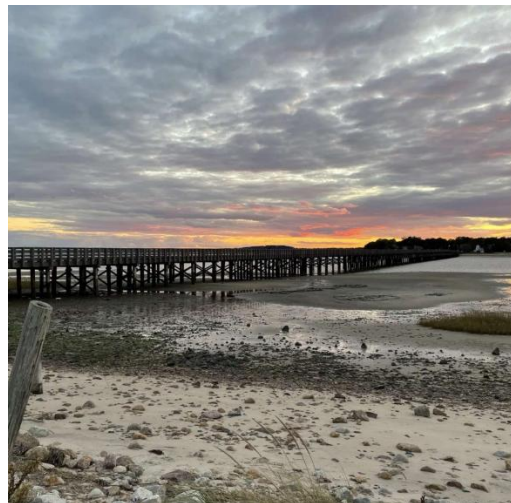


TOWN OF DUXBURY
HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE



DRAFT
September 16, 2026
Prepared by
Metropolitan Area Planning Council
For the Town of Duxbury



**TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE**

ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the Town of Duxbury by the Metropolitan Area Planning Council (MAPC) under the direction of the Massachusetts Emergency Management Agency (MEMA), in accordance with FEMA Hazard Mitigation Plan Guidance.

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SECTION 1: EXECUTIVE SUMMARY

Hazard Mitigation planning is a proactive effort to identify actions that can be taken to reduce the dangers to life and property from natural hazard events. In the communities of the Boston region of Massachusetts, hazard mitigation planning tends to focus most on flooding, the most likely natural hazard to impact these communities. However, the plan focuses on all categories of natural hazards that could potentially affect the community, including those that infrequently occur. This plan also considers how our changing climate will affect natural hazards. Warming temperatures will fuel changing precipitation patterns and an increasing frequency and intensity of severe storms, as well as increasing sea level rise.

PLANNING PROCESS

The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to be eligible to receive FEMA funding for hazard mitigation grants, such as Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA) to adopt a local multi-hazard mitigation plan and update this plan in five-year intervals.

This plan is an update of the Town of Duxbury's first Natural Hazard Mitigation Plan, which was approved by FEMA in 2019. Planning for this update was conducted by the Metropolitan Area Planning Council under the direction of the Duxbury Local Hazard Mitigation Team, composed of staff from several Town Departments and community partners. The team met on the following dates, focusing on various aspects of developing the updated plan:

December 12, 2024	Identify and map Critical Facilities, Local Hazard Areas, and Development
March 13, 2025	Review/update Existing Mitigation Measures and Hazard Mitigation Goals
July 28, 2025	Review the status of recommended mitigation measures from the 2015 plan
November 19, 2025	Review and finalize the mitigation strategy for the 2026 updated plan

Public participation in this planning process is important for improving awareness of the potential impacts of natural hazards and to build support for the actions the Town takes to mitigate them. The Town's Select Board hosted two public meetings, the first on May 5, 2025 and the second on September 28, 2026. The draft plan was posted online for public review, and a dedicated project email, DuxburyResilience@mapc.org, was set up to receive public comments and questions.

Key town stakeholders and neighboring communities were notified and invited to review the draft plan and submit comments. See Documentation of Public Meetings in Appendix C.

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RISK ASSESSMENT

The Duxbury Hazard Mitigation Plan assesses the potential impacts to the Town from flooding, coastal flooding and erosion, hurricanes, Tornadoes, severe weather, winds, severe winter/Nor'easters, winter/ice storms, brush fire, geologic hazards, extreme temperatures, drought, invasive species, and changes in groundwater. Coastal flooding, driven by hurricanes, northeasters and other storms, clearly presents the greatest hazard to the Town of Duxbury. These are described in Section 4 and the locations of hazard areas are shown on the map series in Appendix A.

The Duxbury Hazard Mitigation Team identified xx Critical Facilities. These are shown on the map series in Appendix A and listed in Table xx.

A HAZUS-MH analysis provided estimates of damages from Hurricanes of 100-year and 500-year recurrence (\$19.4 million to \$211.3 million) as well as earthquakes of magnitudes 5 and 7 (\$355.7 million to \$2.356 billion). Flood damage estimates range from \$211.8 million for a 100-year event to \$375.7million for a 500-year event.

HAZARD MITIGATION GOALS

The Duxbury Hazard Mitigation Team reviewed and discussed the goals from the previous 2019 Hazard Mitigation Plan. The Team modified the goals to reflect a more comprehensive approach and to incorporate climate resiliency for this 2026 plan update. Goals 10 through 12 were added by the local team for this updated plan. All of the goals are considered critical for the Town, and they are not listed in order of importance.

Goal 1: Reduce and mitigate the loss of life, injury, public health impacts, property damages, and critical services resulting from all major natural hazards.

Goal 2: Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

Goal 3: Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.

Goal 4: Reduce and mitigate the damage to public infrastructure resulting from all hazards.

Goal 5: Encourage the business community, major institutions and non-profits to work with the Town to develop, review and implement the hazard mitigation plan.

Goal 6: Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

Goal 7: Ensure that future development meets federal, state and local standards for mitigating and reducing the impacts of natural hazards.

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Goal 8: Take maximum advantage of resources from FEMA and MEMA to educate Town staff and the public about hazard mitigation.

Goal 9: Consider the potential impacts of climate change and incorporate climate mitigation and resilience in all planning efforts.

GOAL 10: Incorporate environmental justice considerations into hazard mitigation, including outreach to climate vulnerable populations, identification of hazard impacts, and mitigation measures.

GOAL 11: Increase public awareness through education on potential hazards that threaten the community and outline mitigation measures to reduce impacts.

GOAL 12: Ensure that mitigation measures are sensitive to the natural features, historic resources, and community character of Duxbury.

HAZARD MITIGATION STRATEGY

The Duxbury Local Hazard Mitigation Planning Team identified a number of mitigation measures that would serve to reduce the Town's vulnerability to natural hazard events. Overall, the hazard mitigation strategy recognizes that mitigating hazards for Duxbury will be an ongoing process as our understanding of natural hazards and the steps that can be taken to mitigate their damages changes over time. Climate change and a variety of other factors impact the Town's vulnerability, and local officials will need to work together across municipal lines and with state and federal agencies in order to understand and address these changes. The Hazard Mitigation Strategy will be incorporated into the Town's other related plans and policies. See Chapter 8 for more details on these mitigation measures.

Flood Hazards

1. Implement Beach Nourishment and Nature Based Solutions projects identified in the Duxbury Beach Reservation's resiliency plans
2. implement culvert replacements identified in the Culvert and Bridge Assessment
- 3 Provide Beach Nourishment related to seawall
4. Land acquisition program in flood areas, along the coast , including easement for seawall
5. Implement Seawall restoration and improvement (Phase 2 completed)
6. Perform Coastal Erosion/Accretion Littoral Study

Geologic Hazards

7. Assess earthquake vulnerability of all public buildings and implement upgrades if feasible

Fire-Related Hazards

8. Conduct regional forest management planning for conservation lands
9. Increase public information and awareness about fire hazards year round

Winter Hazards

10. Assess municipal structures for susceptibility to snow loads
11. Acquire emergency generators for public safety (water pumps, package plant, town hall)

Drought

12. Develop and implement a water conservation plan; public education
13. Promote drought tolerant landscaping and site design measures

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Extreme Temperatures

14. Increase public notification for cooling and warming centers at the Senior Center and regional cooling center as needed

Dam Hazards

15. Temple Street Dam scheduled to be removed

Wind Hazards

16. Coordinate with electric utility to manage trees to reduce risk of power outages
17. Assess public buildings for vulnerability to wind damage
18. Discourage tree planting near homes and critical infrastructure

Invasive Species

19. Implement Invasive Species management: Potential species include European Green Crab, Asian Shore Crab, Tunicates, Bryozoa, Caprella, Musca, Palaemon elegans
20. Guidelines to encourage use of native species in landscaping and development

Climate Change

21. Implement the Town of Duxbury Climate Vulnerability Assessment and Action Plan and Snug Harbor Resiliency Plan; incorporate climate resilience into the Town's comprehensive planning, CEMP, and capital improvement plan
22. Incorporate climate resilience into all local and regional plans as well as capital improvement.
23. Salt Marsh management and protection: Monitor health of submerged aquatic vegetation such as eelgrass beds, and salt marshes; drones used to survey marshes; and restore marshes.
24. Collaborate with residents and businesses in the near- and long-term most vulnerable areas to examine potential zoning, regulatory, incentive, mitigation, or cooperative-based approaches on sea level rise.
25. Increase the width of Mattakeeset Court to allow emergency vehicle access; move utility poles | and sewer/drainage

This Hazard Mitigation Strategy is intended to provide the Town with a “roadmap” to key actions that will improve its resilience to current natural hazards as well as future climate change impacts. The plan's recommended mitigation measures will be incorporated into other Town plans and policies, such as the Comprehensive Plan, the Open Space and Recreation Plan, the Capital Investment Plan, and the Municipal Vulnerability Preparedness 2.0.

PLAN REVIEW & UPDATE PROCESS

The process for developing the Duxbury Hazard Mitigation Plan 2026 Update is summarized in Table 1 below.

Table 1 Plan Review and Update Process

Section	Reviews and Updates
3 – Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan, discussing strategies to enhance participation opportunities at the local team meetings. During plan development, the plan was discussed at two public meetings hosted by the Select Board. The plan was available on the project web page for public comment. Outreach efforts to publicize these engagement opportunities included webpage content, social media, email, flyers, and press outreach.

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4 – Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. Town staff reviewed critical infrastructure with MAPC staff in order to create an up-to-date list. MAPC also used the most recently available version of HAZUS to assess potential impacts of flooding, earthquakes, and hurricanes.
5 – Goals	The Hazard Mitigation Goals were reviewed and endorsed by the Duxbury Hazard Mitigation Team. The goals were revised in order to reflect a more comprehensive approach and to incorporate climate resiliency for this 2026 plan update.
6 – Existing Mitigation Measures	The inventory of Duxbury’s existing mitigation measures was updated to reflect current mitigation activities in the Town.
7 & 8 – Hazard Mitigation Strategy	Mitigation measures from the 2018 plan were reviewed by the local team and assessed as to whether they were completed, in-progress, or deferred. The local team determined whether to carry forward mitigation measures that have not yet been completed into this 2026 Plan Update or modify them or delete them. The 2026 plan's recommended hazard mitigation strategy reflects both new measures and measures carried forward from the 2018 plan that have not yet been completed. The Duxbury Hazard Mitigation Team prioritized the mitigation measures based on current conditions.
9 – Plan Adoption & Maintenance	This section of the plan includes an-ongoing plan implementation review and five-year update process that will assist the Town in incorporating hazard mitigation issues into other Town planning and regulatory review processes and better prepare the Town for the next comprehensive plan update.

