IMMEDIATE RELEASE

## **The Town of Braintree Invites Community Input on Hazard Mitigation Plan Update**

*Braintree, Massachusetts – April 22, 2024*

The Hazard Mitigation Planning Committee of Braintree has developed a comprehensive Hazard Mitigation Plan that identifies and prioritizes strategies to mitigate the impacts of natural hazards and climate change on our community.

### **Engage with the Draft Plan:**

- Online Access: Visit the Town’s website at <https://www.braintreema.gov/> to review the draft plan.
- In-Person Review: Hard copies are available for review at the Thayer Public Library located at 798 Washington Street, Braintree, MA 02184, the Mayor’s Office, and the Senior Center.

**Commentary Period:** April 22, 2024 – May 6, 2024

### **How to Provide Feedback:**

- Complete the Google Form provided on the Town’s website and available in hard copy at the designated viewing locations.

Braintree’s Hazard Mitigation Planning Committee has developed this plan as a strategy for our Town against existing and future natural hazard threats and the evolving challenges posed by climate change. Implementation of this plan will significantly enhance our resilience to hazards such as flooding, snowstorms, high winds, and extreme temperatures.

Town officials and local stakeholders developed this plan with funding support from the Massachusetts Emergency Management Agency. Federal Emergency Management Agency (FEMA) approval, and Town adoption, of the Hazard Mitigation Plan Update allows the Town to pursue pre- and post-disaster hazard mitigation grant opportunities.

### **For Further Inquiries:**

- **Kelly Phelan, Conservation Planner**
- **Phone:** 781-794-8233
- **Email:** [kphelan@braintreema.gov](mailto:kphelan@braintreema.gov)

Public engagement lies at the core of our Hazard Mitigation Plan. It is imperative that this plan reflects the diverse perspectives and priorities of our community members as we move to mitigate risks posed by natural hazards and climate change.

The Town looks forward to a collaborative effort in building a resilient and secure future!  
###

## Appendix B. Mitigation Actions.

### 2020 Annual Update of Flood Mitigation Activities



Mayor Charles C. Kokoros

#### Department of Planning and Community Development

1 JFK Memorial Dr.  
Braintree, MA 02184  
781 794-8230

#### TOWN OF BRAINTREE EVALUATION OF HAZARD MITIGATION PLAN – FLOOD MITIGATION ACTIVITIES Annual Update 2020

In 2018-2019 the Town of Braintree worked with the Metropolitan Area Planning Commission to update its Hazard Mitigation Plan. The plan, approved by FEMA in June, 2019, includes a comprehensive list of prioritized mitigation actions to address the flood hazard risk. These actions are discussed below along with progress toward their implementation.

#### **Flood Hazard Mitigation Measures from Town of Braintree Hazard Mitigation Plan**

1. Complete Upgrade of Great Pond Dam: The Town made significant improvements to the dam in the past five years. However, there are continuing issues with infiltration. Addressing the remaining work will result in an upgrade of the status of the dam from “fair” to “good”.

2020 Update: The Town is awaiting the results of the next dam inspection report.

2. West Street/Pond Street: The Town enlarged a culvert in 2006 and believes that this has addressed much of the flooding. The Town will continue to monitor flooding and assess options for, and the necessity of, road elevation.

2020 Update: The Town continues to monitor this area.

3. Repetitive Loss Area Property Owner Outreach: As part of the town’s participation in FEMA’s CRS program, Braintree does annual outreach to repetitive loss areas.

2020 Update: The Town continues to send information to residents in repetitive loss areas with targeted suggestions.

4. Relocate Braintree Highway Barn: The highway barn is frequently flooded in large storm events. Relocating the barn is a high priority for the town. In addition to eliminating damage to the barn, relocation would have the benefit of providing additional flood storage as well as environmental, scenic and recreational benefits, including restoration of a vegetated buffer to the Monaquot River.

2020 Update: Relocation of the Highway Barn remains a priority and it has been included by the Department of Public Works in capital requests each year. Funding has not been available, to date.

5. Enhance drainage at Union Street at Route 3: This is a chronic flooding area during heavy rainstorms and Union Street is a critical pathway for emergency evacuation and response. Much of the area is under the control of MassDOT. The town will engage with the state regarding drainage solutions.

2020 Update: The Town intends to evaluate the condition of the culvert under Union St.

6. Promote Low Impact Development Techniques (LID) and Encourage Reduction of Impervious Pavement: The town will continue to promote LID through its various regulatory and stormwater review processes. As much of the flooding in Braintree is the result of the rapid drainage of stormwater from impervious surfaces, to the extent that LID techniques can lead to less impervious area and reduced runoff, these practices can also help to address flooding issues.

2020 Update: Comprehensive stormwater regulations were adopted in June, 2019. These regulations mandate a consideration of LID in any new projects that meet the applicability thresholds. Public outreach materials to residents on our website and in our publications include information on LID BMPs including rain gardens and rain barrels.

7. Continue Participation in CRS Program: Continue active participation in the Community Rating System program including regular public education events related to flood awareness and prevention as well as the availability of flood insurance through NFIP.

2020 Update: The Town continues to participate in the Community Rating System program.

8. Map Storm Drain System: Building on the mapping already completed, the town will add detailed information included inverts, and condition, size, and type of pipes.

2020 Update: Storm drain system mapping is much more robust and continues to improve as new structures and sub-systems are discovered and added to the GIS.

9. Continue Public Education on Flood Mitigation: Continue active public education programs related to flood and hurricane awareness and mitigation measures. In particular, information on strategies property owners can adopt to mitigate the impact of flooding on

their homes or businesses should be provided to those in repetitive loss areas, floodplains, and areas with high water tables.

2020 Update: The Town continues outreach efforts, including mailings, fliers and resources which are available on the Town website and local library.

10. Continue to enforce the Floodplain Zoning District Requirements: Update as part of comprehensive zoning project and continue enforcement of the Floodplain Zoning District (Article VI, Section 135-608) and associated building regulations for floodplain areas.

2020 Update: The Town continues to enforce the requirements of the Floodplain Zoning District.

11. Acquire Vacant Flood Prone Lands: Acquire priority open space parcels in floodplain areas as they become available, in order to maintain flood storage and water infiltration capacity.

2020 Update: The Town continues to explore opportunities for acquisition of flood-prone land.

12. Update Rainfall Rates in Stormwater and Wetlands Bylaws: Update the 10-year, 24-hour stormwater requirements from TP-40, to NOAA 14 or Northeast Regional Climate Center standards.

2020 Update: The stormwater regulations which were adopted in June, 2019 include a requirement for NOAA Atlas 14 rainfall data to be used in stormwater calculations. The local Wetland Bylaw regulations need to be updated to also require NOAA 14 data.

## 2019 Annual Update of Flood Mitigation Activities



Mayor Joseph C. Sullivan

### Department of Planning and Community Development

1 JFK Memorial Dr.  
Braintree, MA 02184  
781 794-8230

### TOWN OF BRAINTREE EVALUATION OF HAZARD MITIGATION PLAN – FLOOD MITIGATION ACTIVITIES Annual Update 2019

In 2011-2012 the Town of Braintree worked with the Metropolitan Area Planning Commission to update its Hazard Mitigation Plan. The plan, approved by FEMA in February 2013, includes a comprehensive list of prioritized mitigation actions to address the flood hazard risk. These actions are discussed below along with progress toward their implementation.

Note: the 2019 Update to the Hazard Mitigation Plan is currently under review by FEMA and MEMA and will be adopted by the Town upon completion of that review, anticipated to be in early June.

#### **Proposed Hazard Mitigation Measures from Town of Braintree Hazard Mitigation Plan**

A) Dickerman Lane and Staten Road Project: This project includes the installation of two new culverts and an upstream runoff impoundment area to address frequent storm driven flooding in this dense residential neighborhood. The existing culverts are undersized for addressing current storm flow and are constricted with interior physical obstructions. The improvements will also include water quality treatment for road runoff. This project is phase three of the Bestick Road Area Flood Control Study identified in the Flood Hazard Mitigation Plan.

**2019 Update- This project was completed in spring of 2015.**

B) Monaquot River Watershed Management Plan: The majority of flooding in Braintree occurs along the Monaquot River and its tributaries. The proposed study would look at the watershed area in order to identify storm water management projects and policies that could serve to reduce flooding. This study could also look at addressing water quality and habitat issues in the river as well. Fairfax County, VA has conducted detailed watershed studies addressing multiple issues that could serve as one model for the Monaquot study, available at <http://www.fairfaxcounty.gov/dpwes/watersheds/>. The City of Quincy recently conducted a flood control study of the Furnace Brook that involved studying the entire stream system and proposing infrastructure improvements to address flooding.

**2019 Update: The Town continues to evaluate opportunities to implement recommendations from the watershed plan developed by the University of Massachusetts students in 2011. The new Stormwater Division is also considering opportunities for implementation.**

C) Great Pond Dam: The Town has engaged an engineering consultant to assist with the development of a strategy to bring this dam back into compliance with State safety regulations. Once that strategy is complete the Town will implement the necessary repairs and modifications.

**2019 Update: Dam repair and rehabilitation was completed in 2017.**

D) West Street / Pond Street Roadway Elevation: This roadway skirts the Great Pond Reservoir, which supplies drinking water to Braintree, Randolph, and Holbrook. When the area is inundated with heavy rains the roadway frequently floods resulting in loss of access and road damage. This regional project would build the roadway higher than the present roadbed and enlarge the culvert under the present road.

**2019 Update: No action at this time.**

E) Water Elevation Control: The Town needs the ability to make adjustments to the outflow from dams in advance of heavy rains in order to reduce or prevent upstream flooding. While the Town has successfully implemented a program to accomplish this objective for publicly owned dams, the privately owned Armstrong Dam must still be addressed. The ability for Town staff to temporarily remove boards would be one solution at this dam (This measure combines the Armstrong dam measure from 2005 and the lowering water levels behind dams measure from 2008).

**2019 Update: The owner of the Armstrong Dam has permanently removed boards since there is no function to the dam any longer. The Town continues to work with the dam owner as well as the Division of Marine Fisheries and the Fore River Watershed Association to fund full removal of the dam.**

F) Regional Vacuum Truck: A vacuum truck allows for clearing debris and blockages from storm drain lines. On an individual basis, the Town would only occasionally make use of this truck, but, if it were purchased jointly with neighboring towns, the cost of the truck would be reduced for each participating town to the point where the cost would be more in line with the potential level of use.

**2019 Update: The Braintree Highway Department acquired their own vacuum truck in 2017.**

G) Repetitive Loss Area Property Owner Outreach: Targeting flood information outreach to repetitive loss area property owners would get valuable information to property owners in the Town who have historically experienced the greatest impact from flood events while also giving the Town an opportunity to learn from people in these areas about the causes and extent of flooding.

**2019 Update: The Town sent a mailing to residents in repetitive loss areas in May of 2019 with targeted suggestions.**

H) Bestick Road Area Flood Control: A hydrologic study of the Bestick Road Area was completed and the result of this study was a three phase mitigation project. The first phase involved the construction of an upstream drainage basin, completed in 2008. The Town will continue to pursue the second and third phases of this project; the second phase, wetlands restoration and water detention area, is in permitting and the third phase is the Dickerman Lane and Staten Road Project identified above.

**2019 Update: The second phase, wetland restoration and detention has been tabled at this time. The Town has observed that phase one (the upstream detention basin) has prevented additional flooding and the Town completed the culvert replacement project (third phase).**

D) Braintree Highway Department Barn: The Highway Department Barn is frequently flooded during large storm events. The best solution for addressing this problem would be to relocate the facility. An alternative site has been identified but there is not currently funding available to complete the restoration. Until that solution is feasible, Town staff should identify other measures that could be taken to reduce the vulnerability of the building and protect the equipment and materials stored there.

**2019 Update: No action has been taken on this but discussion is ongoing regarding funding for construction of a new building in a higher location.**

J) Enhance Drainage at Union Street: Union Street is a critical pathway for emergency evacuation and response during a natural hazard event but is prone to flooding. A combination of physical drainage enhancements and enhanced maintenance are necessary to reduce flooding on this roadway. The engineering division has begun discussion with MA DOT on this project.

**2019 Update: MA DOT dredged a drainage channel near the rotary in late 2015.**

K) Promote Low Impact Development Techniques: Low impact development (LID) practices, including infiltration, dry wells, green roofs, cisterns, and other measures, minimize runoff and mimic the natural hydrology of a site. As much of the flooding in Braintree is the result of the rapid drainage of stormwater from impervious surfaces, to the extent that LID techniques can lead to less impervious area and reduced runoff these practices can also help to address flooding issues.

**2019 Update: The Planning Board and Conservation Commission continue to work with project proponents to implement LID techniques on projects reviewed by these boards.**

L) CRS Program Maintenance: Continue Active Participation in the Community Rating System program including regular public education events related to flood awareness and prevention as well as the availability of flood insurance through NFIP. Flood outreach programs have already been enhanced and the Town will formalize the CRS coordinator position to oversee on-going program maintenance.

**2019 Update: The Town continues to participate in the Community Rating System.**

M) Reduce Impervious Area: As a largely built out area, impervious surfaces contribute to flooding events throughout the river and creek system. Steps taken to reduce the amount of impervious area can help to mitigate the amount of flooding. During the site plan review process, the Town will look for opportunities to reduce impervious area in redevelopment projects.

**2019 Update: The Planning Board and Conservation Commission continue to work with project proponents to reduce impervious surfaces during redevelopment projects.**

N) Map Storm Drain System: An accurate map of the Town's storm drain system can aid the maintenance process and help the Town determine where to apply mitigation measures.

**2019 Update: The Town has successfully mapped 90% of the system. The Town's Stormwater Division is completing the remaining mapping**

O) Restore Riverfronts: As redevelopment occurs, the Town will seek opportunities to restore riverfront and floodplain areas to more natural conditions so as to allow them to better handle flooding and provide a water quality benefit. As funding is available, and pending the recommendations of a larger study of the Monaquot River, restoration efforts will also be undertaken on publicly owned waterfront areas where appropriate.

**2019 Update: The Town continues to work toward riverfront restoration, both with publicly-owned land and privately owned land.**

P) Pump Station Back-up Generators: All but one of the sewage pump stations now has a back-up generator.

**2019 Update: All pump stations now have generators.**

Q) Public Education, Flooding: Continue active public education programs related to flood and hurricane awareness and mitigation measures. In particular, information on strategies property owners can adopt to mitigate the impact of flooding on their homes or businesses should be provided to those in repetitive loss areas, floodplains, and areas with high water tables.

**2019 Update: The Town continues to send a mailing to residents with targeted suggestions and resources.**

#### *Measures to Ensure Compliance with NFIP*

R) Floodplain Management: Continue to enforce the Floodplain Zoning District (Article VI, Section 135-608) and associated building regulations for floodplain areas. Update this district to remain consistent with FEMA guidelines and floodplain mapping.

**2019 Update: No changes have occurred to flood insurance rate maps since last update. Continue to implement floodplain zoning.**

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

**2019 Update: The Town continues to post the Flood Insurance Rate Maps on its website and has hard copies available in the Engineering Department. The maps are also a layer on the Town's GIS.**

T) Acquisition of Vacant Flood Prone Lands: Acquire priority open space parcels in floodplain areas as they become available in order to maintain flood storage and water infiltration capacity. These parcels may also be used for general conservation and recreation purposes.

**2019 Update: The Town continues to explore opportunities for acquisition of flood-prone land. The Town acquired six acres of land on the river in 2018 for open space. This land will remain undeveloped with the exception of a walking trail.**

## Town of Braintree, MA Hazard Mitigation Plan

### Priority Ranking Points

Table 83. Priority Ranking Points for Each Action.

Action #	Action Title	Hazards Addressed	Approximate Cost	Implementation Timeline	Equity Focus	Protection of Lives	Protection of Critical Facilities or Infrastructure	Protection of Natural Resources	Alignment with Objectives	Total
1	Replace School Roofs with Wind Resistant Materials	3	2	2	3	3	3	0	2	18
2	Integrate Resilience Into Other Plans	3	3	3	0	2	3	2	2	18
3	Consider Long-Term Options for Watson Park Seawall & Smith Beach Seawall	3	1	3	2	1	3	2	2	17
4	Sewer Pump Station Evaluation & Implement Recommendations	3	2	1	2	2	3	0	2	15
5	Upgrade Generators	3	2	1	2	2	3	0	2	15
6	Continue Participation in CRS Program	3	3	3	2	2	0	0	2	15
7	Outreach on Extreme Weather	3	3	3	3	1	0	0	2	15
8	Review Capacity for Wildfires - Capacity to Mitigate Risk to Areas Prone to Wildfire and Educate Residents About How to Prevent Brushfires on Their Properties	2	3	3	0	2	0	2	2	14
9	Bylaw and Regulatory Review	3	3	3	0	1	0	2	2	14
10	Seek Funding for Urban Tree Inventory	3	2	3	0	1	0	2	2	13
11	Restore Riverfront and Floodplain to Natural Conditions	3	2	1	0	0	3	2	2	13
12	Educate Residents in Repetitive Loss Areas with Targeted Suggestions	3	3	1	2	2	0	0	2	13
13	Culvert Assessment and Reconstruction or Replacement of Inadequate Culverts	3	2	1	0	1	3	0	2	12

## Town of Braintree, MA Hazard Mitigation Plan

Action #	Action Title	Hazards Addressed	Approximate Cost	Implementation Timeline	Equity Focus	Protection of Lives	Protection of Critical Facilities or Infrastructure	Protection of Natural Resources	Alignment with Objectives	Total
14	Create Interactive Flood Map	3	3	3	0	1	0	0	2	12
15	Outreach on Water Restriction	2	3	3	0	0	0	2	2	12
16	Outreach on Invasive Species	2	3	3	0	0	0	2	2	12
17	Do Public Outreach and Education on Natural Hazard Mitigation, Climate Adaptation, and Low Impact Development (LID)	3	2	1	2	1	0	0	2	11
18	Acquire Vacant Flood Prone Lands	3	2	1	0	1	0	2	2	11
19	Develop an Educational Campaign to Notify Residents of Potential Earthquake Hazards and Mitigation and Safety Measures	1	3	3	0	2	0	0	2	11
20	Build a New Department of Public Works Facility Outside the Floodplain	3	0	1	0	1	3	0	2	10
21	Reconstruct the Stetson St. Culvert	3	0	1	0	1	3	0	2	10

# Town of Braintree, MA Hazard Mitigation Plan

## Types of Mitigation Actions

Table 84. Mitigation Actions Sorted by Type.

Mitigation Category	Action #	Action Title
<b>Local Plans &amp; Regulations</b>	2	Integrate Resilience Into Other Plans
	3	Consider Long-Term Options for Watson Park Seawall & Smith Beach Seawall
	6	Continue Participation in CRS Program
	9	Bylaw and Regulatory Review
	14	Create Interactive Flood Map
<b>Structure &amp; Infrastructure Projects</b>	1	Replace School Roofs with Wind Resistant Materials
	4	Sewer Pump Station Evaluation & Implement Recommendations
	5	Upgrade Generators
	13	Culvert Assessment and Reconstruction or Replacement of Inadequate Culverts
	20	Build a New Department of Public Works Facility Outside the Floodplain
	21	Reconstruct the Stetson St. Culvert
<b>Natural Systems Protection</b>	8	Review Capacity for Wildfires - Capacity to Mitigate Risk to Areas Prone to Wildfire and Educate Residents About How to Prevent Brushfires on Their Properties
	10	Seek Funding for Urban Tree Inventory
	11	Restore Riverfront and Floodplain to Natural Conditions
	16	Outreach on Invasive Species
	18	Acquire Vacant Flood Prone Lands
<b>Education &amp; Awareness Programs</b>	7	Outreach on Extreme Weather
	12	Educate Residents in Repetitive Loss Areas with Targeted Suggestions

## Town of Braintree, MA Hazard Mitigation Plan

Mitigation Category	Action #	Action Title
	15	Outreach on Water Restriction
	17	Develop an Educational Campaign to Notify Residents of Potential Earthquake Hazards and Mitigation and Safety Measures
	19	Do Public Outreach and Education on Natural Hazard Mitigation, Climate Adaptation, and Low Impact Development (LID)

# Town of Braintree, MA Hazard Mitigation Plan

## Actions Sorted by Goal Statement

Table 85. Mitigation Actions Sorted by Goal Statement and Priority.

Goal	Action #	Action Title
<b>Capacity</b>	2	Integrate Resilience Into Other Plans
	9	Bylaw and Regulatory Review
<b>Education</b>	7	Outreach on Extreme Weather
	12	Educate Residents in Repetitive Loss Areas with Targeted Suggestions
	14	Create Interactive Flood Map
	15	Outreach on Water Restriction
	17	Develop an Educational Campaign to Notify Residents of Potential Earthquake Hazards and Mitigation and Safety Measures
	19	Do Public Outreach and Education on Natural Hazard Mitigation, Climate Adaptation, and Low Impact Development (LID)
<b>Infrastructure</b>	3	Consider Long-Term Options for Watson Park Seawall & Smith Beach Seawall
	4	Sewer Pump Station Evaluation & Implement Recommendations
	5	Upgrade Generators
	13	Culvert Assessment and Reconstruction or Replacement of Inadequate Culverts
	20	Build a New Department of Public Works Facility Outside the Floodplain
	21	Reconstruct the Stetson St. Culvert
<b>Natural Resources</b>	8	Review Capacity for Wildfires - Capacity to Mitigate Risk to Areas Prone to Wildfire and Educate Residents About How to Prevent Brushfires on Their Properties
	10	Seek Funding for Urban Tree Inventory
	11	Restore Riverfront and Floodplain to Natural Conditions
	16	Outreach on Invasive Species
	18	Acquire Vacant Flood Prone Lands
<b>Save Lives and Property</b>	1	Replace School Roofs with Wind Resistant Materials
	6	Continue Participation in CRS Program

## Town of Braintree, MA Hazard Mitigation Plan

### Actions Sorted by Hazard

Table 86. Mitigation Actions Sorted by Hazard.

Specific Hazards Addressed	Action #	Action Title
All hazards	17	Do Public Outreach and Education on Natural Hazard Mitigation, Climate Adaptation, and Low Impact Development (LID)
Average and Extreme Temperatures, Drought, Invasive Species, Wildfires and Brushfires	10	Seek Funding for Urban Tree Inventory
Coastal Flooding	3	Consider Long-Term Options for Watson Park Seawall & Smith Beach Seawall
	11	Restore Riverfront and Floodplain to Natural Conditions
Coastal Flooding, Flooding from Precipitation	6	Continue Participation in CRS Program
	12	Educate Residents in Repetitive Loss Areas with Targeted Suggestions
	14	Create Interactive Flood Map
Droughts	15	Outreach on Water Restriction
Earthquakes	19	Develop an Educational Campaign to Notify Residents of Potential Earthquake Hazards and Mitigation and Safety Measures
Flooding from Precipitation	4	Sewer Pump Station Evaluation & Implement Recommendations
Flooding from Precipitation, Average and Extreme Temperatures, Severe Winter Storms, Drought	9	Bylaw and Regulatory Review
Flooding from Precipitation, Severe Winter Storms, Average and Extreme Temperatures, Hurricanes and Tropical Storms, Other Severe Weather, Droughts, Tornadoes, Earthquakes	5	Upgrade Generators
Flooding from Precipitation, Severe Winter Storms, Hurricanes and Tropical Storms, Other Severe Weather	13	Culvert Assessment and Reconstruction or Replacement of Inadequate Culverts
	18	Acquire Vacant Flood Prone Lands

## Town of Braintree, MA Hazard Mitigation Plan

Specific Hazards Addressed	Action #	Action Title
	20	Build a New Department of Public Works Facility Outside the Floodplain
	21	Reconstruct the Stetson St. Culvert
Invasive Species	16	Outreach on Invasive Species
Severe Winter Storms, Average and Extreme Temperature, Hurricanes & Tropical Storms, Tornados	7	Outreach on Extreme Weather
Severe Winter Storms, Average and Extreme Temperatures, Hurricanes & Tropical Storms, Invasive Species, Droughts, Tornadoes	2	Integrate Resilience Into Other Plans
Severe Winter Storms, Hurricanes & Tropical Storms, Tornadoes	1	Replace School Roofs with Wind Resistant Materials
Wildfires and Brushfires	8	Review Capacity for Wildfires - Capacity to Mitigate Risk to Areas Prone to Wildfire and Educate Residents About How to Prevent Brushfires on Their Properties

## Town of Braintree, MA Hazard Mitigation Plan

### Actions Sorted by Lead Position

Table 87. Mitigation Actions Sorted by Action Lead.

Action Lead	Action #	Action Title
Facilities Director	1	Replace School Roofs with Wind Resistant Materials
	5	Upgrade Generators
Conservation Planner	2	Integrate Resilience Into Other Plans
	6	Continue Participation in CRS Program
	11	Restore Riverfront and Floodplain to Natural Conditions
	12	Educate Residents in Repetitive Loss Areas with Targeted Suggestions
	16	Outreach on Invasive Species
	18	Acquire Vacant Flood Prone Lands
Water and Sewer Superintendent	4	Sewer Pump Station Evaluation & Implement Recommendations
Elder Affairs Director	7	Outreach on Extreme Weather
Mayor's Office	3	Consider Long-Term Options for Watson Park Seawall & Smith Beach Seawall
	15	Outreach on Water Restriction
Fire Chief	8	Review Capacity for Wildfires - Capacity to Mitigate Risk to Areas Prone to Wildfire and Educate Residents About How to Prevent Brushfires on Their Properties
Planning & Community Development Director	9	Bylaw and Regulatory Review
DPW Director/Tree Warden	10	Seek Funding for Urban Tree Inventory
GIS Coordinator	14	Create Interactive Flood Map
Stormwater Manager	13	Culvert Assessment and Reconstruction or Replacement of Inadequate Culverts
	21	Reconstruct the Stetson St. Culvert
Municipal License & Inspections Director & Building Inspector	19	Develop an Educational Campaign to Notify Residents of Potential Earthquake Hazards and Mitigation and Safety Measures
Conservation Planner	17	Do Public Outreach and Education on Natural Hazard Mitigation, Climate Adaptation, and Low Impact Development (LID)

# Town of Braintree, MA Hazard Mitigation Plan

Public Works Director	20	Build a New Department of Public Works Facility Outside the Floodplain
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# Town of Braintree, MA Hazard Mitigation Plan

## Actions Sorted by Implementation Schedule

Table 88. Mitigation Actions Sorted by Implementation Schedule.

Implementation Schedule	Action #	Action Title
2024	4	Sewer Pump Station Evaluation & Implement Recommendations
	9	Bylaw and Regulatory Review
	14	Create Interactive Flood Map
	15	Outreach on Water Restriction
	16	Outreach on Invasive Species
	19	Develop an Educational Campaign to Notify Residents of Potential Earthquake Hazards and Mitigation and Safety Measures
2026	2	Integrate Resilience Into Other Plans
2028	20	Build a New Department of Public Works Facility Outside the Floodplain
2024-2025	6	Continue Participation in CRS Program
	8	Review Capacity for Wildfires - Capacity to Mitigate Risk to Areas Prone to Wildfire and Educate Residents About How to Prevent Brushfires on Their Properties
	13	Culvert Assessment and Reconstruction or Replacement of Inadequate Culverts
2024-2028	11	Restore Riverfront and Floodplain to Natural Conditions
	12	Educate Residents in Repetitive Loss Areas with Targeted Suggestions
	18	Acquire Vacant Flood Prone Lands
	21	Reconstruct the Stetson St. Culvert
2024-2029	17	Do Public Outreach and Education on Natural Hazard Mitigation, Climate Adaptation, and Low Impact Development (LID)
2025-2026	3	Consider Long-Term Options for Watson Park Seawall & Smith Beach Seawall
	7	Outreach on Extreme Weather
	10	Seek Funding for Urban Tree Inventory
2025-2028	5	Upgrade Generators
2027-2028	1	Replace School Roofs with Wind Resistant Materials

## Appendix C. Plan Implementation and Review Supporting Materials.

### Plan Update Evaluation Worksheet

Table 89. Plan Update Evaluation Worksheet.

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

# Town of Braintree, MA Hazard Mitigation Plan

## Mitigation Action Progress Worksheet

Table 90. Mitigation Action Progress Worksheet.

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

## Appendix D. CRS 511.a Checklist

Table 91. CRS 511.a Checklist.