As indicated on Section 7 of this plan, Duxbury made significant progress on implementing some of the mitigation measures recommended in the 2019 Hazard Mitigation Plan. Mitigation measures that have been completed or partially completed include the following:

- Regulatory revisions for stormwater management
- Updated FIRM mapping and bylaws
- Provide public information on NFIP compliance
- Establish and maintain a Coastal Resilience Task Force that works across departments and commissions for a multi-disciplinary approach toward climate resilience.
- Culvert replacements townwide
- Provide Beach Nourishment related to seawall on Plymouth Avenue
- Land acquisition program in flood areas, including easement for seawall
- Seawall restoration and improvement
- Perform Coastal Erosion/Accretion Littoral Study
- Maintain Duxbury Beach to a minimum elevation of 16.5 feet NGVD 88
- Increase public information and awareness about fire hazards
- Dam management and maintenance plan
- Increase public information and awareness about fire hazards
- Implement the Town of Duxbury Climate Vulnerability Assessment and Action Plan and incorporate these recommendations into Comprehensive Planning for the Town

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- Incorporate climate resilience into all local and regional plans as well as capital improvement plans.
- Monitor health of submerged aquatic vegetation such as eelgrass beds, and salt marshes, and restore as necessary.
- Collaborate with the residents and businesses in the near- and long-term most vulnerable areas to examine potential zoning, regulatory, incentive, mitigation or cooperative-based approaches on sea level rise.

Progress toward implementing these recommended mitigation measures will be continued in this 2026 Plan Update. Moving forward into the next five-year plan implementation period there will be more opportunities to incorporate hazard mitigation into the Town's decision-making processes. The Duxbury Hazard Mitigation Team will continue to oversee the implementation of this 2026 updated plan, as described in Section 9, Plan Adoption and Maintenance.

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SECTION 2: INTRODUCTION

PLANNING REQUIREMENTS UNDER THE FEDERAL DISASTER MITIGATION ACT

The Federal Disaster Mitigation Act, passed in 2000, requires that after November 1 2004, all municipalities that wish to continue to be eligible to receive FEMA funding for hazard mitigation grants, must adopt a local multi-hazard mitigation plan and update this plan in five-year intervals. This planning requirement does not affect disaster assistance funding.

Federal hazard mitigation planning, and grant programs are administered by the Federal Emergency Management Agency (FEMA) in collaboration with the states. These programs are administered in Massachusetts by the Massachusetts Emergency Management Agency (MEMA) in partnership with the Department of Conservation and Recreation (DCR).

The Town of Duxbury contracted with the Metropolitan Area Planning Council (MAPC), to assist the Town in updating its local Hazard Mitigation Plan, which was approved by FEMA in 2018. The updated local plan produced under this contract is designed to meet the requirements of the Disaster Mitigation Act for the Town of Duxbury, addressing local and regional concerns and hazards that impact the Town.

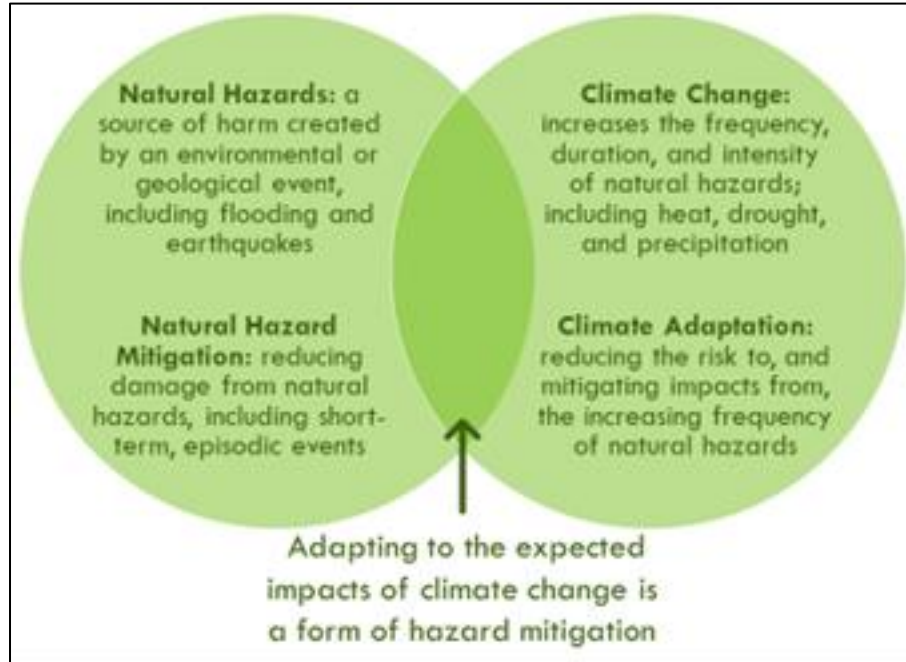
WHAT IS A HAZARD MITIGATION PLAN?

Natural hazard mitigation planning is the process of determining how to systematically reduce or eliminate the loss of life and property damage resulting from natural hazards such as floods, earthquakes, and hurricanes. Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, projects, and other activities. This plan also incorporates consideration of future risks due to projections for the increased frequency and severity of extreme weather and sea level rise fueled by global climate change.

As more is understood about the impacts of climate change, it is becoming increasingly important to recognize the relationship between climate change and many of the natural hazards addressed in FEMA Hazard Mitigation Plans. These climate impacts were addressed in the 2023 state hazard mitigation plan, the Resilient Mass Plan, as well as the previous 2018 Massachusetts State Hazard Mitigation and Climate Resilience Plan. Accordingly, MAPC has updated the format of local Hazard Mitigation Plans to incorporate climate change considerations based on available state and regional data such as the 2022 Massachusetts Climate Change Assessment. Figure 1 illustrates the relationship between natural hazards and climate change.

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Figure 1. Natural Hazards and Climate Change



PREVIOUS FEDERAL/STATE DISASTERS

The Town of Duxbury has experienced 23 natural hazards that triggered federal or state disaster declarations since 1991. These are listed in Table 2 below. The majority of these events involved flooding, while eight were due to hurricanes or nor'easters, and seven were due to severe winter weather.

Table 2 Previous Federal Disaster Declarations

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
Hurricane Bob (August 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)
No-Name Storm (October 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)

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DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
December Blizzard (December 1992)	Hazard Mitigation Grant Program	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk (7 projects)
	FEMA Public Assistance Project Grants	All 14 Counties
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
October Flood (October 1996)	FEMA Individual Household Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk (36 projects)
	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
1997	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
June Flood (June 1998)	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (19 projects)
	Community Development Block Grant-HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
(1998)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
March Flood (March 2001)	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)
	FEMA Public Assistance Project Grants	All 14 Counties
February Snowstorm (Feb 17-18, 2003)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 22, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
Hurricane Katrina (August 29, 2005)	Hazard Mitigation Grant Program	Statewide
May Rainstorm/Flood (May 12-23, 2006)	Hard Mitigation Grant Program	Statewide
April Nor'easter (April 15-27, 2007)	FEMA Public Assistance	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester

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DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
Flooding (March, 2010)	Hazard Mitigation Grant Program	Statewide
	FEMA Public Assistance Project Grants	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester
Hurricane Earl (September 2010)	FEMA Public Assistance	Statewide
Tropical Storm Irene (August 27-28, 2011)	FEMA Public Assistance	Statewide
Hurricane Sandy (October 27-30, 2012)	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide
Severe snowstorm and Flooding (February 8-09, 2013)	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide
Blizzard of 2015 (January 26-28, 2015)	FEMA Public Assistance; Hazard Mitigation Grant Program	Barnstable, Bristol, Essex, Nantucket, Norfolk, Plymouth
Severe winter storm and flooding (March 2018)	Hazard Mitigation Grant Program	Statewide
COVID-19 Pandemic (January 2020)	Hazard Mitigation Grant Program	Statewide
Severe winter storm January 2022	Hazard Mitigation Grant Program	Bristol, Norfolk, Plymouth, Suffolk

Source: database provided by MEMA

Since 2018, there have been five Massachusetts State Declared Disasters that affected Duxbury. Below is a list of them, which includes several winter storms as well as the Covid-19 pandemic.

Table 3. State Disaster Declarations since 2018

Disaster Name	Date of Event	Declared Areas
Massachusetts Severe Winter Storm and Flooding	March 2-3, 2018	Statewide
Massachusetts Severe Winter Storm and Snowstorm	March 13-14, 2018	Statewide
Massachusetts Covid-19 Pandemic	January 20, 2020 – May 11, 2023	Statewide
Massachusetts Severe Winter Storm and Snowstorm	January 28-29, 2022	Statewide
Massachusetts Hurricane Lee	September 15-17, 2023	Statewide

Source: FEMA Declared Disasters; OpenFEMA Dataset: Disaster Declarations; and FEMA Declared Disasters.

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FEMA FUNDED MITIGATION PROJECTS

Duxbury received funding from FEMA and MEMA in 1991/1992 for two sacrificial dune projects on Duxbury Beach to maintain a minimum of sixteen feet NGVD along the entire length of the barrier beach. This also provided flood hazard protection for a large number of properties and is a critical component of safeguarding coastal infrastructure in Duxbury and its neighboring towns Kingston and Plymouth.

COMMUNITY PROFILE

Duxbury is a coastal community of 16,090 people located 33 miles southeast of Boston in Plymouth County. It is primarily accessible from the north and south by Route 3 and is bordered by Pembroke on the west, Marshfield on the north, Kingston and Plymouth on the south, and the Atlantic Ocean on the east and southeast.

Duxbury was incorporated in 1637, 17 years after Pilgrims established their colony in Plymouth. The town was a center of shipbuilding until the mid-19th century, when ships became too large for the shallow bay. It maintains ties to its seagoing past through a variety of harbor-related activities and programs, including many run by the Duxbury Bay Maritime School in Snug Harbor. Duxbury Bay supports both a recreational and commercial fishing industry, and the town has become well known for its oysters and other shellfish.

Following the shipbuilding era in the town's history, the community became a rural, summer community with its economic base tied to fishing and agriculture. Today, Duxbury is a residential suburb of Boston, with Route 3 serving as its main route to Boston and other points. Many historic and beautiful homes from Pilgrim times and the shipbuilding period remain in Duxbury, and residents cherish the town's historic assets.

The Town is governed by a Town Manager, Select Board, and Open Town Meeting governmental structure.

Some of Duxbury's unique characteristics to keep in mind include:

- As a coastal community, the town is directly threatened by high seas and Nor'easter storms that pound the coastline and damage and flood the property and residents living in those areas.
- Flooding in the town is a significant threat to property and the town has problems with water inundation during high rain and storm events, particularly during the spring snowmelt exacerbates flooding due to an elevated water table.
- A defining characteristic of the town are its tree-lined streets. Although these trees are vulnerable to high winds and ice storms, they are a tradeoff the town is willing to have.
- The town has a number of dams that are currently reported to be in good shape. However, should a dam fail at one these locations, it could cause increased risks of flooding downstream.

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- The town has proactive municipal officials that frequently share information and coordinate on a regular basis. An example of this was the data collection sessions for this PDM plan, at which representatives of several Town departments were present.
- Duxbury is home to historic structures and sites that are irreplaceable and bring economic value to the town.
- Duxbury contains several major roadways and bridge crossings that provide emergency routes for evacuation and for routes to medical facilities. Some of these transportation resources or infrastructures are frequently at risk of flooding, particularly from ocean storm-related flooding.
- Duxbury has 65 Repetitive Loss properties and 11 Severe Repetitive Loss properties that have resulted in 289 claims, totaling \$6.5 million.
- Duxbury would be a good candidate for flood-related grants due to the potential impact to property, transportation emergency routes, and economic/historic resources, and the ability to solve the flooding problems through structural measures such as culvert upgrades, dam and bridge upgrades, or flood proofing. The cost-benefit analysis would likely be in the town's favor.
- Much of the critical infrastructure in the town is located in clusters, and in some cases near areas of floodplain. These facilities are therefore at higher risk of damage.