CRS Step	Page #
<b>1. Organize to prepare the Plan. (max:15)</b>	
a. Involvement of Office Responsible for Community Planning (4)	
b. Planning committee of department staff (9)	
c. Process formally created by the community’s governing board (2)	
<b>2. Involve the public. (max: 120)</b>	
a. Planning process conducted through a planning committee (60)	
b. Public meetings held at the beginning of the planning process (15)	
c. Public meeting held on draft Plan (15)	
d. Other public information activities to encourage input (Up to 30)	
<b>3. Coordinate with other agencies. (max: 35)</b>	
a. Review of existing studies and plans [REQUIRED] (5)	
b. Coordinating with communities and other agencies (Up to 30)	
<b>4. Assess the hazard. (max: 35)</b>	
a. Plan includes an assessment of the flood hazard [REQUIRED] with:	
(1) A map of known flood hazards (5)	
(2) A description of known flood hazard (5)	
(3) A discussion of past floods (5)	
b. Plan includes assessment of less frequent floods (10)	
c. Plan includes assessment of areas likely to flood (5)	

## Town of Braintree, MA Hazard Mitigation Plan

CRS Step	Page #
d. The Plan describes other natural hazards [REQUIRED FOR DMA] (5)	
<b>5. Assess the problem. (max: 52)</b>	
a. Summary of each hazard identified in the hazard assessment and	
their community impact [REQUIRED] (2)	
b. Description of the impact of the hazards on: (max: 25)	
(1) Life, safety, health, procedures for warning and evacuation (5)	
(2) Public health including health hazards to floodwaters/mold (5)	
(3) Critical facilities and infrastructure (5)	
(4) The community's economy and tax base (5)	
(5) Number and type of affected buildings (5)	
c. Review of all damaged buildings/flood insurance claims (5)	
d. Areas the provide natural floodplain functions (5)	
e. Development/redevelopment/Population Trends (7)	
f. Impact of future flooding conditions outline in Step 4, item c (5)	
<b>6. Set goals. [REQUIRED] (2)</b>	
<b>7. Review possible activities. (max: 35)</b>	
a. Preventive activities (5)	
b. Floodplain Management Regulatory/current & future conditions (5)	
c. Property protection activities (5)	
d. Natural resource protection activities (5)	
e. Emergency services activities (5)	
f. Structural projects (5)	

## Town of Braintree, MA Hazard Mitigation Plan

CRS Step	Page #
g. Public information activities (5)	
<b>8. Draft an action plan. (max: 60)</b>	
a. Actions must be prioritized [REQUIRED]	
(1) Recommendations for activities from two of the six categories (10)	
(2) Recommendations for activities from three of the six categories (20)	
(3) Recommendations for activities from four of the six categories (30)	
(4) Recommendations for activities from five of the six categories (45)	
b. Post-disaster mitigation policies and procedures (10)	
c. Action items for mitigation of other hazards (5)	
<b>9. Adopt the plan. (2)</b>	
<b>10. Implement, evaluate and revise. (max: 26)</b>	
a. Procedures to monitor and recommend revisions [REQUIRED] (2)	
b. Same planning committee or successor committee that qualifies	
under Section 511.a.2 (a) does the evaluation (24)	

**Appendix E. Hazus Reports**



# Hazus: Flood Global Risk Report

**Region Name:** Braintree\_Flood

**Flood Scenario:** 100year

**Print Date:** Tuesday, November 28, 2023

**Disclaimer:**

Totals only reflect data for those census tracts/blocks included in the user's study region.

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



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## General Description of the Region

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

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

- Massachusetts

Note:

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

The geographical size of the region is approximately 6 square miles and contains 432 census blocks. The region contains over 15 thousand households and has a total population of 39,143 people. The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 13,270 buildings in the region with a total building replacement value (excluding contents) of 8,497 million dollars. Approximately 86.66% of the buildings (and 60.43% of the building value) are associated with residential housing.



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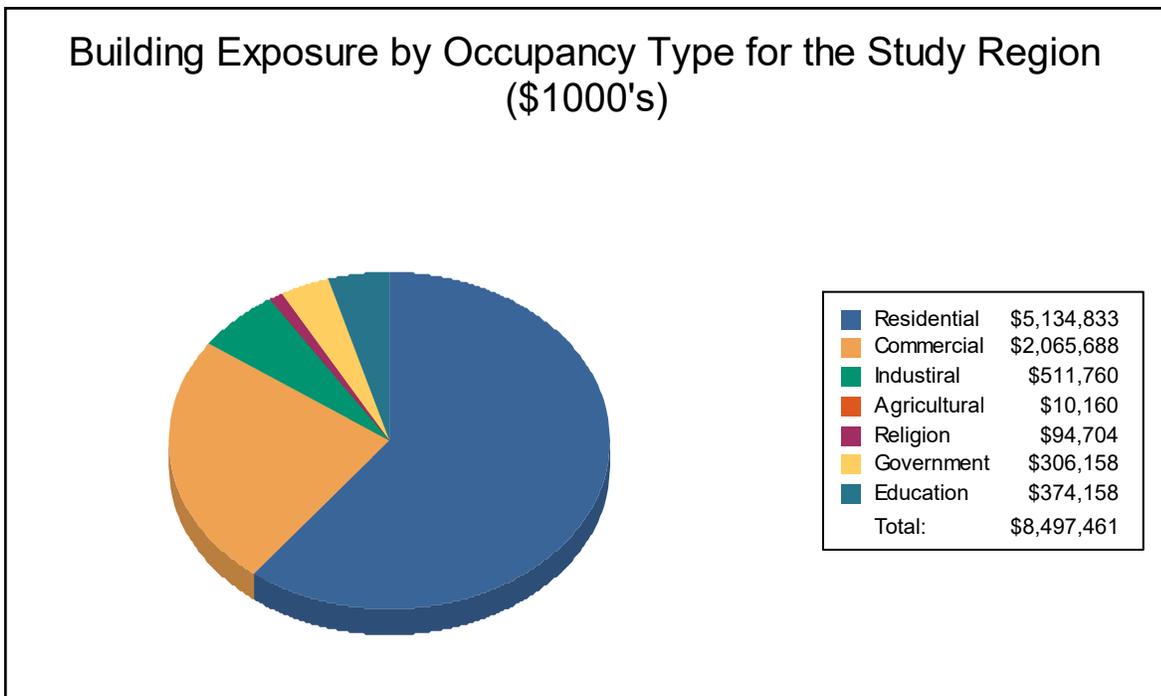
## Building Inventory

### General Building Stock

Hazus estimates that there are 13,270 buildings in the region which have an aggregate total replacement value of 8,497 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

**Table 1**  
**Building Exposure by Occupancy Type for the Study Region**

Occupancy	Exposure (\$1000)	Percent of Total
Residential	5,134,833	60.4%
Commercial	2,065,688	24.3%
Industrial	511,760	6.0%
Agricultural	10,160	0.1%
Religion	94,704	1.1%
Government	306,158	3.6%
Education	374,158	4.4%
<b>Total</b>	<b>8,497,461</b>	<b>100%</b>



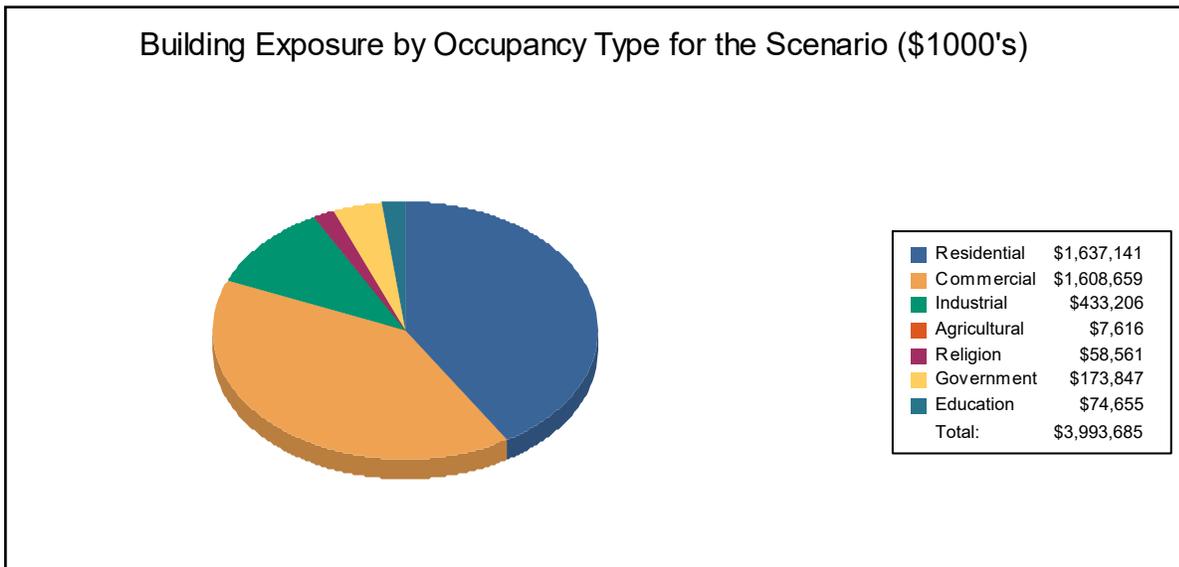
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**Table 2**  
**Building Exposure by Occupancy Type for the Scenario**

<b>Occupancy</b>	<b>Exposure (\$1000)</b>	<b>Percent of Total</b>
Residential	1,637,141	41.0%
Commercial	1,608,659	40.3%
Industrial	433,206	10.8%
Agricultural	7,616	0.2%
Religion	58,561	1.5%
Government	173,847	4.4%
Education	74,655	1.9%
<b>Total</b>	<b>3,993,685</b>	<b>100%</b>



**Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 166 beds. There are 18 schools, 3 fire stations, 1 police station and 2 emergency operation centers.



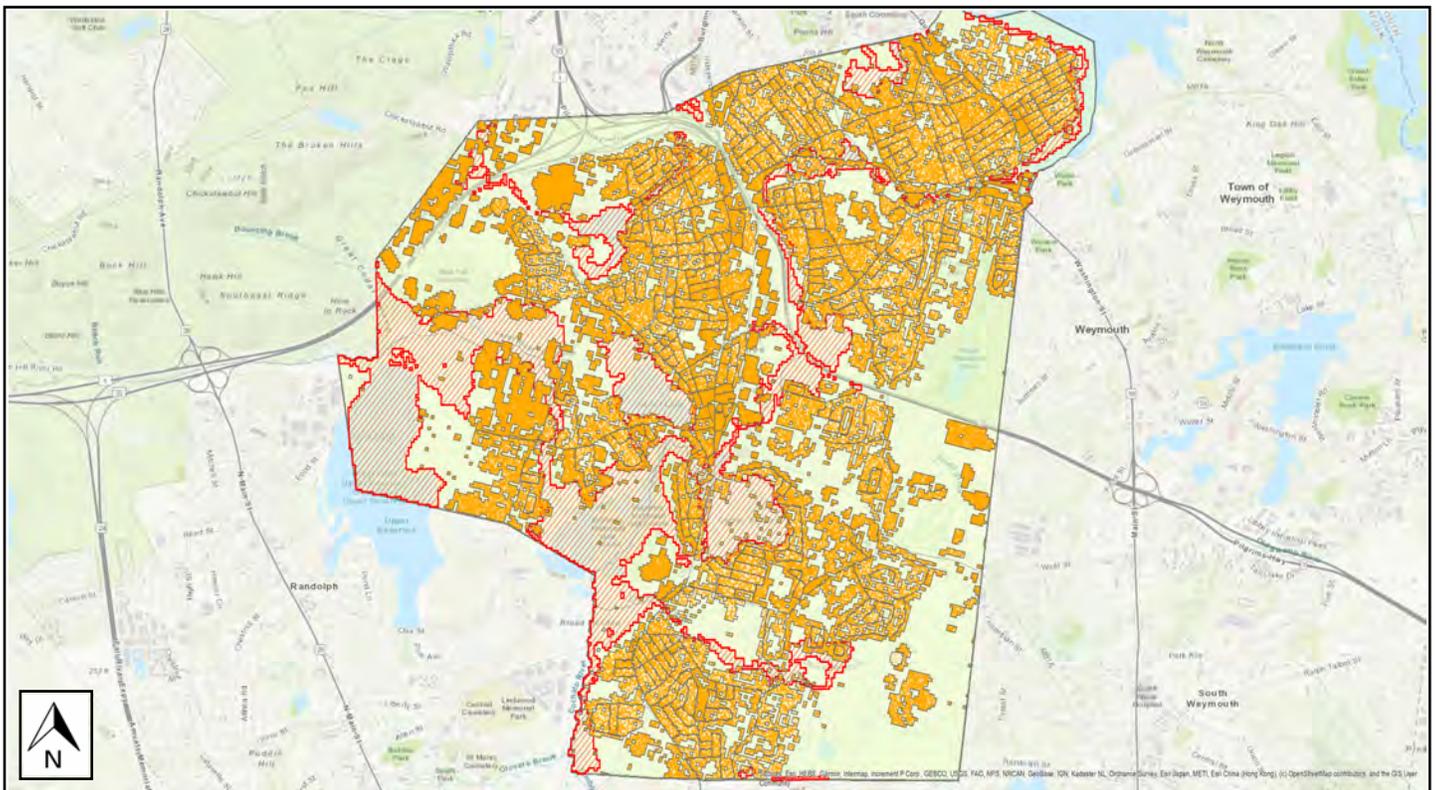
## Flood Scenario Parameters

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

<b>Study Region Name:</b>	Braintree_Flood
<b>Scenario Name:</b>	100year
<b>Return Period Analyzed:</b>	100
<b>Analysis Options Analyzed:</b>	No What-Ifs

### Study Region Overview Map

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





## Building Damage

### General Building Stock Damage

Hazus estimates that about 11 buildings will be at least moderately damaged. This is over 63% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

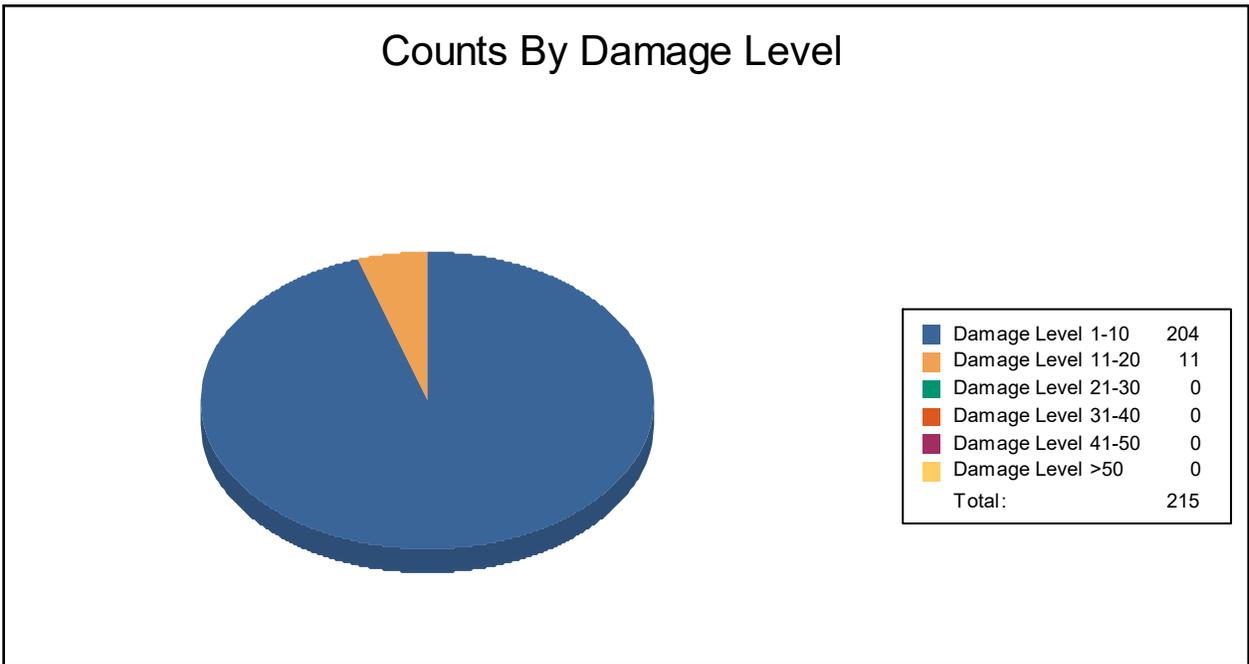
**Total Economic Loss (1 dot = \$300K) Overview Map**





**Table 3: Expected Building Damage by Occupancy**

Occupancy	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	23	100	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	3	100	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	178	94	11	6	0	0	0	0	0	0	0	0
<b>Total</b>	<b>204</b>		<b>11</b>		<b>0</b>		<b>0</b>		<b>0</b>		<b>0</b>	



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**Table 4: Expected Building Damage by Building Type**

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)										
Concrete	2	100	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	11	100	0	0	0	0	0	0	0	0	0	0
Steel	10	100	0	0	0	0	0	0	0	0	0	0
Wood	180	94	11	6	0	0	0	0	0	0	0	0



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## Essential Facility Damage

Before the flood analyzed in this scenario, the region had 166 hospital beds available for use. On the day of the scenario flood event, the model estimates that 166 hospital beds are available in the region.

**Table 5: Expected Damage to Essential Facilities**

Classification	# Facilities			
	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	3	0	0	0
Hospitals	1	0	0	0
Police Stations	1	0	0	0
Schools	18	0	0	0

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

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.



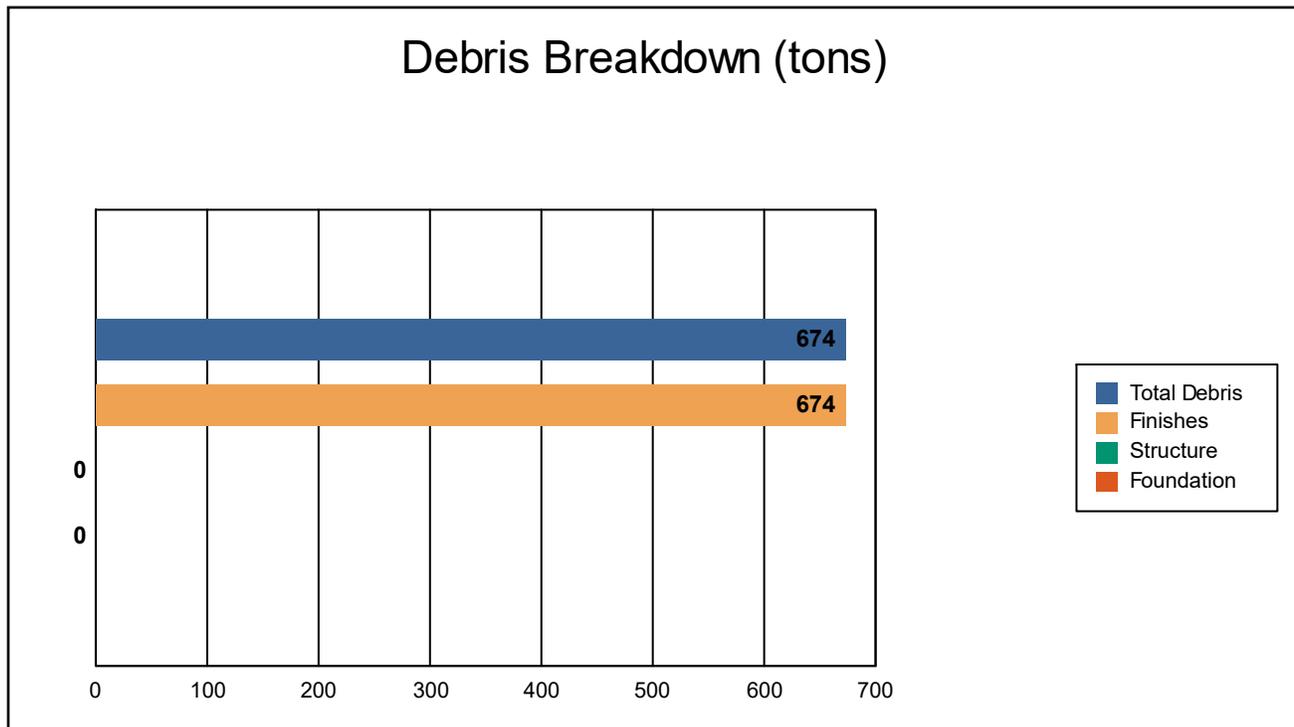
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## Induced Flood Damage

### Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.



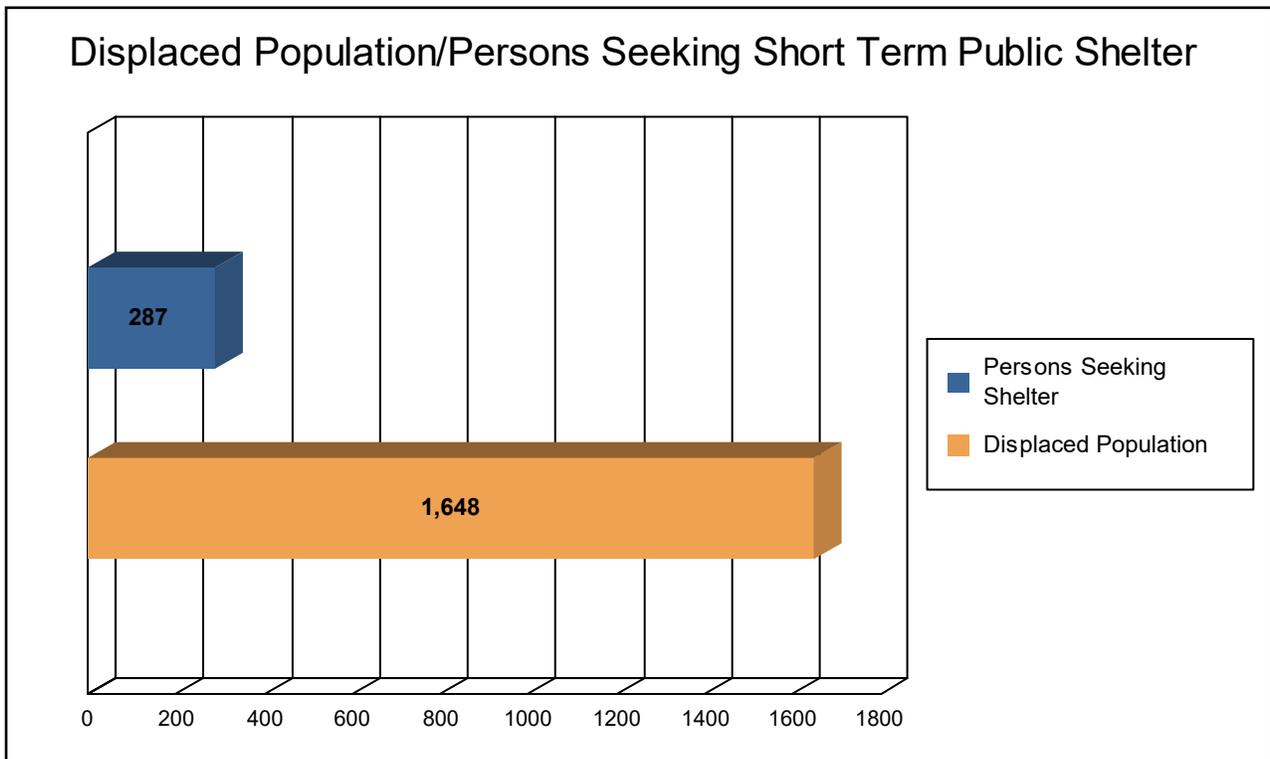
The model estimates that a total of 674 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total, and Foundation comprises 0%. If the debris tonnage is converted into an estimated number of truckloads, it will require 27 truckloads (@25 tons/truck) to remove the debris generated by the flood.



## Social Impact

### Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 549 households (or 1,648 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 287 people (out of a total population of 39,143) will seek temporary shelter in public shelters.



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## Economic Loss

The total economic loss estimated for the flood is 177.38 million dollars, which represents 4.44 % of the total replacement value of the scenario buildings.

### **Building-Related Losses**

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 18.37 million dollars. 90% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 11.14% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.



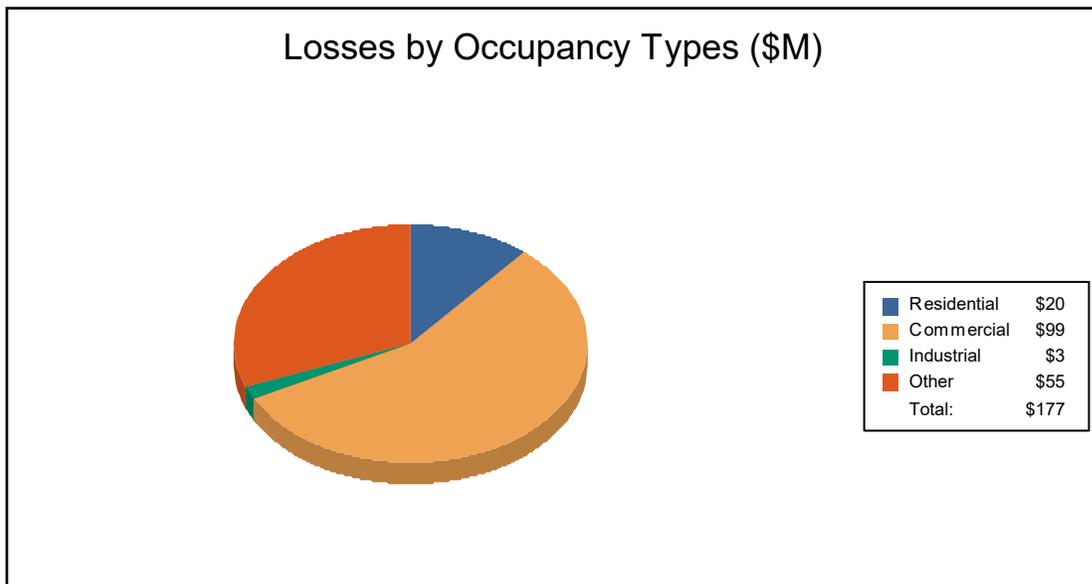
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**Table 6: Building-Related Economic Loss Estimates**  
(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
<u>Building Loss</u>						
	Building	5.05	1.59	0.28	0.00	6.92
	Content	3.82	5.29	0.58	0.76	10.44
	Inventory	0.00	0.92	0.09	0.00	1.02
	<b>Subtotal</b>	<b>8.87</b>	<b>7.79</b>	<b>0.95</b>	<b>0.76</b>	<b>18.37</b>
<u>Business Interruption</u>						
	Income	0.18	34.48	0.55	3.12	38.33
	Relocation	6.99	12.02	0.71	3.24	22.96
	Rental Income	3.29	8.49	0.13	0.97	12.87
	Wage	0.43	36.61	0.87	46.94	84.85
	<b>Subtotal</b>	<b>10.89</b>	<b>91.60</b>	<b>2.25</b>	<b>54.27</b>	<b>159.00</b>
<b>ALL</b>	<b>Total</b>	<b>19.76</b>	<b>99.40</b>	<b>3.20</b>	<b>55.02</b>	<b>177.38</b>





## **Appendix A: County Listing for the Region**

Massachusetts

- Norfolk



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**Appendix B: Regional Population and Building Value Data**

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
<b>Massachusetts</b>				
Norfolk	39,143	5,134,833	3,362,628	8,497,461
<b>Total</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>
<b>Total Study Region</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>



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# Hazus: Hurricane Global Risk Report

**Region Name:** Braintree\_Wind

**Hurricane Scenario:** Probabilistic 500-year Return Period

**Print Date:** Tuesday, November 28, 2023

**Disclaimer:**

*Totals only reflect data for those census tracts/blocks included in the user's study region.*

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



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## General Description of the Region

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

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Massachusetts

Note:

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

The geographical size of the region is 14.56 square miles and contains 9 census tracts. There are over 14 thousand households in the region and a total population of 39,143 people. The distribution of population by State and County is provided in Appendix B.

There are an estimated 13 thousand buildings in the region with a total building replacement value (excluding contents) of 8,497 million dollars. Approximately 87% of the buildings (and 60% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 13,270 buildings in the region which have an aggregate total replacement value of Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides distribution of the building value by State and County.

### Building Exposure by Occupancy Type

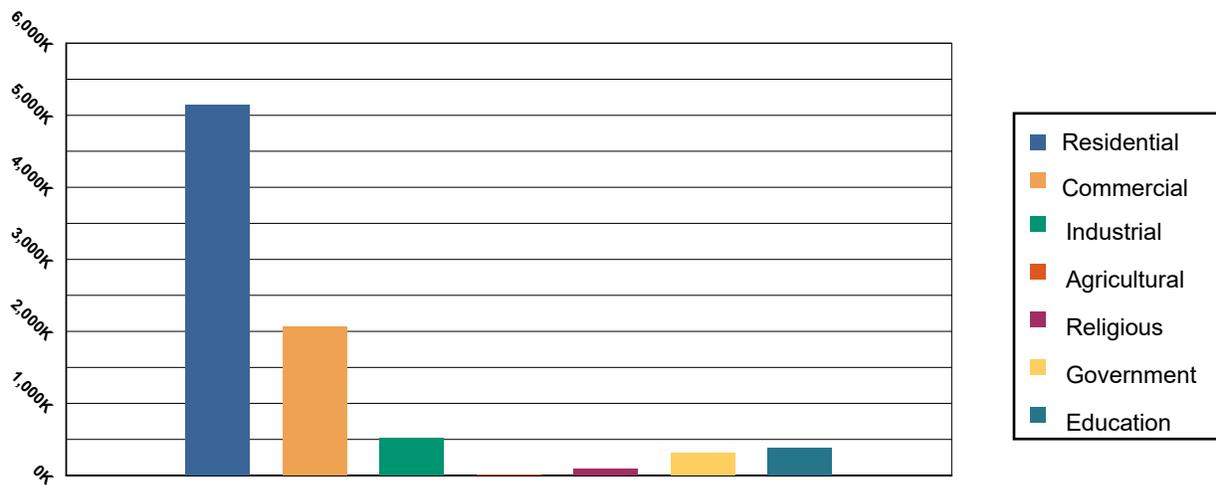


Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure (\$1000)	Percent of Tot
Residential	5,134,833	60.43%
Commercial	2,065,688	24.31%
Industrial	511,760	6.02%
Agricultural	10,160	0.12%
Religious	94,704	1.11%
Government	306,158	3.60%
Education	374,158	4.40%
<b>Total</b>	<b>8,497,461</b>	<b>100.00%</b>

### Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 166 beds. There are 18 schools, 3 fire stations, 1 police stations and 2 emergency operation facilities.



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## Hurricane Scenario

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

**Scenario Name:** Probabilistic

**Type:** Probabilistic

## Building Damage

### General Building Stock Damage

Hazus estimates that about 682 buildings will be at least moderately damaged. This is over 5% of the total number of buildings in the region. There are an estimated 24 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

### Expected Building Damage by Occupancy

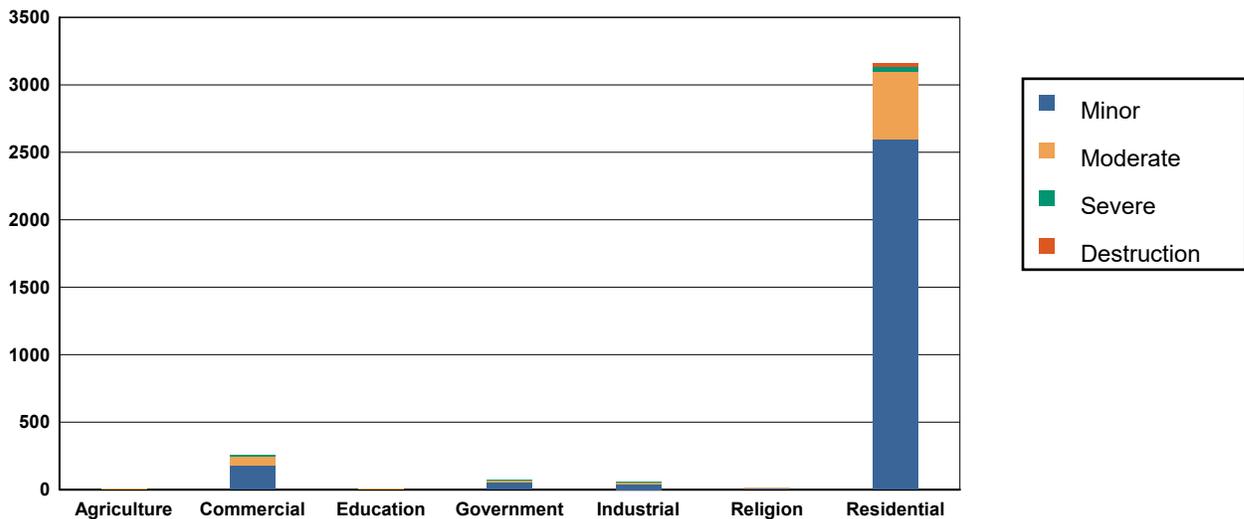


Table 2: Expected Building Damage by Occupancy : 500 - year Event

Occupancy	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	15.01	71.49	4.01	19.11	1.28	6.07	0.62	2.94	0.08	0.39
Commercial	795.21	75.59	179.65	17.08	66.49	6.32	10.57	1.00	0.07	0.01
Education	27.95	77.63	5.98	16.62	1.89	5.26	0.18	0.49	0.00	0.00
Government	273.56	78.84	54.86	15.81	17.11	4.93	1.47	0.42	0.00	0.00
Industrial	188.18	77.44	38.30	15.76	13.68	5.63	2.67	1.10	0.18	0.07
Religion	54.53	76.81	12.96	18.25	3.23	4.55	0.28	0.39	0.00	0.00
Residential	8,341.77	72.54	2,596.47	22.58	502.58	4.37	35.81	0.31	23.37	0.20
<b>Total</b>	<b>9,696.22</b>		<b>2,892.23</b>		<b>606.26</b>		<b>51.59</b>		<b>23.70</b>	



**Table 3: Expected Building Damage by Building Type : 500 - year Event**

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	128	75.67	29	17.05	11	6.80	1	0.48	0	0.00
Masonry	729	72.32	183	18.15	88	8.73	7	0.71	1	0.09
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	626	77.53	121	15.01	50	6.24	10	1.21	0	0.01
Wood	8,000	73.00	2,501	22.82	405	3.70	32	0.29	22	0.20

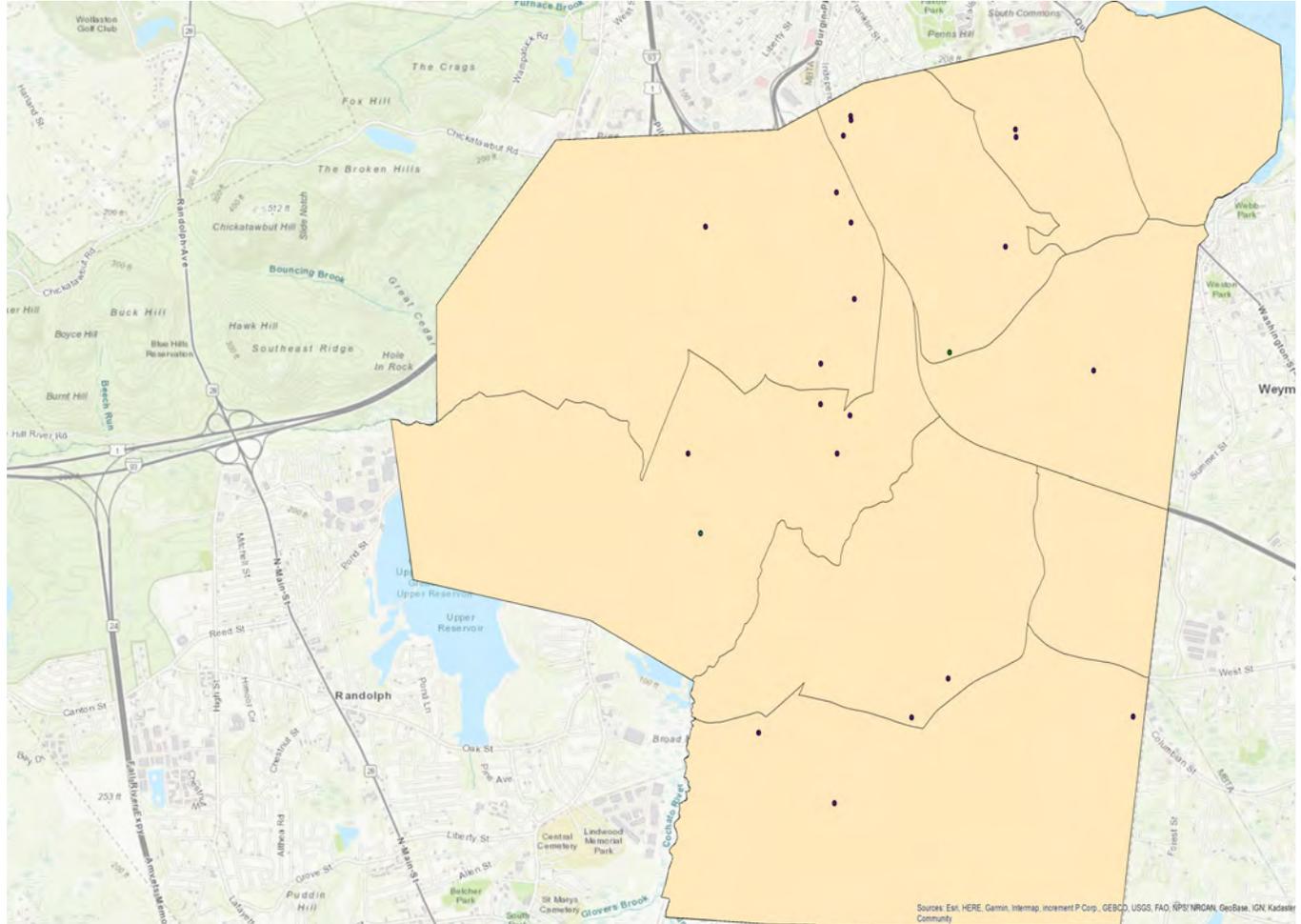


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### **Essential Facility Damage**

Before the hurricane, the region had 166 hospital beds available for use. On the day of the hurricane, the model estimates that 166 hospital beds (100%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100% of the beds will be in service. By 30 days, 100% will be operational.

### Thematic Map of Essential Facilities

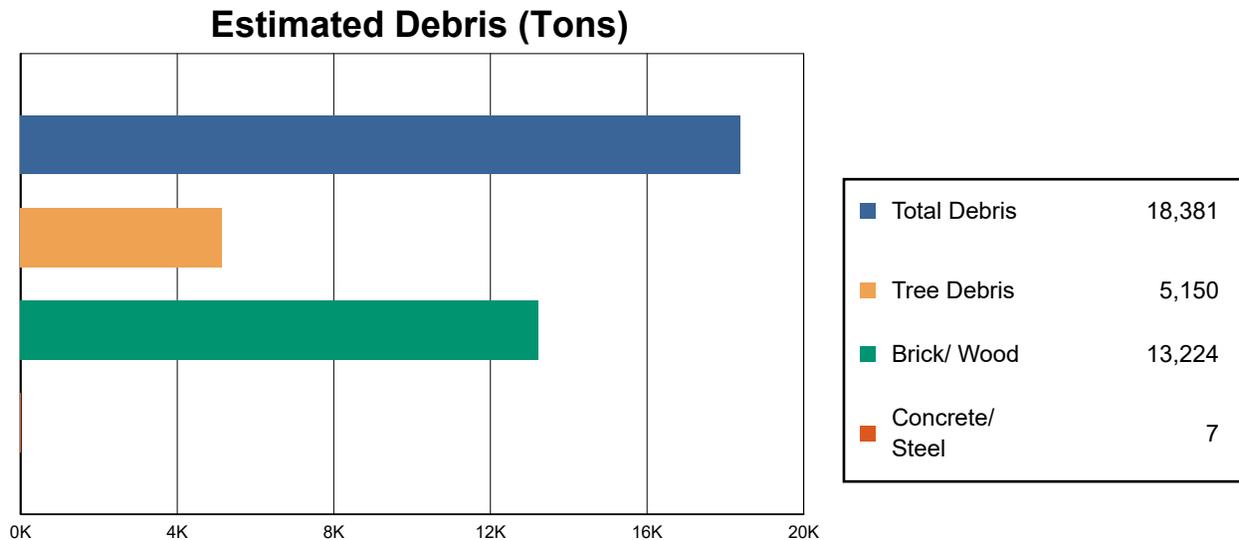


**Table 4: Expected Damage to Essential Facilities**

Classification	Total	# Facilities		
		Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	2	0	0	2
Fire Stations	3	0	0	3
Hospitals	1	0	0	1
Police Stations	1	0	0	1
Schools	18	0	0	3

## Induced Hurricane Damage

### Debris Generation

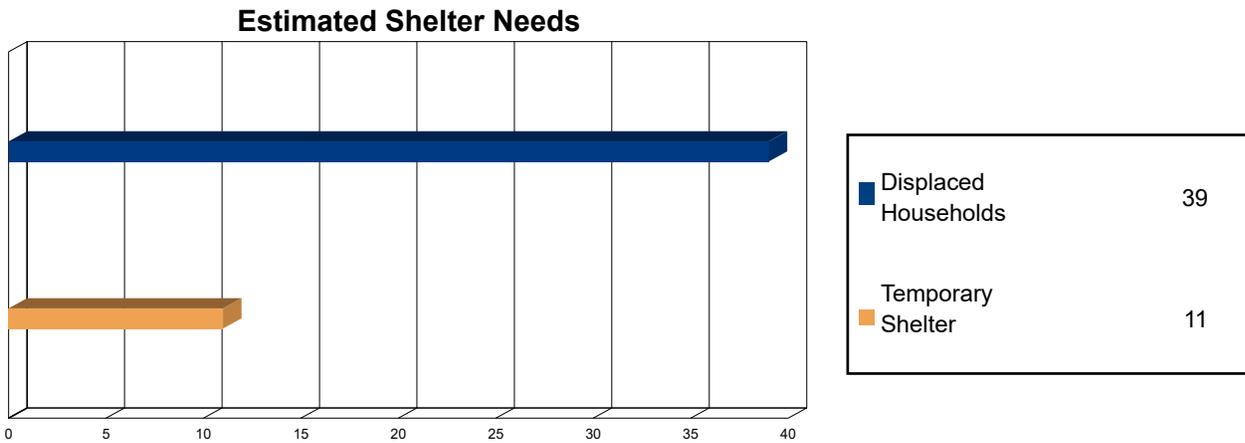


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 18,381 tons of debris will be generated. Of the total amount, 948 tons (5%) is Other Tree Debris. Of the remaining 17,433 tons, Brick/Wood comprises 76% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 529 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 4,202 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

## Social Impact

### Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 39 households to be displaced due to the hurricane. Of these, 11 people (out of a total population of 39,143) will seek temporary shelter in public shelters.



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## Economic Loss

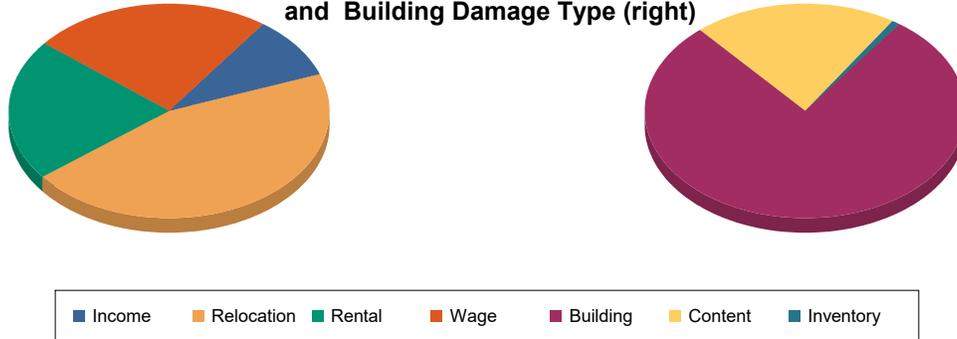
The total economic loss estimated for the hurricane is 207.5 million dollars, which represents 2.44 % of the total replacement value of the region's buildings.

### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 208 million dollars. 12% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 73% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left) and Building Damage Type (right)



Loss Type by General Occupancy

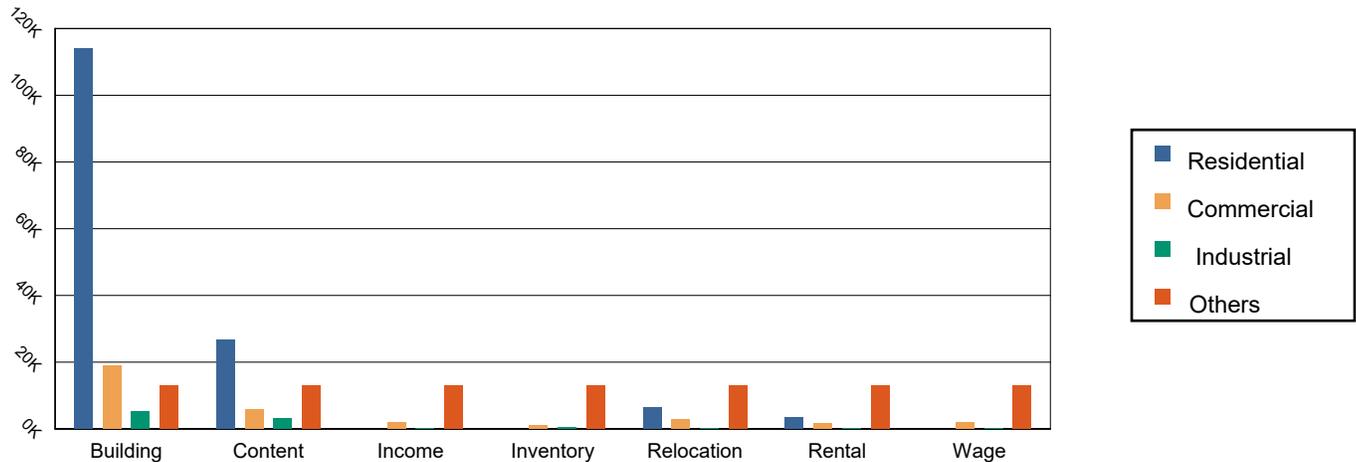


Table 5: Building-Related Economic Loss Estimates  
(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
<b>Property Damage</b>						
	Building	113,945.41	19,025.04	5,257.32	5,903.60	144,131.38
	Content	26,808.13	5,981.90	3,230.36	1,698.67	37,719.06
	Inventory	0.00	1,178.16	366.17	57.79	1,602.11
	<b>Subtotal</b>	<b>140,753.54</b>	<b>26,185.10</b>	<b>8,853.85</b>	<b>7,660.05</b>	<b>183,452.55</b>
<b>Business Interruption Loss</b>						
	Income	0.00	1,817.08	57.72	424.92	2,299.73
	Relocation	6,504.64	2,946.55	307.55	1,018.43	10,777.17
	Rental	3,385.05	1,586.80	50.32	149.47	5,171.64
	Wage	0.00	1,987.71	90.37	3,724.73	5,802.80
	<b>Subtotal</b>	<b>9,889.69</b>	<b>8,338.14</b>	<b>505.96</b>	<b>5,317.56</b>	<b>24,051.34</b>



FEMA

Total

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Total	150,643.23	34,523.25	9,359.81	12,977.61	207,503.89
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**Appendix A: County Listing for the Region**

Massachusetts  
- Norfolk



**Appendix B: Regional Population and Building Value Data**

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
<b>Massachusetts</b>				
Norfolk	39,143	5,134,833	3,362,628	8,497,461
<b>Total</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>
<b>Study Region Total</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>



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## Hazus: Hurricane Global Risk Report

**Region Name:** Braintree\_Wind

**Hurricane Scenario:** Probabilistic 1000-year Return Period

**Print Date:** Tuesday, November 28, 2023

**Disclaimer:**

*Totals only reflect data for those census tracts/blocks included in the user's study region.*

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



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## General Description of the Region

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

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Massachusetts

Note:

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

The geographical size of the region is 14.56 square miles and contains 9 census tracts. There are over 14 thousand households in the region and a total population of 39,143 people. The distribution of population by State and County is provided in Appendix B.

There are an estimated 13 thousand buildings in the region with a total building replacement value (excluding contents) of 8,497 million dollars. Approximately 87% of the buildings (and 60% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 13,270 buildings in the region which have an aggregate total replacement value of Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides distribution of the building value by State and County.

### Building Exposure by Occupancy Type

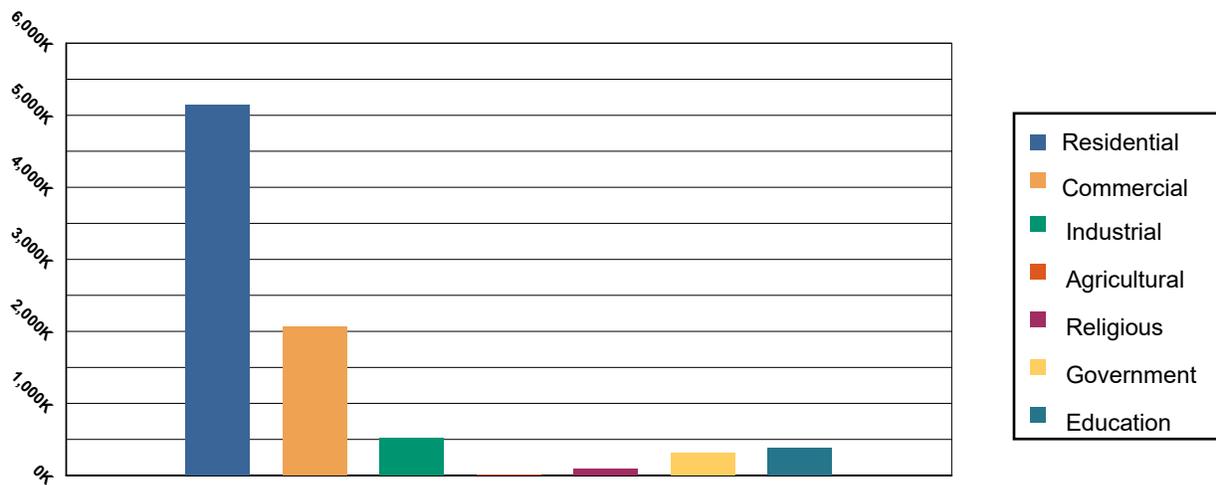


Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure (\$1000)	Percent of Tot
Residential	5,134,833	60.43%
Commercial	2,065,688	24.31%
Industrial	511,760	6.02%
Agricultural	10,160	0.12%
Religious	94,704	1.11%
Government	306,158	3.60%
Education	374,158	4.40%
<b>Total</b>	<b>8,497,461</b>	<b>100.00%</b>

### Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 166 beds. There are 18 schools, 3 fire stations, 1 police stations and 2 emergency operation facilities.



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## Hurricane Scenario

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

**Scenario Name:** Probabilistic

**Type:** Probabilistic

## Building Damage

### General Building Stock Damage

Hazus estimates that about 1,132 buildings will be at least moderately damaged. This is over 9% of the total number of buildings in the region. There are an estimated 55 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

### Expected Building Damage by Occupancy

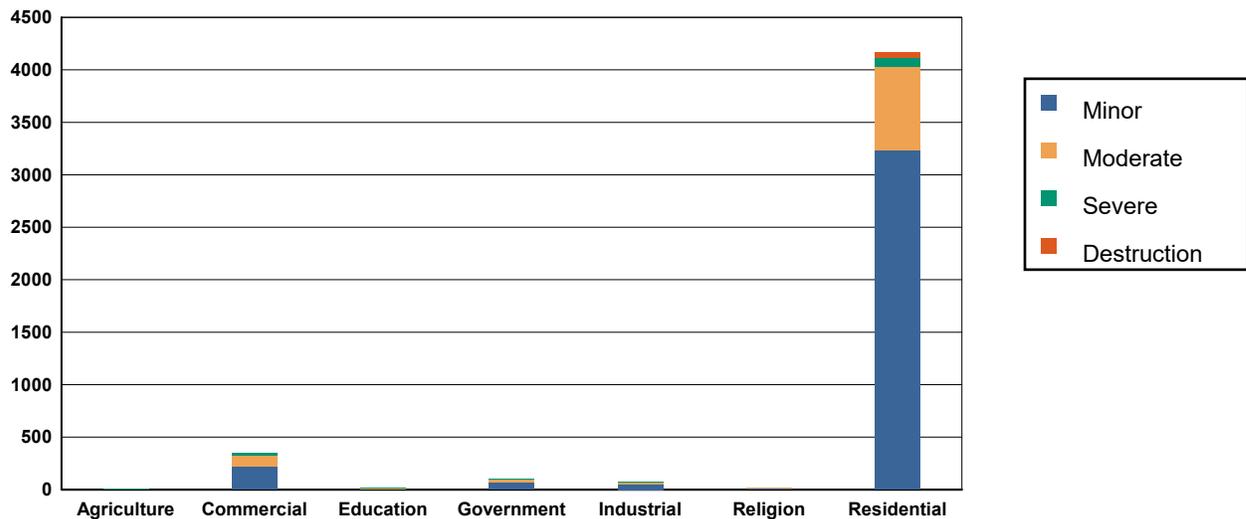


Table 2: Expected Building Damage by Occupancy : 1000 - year Event

Occupancy	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	13.05	62.14	4.99	23.75	1.89	8.98	0.93	4.43	0.15	0.69
Commercial	701.24	66.66	222.73	21.17	106.98	10.17	20.89	1.99	0.16	0.02
Education	24.79	68.87	7.50	20.84	3.24	9.00	0.47	1.29	0.00	0.00
Government	241.93	69.72	69.95	20.16	30.88	8.90	4.24	1.22	0.00	0.00
Industrial	166.78	68.63	47.85	19.69	22.82	9.39	5.23	2.15	0.32	0.13
Religion	48.23	67.93	16.44	23.16	5.60	7.89	0.72	1.02	0.00	0.00
Residential	7,336.31	63.79	3,235.96	28.14	791.29	6.88	81.80	0.71	54.64	0.48
<b>Total</b>	<b>8,532.34</b>		<b>3,605.42</b>		<b>962.70</b>		<b>114.27</b>		<b>55.27</b>	



**Table 3: Expected Building Damage by Building Type : 1000 - year Event**

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	112	66.44	35	20.76	19	11.47	2	1.32	0	0.00
Masonry	641	63.57	222	22.02	129	12.81	14	1.43	2	0.18
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	554	68.60	151	18.69	83	10.28	19	2.41	0	0.02
Wood	7,040	64.23	3,135	28.60	660	6.03	73	0.67	52	0.47

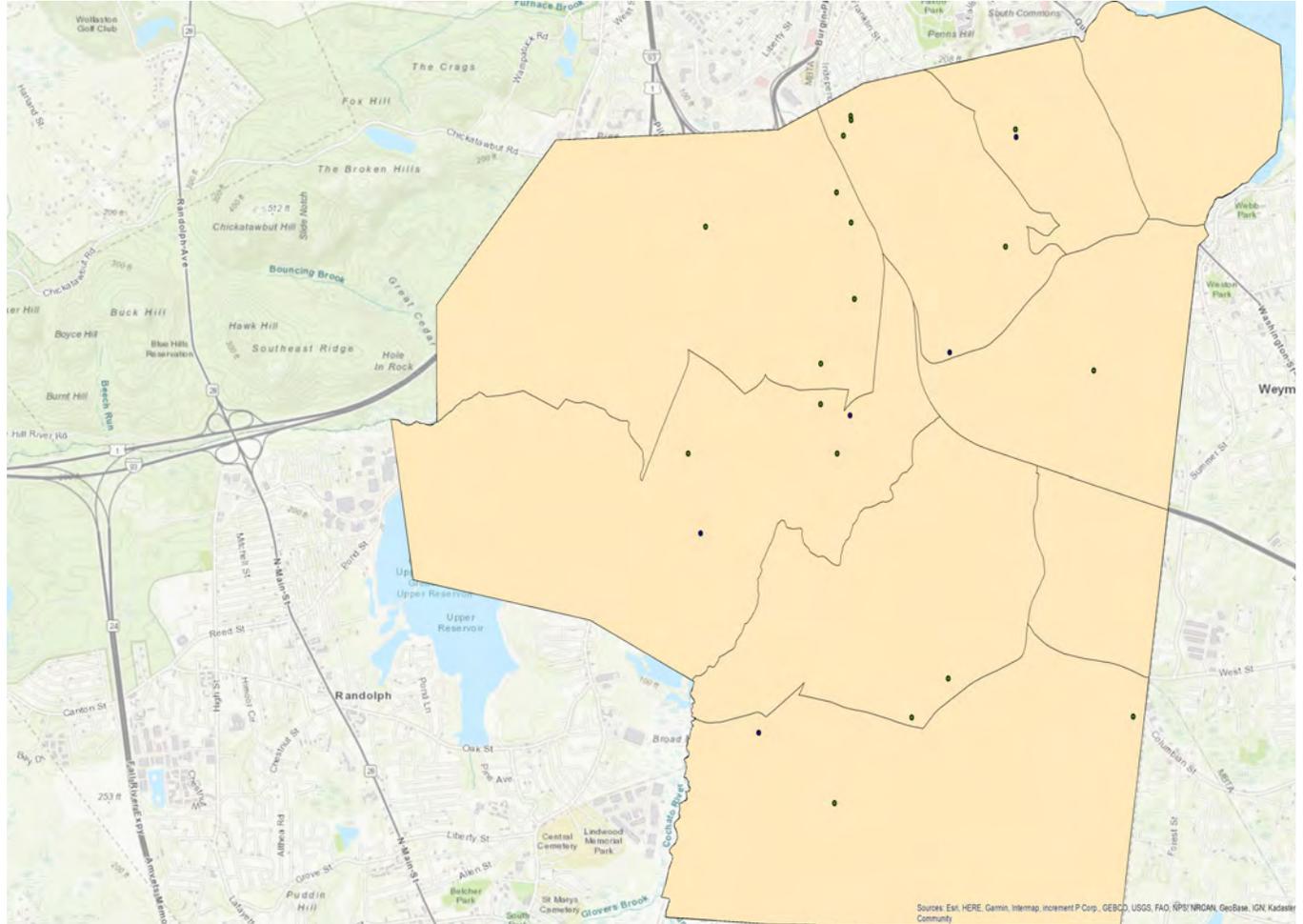


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### **Essential Facility Damage**

Before the hurricane, the region had 166 hospital beds available for use. On the day of the hurricane, the model estimates that 166 hospital beds (100%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100% of the beds will be in service. By 30 days, 100% will be operational.