The Town maintains a website at www.town.duxbury.ma.us

Table 4: Duxbury Characteristics

Population = 16,090
• 4.8% are under age 5 • 26.5% are under age 18 • 24.5% are over age 65 • 7.1% have a disability • 2.2% are foreign born
Number of Housing Units = 6,373
• 8.8% are renter-occupied housing units • 17.5% of housing units were built before 1940 • 89.9% of housing units are single family homes

Source US Census Bureau

Environmental Justice Populations

An environmental justice population is a neighborhood where one or more of the following criteria are true:

- Median household income is 65 percent or less of the statewide median household income
- Minorities make up 40 percent or more of the population
- 25 percent or more of households identify as speaking English less than "very well"

Duxbury does not have any Environmental Justice areas as designated by the MA Executive Office of Energy and Environmental Affairs.

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SECTION 3: PLANNING PROCESS & PUBLIC PARTICIPATION

MAPC employs a planning process based on FEMA’s hazard mitigation planning guidance focusing on local needs and priorities, but maintaining a regional perspective matched to the scale and nature of natural hazard events. Public participation is an important component of this process, often providing critical information about the local occurrence of hazards while also serving as a means to build a base of support for hazard mitigation activities.

MAPC supports participation by the public and community stakeholders through:

- Meetings and coordination with the local Hazard Mitigation Team (four team meetings)
- Two public meetings, advertised through email, webpage content, a flyer, press release to local media, and social media posts, and made available town-wide on Local Access TV,
- A project website at: www.mapc.org/resource-library/duxbury-hmp and a dedicated email for public comments DuxburyResilience@mapc.org
- Opening a public comment period at the second public meeting, and posting the draft plan to the project website to facilitate public review,
- Outreach to neighboring communities, boards and commissions, the local chamber of commerce and businesses, environmental NGO’s, social service providers, and other local or regional entities

PLANNING PROCESS SUMMARY

The six-step planning process shown in Figure 2 and described below is based on FEMA’s Local Multi-Hazard Mitigation Planning Guidance. The process focuses on local problem areas and identifies needed mitigation measures based on where gaps occur in the existing mitigation efforts of the municipality. The planning process allows town staff to bring the most recent hazard information into the plan, including new hazard occurrence data, changes to a municipality’s mitigation measures, and progress made on actions identified in previous plans.

Figure 2. Six-Step Planning Process



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1. **Map the Hazards** – MAPC relies on data from a number of different federal, state, and local sources in order to map the areas with the potential to experience natural hazards. This mapping represents a multi-hazard assessment of the municipality and is used as a set of base maps for the remainder of the planning process. A particularly important source of information is the knowledge drawn from local municipal staff on where natural hazard impacts have occurred, which is collected. These maps can be found in Appendix A.
2. **Assess the Risks & Potential Damages** – Working with local staff, critical facilities, infrastructure, vulnerable populations, and other features are mapped and contrasted with the hazard data from the first step to identify those that might represent particular vulnerabilities to these hazards. Land use data and development trends are also incorporated into this analysis in Chapter 4 of this plan. MAPC utilized FEMA's computer model HAZUS-MH to provide estimates of the potential impacts of certain hazard events on the community, including flooding, hurricanes, and tornadoes. MAPC drew on the following local, state, federal, and academic resources to provide data for the plan:
 - Blue Hills Observatory
 - Town of Duxbury, Coastal Resilience Task Force Report, 2022
 - Town of Duxbury Vulnerability Assessment and Climate Adaptation Plan, 2021
 - Town of Duxbury, *Open Space and Recreation Plan*, 2021
 - Town of Duxbury, *State of the Bay*, 2025
 - Town of Duxbury Zoning By-Laws
 - Environment America Research and Policy Center, *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation*, July 2012
 - FEMA, *Disaster Declarations for States and Counties*, 2025
 - FEMA, HAZUS-MH, 2023
 - FEMA, *Local Mitigation Planning Policy Guide*, 2025
 - FEMA, *Flood Insurance Study*, Plymouth County
 - FEMA *Flood Insurance Rate Maps* for Plymouth County, MA
 - Kleinfelder Inc., *Sea Level Rise Study*, 2013
 - MAPC, *Duxbury Climate Resiliency Assessment and Action Plan* 2018
 - MAPC, *Snug Harbor Resilience Plan*, 2019
 - MAPC, *South Shore Coastal Adaptation Study* 2011
 - Massachusetts Climate Change Assessment, 2022
 - Massachusetts Coastal Protection Structure Inventory and Assessment, 2015
 - MA Office of Coastal Zone Management, *Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning*, December 2013
 - MA Office of Dam Safety, *Inventory of Massachusetts Dams*
 - Massachusetts Report of the MA Coastal Erosion Commission, 2016
 - Massachusetts Resilient MA Plan, 2023
 - Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018
 - Massachusetts Climate Vulnerability Assessment, 2022
 - Metropolitan Area Planning Council, GIS Lab, *Regional Plans and Data*
 - New England Seismic Network, Boston College Weston Observatory
 - NOAA National Centers for Environmental Information,

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- Northeast States Emergency Consortium, <http://www.nesec.org/>
 - US Census, 2020
 - USDA Forest Service, Wildfire Risk to Communities
 - USGS, National Water Information System,
 - U.S. Global Change Research Program, Fourth National Climate Assessment, 2018
3. **Review Existing Mitigation** – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as most have adopted flood plain zoning districts, wetlands protection programs, and other measures as well as enforcing the State building code, which has strong provisions related to hazard resistant building requirements. All current municipal mitigation measures are documented in the plan in Chapter 6.
4. **Develop Mitigation Strategies** – MAPC works with the local municipal staff to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessments, and the community’s existing mitigation efforts to determine where additional work is necessary to reduce the potential damages from hazard events. Additional information on the development of hazard mitigation strategies can be found in Chapter 7.
5. **Plan Approval & Adoption** – Once a final draft of the plan is complete it is sent to MEMA for the state level review and, following that, to FEMA for approval. Typically, once FEMA has approved the plan the agency issues a conditional approval (Approval Pending Adoption), with the condition being adoption of the plan by the municipality. More information on plan adoption can be found in Chapter 9 and documentation of plan adoption can be found in Appendix D.
6. **Implement & Update the Plan** – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a five-year basis making preparation for the next plan update an important on-going activity. Chapter 9 includes more detailed information on plan implementation.

THE LOCAL HAZARD COMMUNITY PLANNING TEAM

MAPC worked with local officials to convene a local Hazard Mitigation Team for Duxbury. The local team is central to the planning process as it is the primary body tasked with providing relevant local data for the plan and reviewing the mitigation strategy for the community. The local team was tasked with working with MAPC to set plan goals, provide information on critical facilities and the hazards that impact the Town, existing mitigation measures, and help to develop new mitigation measures for this plan update. The Local Hazard Mitigation Planning Team membership can be found in Table 5 below.

The Duxbury Hazard Mitigation Planning Team met four times on the dates listed below. The agendas for these meetings are included in Appendix B.

- **December 12, 2024:** discussed the project overview and update local hazard areas and critical facilities inventory
- **March 13, 2025:** updated hazard mitigation goals and existing mitigation measures
- **July 28, 2025:** updated the recommended mitigation strategies from the 2018 HMP and prepare for Public Meeting #1

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- **November 19, 2025:** developed new recommended mitigation measures for the 2026 plan update and prepared for Public Meeting #2

Table 5: Membership of the Duxbury Hazard Mitigation Team

Name	Position
René Read	Town Administrator
Matthew Heins	Planning Director
Michael Carbone	Police Chief
Jake Emerson	Harbormaster
Lauren Hache	Assistant Health Agent
Emily Hadley	Principal Assistant - Planning
Danielle Klingaman	Superintendent of Duxbury Schools
Cris Luttazi	Executive Director - Duxbury Beach Reservation
Brian Monahan	Deputy Fire Chief
Joanne Moore	COA Director
Nancy O'Connor	Executive Assistant to TM (Communications POC)
Rob Reardon	Fire Chief
Nancy Rufo	Conservation Administrator
Sheila Sgarzi	DPW Director
Katie St. Clair	Facilities Director
Steve Studley	Recreation Direction
Jim Wasielewski	Director of Municipal Services
Lisa Freeley	Director of Business and Finance, School Dept.

The Duxbury Planning Board and the Duxbury Conservation Commission are the primary entities responsible for regulating development in town. Feedback from the Planning Board and the Conservation Commission was assured through the participation of the Planning Director, the Conservation Administrator and the Town Manager, as well as other local public safety officials including the Dept. of Public Works, Health Department, Facilities Director, Fire Chief, Police Chief and Harbormaster. In addition, MAPC, the State-designated regional planning authority for Duxbury, works with all agencies that regulate development and infrastructure in the region, including the listed municipal entities and state agencies, such as the MassDOT and the Department of Conservation and Recreation.

PUBLIC MEETINGS

Public participation in the hazard mitigation planning process is important, both for plan development and for later implementation of the plan. Residents, business owners, and other community members are an excellent source for information on the historical and potential impacts of natural hazard events and particular vulnerabilities the community may face from these hazards. Their participation in this planning process also builds understanding of the concept of hazard mitigation, potentially creating support for mitigation actions taken in the future to implement the plan.

To gather this information and educate residents on hazard mitigation, the Town hosted two public meetings. The public had an opportunity to provide input during the planning process at meeting

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hosted by the Duxbury Select Board on May 5, 2025. The draft plan was presented at a second public meeting on September 28, 2026, also hosted by the Select Board. The draft plan was available online for the public to review, and comments were invited to be sent to a dedicated project email, DuxburyResilience@mapc.org. Both public meetings were publicized in accordance with the Massachusetts Public Meeting Law and publicized on the Town's website and social media, as well as by direct outreach to stakeholders by email. A Media Advisory was also sent to the local press. See public meeting notices in Appendix C.

LOCAL STAKEHOLDER INVOLVEMENT

The Town reached out to local stakeholders that might have an interest in the Hazard Mitigation Plan including neighboring communities, agencies, community organizations, and other interested parties. Notice was sent to the following organizations and neighboring municipalities inviting them to review the Hazard Mitigation Plan and submit comments to the Town:

Table 6: Duxbury Community Stakeholders

Allerton House Assisted Living at The Village	Duxbury Yacht Clubs
Bay Farm Montessori Academy	Greater Attleboro Transit Authority
Bay Path Rehab & Nursing Center	Island Creek Oysters
Bayside Marina Corporation	Jones River Watershed Association
Borhek Insurance	Long-Point Marina
Duxbury Bay Management Commission	North and South River Watershed Assoc.
Duxbury Bay Maritime School	Old Colony Planning Council
Duxbury Beach Reservation, Inc.	Jones River Watershed Association
Duxbury Business Association	Long-Point Marina
Duxbury Chamber of Commerce	North and South River Watershed Assoc.
Duxbury Community Preservation Comm.	Old Colony Planning Council
Duxbury Council on Aging	South Shore Chamber of Commerce
Duxbury Finance Committee	Town of Kingston
Duxbury Historical Commission	Town of Marshfield
Duxbury Local Historic District Commission	Town of Pembroke
Duxbury Mortgages	Town of Plymouth
Duxbury Rural and Historical Society	US Coast Guard
Duxbury School Committee	Wildlands Trust of Southeastern MA
Duxbury Seawall Committee	

See Appendix C for public meeting notices. The draft Hazard Mitigation Plan 2026 was posted online on the project web page for the second public meeting in September 2026. Members of the public could access the draft document and submit comments or questions to the Town.