**Thematic Map of Essential Facilities**



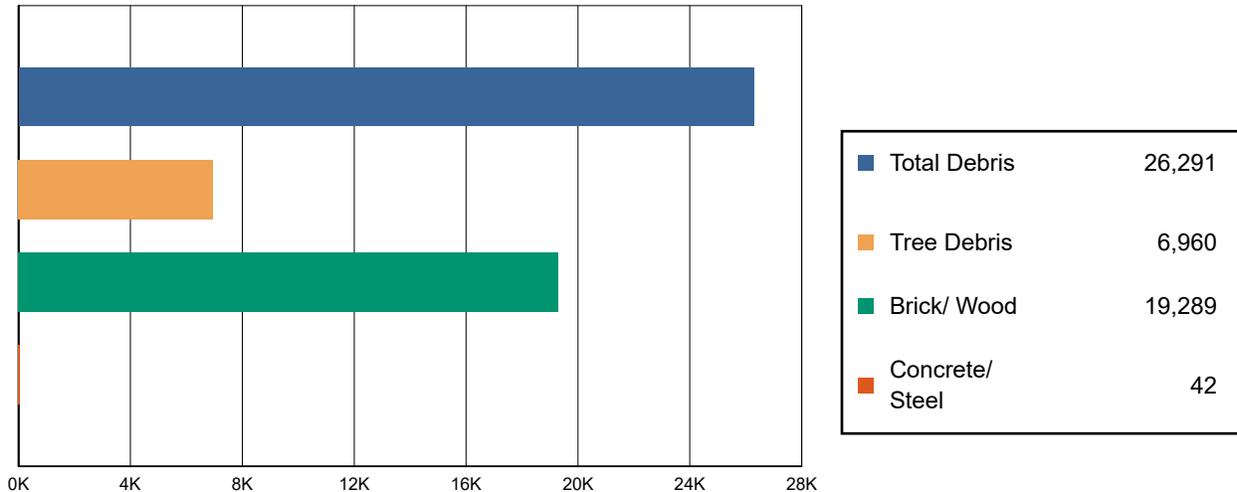
**Table 4: Expected Damage to Essential Facilities**

Classification	Total	# Facilities		
		Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	2	0	0	2
Fire Stations	3	0	0	3
Hospitals	1	0	0	1
Police Stations	1	0	0	1
Schools	18	0	0	0

## Induced Hurricane Damage

### Debris Generation

Estimated Debris (Tons)

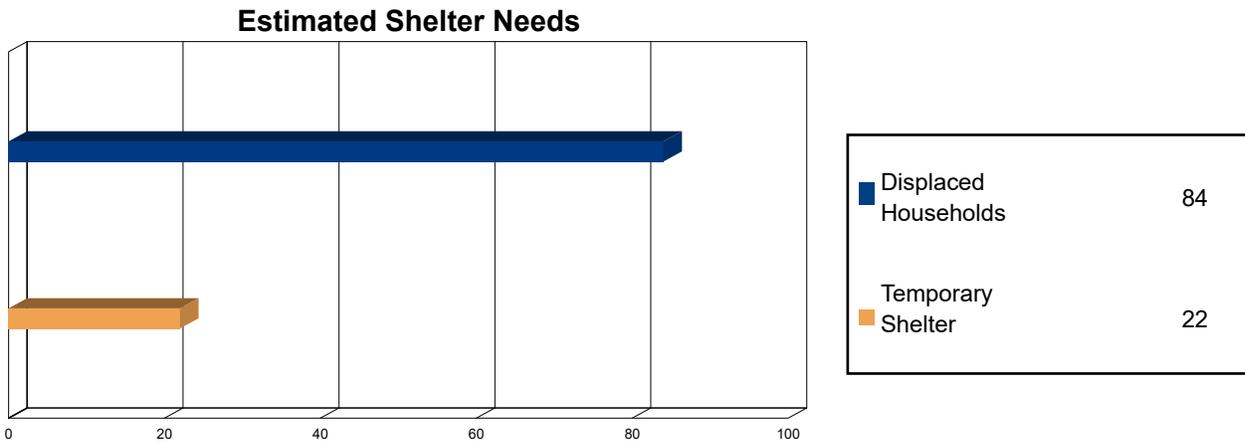


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 26,291 tons of debris will be generated. Of the total amount, 1,288 tons (5%) is Other Tree Debris. Of the remaining 25,004 tons, Brick/Wood comprises 77% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 773 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 5,673 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

## Social Impact

### Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 84 households to be displaced due to the hurricane. Of these, 22 people (out of a total population of 39,143) will seek temporary shelter in public shelters.



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## Economic Loss

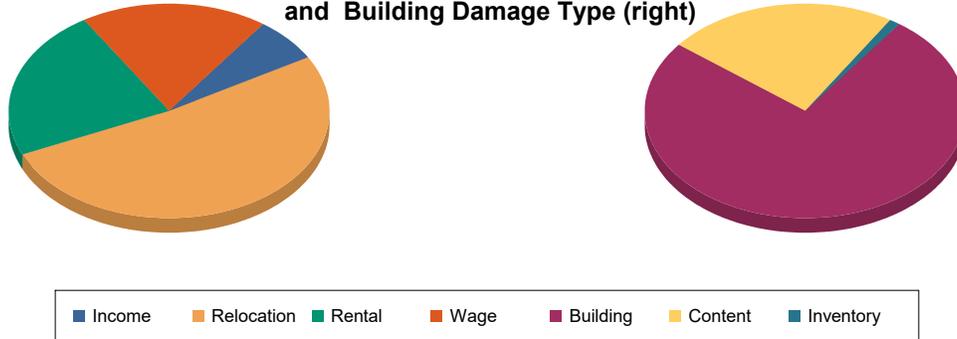
The total economic loss estimated for the hurricane is 327.3 million dollars, which represents 3.85 % of the total replacement value of the region's buildings.

### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 327 million dollars. 12% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 72% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.

Loss by Business Interruption Type (left) and Building Damage Type (right)



Loss Type by General Occupancy

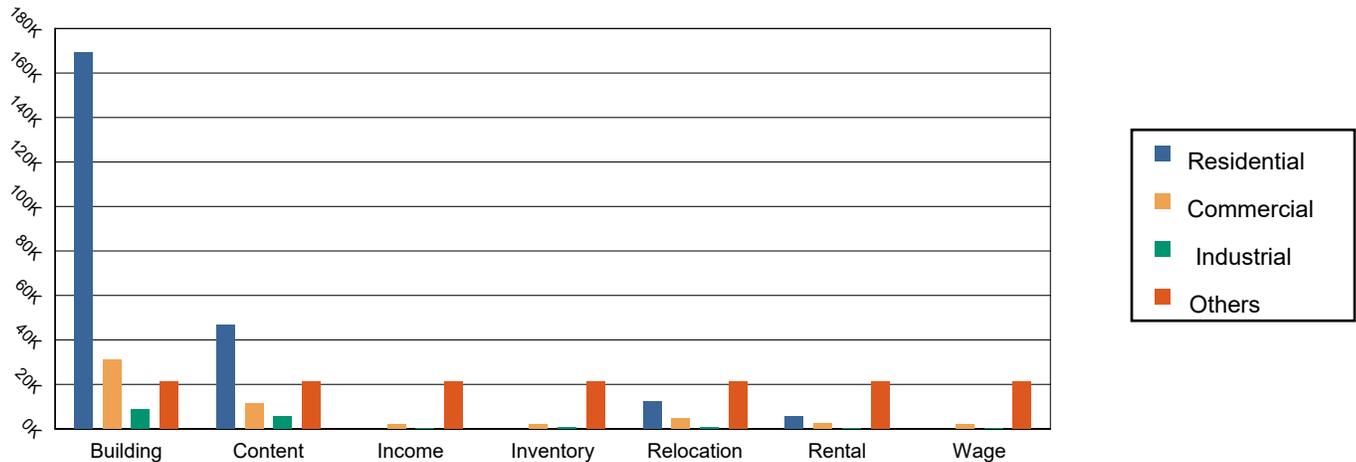


Table 5: Building-Related Economic Loss Estimates  
(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
<b>Property Damage</b>						
	Building	169,265.28	30,965.39	8,705.37	10,163.41	219,099.45
	Content	46,696.05	11,459.79	5,811.15	3,595.42	67,562.41
	Inventory	0.00	2,247.58	654.79	95.22	2,997.60
	<b>Subtotal</b>	<b>215,961.33</b>	<b>44,672.77</b>	<b>15,171.31</b>	<b>13,854.05</b>	<b>289,659.46</b>
<b>Business Interruption Loss</b>						
	Income	0.44	1,905.21	80.61	480.74	2,467.00
	Relocation	12,468.50	4,750.56	520.60	1,776.30	19,515.96
	Rental	5,659.71	2,536.49	82.08	267.63	8,545.91
	Wage	1.04	2,180.28	127.29	4,826.22	7,134.82
	<b>Subtotal</b>	<b>18,129.68</b>	<b>11,372.54</b>	<b>810.58</b>	<b>7,350.89</b>	<b>37,663.69</b>



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Total

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Total	234,091.01	56,045.31	15,981.89	21,204.94	327,323.15
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**Appendix A: County Listing for the Region**

Massachusetts  
- Norfolk



**Appendix B: Regional Population and Building Value Data**

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
<b>Massachusetts</b>				
Norfolk	39,143	5,134,833	3,362,628	8,497,461
<b>Total</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>
<b>Study Region Total</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>



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## Hazus: Earthquake Global Risk Report

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**Region Name:** Braintree\_EQ

**Earthquake Scenario:** 1500-year

**Print Date:** November 28, 2023

**Disclaimer:**

*Totals only reflect data for those census tracts/blocks included in the user's study region.*

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

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## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Massachusetts

**Note:**

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

The geographical size of the region is 14.56 square miles and contains 9 census tracts. There are over 14 thousand households in the region which has a total population of 39,143 people. The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 13 thousand buildings in the region with a total building replacement value (excluding contents) of 8,498 (millions of dollars). Approximately 87.00 % of the buildings (and 60.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 3,477 and 524 (millions of dollars) , respectively.

---

## **Building and Lifeline Inventory**

### **Building Inventory**

Hazus estimates that there are 13 thousand buildings in the region which have an aggregate total replacement value of 8,498 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 166 beds. There are 18 schools, 3 fire stations, 1 police stations and 2 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no nuclear power plants.

### **Transportation and Utility Lifeline Inventory**

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 4,001.00 (millions of dollars). This inventory includes over 68.35 miles of highways, 43 bridges, 310.69 miles of pipes.

**Table 1: Transportation System Lifeline Inventory**

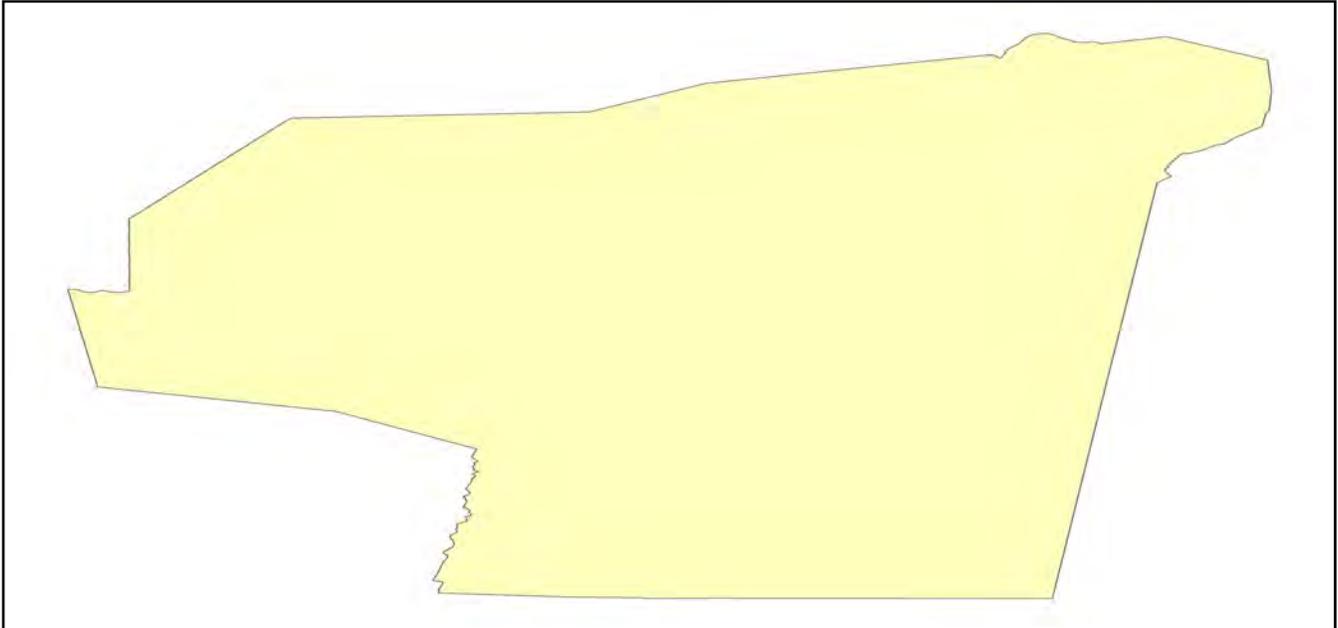
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
<b>Highway</b>	Bridges	43	92.8843
	Segments	71	805.7967
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>898.6810</b>
<b>Railways</b>	Bridges	9	46.7100
	Facilities	0	0.0000
	Segments	26	2525.0804
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>2571.7904</b>
<b>Light Rail</b>	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Bus</b>	Facilities	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Ferry</b>	Facilities	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Port</b>	Facilities	2	6.9537
	<b>Subtotal</b>		<b>6.9537</b>
<b>Airport</b>	Facilities	0	0.0000
	Runways	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
		<b>Total</b>	<b>3,477.40</b>

**Table 2: Utility System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># Locations / Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Potable Water</b>	Distribution Lines	NA	5.8696
	Facilities	0	0.0000
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>5.8696</b>
<b>Waste Water</b>	Distribution Lines	NA	3.5218
	Facilities	0	0.0000
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>3.5218</b>
<b>Natural Gas</b>	Distribution Lines	NA	2.3479
	Facilities	0	0.0000
	Pipelines	6	195.2346
	<b>Subtotal</b>		<b>197.5825</b>
<b>Oil Systems</b>	Facilities	0	0.0000
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Electrical Power</b>	Facilities	1	317.4796
	<b>Subtotal</b>		<b>317.4796</b>
<b>Communication</b>	Facilities	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
	<b>Total</b>		<b>524.50</b>

## Earthquake Scenario

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



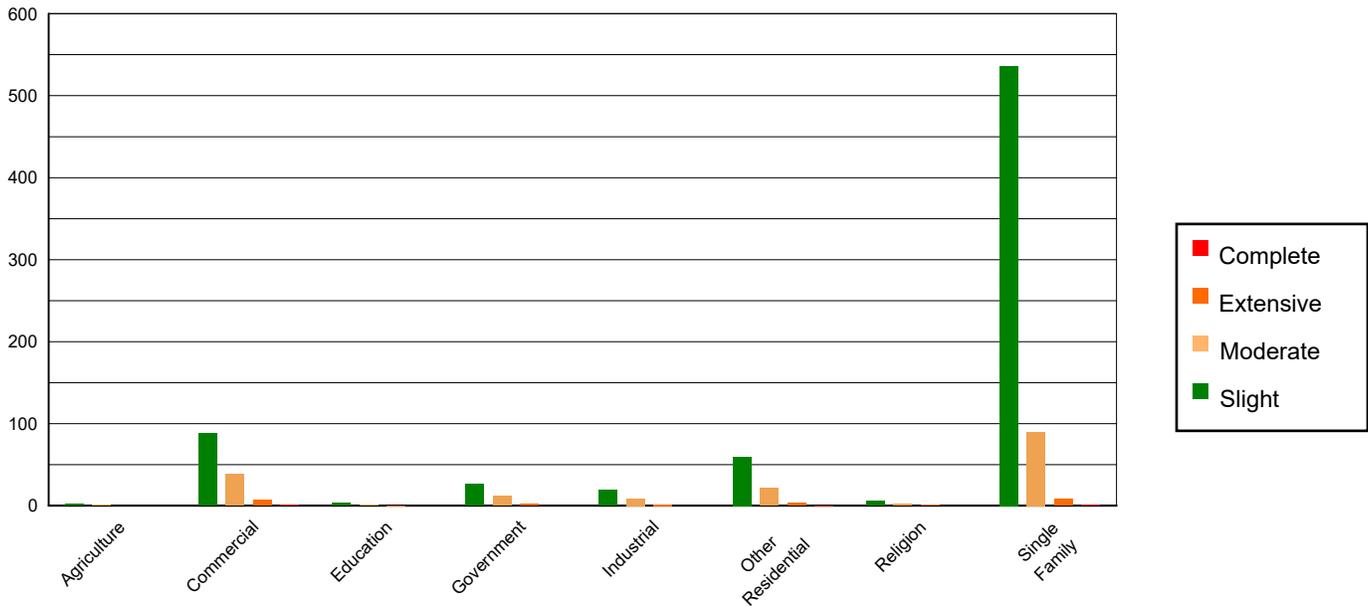
<b>Scenario Name</b>	1500-year
<b>Type of Earthquake</b>	Probabilistic
<b>Fault Name</b>	NA
<b>Historical Epicenter ID #</b>	NA
<b>Probabilistic Return Period</b>	1,500.00
<b>Longitude of Epicenter</b>	NA
<b>Latitude of Epicenter</b>	NA
<b>Earthquake Magnitude</b>	6.00
<b>Depth (km)</b>	NA
<b>Rupture Length (Km)</b>	NA
<b>Rupture Orientation (degrees)</b>	NA
<b>Attenuation Function</b>	NA

## Direct Earthquake Damage

### Building Damage

Hazus estimates that about 198 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 1 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

### Damage Categories by General Occupancy Type



**Table 3: Expected Building Damage by Occupancy**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Agriculture</b>	18.50	0.15	1.77	0.24	0.63	0.36	0.10	0.47	0.01	0.29
<b>Commercial</b>	917.93	7.44	88.31	11.94	38.77	22.21	6.53	29.53	0.47	25.73
<b>Education</b>	31.85	0.26	2.78	0.38	1.18	0.68	0.18	0.80	0.02	0.86
<b>Government</b>	307.06	2.49	26.59	3.59	11.61	6.65	1.64	7.44	0.10	5.50
<b>Industrial</b>	213.86	1.73	18.99	2.57	8.72	5.00	1.35	6.12	0.08	4.19
<b>Other Residential</b>	828.47	6.72	59.58	8.05	21.16	12.12	3.45	15.61	0.34	18.87
<b>Religion</b>	62.50	0.51	5.54	0.75	2.47	1.41	0.45	2.06	0.05	2.50
<b>Single Family</b>	9951.70	80.70	536.15	72.48	90.00	51.57	8.39	37.97	0.76	42.07
<b>Total</b>	<b>12,332</b>		<b>740</b>		<b>175</b>		<b>22</b>		<b>2</b>	

**Table 4: Expected Building Damage by Building Type (All Design Levels)**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Wood</b>	10413.45	84.44	533.41	72.11	68.61	39.31	2.69	12.19	0.00	0.00
<b>Steel</b>	769.80	6.24	59.64	8.06	26.43	15.14	3.21	14.55	0.06	3.15
<b>Concrete</b>	135.28	1.10	11.95	1.62	5.32	3.05	0.38	1.73	0.01	0.39
<b>Precast</b>	47.75	0.39	5.03	0.68	4.03	2.31	0.96	4.35	0.01	0.53
<b>RM</b>	193.93	1.57	12.94	1.75	8.53	4.89	1.54	6.98	0.00	0.00
<b>URM</b>	771.64	6.26	116.72	15.78	61.60	35.30	13.30	60.20	1.74	95.93
<b>MH</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>12,332</b>		<b>740</b>		<b>175</b>		<b>22</b>		<b>2</b>	

\*Note:

- RM Reinforced Masonry
- URM Unreinforced Masonry
- MH Manufactured Housing

### **Essential Facility Damage**

Before the earthquake, the region had 166 hospital beds available for use. On the day of the earthquake, the model estimates that only 126 hospital beds (76.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 90.00% of the beds will be back in service. By 30 days, 98.00% will be operational.

**Table 5: Expected Damage to Essential Facilities**

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	0	0	1
Schools	18	0	0	18
EOCs	2	0	0	2
PoliceStations	1	0	0	1
FireStations	3	0	0	3



**Table 6: Expected Damage to the Transportation Systems**

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	71	0	0	53	53
	Bridges	43	0	0	43	43
	Tunnels	0	0	0	0	0
Railways	Segments	26	0	0	23	23
	Bridges	9	0	0	9	9
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	2	0	0	2	2
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

**Table 7 : Expected Utility System Facility Damage**

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	1	0	0	1	1
Communication	0	0	0	0	0

**Table 8 : Expected Utility System Pipeline Damage (Site Specific)**

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	182	1	0
Waste Water	109	1	0
Natural Gas	19	0	0
Oil	0	0	0

**Table 9: Expected Potable Water and Electric Power System Performance**

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	14,510	0	0	0	0	0
Electric Power		0	0	0	0	0

## Induced Earthquake Damage

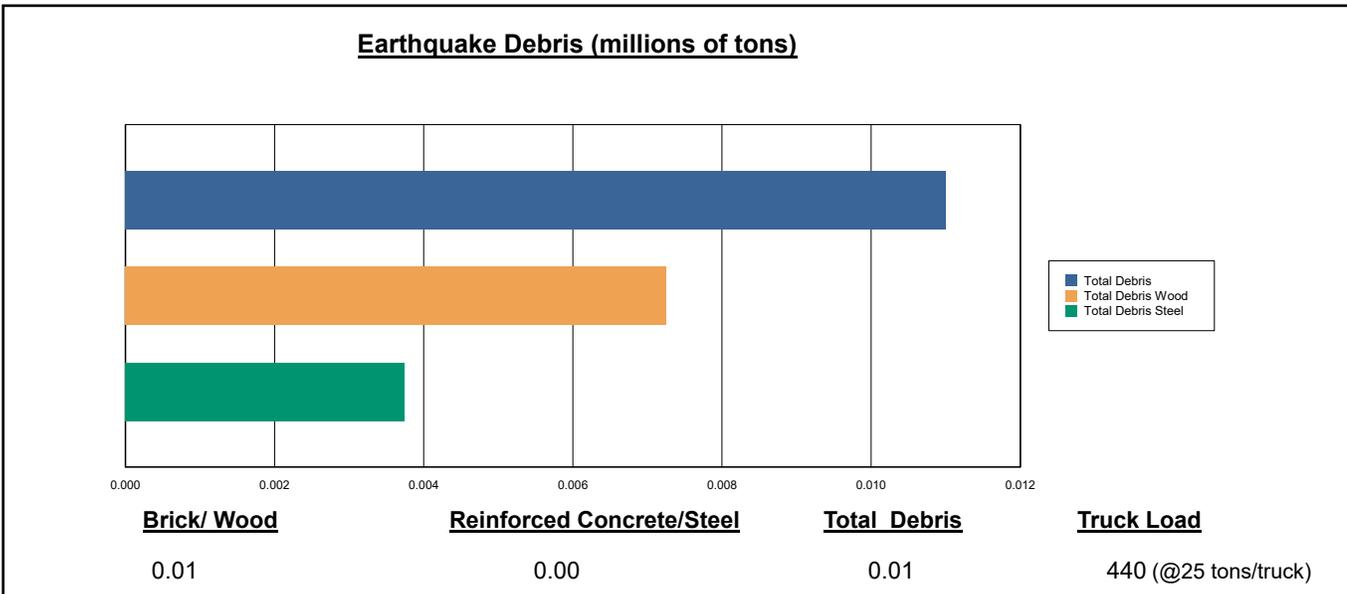
### Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

### Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

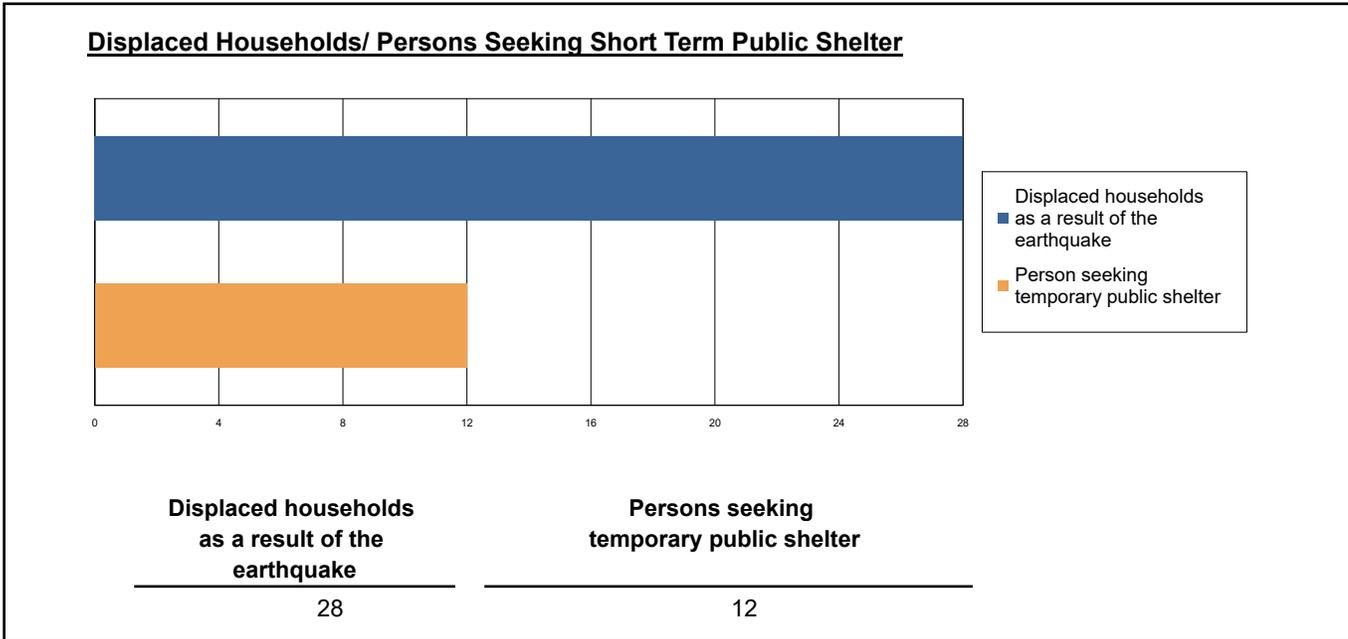
The model estimates that a total of 11,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 66.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 440 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.



## Social Impact

### Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 28 households to be displaced due to the earthquake. Of these, 12 people (out of a total population of 39,143) will seek temporary shelter in public shelters.



### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

**Table 10: Casualty Estimates**

		Level 1	Level 2	Level 3	Level 4
<b>2 AM</b>	Commercial	0.13	0.02	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.01	0.00	0.00	0.00
	Industrial	0.07	0.01	0.00	0.00
	Other-Residential	1.51	0.22	0.02	0.04
	Single Family	2.12	0.22	0.02	0.03
	<b>Total</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>2 PM</b>	Commercial	7.50	1.03	0.09	0.16
	Commuting	0.00	0.00	0.00	0.00
	Educational	1.53	0.22	0.02	0.04
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.52	0.07	0.01	0.01
	Other-Residential	0.42	0.06	0.01	0.01
	Single Family	0.55	0.06	0.01	0.01
	<b>Total</b>	<b>11</b>	<b>1</b>	<b>0</b>	<b>0</b>
<b>5 PM</b>	Commercial	4.85	0.67	0.06	0.11
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.32	0.04	0.00	0.01
	Other-Residential	0.60	0.09	0.01	0.02
	Single Family	0.81	0.09	0.01	0.01
	<b>Total</b>	<b>7</b>	<b>1</b>	<b>0</b>	<b>0</b>



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## Economic Loss

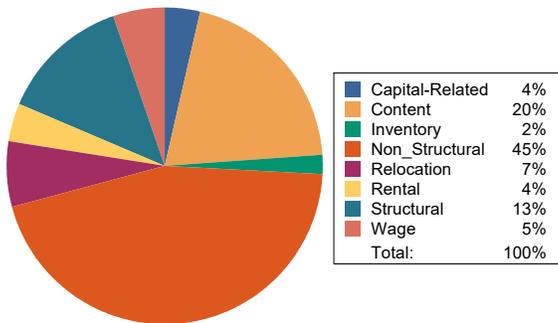
The total economic loss estimated for the earthquake is 76.62 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

### Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 66.04 (millions of dollars); 19 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 39 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type (\$ millions)



Earthquake Losses by Occupancy Type (\$ millions)

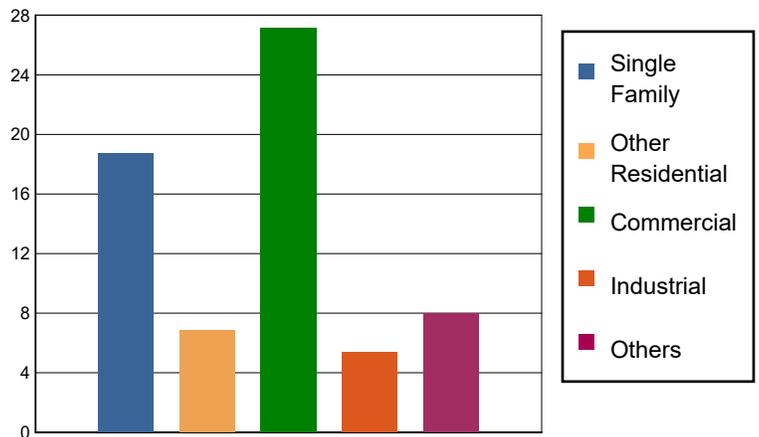


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
<b>Income Losses</b>							
	Wage	0.0000	0.4135	2.5369	0.0831	0.4273	3.4608
	Capital-Related	0.0000	0.1759	2.1678	0.0513	0.0478	2.4428
	Rental	0.2379	0.5391	1.5119	0.0508	0.1747	2.5144
	Relocation	0.8047	0.3030	2.1175	0.2252	0.9026	4.3530
	<b>Subtotal</b>	<b>1.0426</b>	<b>1.4315</b>	<b>8.3341</b>	<b>0.4104</b>	<b>1.5524</b>	<b>12.7710</b>
<b>Capital Stock Losses</b>							
	Structural	2.3806	0.8118	3.8330	0.7022	1.1527	8.8803
	Non_Structural	11.4095	3.6566	8.8669	2.3862	3.3739	29.6931
	Content	3.9067	0.9469	4.9225	1.6470	1.8493	13.2724
	Inventory	0.0000	0.0000	1.1615	0.2395	0.0209	1.4219
	<b>Subtotal</b>	<b>17.6968</b>	<b>5.4153</b>	<b>18.7839</b>	<b>4.9749</b>	<b>6.3968</b>	<b>53.2677</b>
	<b>Total</b>	<b>18.74</b>	<b>6.85</b>	<b>27.12</b>	<b>5.39</b>	<b>7.95</b>	<b>66.04</b>

### Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

**Table 12: Transportation System Economic Losses**  
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	805.7967	0.0000	0.00
	Bridges	92.8843	0.0647	0.07
	Tunnels	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>898.6810</b>	<b>0.0647</b>	
Railways	Segments	2525.0804	0.0000	0.00
	Bridges	46.7100	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>2571.7904</b>	<b>0.0000</b>	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Bus	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Ferry	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Port	Facilities	6.9537	0.4222	6.07
	<b>Subtotal</b>	<b>6.9537</b>	<b>0.4222</b>	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
<b>Total</b>		<b>3,477.43</b>	<b>0.49</b>	

**Table 13: Utility System Economic Losses**  
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	5.8696	0.0057	0.10
	<b>Subtotal</b>	<b>5.8696</b>	<b>0.0057</b>	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	3.5218	0.0029	0.08
	<b>Subtotal</b>	<b>3.5218</b>	<b>0.0029</b>	
Natural Gas	Pipelines	195.2346	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	2.3479	0.0010	0.04
	<b>Subtotal</b>	<b>197.5825</b>	<b>0.0010</b>	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Electrical Power	Facilities	317.4796	10.0870	3.18
	<b>Subtotal</b>	<b>317.4796</b>	<b>10.0870</b>	
Communication	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
	<b>Total</b>	<b>524.45</b>	<b>10.10</b>	



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**Appendix A: County Listing for the Region**

Norfolk,MA

**Appendix B: Regional Population and Building Value Data**

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
<b>Massachusetts</b>	Norfolk	39,143	5,135	3,362	8,498
<b>Total Region</b>		<b>39,143</b>	<b>5,135</b>	<b>3,362</b>	<b>8,498</b>



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# Hazus: Earthquake Global Risk Report

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**Region Name:** Braintree\_EQ

**Earthquake Scenario:** 2500-year

**Print Date:** November 28, 2023

**Disclaimer:**

*Totals only reflect data for those census tracts/blocks included in the user's study region.*

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

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## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Massachusetts

**Note:**

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

The geographical size of the region is 14.56 square miles and contains 9 census tracts. There are over 14 thousand households in the region which has a total population of 39,143 people. The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 13 thousand buildings in the region with a total building replacement value (excluding contents) of 8,498 (millions of dollars). Approximately 87.00 % of the buildings (and 60.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 3,477 and 524 (millions of dollars) , respectively.

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## **Building and Lifeline Inventory**

### **Building Inventory**

Hazus estimates that there are 13 thousand buildings in the region which have an aggregate total replacement value of 8,498 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 166 beds. There are 18 schools, 3 fire stations, 1 police stations and 2 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no nuclear power plants.

### **Transportation and Utility Lifeline Inventory**

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 4,001.00 (millions of dollars). This inventory includes over 68.35 miles of highways, 43 bridges, 310.69 miles of pipes.

**Table 1: Transportation System Lifeline Inventory**

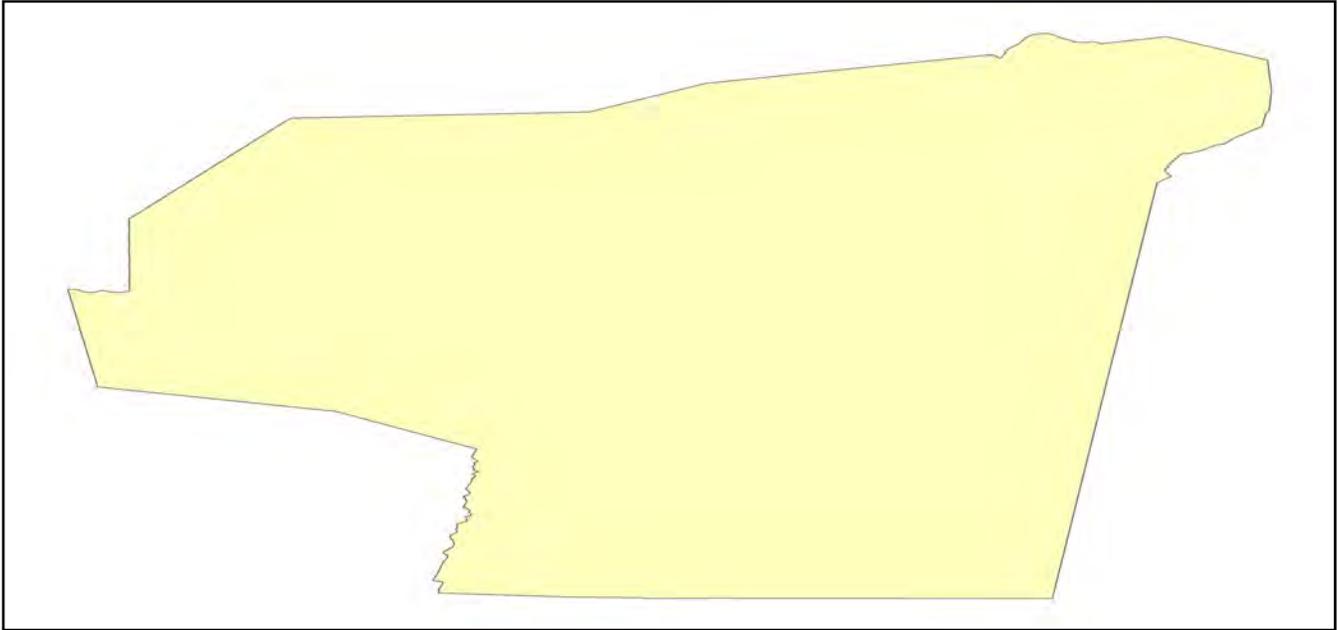
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
<b>Highway</b>	Bridges	43	92.8843
	Segments	71	805.7967
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>898.6810</b>
<b>Railways</b>	Bridges	9	46.7100
	Facilities	0	0.0000
	Segments	26	2525.0804
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>2571.7904</b>
<b>Light Rail</b>	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Bus</b>	Facilities	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Ferry</b>	Facilities	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Port</b>	Facilities	2	6.9537
	<b>Subtotal</b>		<b>6.9537</b>
<b>Airport</b>	Facilities	0	0.0000
	Runways	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
		<b>Total</b>	<b>3,477.40</b>

**Table 2: Utility System Lifeline Inventory**

System	Component	# Locations / Segments	Replacement value (millions of dollars)
<b>Potable Water</b>	Distribution Lines	NA	5.8696
	Facilities	0	0.0000
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>5.8696</b>
<b>Waste Water</b>	Distribution Lines	NA	3.5218
	Facilities	0	0.0000
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>3.5218</b>
<b>Natural Gas</b>	Distribution Lines	NA	2.3479
	Facilities	0	0.0000
	Pipelines	6	195.2346
	<b>Subtotal</b>		<b>197.5825</b>
<b>Oil Systems</b>	Facilities	0	0.0000
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Electrical Power</b>	Facilities	1	317.4796
	<b>Subtotal</b>		<b>317.4796</b>
<b>Communication</b>	Facilities	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
		<b>Total</b>	<b>524.50</b>

## Earthquake Scenario

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



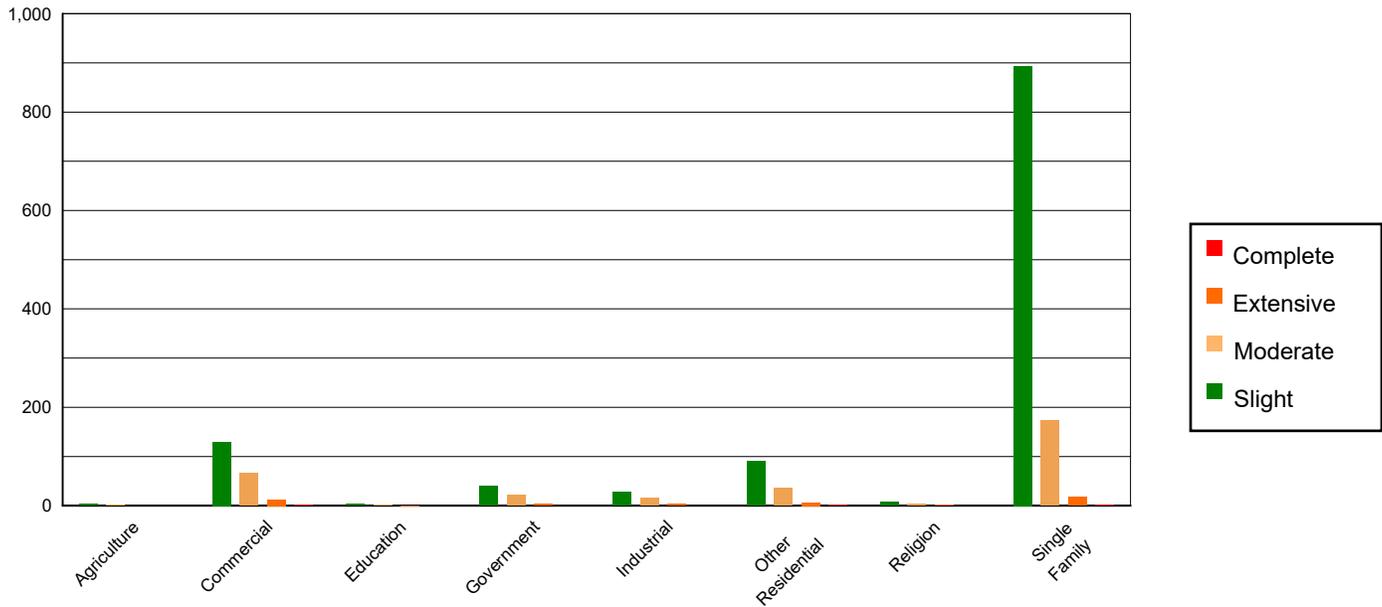
<b>Scenario Name</b>	2500-year
<b>Type of Earthquake</b>	Probabilistic
<b>Fault Name</b>	NA
<b>Historical Epicenter ID #</b>	NA
<b>Probabilistic Return Period</b>	2,500.00
<b>Longitude of Epicenter</b>	NA
<b>Latitude of Epicenter</b>	NA
<b>Earthquake Magnitude</b>	7.00
<b>Depth (km)</b>	NA
<b>Rupture Length (Km)</b>	NA
<b>Rupture Orientation (degrees)</b>	NA
<b>Attenuation Function</b>	NA

## Direct Earthquake Damage

### Building Damage

Hazus estimates that about 366 buildings will be at least moderately damaged. This is over 3.00 % of the buildings in the region. There are an estimated 4 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

### Damage Categories by General Occupancy Type



**Table 3: Expected Building Damage by Occupancy**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Agriculture</b>	16.97	0.14	2.71	0.23	1.11	0.35	0.20	0.46	0.01	0.32
<b>Commercial</b>	842.29	7.19	129.64	10.84	66.32	20.81	12.66	28.67	1.09	27.06
<b>Education</b>	29.40	0.25	4.13	0.35	2.08	0.65	0.35	0.80	0.04	0.90
<b>Government</b>	282.15	2.41	39.86	3.33	21.22	6.66	3.49	7.91	0.26	6.59
<b>Industrial</b>	196.44	1.68	28.10	2.35	15.48	4.86	2.79	6.31	0.20	4.88
<b>Other Residential</b>	780.75	6.67	89.93	7.52	35.15	11.03	6.45	14.60	0.73	18.25
<b>Religion</b>	58.23	0.50	7.90	0.66	3.94	1.24	0.83	1.88	0.10	2.41
<b>Single Family</b>	9501.01	81.16	893.54	74.72	173.47	54.42	17.39	39.38	1.59	39.59
<b>Total</b>	<b>11,707</b>		<b>1,196</b>		<b>319</b>		<b>44</b>		<b>4</b>	

**Table 4: Expected Building Damage by Building Type (All Design Levels)**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Wood</b>	9952.03	85.01	910.96	76.18	147.23	46.19	7.95	18.00	0.00	0.00
<b>Steel</b>	709.74	6.06	91.18	7.62	50.47	15.83	7.44	16.86	0.30	7.54
<b>Concrete</b>	122.94	1.05	18.22	1.52	10.63	3.33	1.10	2.50	0.04	1.11
<b>Precast</b>	42.82	0.37	6.73	0.56	6.36	2.00	1.85	4.19	0.04	0.90
<b>RM</b>	181.43	1.55	18.18	1.52	14.16	4.44	3.17	7.18	0.01	0.19
<b>URM</b>	698.28	5.96	150.54	12.59	89.91	28.21	22.65	51.28	3.63	90.26
<b>MH</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>11,707</b>		<b>1,196</b>		<b>319</b>		<b>44</b>		<b>4</b>	

\*Note:

- RM Reinforced Masonry
- URM Unreinforced Masonry
- MH Manufactured Housing

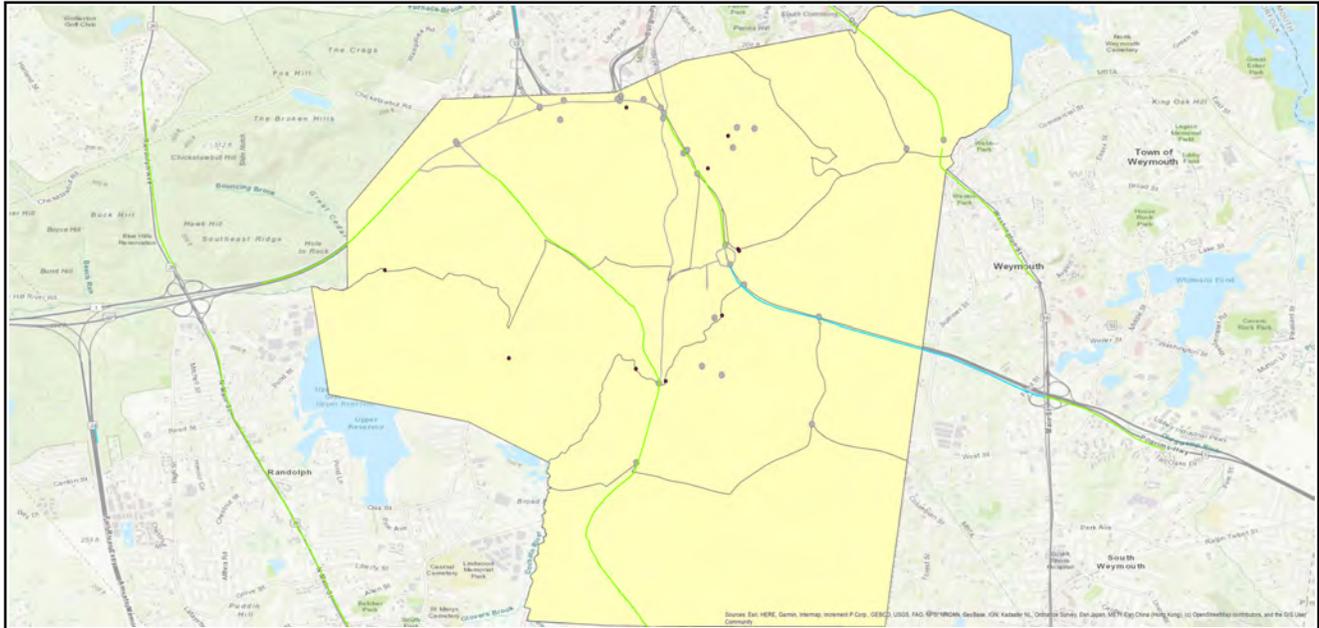
### Essential Facility Damage

Before the earthquake, the region had 166 hospital beds available for use. On the day of the earthquake, the model estimates that only 113 hospital beds (68.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 85.00% of the beds will be back in service. By 30 days, 96.00% will be operational.

**Table 5: Expected Damage to Essential Facilities**

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	0	0	1
Schools	18	0	0	18
EOCs	2	0	0	2
PoliceStations	1	0	0	1
FireStations	3	0	0	3

**Transportation Lifeline Damage**



**Table 6: Expected Damage to the Transportation Systems**

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	71	0	0	53	53
	Bridges	43	0	0	43	43
	Tunnels	0	0	0	0	0
Railways	Segments	26	0	0	23	23
	Bridges	9	0	0	9	9
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	2	0	0	2	2
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

**Table 7 : Expected Utility System Facility Damage**

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	1	0	0	1	1
Communication	0	0	0	0	0

**Table 8 : Expected Utility System Pipeline Damage (Site Specific)**

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	182	3	1
Waste Water	109	1	0
Natural Gas	19	0	0
Oil	0	0	0

**Table 9: Expected Potable Water and Electric Power System Performance**

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	14,510	0	0	0	0	0
Electric Power		0	0	0	0	0

## Induced Earthquake Damage

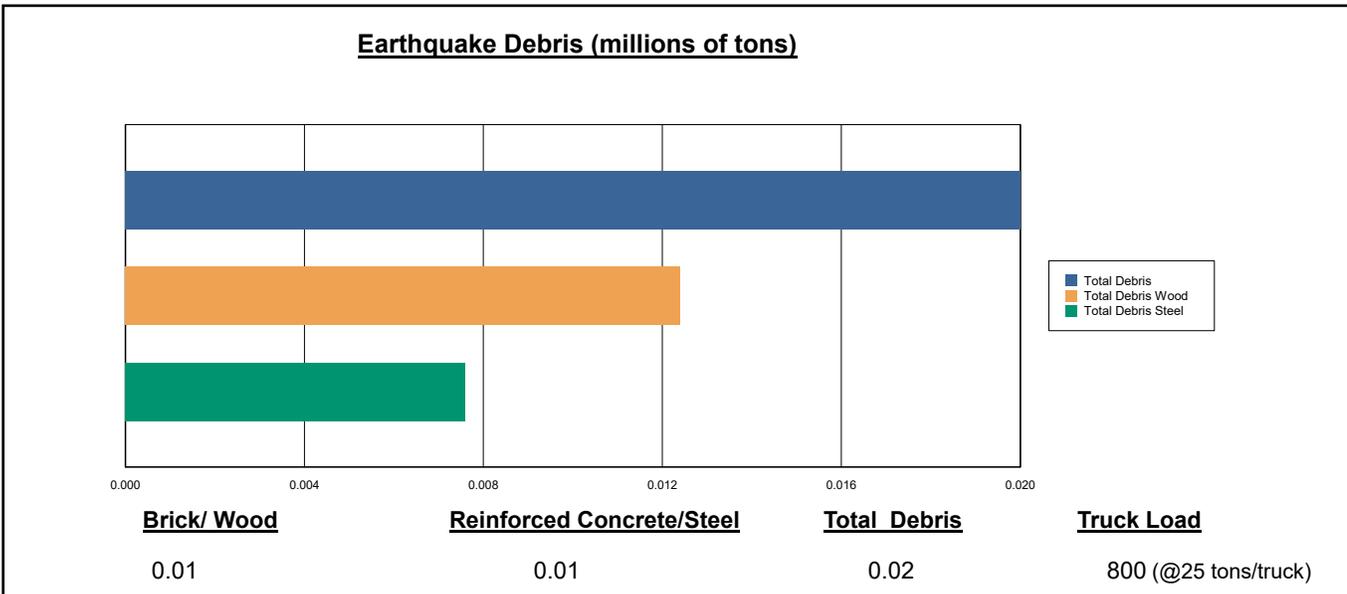
### Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

### Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

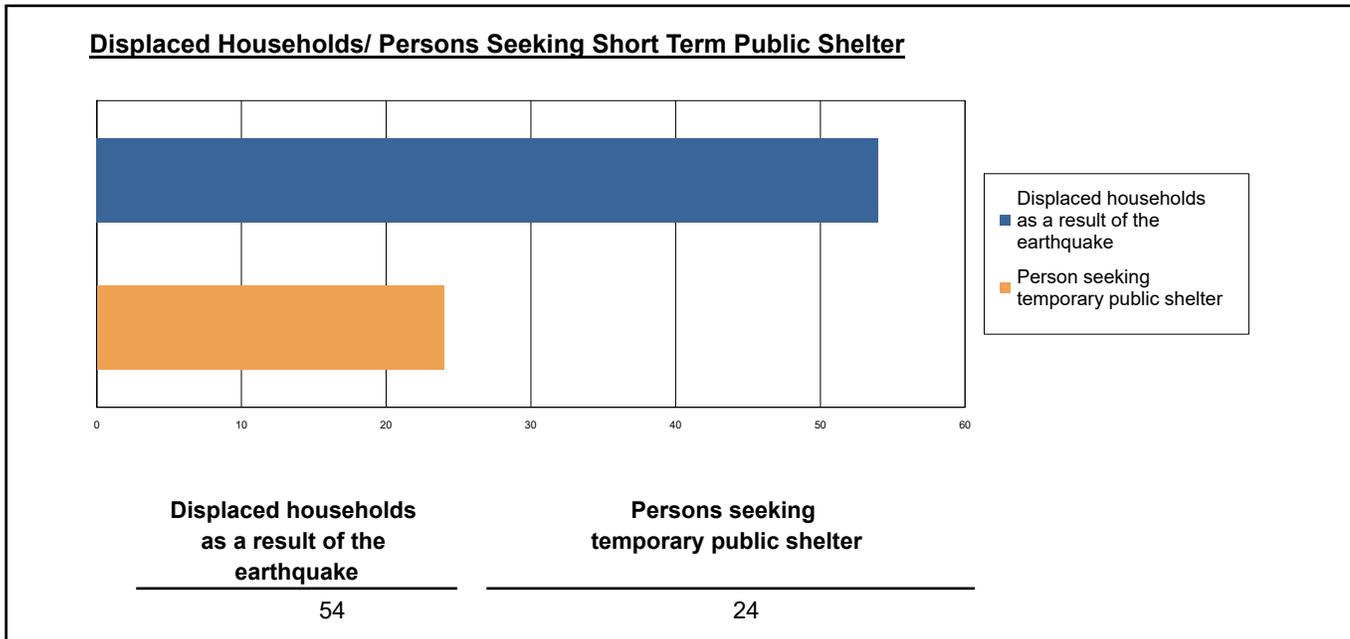
The model estimates that a total of 20,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 62.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 800 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.



## Social Impact

### Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 54 households to be displaced due to the earthquake. Of these, 24 people (out of a total population of 39,143) will seek temporary shelter in public shelters.



### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

**Table 10: Casualty Estimates**

		Level 1	Level 2	Level 3	Level 4
<b>2 AM</b>	Commercial	0.24	0.04	0.00	0.01
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.01	0.00	0.00	0.00
	Industrial	0.13	0.02	0.00	0.00
	Other-Residential	2.69	0.43	0.04	0.08
	Single Family	3.91	0.44	0.04	0.07
	<b>Total</b>	<b>7</b>	<b>1</b>	<b>0</b>	<b>0</b>
<b>2 PM</b>	Commercial	13.74	2.07	0.19	0.37
	Commuting	0.00	0.00	0.00	0.00
	Educational	2.82	0.44	0.04	0.08
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.97	0.14	0.01	0.02
	Other-Residential	0.75	0.12	0.01	0.02
	Single Family	1.02	0.12	0.01	0.02
	<b>Total</b>	<b>19</b>	<b>3</b>	<b>0</b>	<b>1</b>
<b>5 PM</b>	Commercial	8.90	1.35	0.13	0.24
	Commuting	0.01	0.01	0.01	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.60	0.09	0.01	0.01
	Other-Residential	1.07	0.17	0.02	0.04
	Single Family	1.50	0.18	0.02	0.03
	<b>Total</b>	<b>12</b>	<b>2</b>	<b>0</b>	<b>0</b>



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## Economic Loss

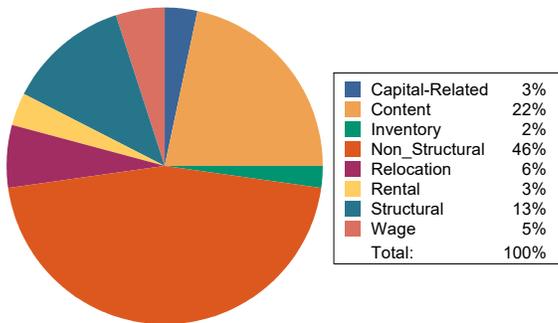
The total economic loss estimated for the earthquake is 151.13 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

### Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 128.39 (millions of dollars); 18 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 40 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type (\$ millions)



Earthquake Losses by Occupancy Type (\$ millions)

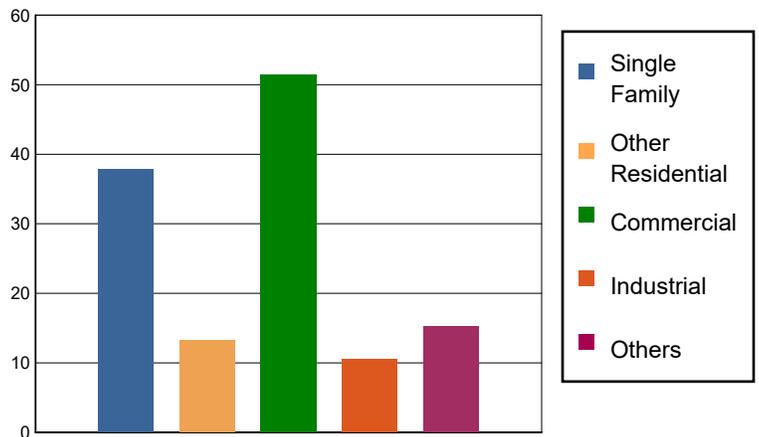


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
<b>Income Losses</b>							
	Wage	0.0000	0.7873	4.5739	0.1562	0.7516	6.2690
	Capital-Related	0.0000	0.3350	3.9359	0.0965	0.0839	4.4513
	Rental	0.4560	0.9496	2.6497	0.0928	0.3270	4.4751
	Relocation	1.5751	0.5273	3.8164	0.4119	1.6852	8.0159
	<b>Subtotal</b>	<b>2.0311</b>	<b>2.5992</b>	<b>14.9759</b>	<b>0.7574</b>	<b>2.8477</b>	<b>23.2113</b>
<b>Capital Stock Losses</b>							
	Structural	4.3713	1.4076	6.9028	1.2848	2.1008	16.0673
	Non_Structural	22.8393	7.2387	17.1946	4.6775	6.5371	58.4872
	Content	8.6404	2.0458	9.9880	3.3094	3.7708	27.7544
	Inventory	0.0000	0.0000	2.3432	0.4812	0.0423	2.8667
	<b>Subtotal</b>	<b>35.8510</b>	<b>10.6921</b>	<b>36.4286</b>	<b>9.7529</b>	<b>12.4510</b>	<b>105.1756</b>
	<b>Total</b>	<b>37.88</b>	<b>13.29</b>	<b>51.40</b>	<b>10.51</b>	<b>15.30</b>	<b>128.39</b>

### Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

**Table 12: Transportation System Economic Losses**  
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	805.7967	0.0000	0.00
	Bridges	92.8843	0.1999	0.22
	Tunnels	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>898.6810</b>	<b>0.1999</b>	
Railways	Segments	2525.0804	0.0000	0.00
	Bridges	46.7100	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>2571.7904</b>	<b>0.0000</b>	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Bus	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Ferry	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Port	Facilities	6.9537	0.6581	9.46
	<b>Subtotal</b>	<b>6.9537</b>	<b>0.6581</b>	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
<b>Total</b>		<b>3,477.43</b>	<b>0.86</b>	

**Table 13: Utility System Economic Losses**  
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	5.8696	0.0115	0.20
	<b>Subtotal</b>	<b>5.8696</b>	<b>0.0115</b>	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	3.5218	0.0058	0.16
	<b>Subtotal</b>	<b>3.5218</b>	<b>0.0058</b>	
Natural Gas	Pipelines	195.2346	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	2.3479	0.0020	0.09
	<b>Subtotal</b>	<b>197.5825</b>	<b>0.0020</b>	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Electrical Power	Facilities	317.4796	21.8626	6.89
	<b>Subtotal</b>	<b>317.4796</b>	<b>21.8626</b>	
Communication	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
	<b>Total</b>	<b>524.45</b>	<b>21.88</b>	



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**Appendix A: County Listing for the Region**

Norfolk,MA

**Appendix B: Regional Population and Building Value Data**

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
<b>Massachusetts</b>	Norfolk	39,143	5,135	3,362	8,498
<b>Total Region</b>		<b>39,143</b>	<b>5,135</b>	<b>3,362</b>	<b>8,498</b>



# Hazus: Flood Global Risk Report

**Region Name:** Braintree\_Cat1

**Flood Scenario:** Category1

**Print Date:** Monday, December 18, 2023

**Disclaimer:**

Totals only reflect data for those census tracts/blocks included in the user's study region.