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CONTINUING PUBLIC PARTICIPATION

Following the approval of the 2026 updated plan, the local Hazard Mitigation Team will continue to provide residents, businesses, and other stakeholders with the opportunity to learn about the hazard mitigation planning process and to contribute information that will update the town's understanding of local hazards.

As reviews of the plan are conducted by the Hazard Mitigation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Team will be publicly noticed in accordance with town and state open meeting laws.

PLANNING TIMELINE

PLAN UPDATE PROCESS 2023-24

December 12, 2024	1 st Meeting of the Duxbury Hazard Mitigation Team
March 13, 2025	2 nd Meeting of the Duxbury Hazard Mitigation Team
May 5, 2025	Public Meeting #1 hosted by the Select Board
July 28, 2025	3 rd Meeting of the S Duxbury Hazard Mitigation Team
November 19, 2025	4 th Meeting of the Duxbury Hazard Mitigation Team
September 28, 2026	Public Meeting #2 hosted by the Select Board
TBD	Draft Plan Update submitted to MEMA
TBD	Revised Draft Plan submitted to FEMA
TBD	Notice of Approval Pending Adoption issued by FEMA
TBD	Adoption of the Plan by the Town
TBD	FEMA Formal Approval of the plan for 5 years

PLAN IMPLEMENTATION MILESTONES 2026-31

After this plan update is approved by FEMA for a five-year period, the Town should take note of the following milestones for the ongoing implementation, review, and updating of this plan:

2028	Conduct Mid-Term Plan Survey on Progress
2029	Seek FEMA grant to prepare next plan update
2030	Begin process to update the plan
2031	Submit Draft 2031 Plan Update to MEMA and FEMA
2031	FEMA approval of 2031 Plan Update

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SECTION 4: RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. This section also includes a vulnerability assessment that estimates the potential damages that could result from certain large-scale natural hazard events. In order to update Duxbury's risk assessment, MAPC gathered the most recently available hazard and land use data and met with the Local Team to identify changes in local hazard areas and development trends. MAPC also used FEMA's damage estimation software, Hazards US (HAZUS).

The projected impacts of our warming climate on natural hazards are integrated throughout this risk assessment. Key impacts include rising temperatures, which in turn affect precipitation patterns and extreme weather. Analysis of these impacts included in this plan aligned closely with the data and assessment presented in Massachusetts' State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) and the Massachusetts' 2022 Climate Change Assessment.

“Global climate is changing rapidly compared to the pace of natural variations in climate that have occurred throughout Earth’s history. Global average temperature has increased by about 1.8°F from 1901 to 2016, and observational evidence does not support any credible natural explanations for this amount of warming; instead, the evidence consistently points to human activities, especially emissions of greenhouse or heat-trapping gases, as the dominant cause.”

Fourth National Climate Assessment, 2018 (Chapter 2-1)

CLIMATE CHANGE OBSERVATIONS AND PROJECTIONS

Climate change observations come from a variety of data sources that have measured and recorded changes in recent decades and centuries. Climate change projections, however, predict future climate impacts and, by their nature, cannot be observed or measured. As a result of the inherent uncertainty in predicting future conditions, climate projections are generally expressed as a range of possible impacts.

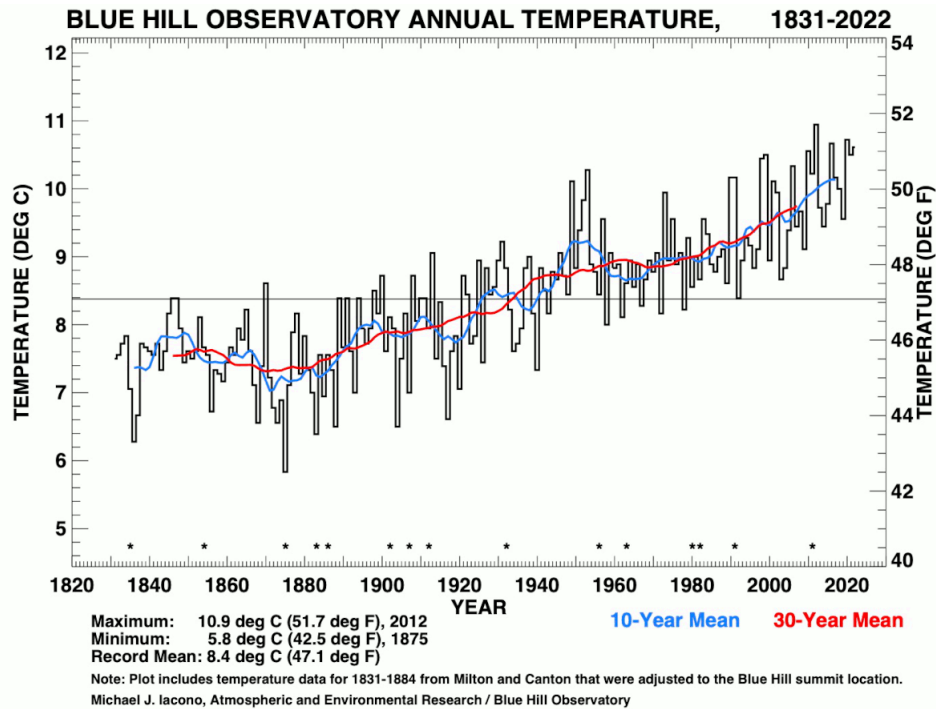
TEMPERATURE

Our climate has always been regulated by gases, including carbon dioxide, methane, and nitrous oxide, which blanket the earth. These gases trap heat that would otherwise be reflected out to space; without them our planet would be too cold to support life. We refer to these gases as “greenhouse gases” (GHGs) for their heat trapping capacity. The combustion of fossil fuels, our primary energy source in the age of industrialization, releases GHGs into the atmosphere. In the past century, human activity associated with industrialization has contributed to a growing concentration of GHGs in our atmosphere. Records from the Blue Hill Observatory in Milton, MA show that average temperatures

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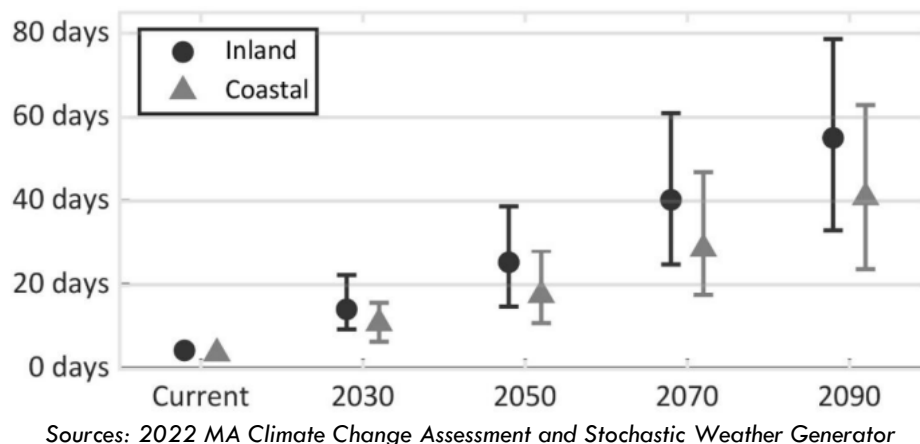
(30-year mean) have risen approximately 3 degrees (F) in the almost 200 years since record keeping began in 1831. See Figure 3 below for more information.

Figure 3: Observed Increase in Temperature



Climate projections include an increase in average temperature and in the number of extreme heat days (Figure 4). Extreme cold days are projected to decrease in number. By 2030, the summer mean temperature could increase by 3.6°F from the historical period (1950-2013). By 2070, there could be 58 fewer days below freezing, which could lead to an increase in ticks. By mid-century, the State anticipates about 25 more days per year where the temperature exceeds 90°F for inland areas, and about 19 more days above 90°F for coastal areas (Commonwealth of Massachusetts, 2022).

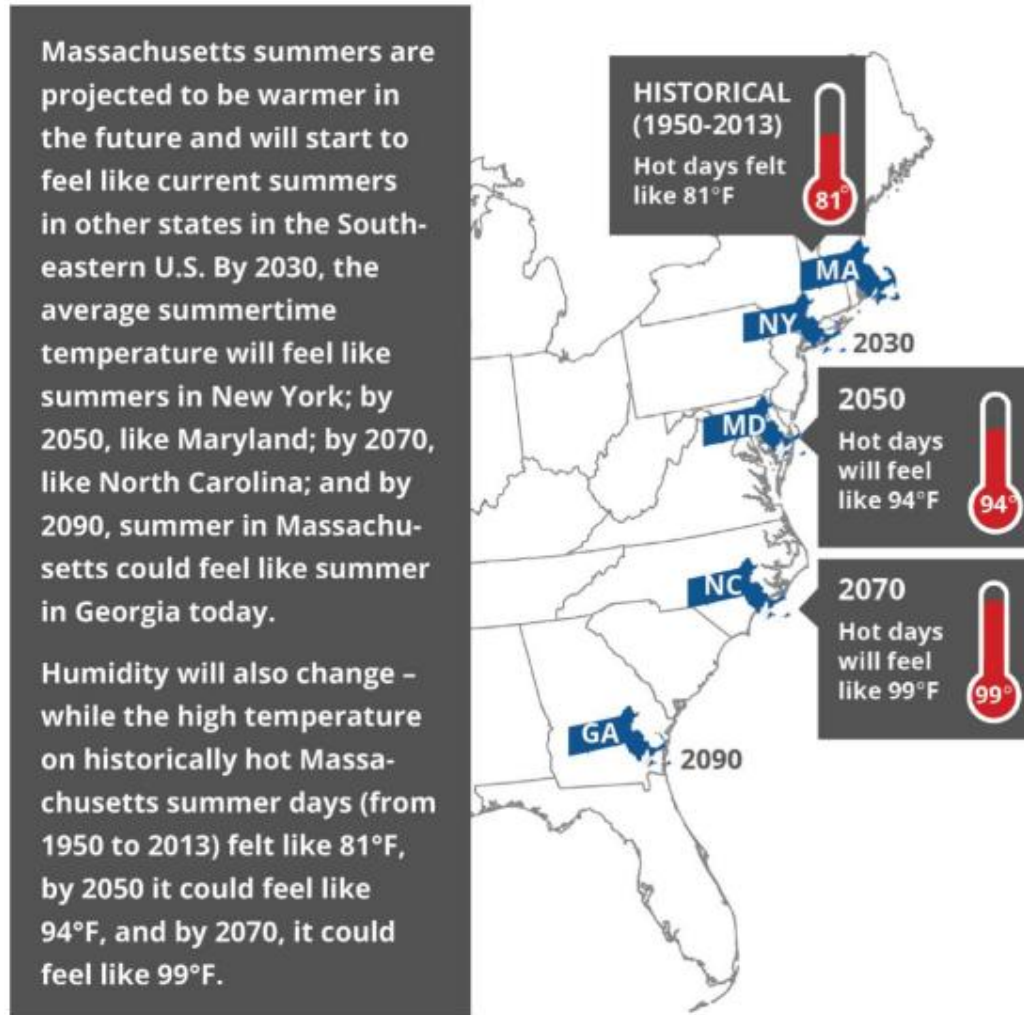
Figure 4: Change in the Annual Number of Days Over 90°F Compared to Today



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These changes could result in Massachusetts summers feeling like a more southern state, as described in the infographic in Figure 5 from the State's 2022 Climate Change Assessment.