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



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## General Description of the Region

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

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

- Massachusetts

Note:

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

The geographical size of the region is approximately 6 square miles and contains 432 census blocks. The region contains over 15 thousand households and has a total population of 39,143 people. The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 13,270 buildings in the region with a total building replacement value (excluding contents) of 8,497 million dollars. Approximately 86.66% of the buildings (and 60.43% of the building value) are associated with residential housing.



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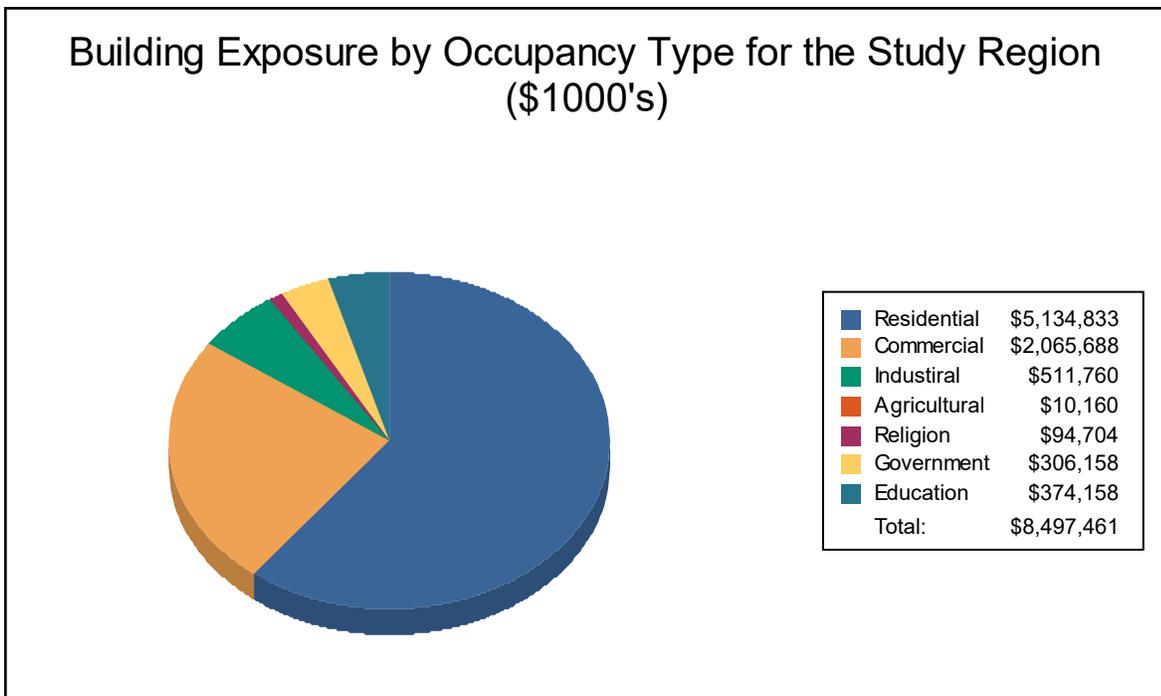
## Building Inventory

### General Building Stock

Hazus estimates that there are 13,270 buildings in the region which have an aggregate total replacement value of 8,497 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

**Table 1**  
**Building Exposure by Occupancy Type for the Study Region**

Occupancy	Exposure (\$1000)	Percent of Total
Residential	5,134,833	60.4%
Commercial	2,065,688	24.3%
Industrial	511,760	6.0%
Agricultural	10,160	0.1%
Religion	94,704	1.1%
Government	306,158	3.6%
Education	374,158	4.4%
<b>Total</b>	<b>8,497,461</b>	<b>100%</b>



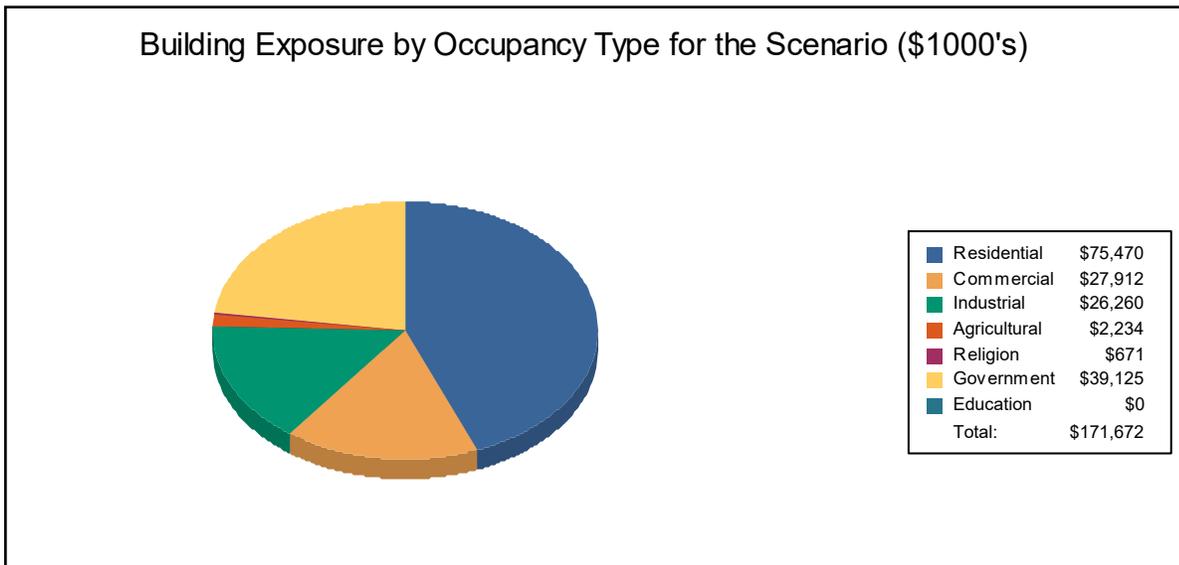
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**Table 2**  
**Building Exposure by Occupancy Type for the Scenario**

<b>Occupancy</b>	<b>Exposure (\$1000)</b>	<b>Percent of Total</b>
Residential	75,470	44.0%
Commercial	27,912	16.3%
Industrial	26,260	15.3%
Agricultural	2,234	1.3%
Religion	671	0.4%
Government	39,125	22.8%
Education	0	0.0%
<b>Total</b>	<b>171,672</b>	<b>100%</b>



**Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 166 beds. There are 18 schools, 3 fire stations, 1 police station and 2 emergency operation centers.



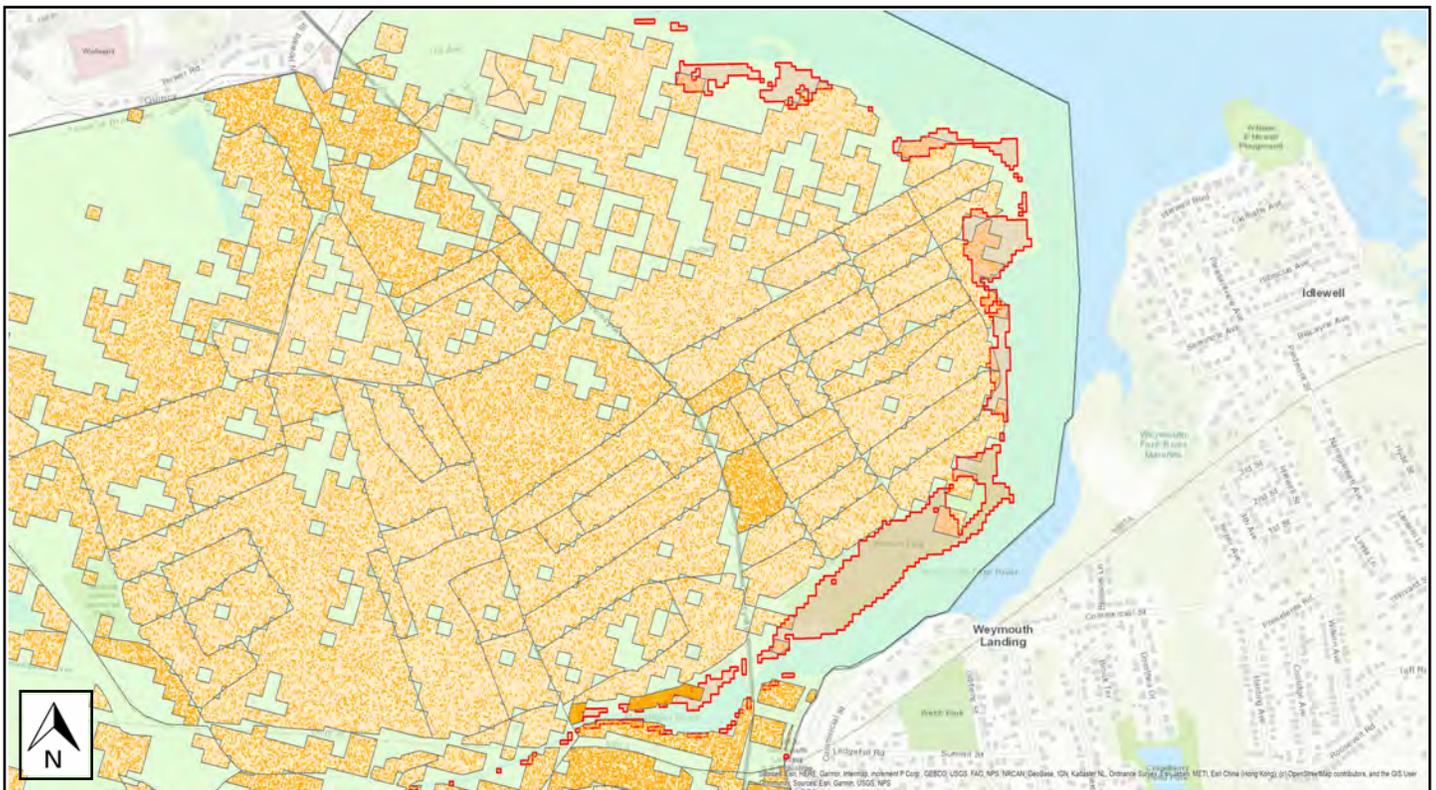
## Flood Scenario Parameters

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

<b>Study Region Name:</b>	Braintree_Cat1
<b>Scenario Name:</b>	Category1
<b>Return Period Analyzed:</b>	100
<b>Analysis Options Analyzed:</b>	No What-Ifs

### Study Region Overview Map

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



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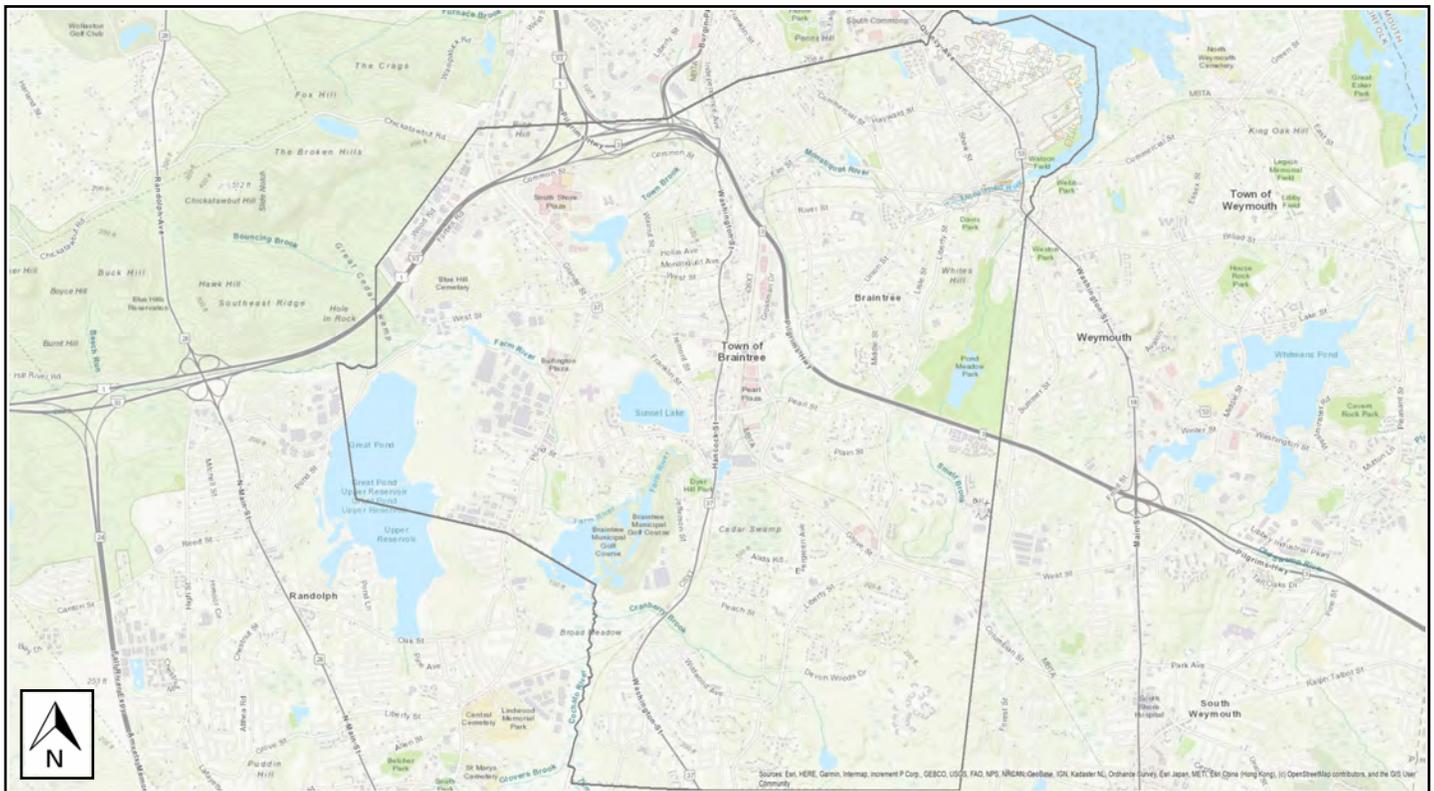


## Building Damage

### General Building Stock Damage

Hazus estimates that about 1 building will be at least moderately damaged. This is over 29% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

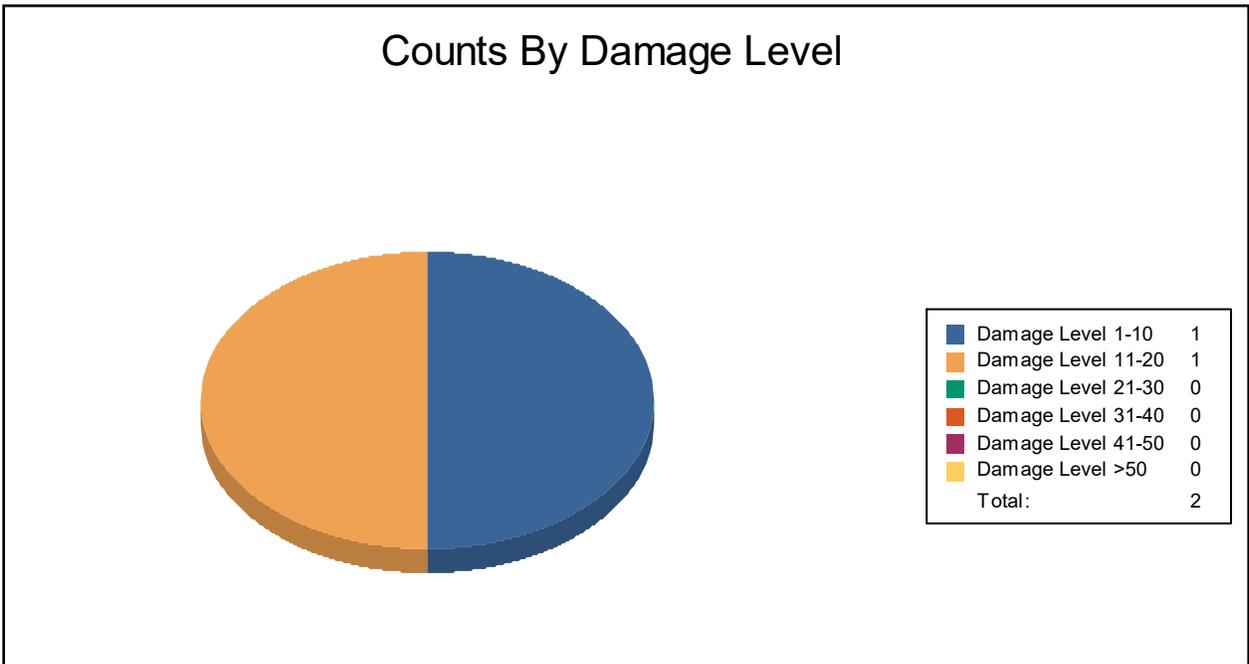
Total Economic Loss (1 dot = \$300K) Overview Map





**Table 3: Expected Building Damage by Occupancy**

Occupancy	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)										
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	1	50	1	50	0	0	0	0	0	0	0	0
<b>Total</b>	<b>1</b>		<b>1</b>		<b>0</b>		<b>0</b>		<b>0</b>		<b>0</b>	



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**Table 4: Expected Building Damage by Building Type**

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)										
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	0	0	0	0	0	0	0	0	0	0
Wood	1	50	1	50	0	0	0	0	0	0	0	0



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## Essential Facility Damage

Before the flood analyzed in this scenario, the region had 166 hospital beds available for use. On the day of the scenario flood event, the model estimates that 166 hospital beds are available in the region.

**Table 5: Expected Damage to Essential Facilities**

Classification	# Facilities			
	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	3	0	0	0
Hospitals	1	0	0	0
Police Stations	1	0	0	0
Schools	18	0	0	0

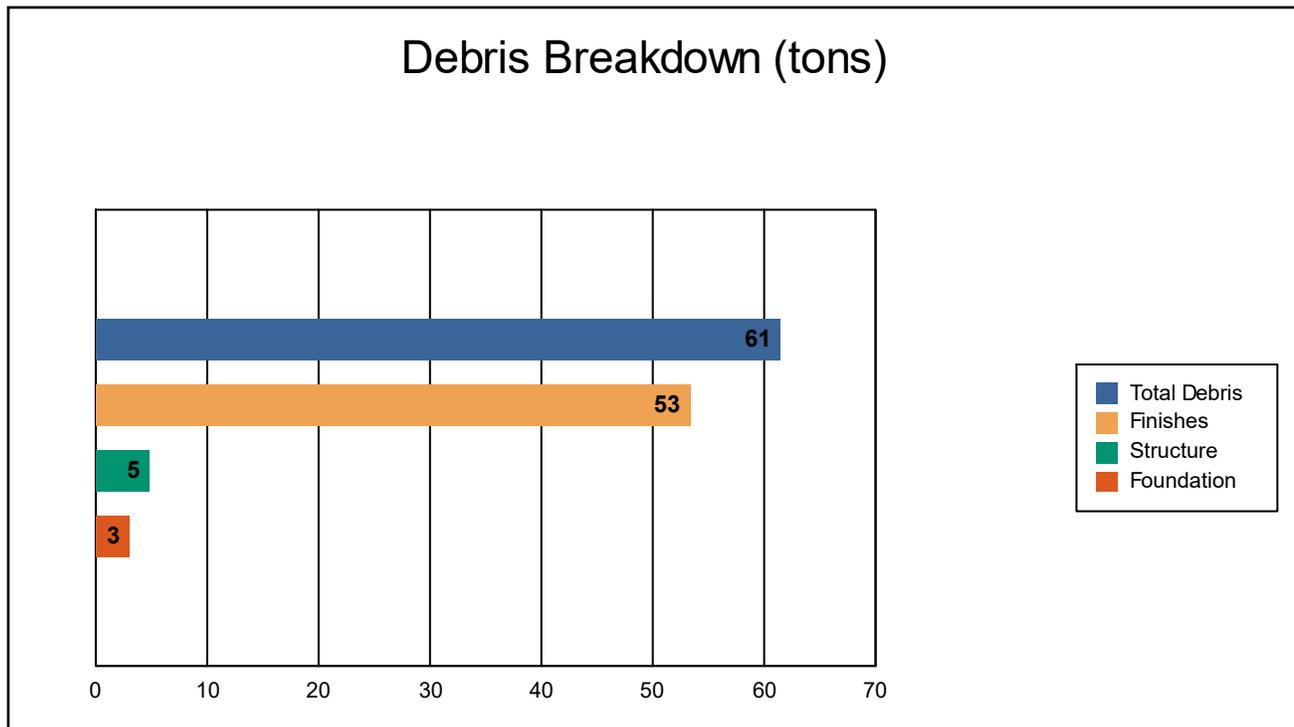
If this report displays all zeros or is blank, two possibilities can explain this.

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

## Induced Flood Damage

### Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.



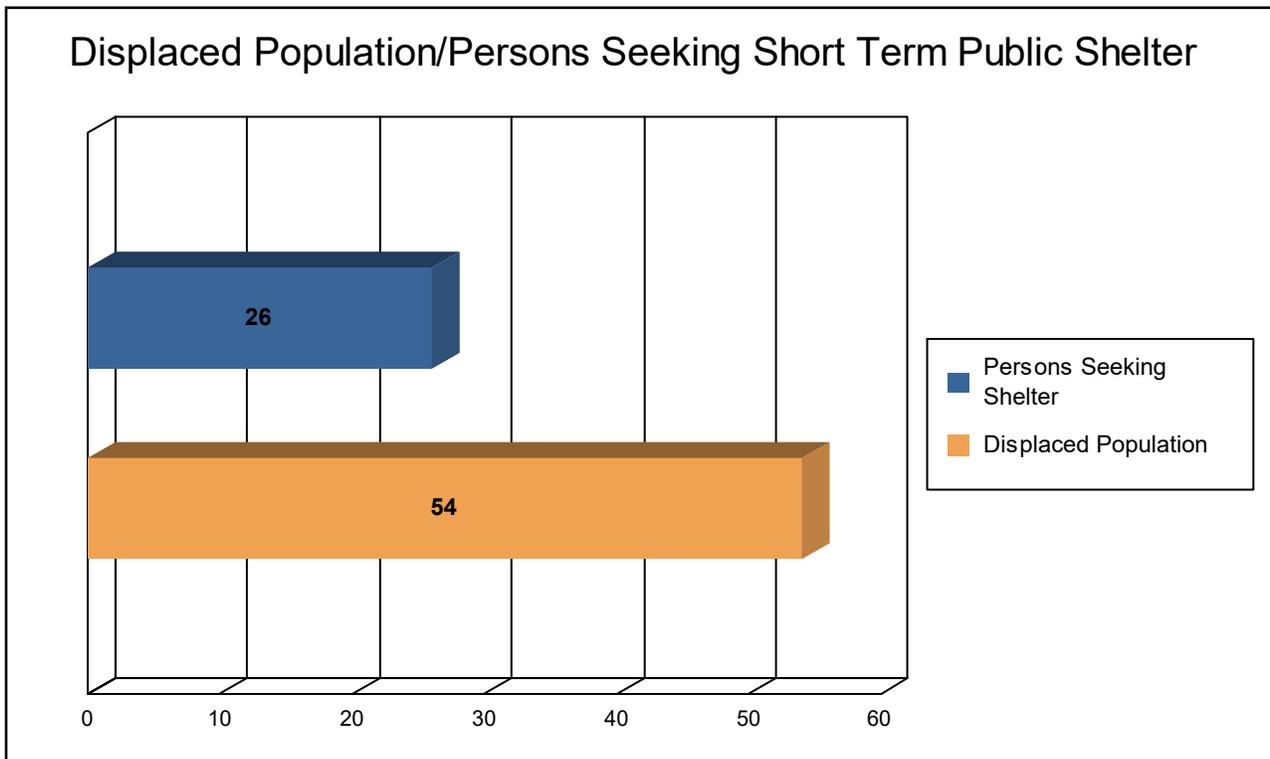
The model estimates that a total of 61 tons of debris will be generated. Of the total amount, Finishes comprises 87% of the total, Structure comprises 8% of the total, and Foundation comprises 5%. If the debris tonnage is converted into an estimated number of truckloads, it will require 3 truckloads (@25 tons/truck) to remove the debris generated by the flood.



## Social Impact

### Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 18 households (or 54 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 26 people (out of a total population of 39,143) will seek temporary shelter in public shelters.



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## Economic Loss

The total economic loss estimated for the flood is 12.32 million dollars, which represents 7.18 % of the total replacement value of the scenario buildings.

### **Building-Related Losses**

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 3.71 million dollars. 70% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 7.89% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.



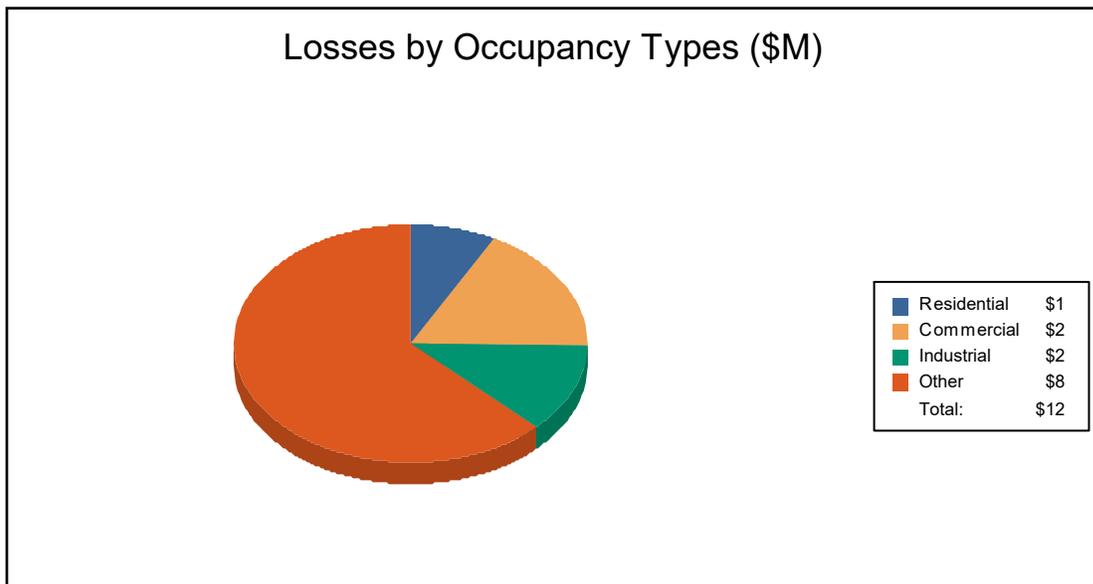
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**Table 6: Building-Related Economic Loss Estimates**  
(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
<u>Building Loss</u>						
	Building	0.37	0.19	0.37	0.11	1.04
	Content	0.30	0.56	0.92	0.74	2.51
	Inventory	0.00	0.02	0.14	0.01	0.16
	<b>Subtotal</b>	<b>0.67</b>	<b>0.76</b>	<b>1.42</b>	<b>0.86</b>	<b>3.71</b>
<u>Business Interruption</u>						
	Income	0.00	0.54	0.03	0.26	0.82
	Relocation	0.19	0.11	0.02	0.34	0.67
	Rental Income	0.11	0.08	0.01	0.13	0.32
	Wage	0.00	0.64	0.05	6.11	6.80
	<b>Subtotal</b>	<b>0.30</b>	<b>1.37</b>	<b>0.10</b>	<b>6.84</b>	<b>8.61</b>
<b>ALL</b>	<b>Total</b>	<b>0.97</b>	<b>2.13</b>	<b>1.52</b>	<b>7.70</b>	<b>12.32</b>





## **Appendix A: County Listing for the Region**

Massachusetts

- Norfolk



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**Appendix B: Regional Population and Building Value Data**

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
<b>Massachusetts</b>				
Norfolk	39,143	5,134,833	3,362,628	8,497,461
<b>Total</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>
<b>Total Study Region</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>



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# Hazus: Flood Global Risk Report

**Region Name:** Braintree\_Cat2

**Flood Scenario:** Category2

**Print Date:** Monday, December 18, 2023

**Disclaimer:**

Totals only reflect data for those census tracts/blocks included in the user's study region.

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



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## General Description of the Region

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

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

- Massachusetts

Note:

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

The geographical size of the region is approximately 6 square miles and contains 432 census blocks. The region contains over 15 thousand households and has a total population of 39,143 people. The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 13,270 buildings in the region with a total building replacement value (excluding contents) of 8,497 million dollars. Approximately 86.66% of the buildings (and 60.43% of the building value) are associated with residential housing.



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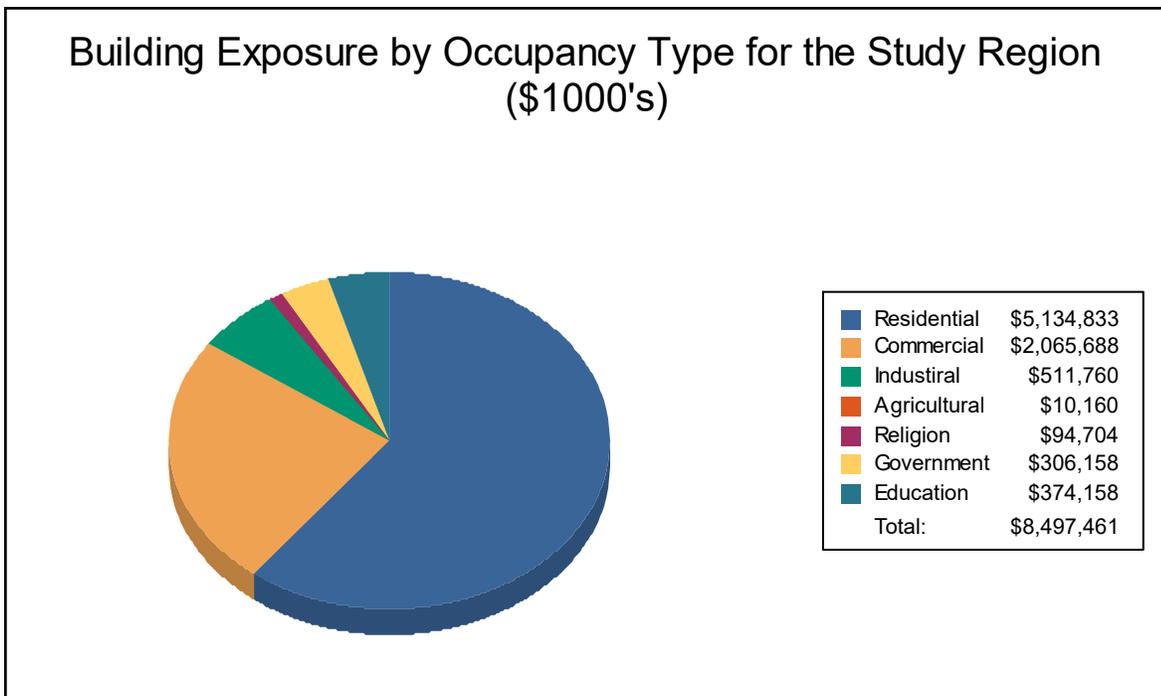
## Building Inventory

### General Building Stock

Hazus estimates that there are 13,270 buildings in the region which have an aggregate total replacement value of 8,497 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

**Table 1**  
**Building Exposure by Occupancy Type for the Study Region**

Occupancy	Exposure (\$1000)	Percent of Total
Residential	5,134,833	60.4%
Commercial	2,065,688	24.3%
Industrial	511,760	6.0%
Agricultural	10,160	0.1%
Religion	94,704	1.1%
Government	306,158	3.6%
Education	374,158	4.4%
<b>Total</b>	<b>8,497,461</b>	<b>100%</b>



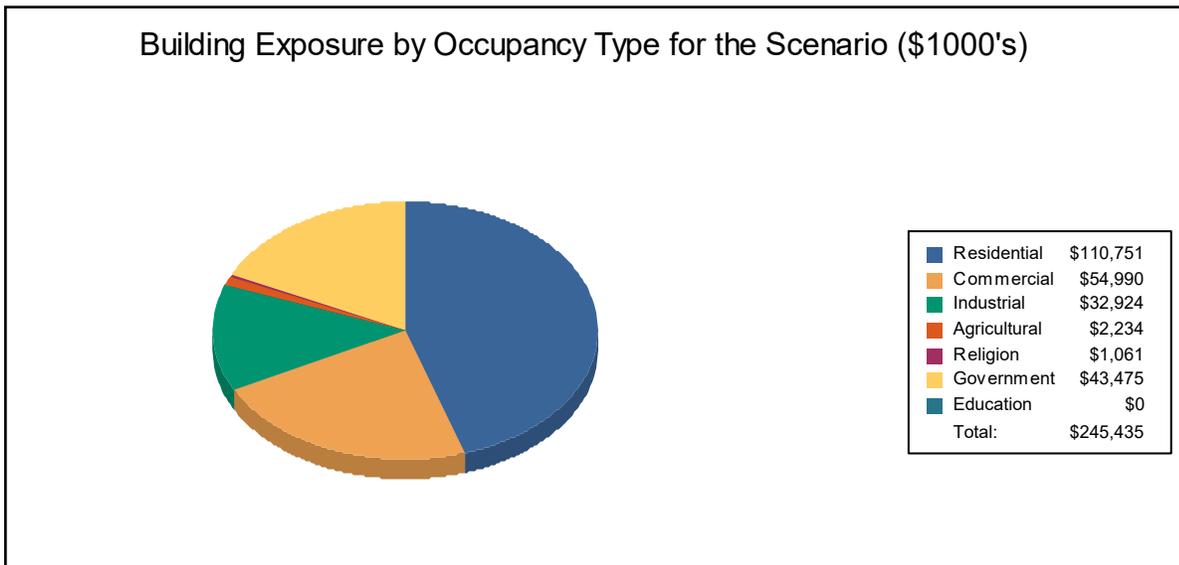
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**Table 2**  
**Building Exposure by Occupancy Type for the Scenario**

Occupancy	Exposure (\$1000)	Percent of Total
Residential	110,751	45.1%
Commercial	54,990	22.4%
Industrial	32,924	13.4%
Agricultural	2,234	0.9%
Religion	1,061	0.4%
Government	43,475	17.7%
Education	0	0.0%
<b>Total</b>	<b>245,435</b>	<b>100%</b>



**Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 166 beds. There are 18 schools, 3 fire stations, 1 police station and 2 emergency operation centers.



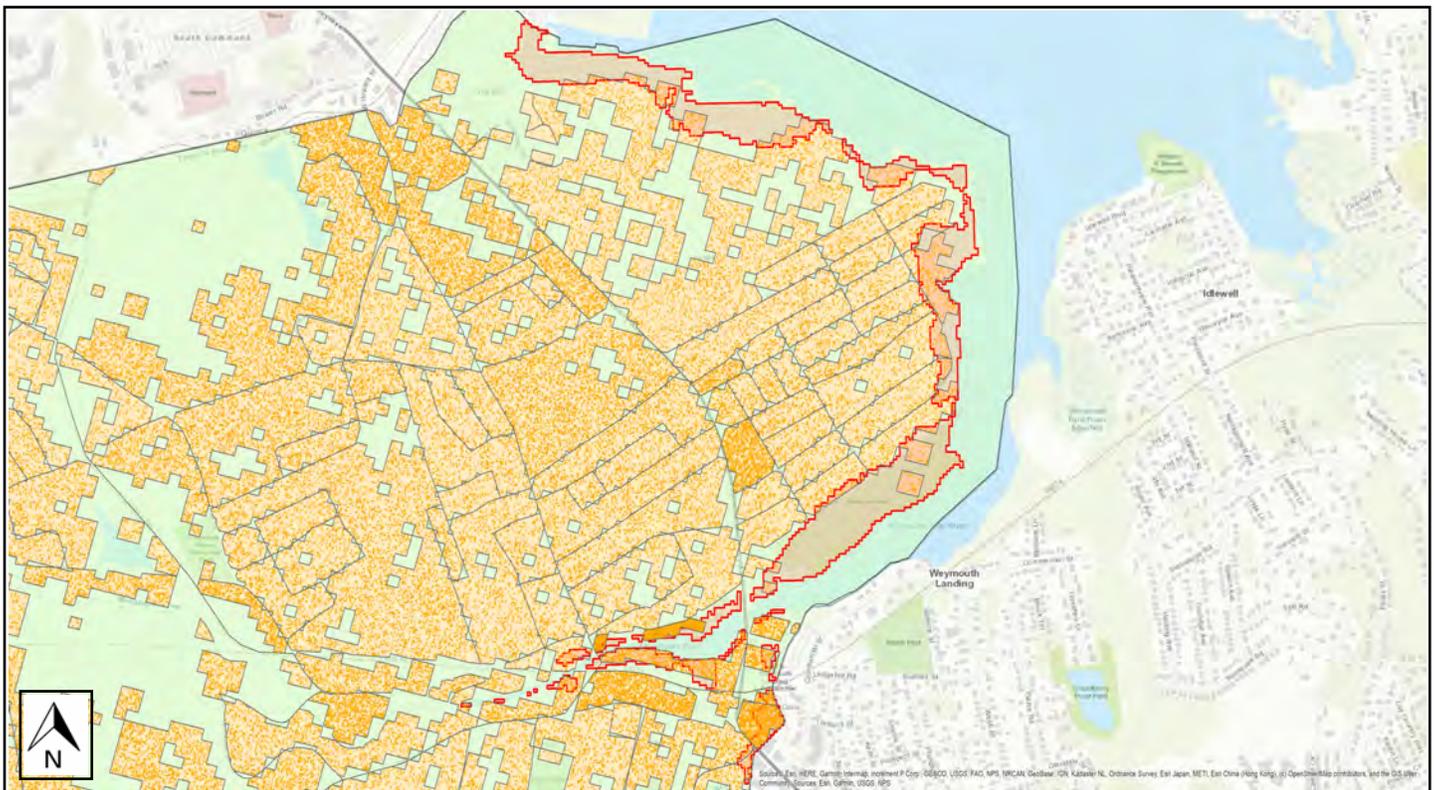
## Flood Scenario Parameters

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

<b>Study Region Name:</b>	Braintree_Cat2
<b>Scenario Name:</b>	Category2
<b>Return Period Analyzed:</b>	100
<b>Analysis Options Analyzed:</b>	No What-Ifs

### Study Region Overview Map

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



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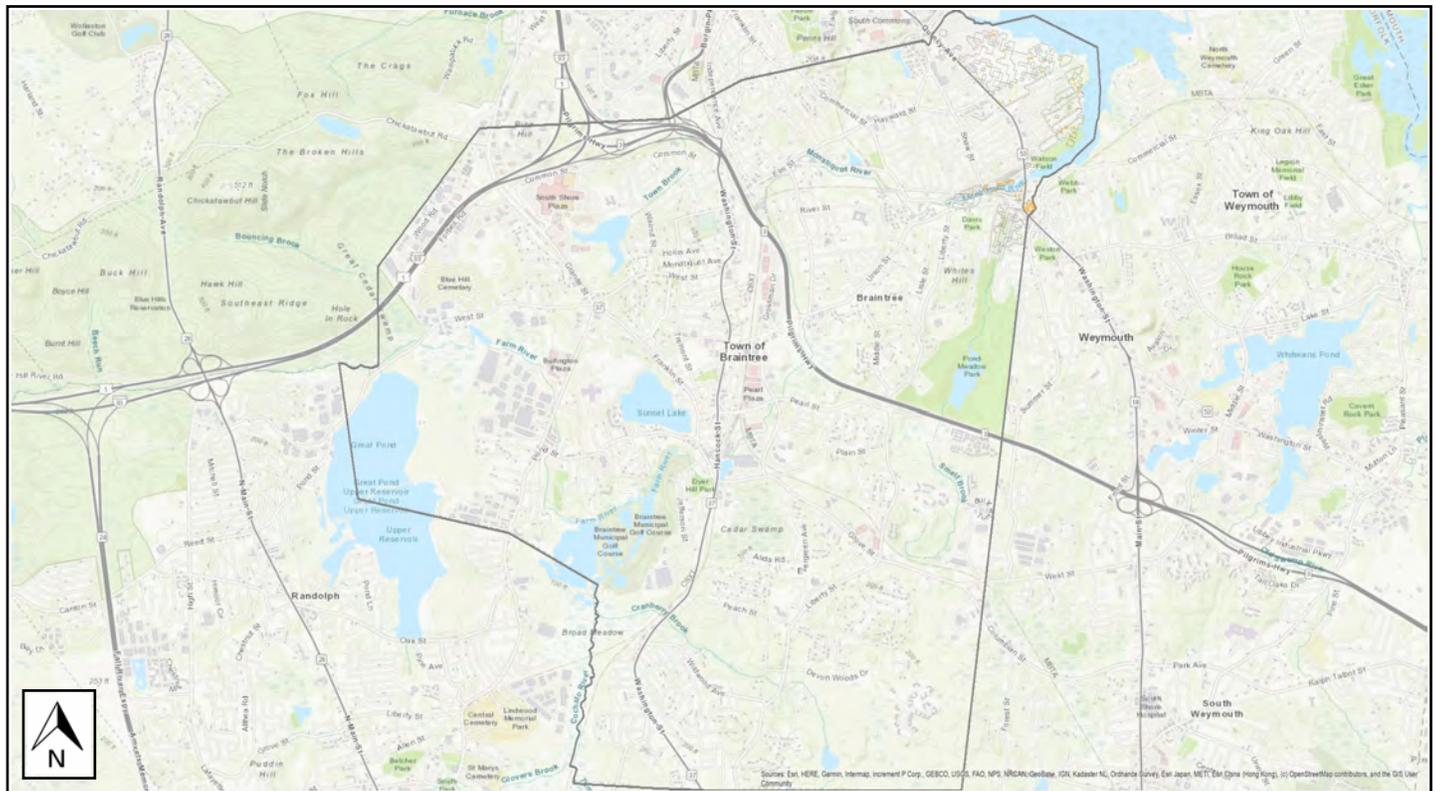


## Building Damage

### General Building Stock Damage

Hazus estimates that about 8 buildings will be at least moderately damaged. This is over 43% of the total number of buildings in the scenario. There are an estimated 1 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

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



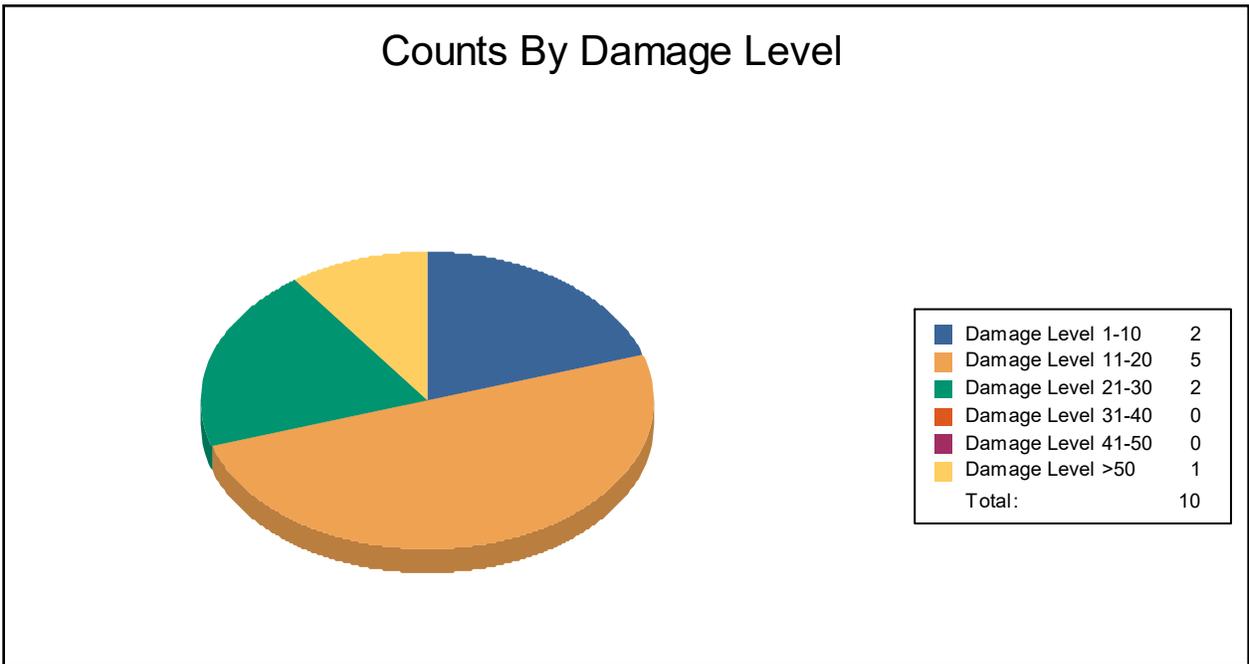
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**Table 3: Expected Building Damage by Occupancy**

Occupancy	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)										
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	1	100	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	2	22	4	44	2	22	0	0	0	0	1	11
<b>Total</b>	<b>2</b>		<b>5</b>		<b>2</b>		<b>0</b>		<b>0</b>		<b>1</b>	





**Table 4: Expected Building Damage by Building Type**

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)										
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	1	100	0	0	0	0	0	0	0	0
Wood	2	22	4	44	2	22	0	0	0	0	1	11



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## Essential Facility Damage

Before the flood analyzed in this scenario, the region had 166 hospital beds available for use. On the day of the scenario flood event, the model estimates that 166 hospital beds are available in the region.

**Table 5: Expected Damage to Essential Facilities**

Classification	# Facilities			
	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	3	0	0	0
Hospitals	1	0	0	0
Police Stations	1	0	0	0
Schools	18	0	0	0

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

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.



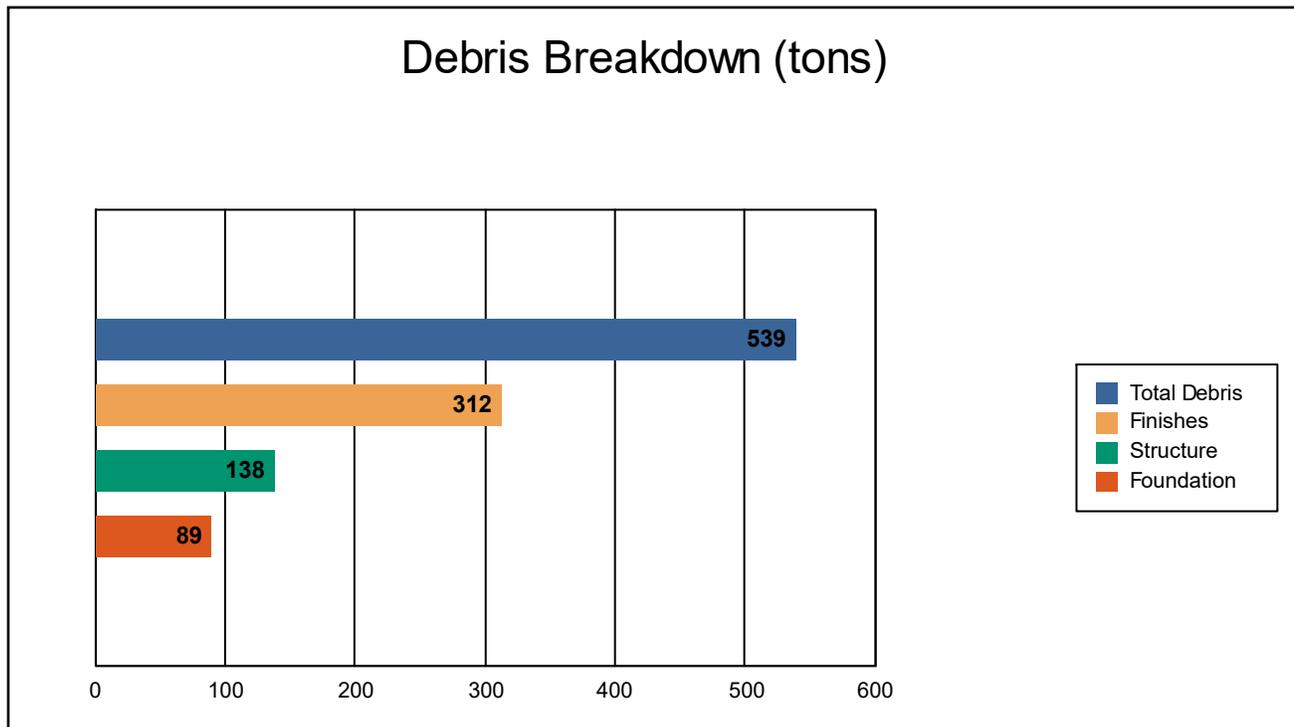
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## Induced Flood Damage

### Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.



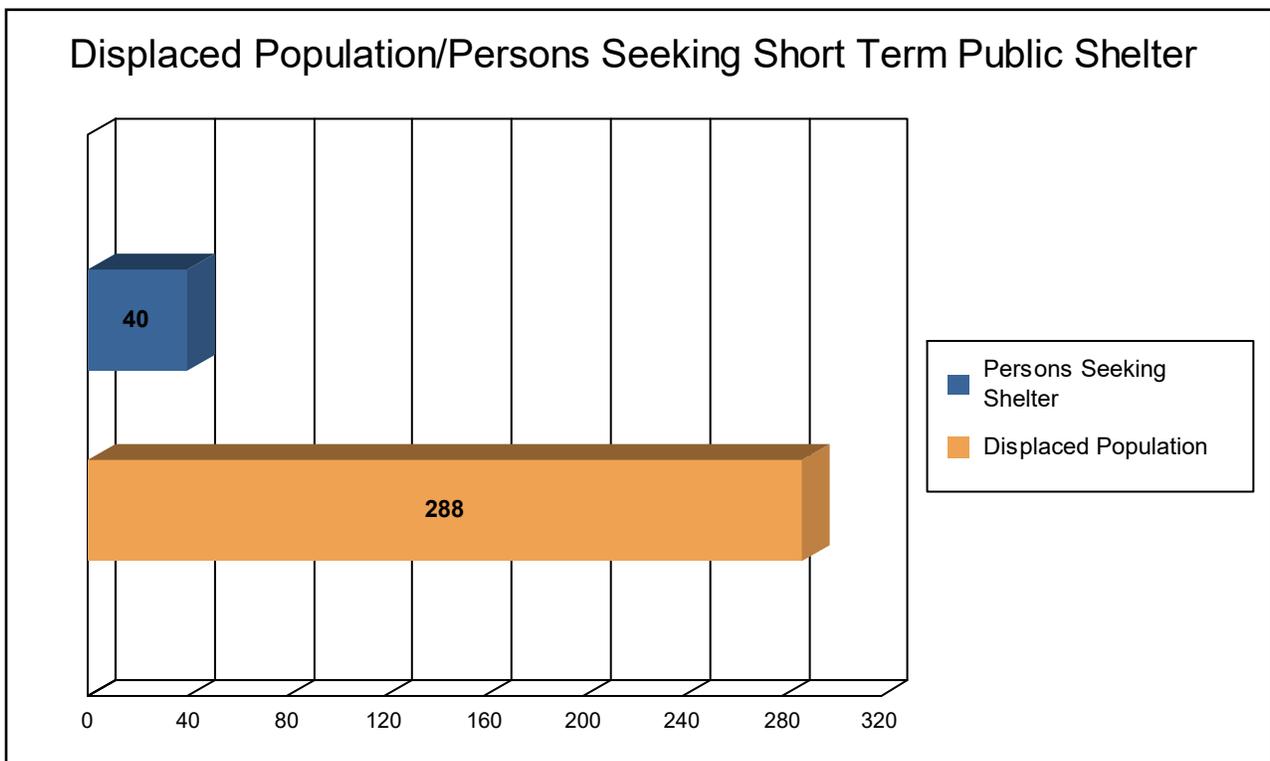
The model estimates that a total of 539 tons of debris will be generated. Of the total amount, Finishes comprises 58% of the total, Structure comprises 26% of the total, and Foundation comprises 16%. If the debris tonnage is converted into an estimated number of truckloads, it will require 22 truckloads (@25 tons/truck) to remove the debris generated by the flood.



## Social Impact

### Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 96 households (or 288 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 40 people (out of a total population of 39,143) will seek temporary shelter in public shelters.



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## Economic Loss

The total economic loss estimated for the flood is 52.73 million dollars, which represents 21.48 % of the total replacement value of the scenario buildings.

### **Building-Related Losses**

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 22.58 million dollars. 57% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 10.56% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.



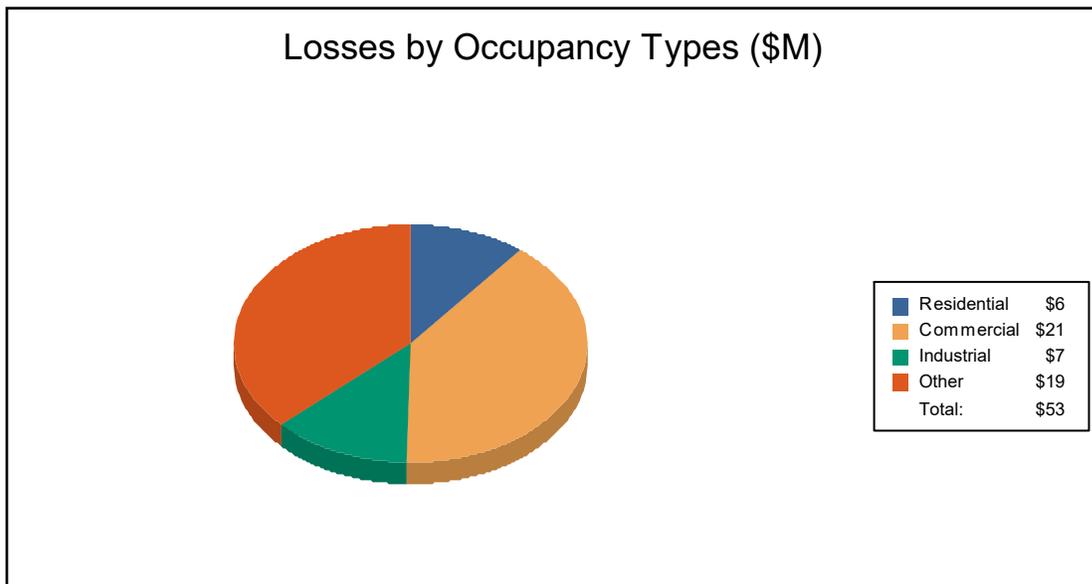
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**Table 6: Building-Related Economic Loss Estimates**  
(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
<u>Building Loss</u>						
	Building	2.49	1.64	1.60	0.45	6.18
	Content	1.94	6.60	4.26	2.79	15.59
	Inventory	0.00	0.16	0.62	0.03	0.81
	<b>Subtotal</b>	<b>4.43</b>	<b>8.41</b>	<b>6.48</b>	<b>3.27</b>	<b>22.58</b>
<u>Business Interruption</u>						
	Income	0.00	5.61	0.09	0.59	6.29
	Relocation	0.69	0.91	0.07	0.80	2.47
	Rental Income	0.44	0.71	0.02	0.32	1.49
	Wage	0.01	5.27	0.15	14.47	19.89
	<b>Subtotal</b>	<b>1.14</b>	<b>12.51</b>	<b>0.33</b>	<b>16.18</b>	<b>30.15</b>
<b>ALL</b>	<b>Total</b>	<b>5.57</b>	<b>20.91</b>	<b>6.80</b>	<b>19.44</b>	<b>52.73</b>



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## **Appendix A: County Listing for the Region**

Massachusetts

- Norfolk



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**Appendix B: Regional Population and Building Value Data**

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
<b>Massachusetts</b>				
Norfolk	39,143	5,134,833	3,362,628	8,497,461
<b>Total</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>
<b>Total Study Region</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>



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# Hazus: Flood Global Risk Report

**Region Name:** Braintree\_Cat3

**Flood Scenario:** Category3

**Print Date:** Monday, December 18, 2023

**Disclaimer:**

Totals only reflect data for those census tracts/blocks included in the user's study region.