Figure 5: Change in Average Summertime Temperatures for Massachusetts



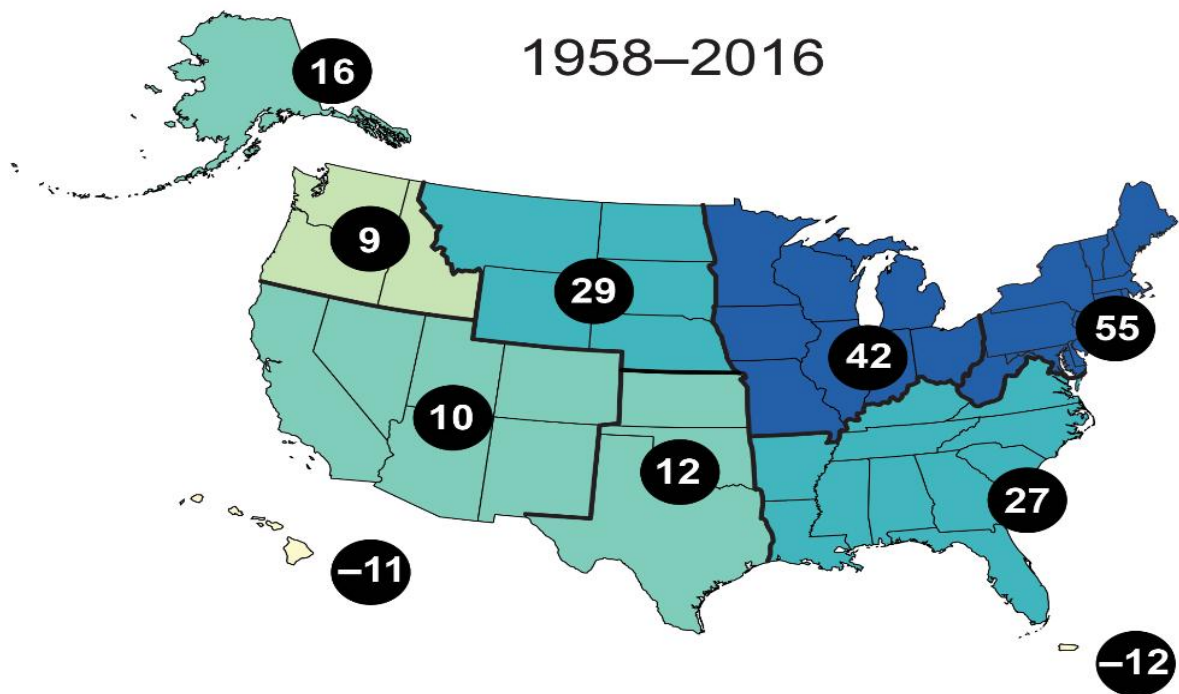
Source: 2022 MA Climate Change Assessment

PRECIPITATION PATTERNS

Annual precipitation in Massachusetts has increased by approximately 10% in the fifty-year period from 1960 to 2010 (MA EEA, 2011). Moreover, there has been a significant increase in the frequency and intensity of large rain events. For the Northeast US, according to the Fourth National Climate Assessment 2018, in the past sixty years there has been a 55% increase in the amount of annual precipitation that falls in the top 1% of storm events, as shown in Figure 6 below (US Global Change Research Program, 2018). Changes in precipitation are fueled by warming temperatures which increase evaporation and, therefore, the amount of water vapor in the air.

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Figure 6: Observed Change in Total Annual Precipitation in the Heaviest 1% Events



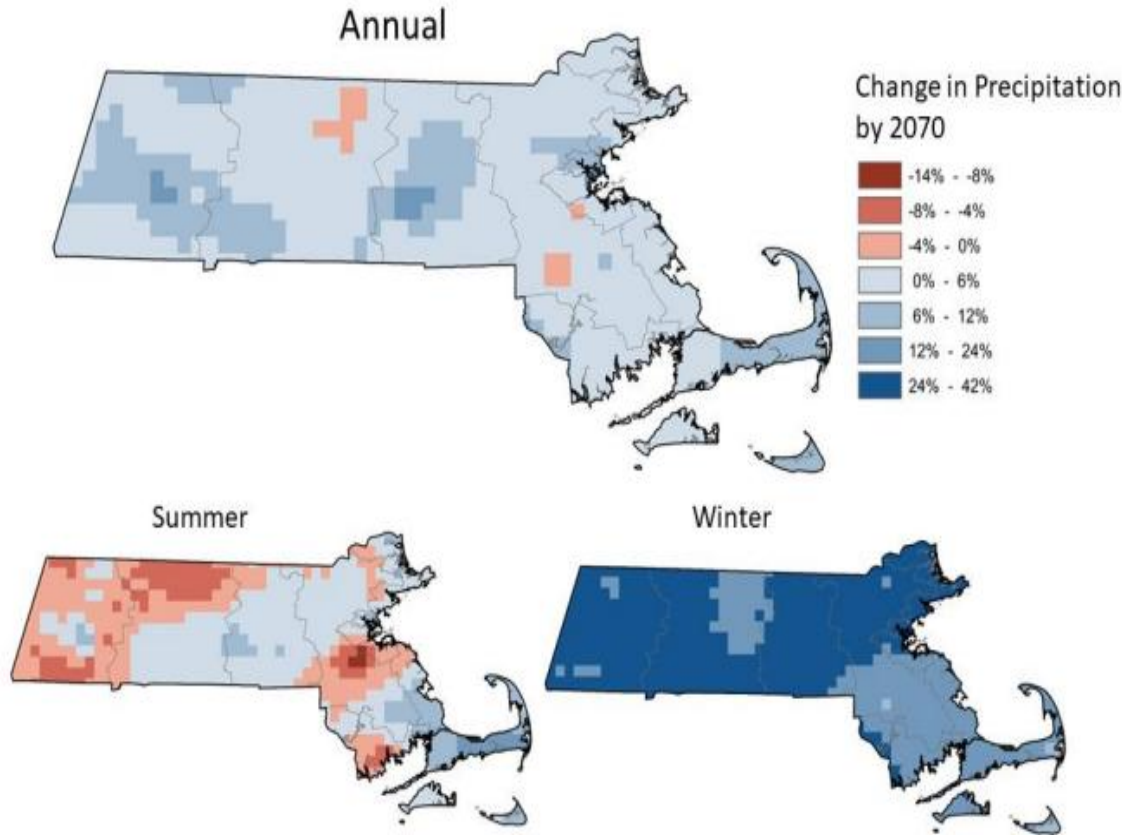
Source: Fourth National Climate Assessment, 2018
Numbers circled in black indicate % change.

Massachusetts' 2022 Climate Change Assessment anticipates that most parts of the State will see a future increase in annual total precipitation of less than 8% per year. Most of these increases are anticipated during the winter months (see Figure 7 below).

Additionally, the historic 10% annual chance daily rainfall event (2.8-4.0" of rain) could occur four times more frequently by 2090 (Commonwealth of Massachusetts, 2022).

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Figure 7: Change in Annual and Seasonal Precipitation in 2070 Compared to Today



Source: 2022 MA Climate Change Assessment. The current climate is the 1986-2005 era, the projection for 2070 is for a 20-year era centered on 2070. Maps show LOCA downscaled GCM projections at the 50th percentile across 20 LOCA GCMs that overlap with the GCMs used in the Stochastic Weather Generator.

Despite overall increasing precipitation, more frequent and significant summer droughts are also a projected consequence of climate change. This is due to projections that precipitation will increase in winter and spring and decrease slightly in the summer and, as a result of earlier snow melt, and higher temperatures that will reduce soil moisture. Massachusetts' 2022 Climate Change Assessment anticipates that these changes will vary by region. The North and South Shore region where Duxbury is located may experience slightly more consecutive dry days, and significantly more days without rain per year, by 2090 (Commonwealth of Massachusetts, 2022). See Figure 8 below for more information.

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Figure 8: Consecutive dry day events (number of multiple-dry-day events per year)

Panel A: Consecutive dry day events (number of multiple-dry-day events per year)					
Region	Baseline	2030	2050	2070	2090
Berkshires & Hilltowns	29	29	30	30	31
Greater Connecticut River Valley	31	31	32	32	33
Central	32	32	32	33	33
Eastern Inland	32	32	32	33	33
Boston Harbor	31	31	32	32	33
North & South Shores	31	31	32	32	33
Cape, Islands, & South Coast	31	31	32	32	33
Statewide	31	31	31	32	33
Statewide Percent Change	0%	1%	2%	4%	6%

Source: Stochastic Weather Generator

Panel B: Annual number of days without rain (days per year)					
Region	Baseline	2030	2050	2070	2090
Berkshires & Hilltowns	159	161	165	167	170
Greater Connecticut River Valley	171	172	175	178	181
Central	180	182	185	188	192
Eastern Inland	186	181	185	188	193
Boston Harbor	192	185	192	194	198
North & South Shores	184	182	187	190	195
Cape, Islands, & South Coast	186	182	187	191	194
Statewide	176	175	179	182	187
Statewide Percent Change	0%	-1%	2%	3%	6%

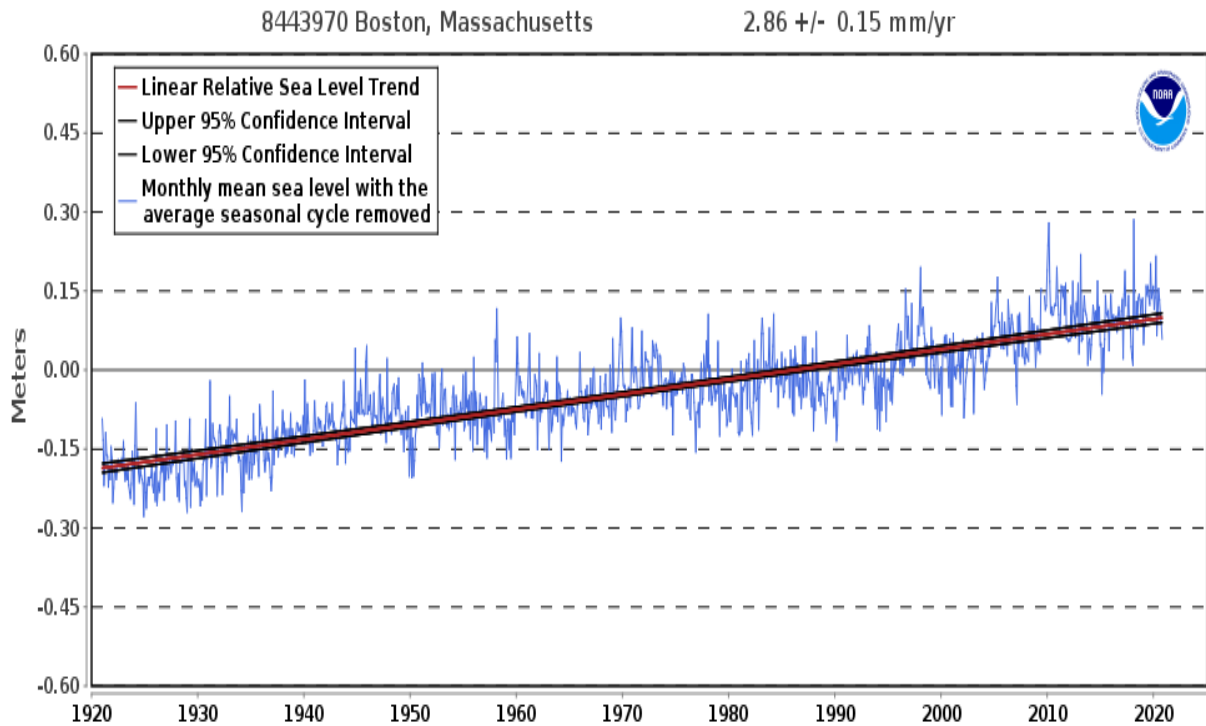
Source: 2022 MA Climate Change Assessment. The Town of Duxbury is located in the North & South Shores region.

SEA LEVEL RISE

High-level information on sea level rise is discussed here as the town as well as the regional economy of the Boston Metro area may be impacted by sea level rise in the future. Warming temperatures contribute to sea level rise in three ways. First, warm water expands to take up more space. Second, rising temperatures are melting land-based ice which enters the oceans as melt water. A third, quite minor, contributor to sea level rise in New England is not related to climate change. New England is still experiencing a small amount of land subsidence (drop in elevation) in response to the last glacial period. NOAA's records from the Boston Tide Station show nearly one foot of sea level rise over the past century. See Figure 9 below for more information.

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Figure 9: Observed Increase in Sea Level Rise



Source: NOAA

The sea level rise information in Massachusetts' 2022 Climate Change Assessment considers sea-level changes, land-level changes, and other regional facts that can impact the rate of change. The report includes the following approximate sea level rise projections for the State:

- **Northern Massachusetts:** 21 inches by 2050, and 43 inches by 2070
- **Southern Massachusetts:** 23 inches by 2050 and 45 inches by 2070

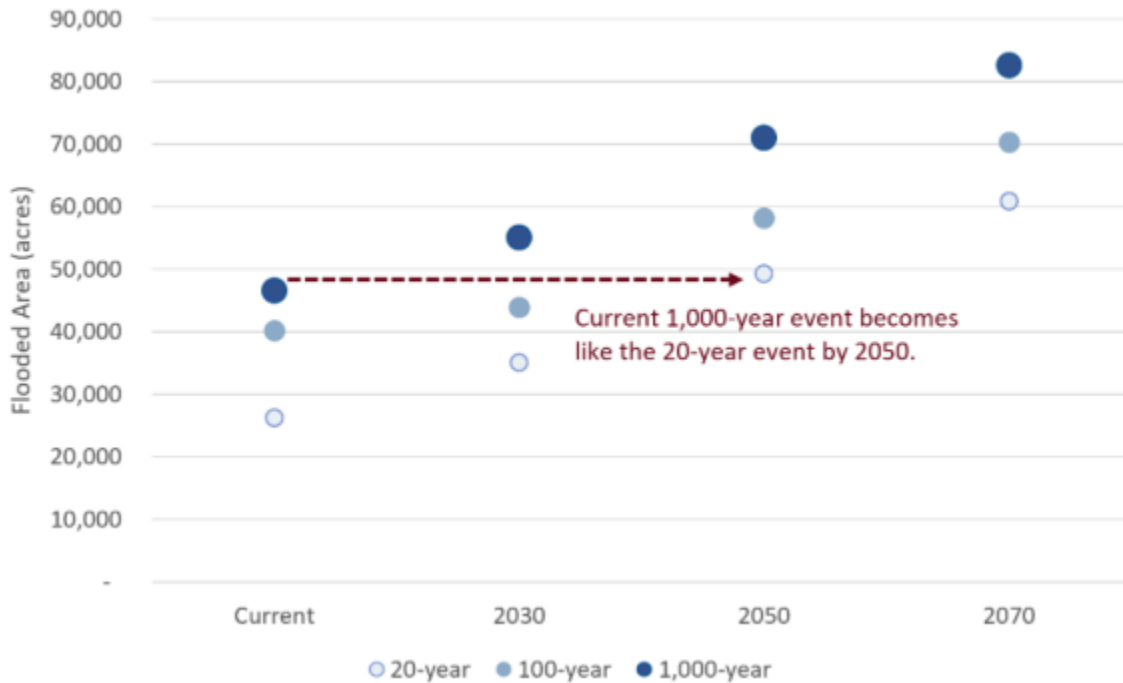
The 2022 Climate Change Assessment also quantified the developed land area flooded for events including:

- the 20-year (5% annual probability)
- 100-year (1% probability)
- 1000-year (0.1% probability) events

This approach found that the area flooded by the current 1000-year event is comparable to the area of a 20-year event by 2050. Even more areas could be impacted by the annual probability event by 2070. See Figure 10 below for more information.

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Figure 10: Total Flooded Area of the Commonwealth for Selected Events



Source: 2022 MA Climate Change Assessment

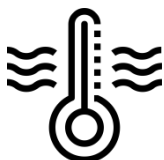
CLIMATE CHANGE AND HAZARD MITIGATION

Following the outline of the Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), this local hazard mitigation plan organizes consideration of natural hazards based on their relationship to projected climate changes.

Table 7 below, which is originally from the 2018 SHMCAP, summarizes the natural hazards reviewed in this plan, climate interactions, and expected impacts.

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Table 7: Climate Change & Natural Hazards

Primary Climate Change Interaction	Natural Hazard	Other Climate Change Interactions	Representative Climate Change Impacts
 Changes in Precipitation	Inland Flooding	Extreme Weather	Flash flooding, urban flooding, drainage system impacts (natural and human-made), lack of groundwater recharge, impacts to drinking water supply, public health impacts from mold and worsened indoor air quality, vector-borne diseases from stagnant water, increased potential for loss of life, episodic drought, changes in snow-rain ratios, changes in extent and duration of snow cover, degradation of stream channels and wetland
	Drought	Rising Temperatures, Extreme Weather	
	Landslide	Rising Temperatures, Extreme Weather	
 Sea Level Rise	Coastal Flooding	Extreme Weather	Increase in tidal and coastal floods, storm surge, coastal erosion, marsh migration, inundation of coastal and marine ecosystems, loss of wetlands
	Coastal Erosion	Extreme Precipitation	
	Tsunami	Rising Temperatures	
 Rising Temperatures	Average/Extreme Temperatures	N/A	Shifting in seasons (longer summer, early spring, including earlier timing of spring peak flow), increase in length of growing season, increase of invasive species, increase in vector-borne illnesses (West Nile, Zika, EEE), ecosystem stress, energy brownouts from higher energy demands, more intense heat waves, public health impacts from high heat exposure and poor outdoor air quality, increased potential for loss of life, drying of streams and wetlands, eutrophication of lakes and ponds
	Wildfires	Changes in Precipitation	
	Invasive Species	Changes in Precipitation, Extreme Weather	
 Extreme Weather	Hurricanes/Tropical Storms	Rising Temperatures, Changes in Precipitation	Increase in frequency and intensity of extreme weather events, resulting in greater damage to natural resources, property, and infrastructure, as well as increased potential for loss of life
	Severe Winter Storm / Nor'easter		
	Tornadoes		
	Other Severe Weather (Strong Wind & Thunderstorms)		

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PLAN UPDATE PROCESS

In order to update Duxbury's risk assessment, MAPC gathered the most recently available hazard and land use data from federal and state sources and met with Town's Hazard Mitigation Team to identify changes in local hazard areas and development trends. The local Team also reviewed critical infrastructure with MAPC staff in order to create an up-to-date inventory and accompanying GIS map. MAPC also used the most recently available version of FEMA's HAZUS-MH program (described below) to assess the potential impacts of Hurricanes, Tornadoes, and Flooding.

OVERVIEW OF HAZARDS AND IMPACTS

The risk assessment analyzes the potential natural hazards that could occur within the Town of Duxbury as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. This updated plan also recognizes that climate change is projected to have significant impacts on many natural hazards in Duxbury. The Resilient MA Plan (2023), the Massachusetts Climate Change Assessment (2022), and the State Hazard Mitigation and Climate Action Plan (SHMCAP, 2018) are key planning documents that examine natural hazards and climate trends that have the potential to impact the Commonwealth. The 2013 State HMP set the stage by defining considerations such as frequency and severity and summarizing the frequency and severity of hazards of greatest concern. The 2018 SHMCAP used similar definitions for hazard considerations and expanded on this research by including additional climate projections. Because the 2013 State HMP includes definitions that were not specified in the SHMCAP, both resources are referred to in this report.

Table 8 below summarizes the hazard risks for Duxbury, with reference to the hazards in Massachusetts. This evaluation takes into account the frequency and severity of each hazard for Massachusetts and Duxbury, based on available data, including:

- **State-level data**, including the Resilient MA Plan, the 2022 MA Climate Change Assessment, and 2018 SHMCAP.
- **County-level data** from NOAA's National Climatic Data Center and Storm Events Database for Plymouth County (where Duxbury is located)
- **Local-level information** including input from the Local Team, the hazard mapping included in Appendix A, and the HAZUS results.

The statewide hazard risk assessment is based on the definitions for hazard frequency and severity listed below. The statewide assessment was modified to reflect local conditions in Duxbury using the same criteria.

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Definitions of Hazard Frequency and Severity

Frequency

Very low: Very unlikely; minimal examples of historical occurrences.

Low: Likely to occur at least once by the end of the century; some examples of historical occurrences; anticipated every 100 years.

Medium: Likely to occur at least once every 50 years (two or more occurrences in the next century)

High: Almost certain to occur at least once a year.

Very High: Almost certain to occur multiple times a year.

Severity

Minor: Limited and scattered property damage; limited damage to public infrastructure and essential services not interrupted; limited injuries or fatalities.

Serious: Scattered major property damage; some minor infrastructure damage; essential services are briefly interrupted; some injuries and/or fatalities.

Extensive: Widespread major property damage; major public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and/or fatalities.

Catastrophic: Property and public infrastructure destroyed; essential services stopped; numerous injuries and fatalities.