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



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## General Description of the Region

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

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

- Massachusetts

Note:

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

The geographical size of the region is approximately 6 square miles and contains 432 census blocks. The region contains over 15 thousand households and has a total population of 39,143 people. The distribution of population by State and County for the study region is provided in Appendix B .

There are an estimated 13,270 buildings in the region with a total building replacement value (excluding contents) of 8,497 million dollars. Approximately 86.66% of the buildings (and 60.43% of the building value) are associated with residential housing.



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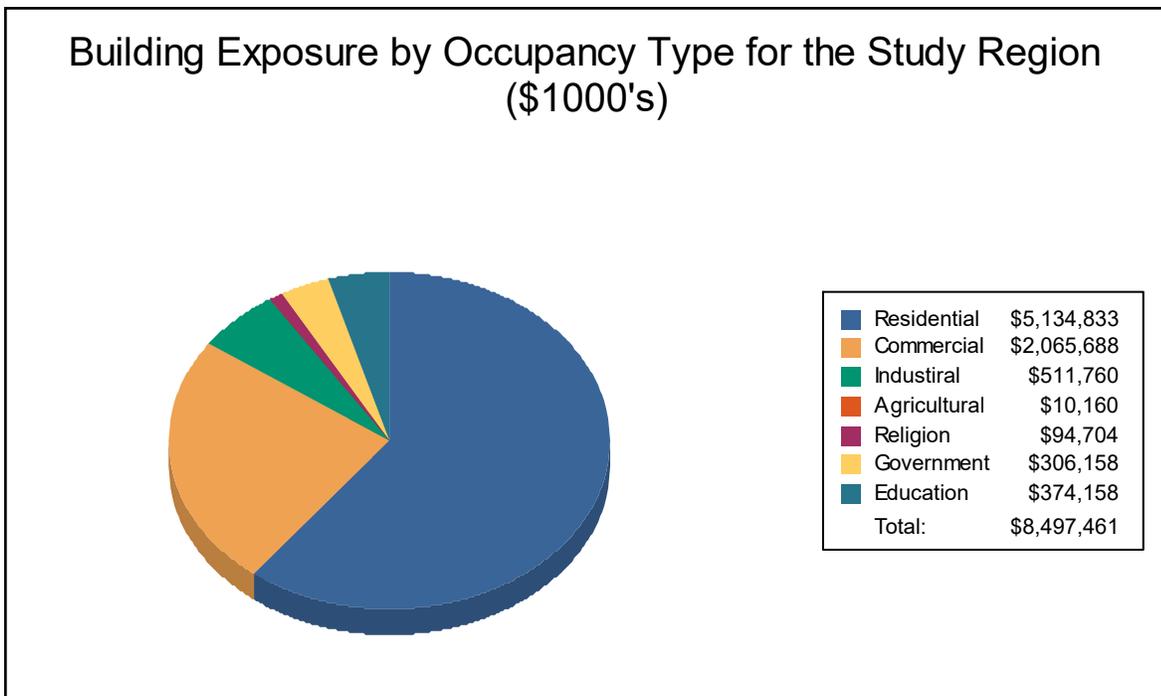
## Building Inventory

### General Building Stock

Hazus estimates that there are 13,270 buildings in the region which have an aggregate total replacement value of 8,497 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

**Table 1**  
**Building Exposure by Occupancy Type for the Study Region**

Occupancy	Exposure (\$1000)	Percent of Total
Residential	5,134,833	60.4%
Commercial	2,065,688	24.3%
Industrial	511,760	6.0%
Agricultural	10,160	0.1%
Religion	94,704	1.1%
Government	306,158	3.6%
Education	374,158	4.4%
<b>Total</b>	<b>8,497,461</b>	<b>100%</b>



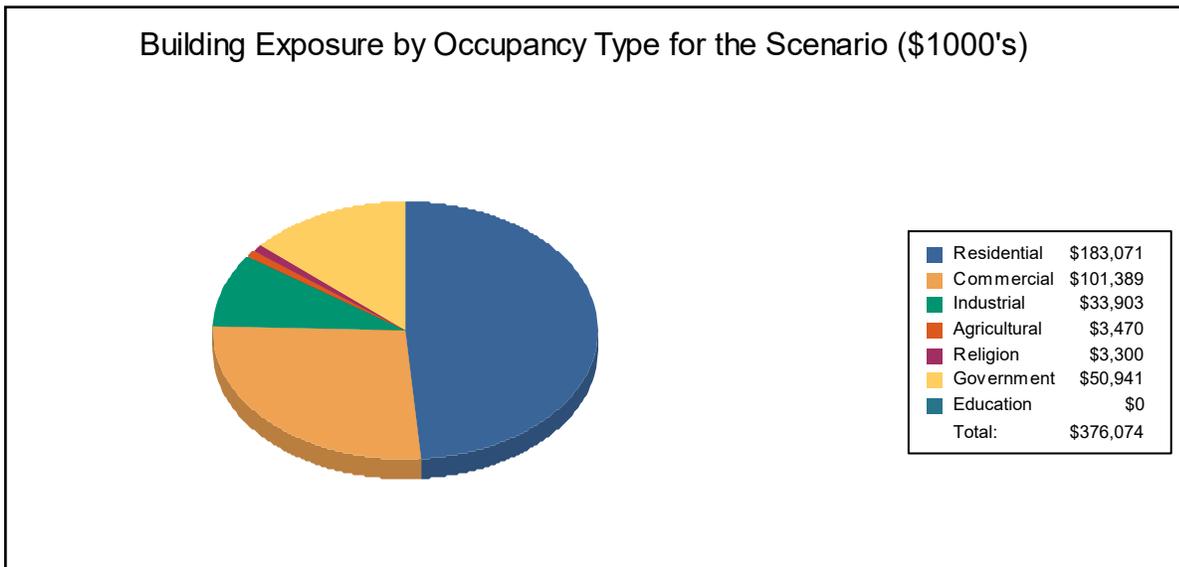
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**Table 2**  
**Building Exposure by Occupancy Type for the Scenario**

<b>Occupancy</b>	<b>Exposure (\$1000)</b>	<b>Percent of Total</b>
Residential	183,071	48.7%
Commercial	101,389	27.0%
Industrial	33,903	9.0%
Agricultural	3,470	0.9%
Religion	3,300	0.9%
Government	50,941	13.5%
Education	0	0.0%
<b>Total</b>	<b>376,074</b>	<b>100%</b>



**Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 166 beds. There are 18 schools, 3 fire stations, 1 police station and 2 emergency operation centers.



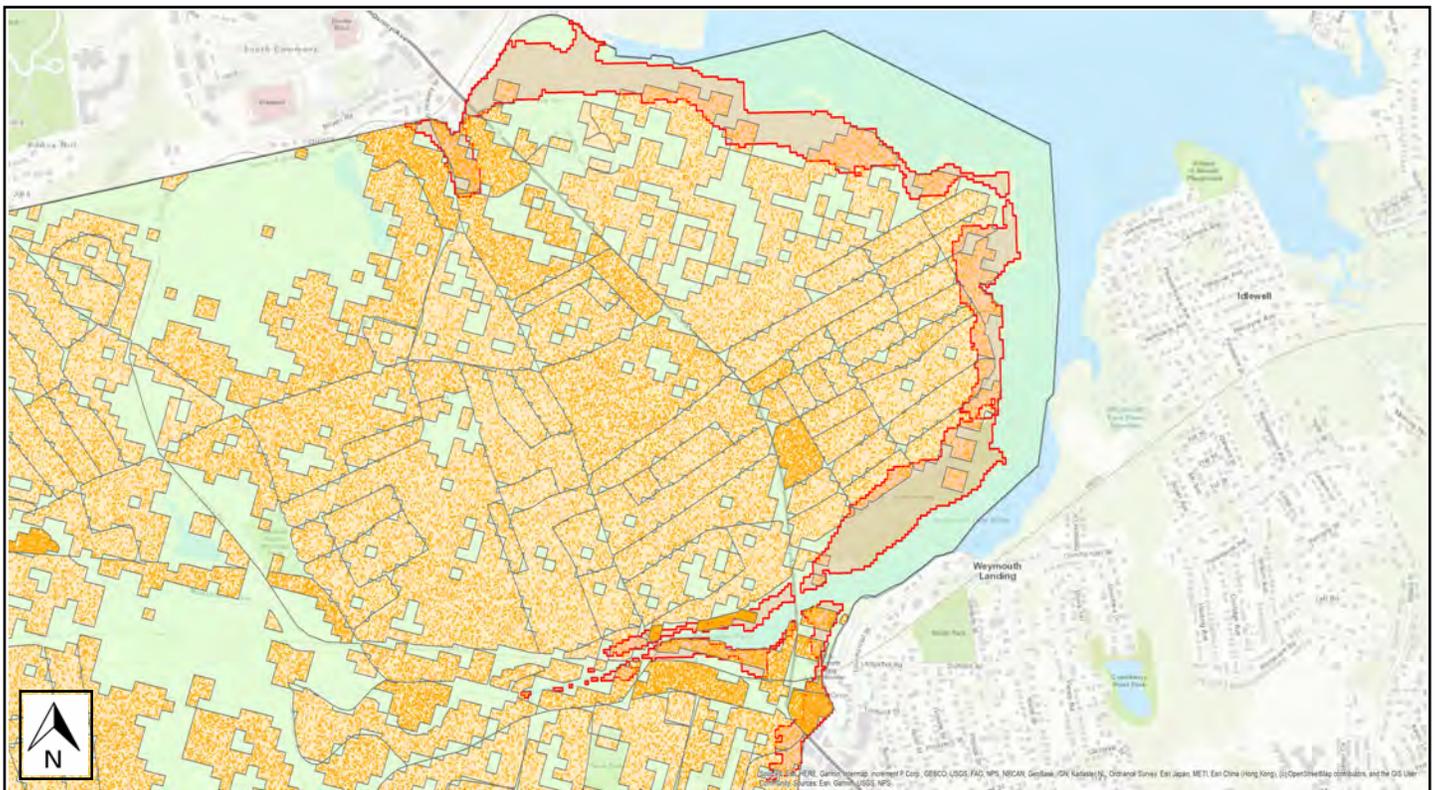
## Flood Scenario Parameters

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

<b>Study Region Name:</b>	Braintree_Cat3
<b>Scenario Name:</b>	Category3
<b>Return Period Analyzed:</b>	100
<b>Analysis Options Analyzed:</b>	No What-Ifs

### Study Region Overview Map

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



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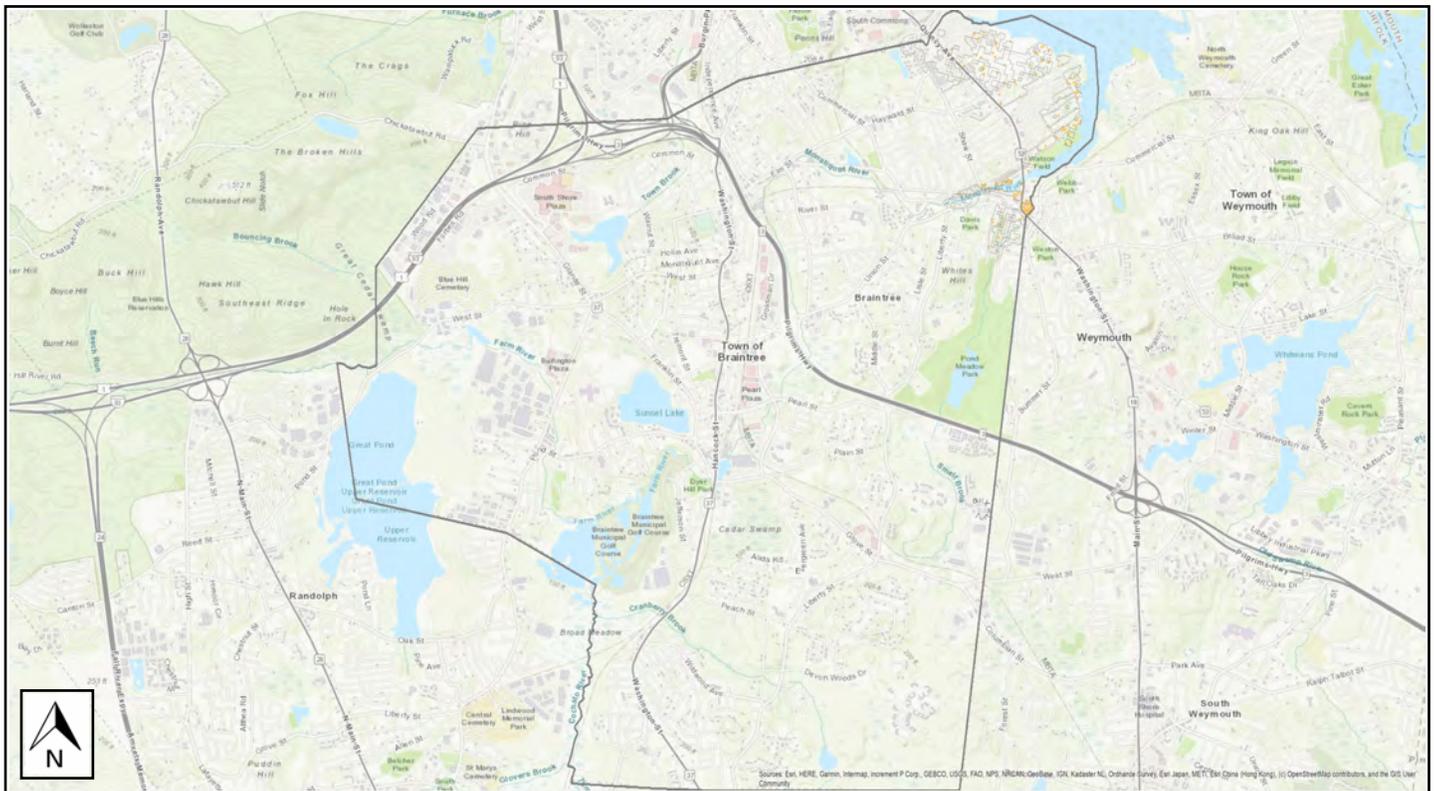


## Building Damage

### General Building Stock Damage

Hazus estimates that about 17 buildings will be at least moderately damaged. This is over 55% of the total number of buildings in the scenario. There are an estimated 2 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

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



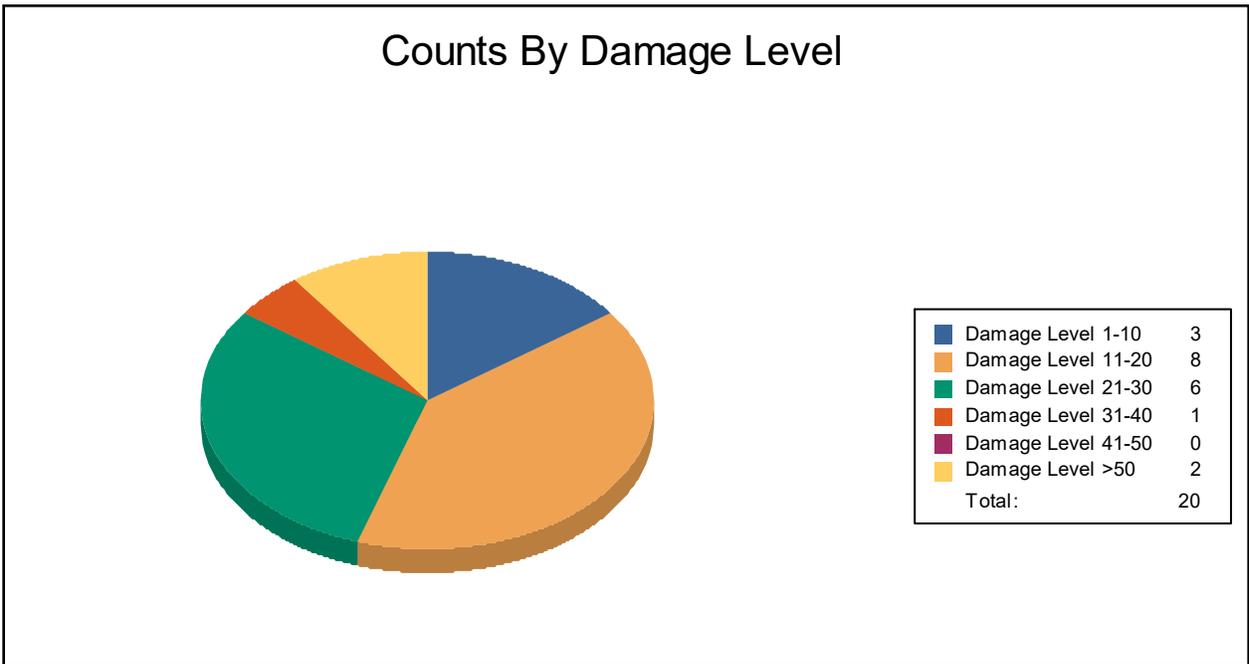
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**Table 3: Expected Building Damage by Occupancy**

Occupancy	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)										
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	1	100	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	3	16	7	37	6	32	1	5	0	0	2	11
<b>Total</b>	<b>3</b>		<b>8</b>		<b>6</b>		<b>1</b>		<b>0</b>		<b>2</b>	



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**Table 4: Expected Building Damage by Building Type**

Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)										
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	0	0	0	0	0	0	0	0	0	0	0	0
Steel	0	0	1	100	0	0	0	0	0	0	0	0
Wood	3	16	7	37	6	32	1	5	0	0	2	11



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## Essential Facility Damage

Before the flood analyzed in this scenario, the region had 166 hospital beds available for use. On the day of the scenario flood event, the model estimates that 166 hospital beds are available in the region.

**Table 5: Expected Damage to Essential Facilities**

Classification	# Facilities			
	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	2	0	0	0
Fire Stations	3	0	0	0
Hospitals	1	0	0	0
Police Stations	1	0	0	0
Schools	18	0	0	0

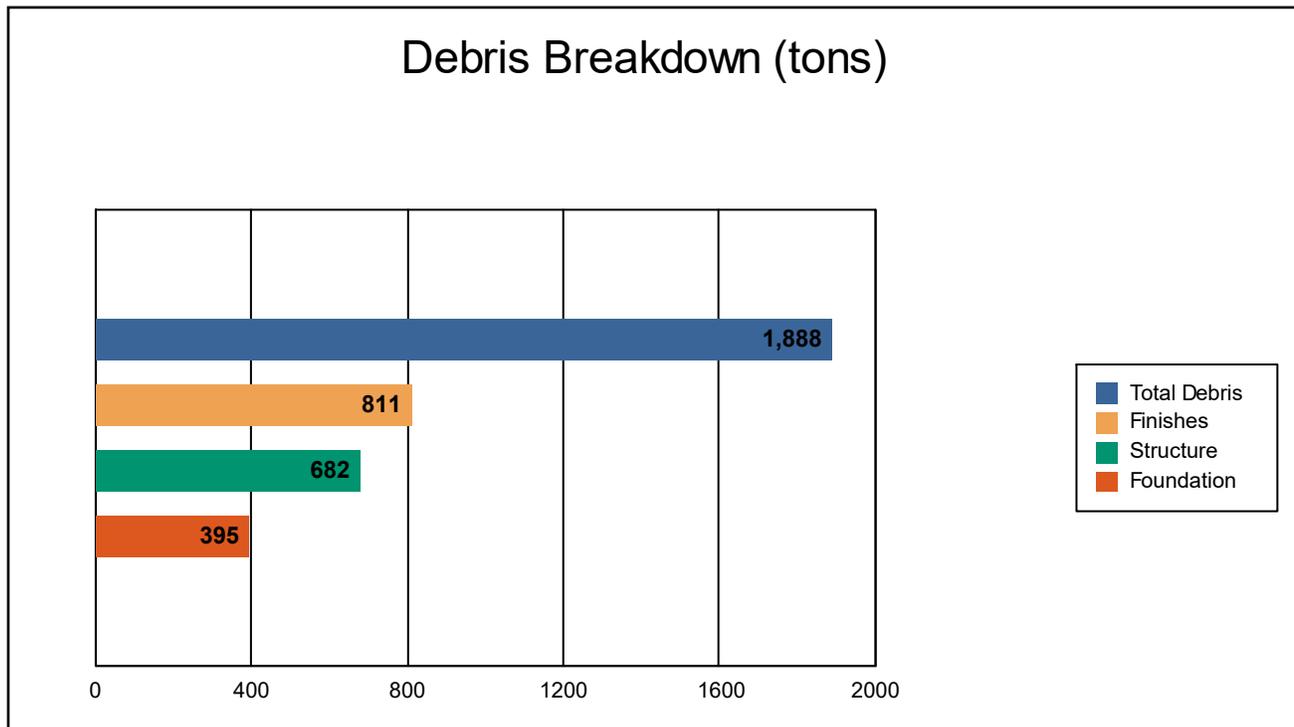
If this report displays all zeros or is blank, two possibilities can explain this.

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

## Induced Flood Damage

### Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.



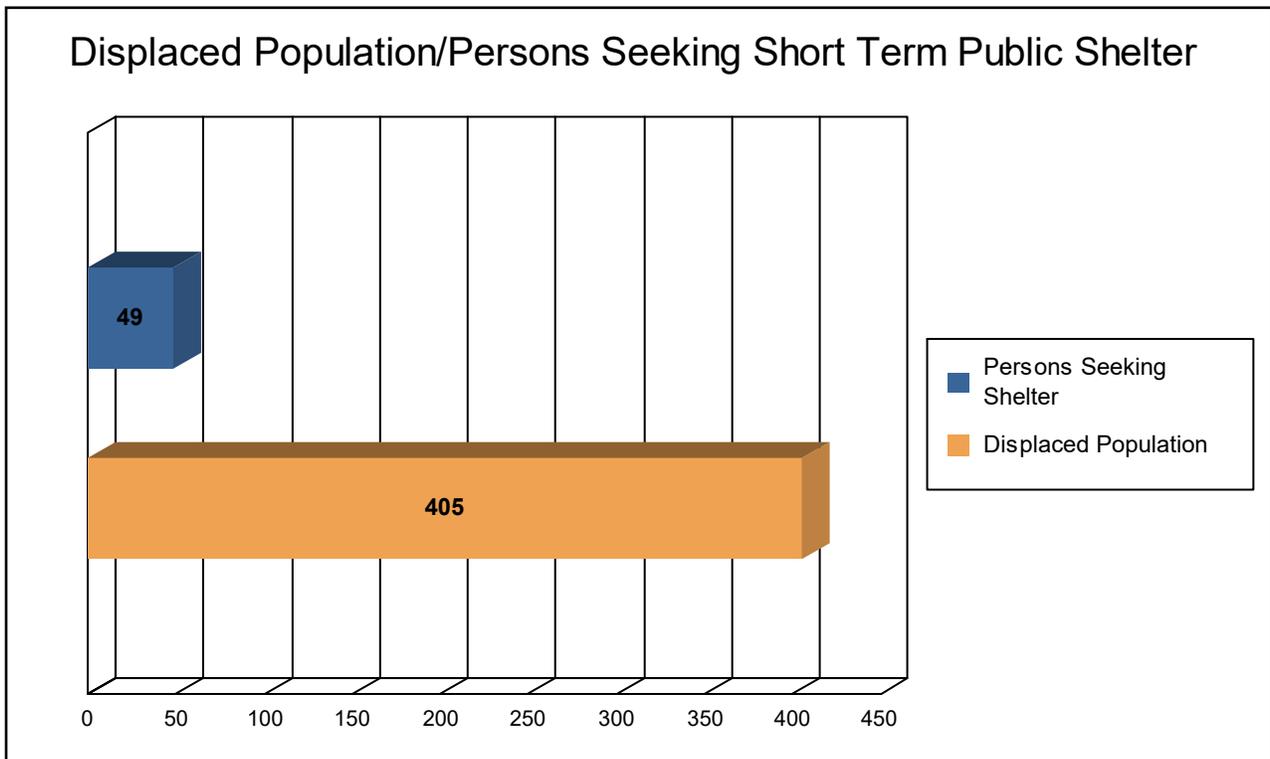
The model estimates that a total of 1,888 tons of debris will be generated. Of the total amount, Finishes comprises 43% of the total, Structure comprises 36% of the total, and Foundation comprises 21%. If the debris tonnage is converted into an estimated number of truckloads, it will require 76 truckloads (@25 tons/truck) to remove the debris generated by the flood.



## Social Impact

### Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 135 households (or 405 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 49 people (out of a total population of 39,143) will seek temporary shelter in public shelters.



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## Economic Loss

The total economic loss estimated for the flood is 95.17 million dollars, which represents 25.31 % of the total replacement value of the scenario buildings.

### **Building-Related Losses**

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 45.79 million dollars. 52% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 14.61% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.



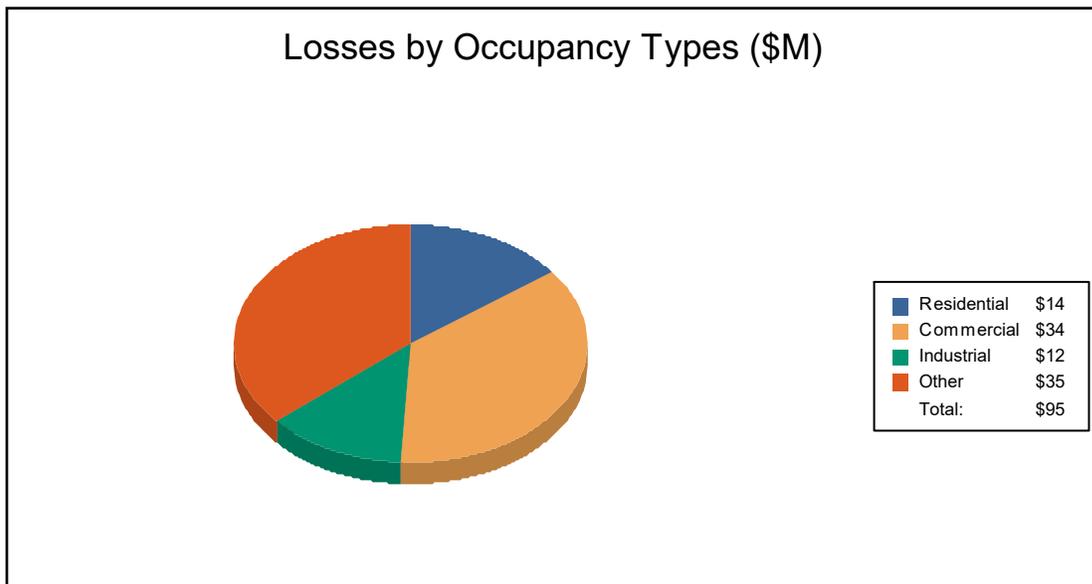
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**Table 6: Building-Related Economic Loss Estimates**  
(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
<u>Building Loss</u>						
	Building	6.74	3.32	3.15	1.03	14.24
	Content	5.18	11.67	7.61	5.58	30.03
	Inventory	0.00	0.41	1.05	0.06	1.52
	<b>Subtotal</b>	<b>11.92</b>	<b>15.40</b>	<b>11.81</b>	<b>6.66</b>	<b>45.79</b>
<u>Business Interruption</u>						
	Income	0.01	8.37	0.14	1.01	9.52
	Relocation	1.26	1.40	0.10	1.37	4.13
	Rental Income	0.70	1.10	0.04	0.54	2.38
	Wage	0.02	8.08	0.23	25.01	33.34
	<b>Subtotal</b>	<b>1.99</b>	<b>18.95</b>	<b>0.50</b>	<b>27.94</b>	<b>49.38</b>
<b>ALL</b>	<b>Total</b>	<b>13.91</b>	<b>34.35</b>	<b>12.32</b>	<b>34.60</b>	<b>95.17</b>





## **Appendix A: County Listing for the Region**

Massachusetts

- Norfolk



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**Appendix B: Regional Population and Building Value Data**

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
<b>Massachusetts</b>				
Norfolk	39,143	5,134,833	3,362,628	8,497,461
<b>Total</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>
<b>Total Study Region</b>	<b>39,143</b>	<b>5,134,833</b>	<b>3,362,628</b>	<b>8,497,461</b>



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