Table 8 - Hazard Risks Summary

Hazard	Frequency		Severity	
	Massachusetts	Duxbury	Massachusetts	Duxbury
Coastal Flooding	Very High	Very High	Serious-Extensive	Serious-Extensive
Coastal Erosion	Very High	Very High	Serious-Extensive	Serious-Extensive
Flooding - Precipitation	Very High	High	Serious	Serious
Dam failures	Very Low	Very Low	Extensive	Minor
Tsunami	Very Low	Very Low	Extensive-Catastrophic	Extensive-Catastrophic
Hurricane/Tropical Storm	Medium	Medium	Serious - Catastrophic	Serious - Catastrophic
Tornadoes	High	Low	Serious - Extensive	Serious
Other Severe Weather- Thunderstorms/Hail	Very High	High	Minor - Extensive	Minor-Serious
Winter Hazards-- Nor'easter/Blizzards	High	High	Minor - Extensive	Minor-Extensive
Winter Hazards--Ice Storms	Medium	Medium	Minor - Extensive	Minor-Serious
Earthquakes	Medium	Medium	Serious - Catastrophic	Serious-Extensive
Landslides	High	Very Low	Minor - Extensive	N/A
Wildfire/Brushfires	Very High	High	Minor - Extensive	Minor-Serious
Extreme Temperatures	Very High	Very High	Minor - Serious	Minor-Serious
Drought	Medium	Medium	Minor - Serious	Minor-Serious
Invasive Species	High	High	Minor	Minor
Changes in Groundwater	High	Very Low	Serious	N/A

Sources: Resilient MA Plan (Frequency), State Hazard Mitigation Plan 2013 (Severity), HAZUS, Local information.

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Not all hazards listed in the Resilient MA Plan affect the Town of Duxbury. Landslides, while theoretically possible, have never occurred and the town is ranked “Low Susceptibility” for landslide, given its low-relief terrain on the coast.. Land use regulations govern stabilization of slopes, and the Town did not conclude that additional mitigation for landslides is warranted. Changing groundwater levels were also not designated a significant hazard in Duxbury. USGS groundwater monitoring records show no trend in lower groundwater levels over the last 50 years.

FLOODING HAZARDS

OVERVIEW OF TOWN-WIDE FLOODING: COASTAL AND PRECIPITATION FLOODING

Flooding was the most prevalent natural hazard identified by local officials in Duxbury. Given the Town’s location on the coast, the Town is subject to two kinds of flooding; coastal flooding and flooding from precipitation, both described below. Coastal flooding occurs when wind, tide, and storm surges lead to flooding in low-lying areas along the shore and tidal waterways, and flooding from precipitation occurs when the rate of precipitation or amount of stormwater runoff overwhelms the capacity of natural and structured drainage systems to convey water, causing it to overflow and flood roads and adjacent properties. These two types of flooding can be combined when inland flooding is prevented from draining to the sea by the push of tide-driven coastal waters.

Importantly, coastal flooding and storm surge also cause significant damage to Duxbury Beach, the barrier beach which provides shoreline protection to the Towns of Duxbury, Kingston, and Plymouth. Coastal storms cause overwash on the beach and dunes. Consistent and persistent overwash with coastal storms could cause a permanent breach of the barrier beach and increase high energy wave action into Duxbury Bay, affecting all three communities, if not restored each year with beach nourishment and sacrificial dunes.

Regionally Significant Floods

There have been a number of major floods that have affected the Metro Boston region over the last fifty years. Significant historic flood events have included those listed below (NOAA, 2024)

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991
- December 1992
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- December 2010
- March 2013
- January 2018
- March 2018
- June 2020

FLOODING FROM PRECIPITATION

Flooding is generally caused by severe rainstorms, hurricanes, nor’easters, and thunderstorms. Severe rainstorms can occur year-round. Hurricanes are most common in the

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summer and early fall while Nor'easters are most common in winter. Spring snowmelt may exacerbate flooding during storm events. Climate change has the potential to exacerbate these issues over time due to increasing extreme rainfall events. Increase in average annual rainfall may also lead to more incidents of basement flooding caused by high seasonal groundwater levels.

Previous Precipitation Flooding Events

The best available local data on previous precipitation flooding events in Duxbury are from NOAA's National Centers for Environmental Information Storm Events Database, which provides county-level records of natural hazards (see Table xx). Plymouth County, which includes the Town of Duxbury, experienced 38 flood events from 2010 –2025. There were no deaths or injuries reported and the total reported property damage in the county was \$24.3 million dollars.

Damages from the two largest flood events, the storms of March 2010, totaled \$24.2 million, or 98% of total flood damages for Plymouth County over the entire 15 year period from 2010 to 2025. The 2010 storms were a federally declared disaster, making federal disaster assistance available to residents who did not carry flood insurance. That resulted in 84 disaster claims in the Town of Duxbury, totaling \$ \$126,742.37. See section below on the flood of 2010.

Potential damages from flooding in the Town of Duxbury were estimated using FEMA's HAZUS-MH program. The results, shown in Table 9, indicate potential building damages from a 1% Annual Chance Flood (100-year) at \$20,660,000 and from a 0.2% Annual Chance Flood (500-year) at \$22,860,000.

Table 9 Plymouth County Flood Events, 2010 - 2025

Date	Deaths	Injuries	Property Damage \$
3/14/2010	0	0	16,150,000
3/29/2010	0	0	8,070,000
4/1/2010	0	0	0
7/13/2011	0	0	5000
8/10/2012	0	0	30,000
5/11/2013	0	0	0
5/11/2013	0	0	0
6/7/2013	0	0	0
9/3/2013	0	0	0
3/30/2014	0	0	0
3/30/2014	0	0	0
10/22/2014	0	0	0
11/17/2014	0	0	0
5/31/2015	0	0	0
7/28/2015	0	0	15,000
9/10/2015	0	0	0
10/29/2015	0	0	0
5/30/2016	0	0	0
4/1/2017	0	0	5000
4/6/2017	0	0	5000
6/24/2017	0	0	1000
10/25/2017	0	0	0

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Date	Deaths	Injuries	Property Damage \$
10/25/2017	0	0	0
10/29/2017	0	0	0
1/12/2018	0	0	0
11/3/2018	0	0	1000
4/15/2019	0	0	0
7/12/2019	0	0	0
7/22/2019	0	0	0
9/2/2019	0	0	1000
9/2/2019	0	0	1000
7/12/2021	0	0	0
9/2/2021	0	0	2000
11/12/2021	0	0	5000
8/5/2022	0	0	4000
8/18/2023	0	0	0
9/10/2023	0	0	0
1/10/2024	0	0	0
TOTAL	0	0	24,295,000

Source: NOAA, National Centers for Environmental Information

While coastal flooding is the main concern for Duxbury (see section below), the town is impacted by several bodies of water that can flood during storms. These include Keene Brook, the South River Reservoir, and the Chase Reservoir. Flooding is relatively limited in this area and active land conservation and wetland protection measures in this area have limited the exposure of homes and businesses to this type of flooding.

Another type of inland flooding that is an issue for Duxbury is flooding driven by stormwater drainage. Particularly an issue in those parts of the town with greater levels of imperviousness, this flooding occurs in areas where the storm drain pipes are inadequately sized compared to the level of stormwater runoff. Exceptionally high tides can also effectively block these storm drain systems, given Duxbury's generally low-lying geography. Combined with the watershed from neighboring towns, the Duxbury area can accumulate a great deal of water in a short amount of time during heavy rains, severe storms, and in the spring season.

Most severe flooding event within last 15 years

The most severe flooding event in Eastern Massachusetts in the last 15 years occurred during March 2010, when a total of 17.7 inches of rainfall was recorded by the Blue Hills Observatory from three storms over 19 days from March 13 to 31. The weather pattern that consisted of early springtime prevailing westerly winds that moved three successive storms, combined with tropical moisture from the Gulf of Mexico, across New England. Torrential rainfall caused March 2010 to be the wettest month on record.

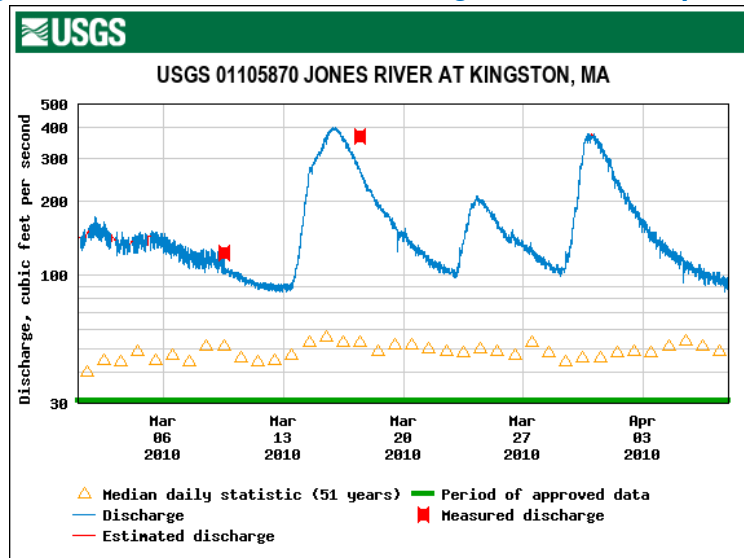
The March 2010 rainstorms fit the profile of a type of severe precipitation event expected to increase in frequency as the climate warms. That is, significant precipitation,

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falling in late winter as rain rather than snow, on frozen ground, and while vegetation is still dormant.

One indication of the extent of flooding is the measured stream discharge at the nearest USGS streamflow gauging station, which is on the Jones River in neighboring Kingston, MA. Figure 11 illustrates that March 2010 had two streamflow peaks at about 400 cubic feet per second (cfs) in mid-March and 390 cfs in late March. By comparison, the median discharge for March is about 50 cfs, as shown on Figure 11.

Figure 11: Jones River USGS Discharge (cfs), March-April 2010



Source, US Geological Service, National Water Information System

COASTAL FLOODING

Coastal flooding is associated with severe coastal storms that, through the combination of winds and tides, drive tidal waters to higher levels than normally experienced. This can lead to the inundation of low-lying land areas and the overtopping of seawalls. Duxbury has extensive exposure to coastal flooding and flooding along large stretches of its coastline can be a relatively frequent occurrence.

All of the repetitive loss sites in Duxbury are located near the Atlantic Ocean, with the greatest concentration along Gurnet Road. This area is particularly vulnerable because coastal flooding occurs in two directions, flooding from the beach side of the road through and over the sea walls, and from inundation from the Great Marsh and Duxbury Bay. Frequent pumping of a low area constructed by the local residents to capture stormwater and floodwater is required in the Gurnet Road portion of Duxbury close to the Marshfield town line, and gaps in the Marshfield sea wall during storm events further contribute to localized flooding along Plymouth Avenue. Other areas repeatedly prone to coastal flooding include the Snug Harbor business district, Mattakeeset public boat landing, King Caesar Road, Bay Road, and Gurnet/High Pines on Duxbury Beach.

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Importantly, coastal flooding and storm surge also cause significant damage to Duxbury Beach, the barrier beach that acts as a flood barrier for Duxbury, Plymouth and Kingston Bays, attenuating high waves and providing shoreline protection to the Towns of Duxbury, Kingston, and Plymouth. Coastal storms cause overwash on the beach and dunes.

Consistent and persistent overwash with coastal storms could cause a permanent breach of the barrier beach and increase high energy wave action into Duxbury Bay if not fully restored with beach nourishment and sacrificial dunes.

Previous Coastal Flooding Events

The best available local data for previous coastal flooding occurrences is provided by the NOAA National Centers for Environmental Information. Plymouth County, which includes the Town of Duxbury, experienced 55 coastal flood events from 2006 through 2025 (see Table 10). No deaths and three injuries were reported and the total reported property damage in the county was \$15.1 million dollars. The top three storm events in 2010, 2013, and 2015 account for 85% of total property damage for the period of 2006-2025.

Table 10: Plymouth County Coastal Flood Events, 2006-2025

Date	Deaths	Injuries	Property Damage (\$)
1/31/2006	0	0	60,000
4/16/2007	0	0	10,000
4/16/2007	0	0	5,000
4/17/2007	0	1	15,000
3/8/2008	0	0	5,000
10/18/2009	0	0	-
1/2/2010	0	0	-
2/25/2010	0	0	-
3/4/2010	0	0	-
3/15/2010	0	0	-
10/6/2010	0	0	-
11/8/2010	0	0	1,000
12/27/2010	0	0	2,200,000
10/30/2011	0	0	10,000
11/23/2011	0	0	-
6/3/2012	0	1	35,000
6/4/2012	0	0	40,000
10/29/2012	0	0	967,000
12/27/2012	0	0	-
2/9/2013	0	0	9,200,000
3/7/2013	0	0	500,000
12/15/2013	0	0	-
1/2/2014	0	0	-
1/3/2014	0	0	-

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Date	Deaths	Injuries	Property Damage (\$)
3/26/2014	0	0	-
10/22/2014	0	0	75,000
10/23/2014	0	0	-
11/2/2014	0	0	-
1/27/2015	0	1	1,500,000
2/15/2015	0	0	-
10/2/2015	0	0	-
1/23/2016	0	0	-
1/24/2016	0	0	3,000
2/8/2016	0	0	-
1/4/2018	0	0	500,000
1/30/2018	0	0	-
3/2/2018	0	0	-
3/8/2018	0	0	-
10/27/2018	0	0	-
11/25/2018	0	0	-
1/20/2019	0	0	-
4/3/2020	0	0	2,000
9/22/2020	0	0	-
12/17/2020	0	0	-
2/2/2021	0	0	-
10/27/2021	0	0	-
1/17/2022	0	0	-
1/29/2022	0	0	-
12/23/2022	0	0	7,000
1/23/2023	0	0	-
12/18/2023	0	0	-
1/10/2024	0	0	-
1/13/2024	0	0	-
3/10/2024	0	0	-
4/4/2024	0	0	-
TOTAL	0	0	\$15,135,000

Source: NOAA, National Centers for Environmental Information

The frequency and locations of coastal flood events in Duxbury can also be indicated by the reported loss occurrences for repetitive loss properties and from local knowledge captured through discussion with local staff and the public during identification of local flood hazard areas. Based on these factors, flooding occurs most often along the ocean shoreline, where even a relatively small storm can lead to very high tides and overwash seawalls and dunes, and in a number of low-lying neighborhoods throughout the town. In particular, winter storms in 1978, 1979, 1987, 1991, 1992, 2005, 2007, 2010, 2013, 2015, and 2018 all led to extensive flood insurance claims in Duxbury's low lying, flood prone areas.

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The first in this series of storms, the “Blizzard of 1978” was one of the most significant coastal flooding events on record. On February 6-8, 1978, New England was battered by one of the most severe winter storms on record. The storm produced record snowfall in many areas. Spring high tides, a stationary storm center, and hurricane force winds combined to produce record high coastal flood levels along much of coastline on February 7. Tidal gages recorded new highs of 10.4 feet in Boston. Fifty five lives were lost and property damage in Massachusetts was greatest north of Cape Cod. The total cost of the storm—principally property damage, snow removal, and economic losses—approached \$1 billion.

In 1979 the US Geological Survey published an assessment of high-water marks documented along the coast of Maine, New Hampshire and Massachusetts. The assessment includes ten points in the Town of Duxbury, shown in Figure 12.

Figure 12: Duxbury Flood Elevations and High-Water Marks for Feb. 7, 1978

307	9.09	Lat 42°03'58", long 70°40'40", Duxbury, Mass., Little Wood Island River, excellent debris line, paint, nail, tag at base of tree seaward of pole 462 on State Route 139, 1 mi east of Moraine Street. Photo. Tidal surge.
308	9.16	Lat 42°03'24", long 70°41'02", Duxbury, Mass., Dug Way River, good debris line, silver paint, nail, tag at base of pole 17 on Duck Hill Road 0.4 mi east of Moraine Street. Photo. Tidal surge.
309	10.6	Lat 42°03'06", long 70°40'20", Duxbury, Mass., Dug Way River, Duxbury Marsh, good debris line, paint, nail, tag on third tree seaward from Bay Road 0.2 mi north of intersection with George Street. Two photos. Tidal surge.
310	11.48	Lat 42°02'49", long 70°39'05", Duxbury, Mass., Back River behind Duxbury Beach, poor debris line at west end of Powder Point Bridge. Elevation is an approximation, water level approached the top of the bridge. Wave action.
311	9.37	Lat 42°02'23", long 70°40'35", Duxbury, Mass., Bluefish River, good ice line, silver paint mark on right downstream side of Bluefish River culvert under Harrison Street near intersection of Bay Road, pole 30 across street. Photo. Tidal surge.
312	10.83	Lat 42°02'53", long 70°40'19", Duxbury, Mass., Bluefish River, good debris and wash line, paint, nail, tag on second telephone pole on south side of Powder Point Road east of intersection of Cove Street and Abrams Hill Road. Photo. Floodmark consistent with other floodmark elevations along bank. Probably tidal surge.
313	10.16	Lat 42°01'38", long 70°40'18", Duxbury, Mass., Duxbury Bay, excellent debris line, paint, nail, tag on piling at end of Shipyard Lane about 150 ft south of Ellison Beach Rock monument. Photo. Tidal surge.
314	9.87	Lat 42°01'13", long 70°41'19", South Duxbury, Mass., The Nook, Kingston Bay, excellent debris line, paint, nail, tag in base of clump of small trees about 50 ft southwest of pole 704 on Bay Road, 0.3 mi west of Standish Street. Photo. Tidal surge.
315	10.55	Lat 42°00'44", long 70°42'02", South Duxbury, Mass., Kingston Bay, good to fair debris line, paint, nail, tag 2.5 ft above base of last telephone pole on right, at end of Landing Road. Probably some effect from wave bore.
316	8.7	Lat 40°00'32", long 70°42'46", South Duxbury, Mass., Miramar, Island Creek, Kingston Bay, excellent debris line, silver paint on left downstream wingwall of Island Creek culvert on Bay Road, about 30 ft southwest of pole 770. Photo. Tidal surge.

Source: USGS, Coastal Flood of 1978 in Maine, New Hampshire and Massachusetts, 1979

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There were several significant coastal storms in January and March of 2018. On January 4, 2018 Duxbury experienced significant flooding due to a nor'easter. The storm coincided with astronomical high tides and resulted in a surge, recorded at the Boston tide station, of 15.16 feet—higher than the highest surge from the Blizzard of 1978. In March 2018, the Greater Boston Region, and in particular the South Shore, suffered from major nor'easters that flooded homes and business, crippled infrastructure, and left hundreds of thousands without power. The storm surge from the March 3 nor'easter was so strong that on March 5, part of Duxbury's seawall collapsed into the ocean.

Local Flood Hazard Areas (Inland and Coastal)

Information on potential flood hazard areas was taken from two sources. The first was the National Flood Insurance Rate Maps (FIRM). The FIRM flood zones are shown on Map 3 in Appendix A and their definitions are listed below. The current FIRM maps in effect in Duxbury are dated July 9, 2021 except for several FIRM panels along the immediate coast dated 2016.

Flood Insurance Rate Map Zone Definitions

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

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

Zone X500 (0.2% annual chance): Zone X500 is the flood insurance rate zone that corresponds to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone.

Zone VE (1% annual chance): Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

Locally Identified Areas of Inland and Coastal Flooding

The second source of information on local flooding was the Duxbury Hazard Mitigation Team. The Team identified local areas subject to flooding in the 2019 Hazard Mitigation Plan, and they updated the identified flood hazard areas for this 2026 Hazard Mitigation Plan (see Table 11). These areas do not necessarily coincide with the flood zones from the FIRM maps. They may be areas that flood due to inadequate drainage systems or other local conditions rather than due to location within a FIRM flood zone.

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These sites have been mapped, and the numbers below correspond to the numbers on the hazard map series found in Appendix A. The numbers do not reflect priority order.

Table 11: Locally Identified Areas of Flooding

Map ID	Site	Description
1	Gurnet Road	This area experiences flooding along the coast that is primarily impacted by nor'easter storms. The area experiences heavy wave overwash from the sea during storms, along with back water and still water flooding. Damages have included loss of homes and residents were evacuated at times. There is an approximately 5,000-foot long sea wall running along the coast here, but portions of the wall are missing or in disrepair in at least two sections. The seawall is currently in the construction phase and will be completed by 2025. Officials estimate that there is flooding here two or three times per year and a need to condemn homes at least once every ten years. There is also significant flooding from the bay side.
2	Duxbury Beach	The Duxbury Beach Reservation (DBR), Inc., is the nonprofit that owns and manages the 4.5 mile (350+ acre) barrier beach that lies to the east of Duxbury Bay and protects 14.95 miles of densely constructed Duxbury shoreline. The beach acts as a flood barrier for Duxbury, Plymouth and Kingston Bays, attenuating high waves as they move toward Duxbury to the west. The Reservation has a comprehensive coastal resiliency plan to proactively maintain the barrier beach, which safeguards the community, whenever funding and materials are available. Between 2022 and 2024, Duxbury Beach Reservation dedicated more than \$2.8 million each year, on programs and projects to preserve the beach and the coastal lifestyle it affords the town's residents. The barrier beach is also the only means of travel to the Gurnet and Saquish Point, with approximately 250 home sites in Plymouth near Duxbury's southeastern town line.
3	Powder Point Ave, Washington and St. George Streets	Still water and high tides, including "sunny day flooding" cause roadway flooding at this spot, hindering access to homes and through the area by vehicles. There are also two homes in this area that have been flooded in the past.
4	King Caesar Road / Powder Point Ave.	Flooding is caused by tidal wave action from the south.
5	Snug Harbor	This commercial district in town is a flooding concern with the roads, homes, and businesses in the area all being subject to damage during extremely high tides and storm events. A Snug Harbor Resilience Plan was prepared in 2019, and the Town is currently working on a Snug Harbor project that includes a number of mitigation and adaptation measures for this key commercial district.

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Map ID	Site	Description
6	Patten Lane	This flooding concern is impacted by tidal wave action along the coast that causes erosion to the dunes and damage through the channel outlet during nor'easters and other storm events.
7	Marshall Street Bridge	This flooding area is of particular note because flooding of the bridge jeopardizes critical access to the Standish Shore neighborhood (approximately 120 homes). As with most areas of town, this area is impacted by extreme storm events.
8	Bay Road Neighborhoods	This flooding concern comprises several smaller neighborhoods that exist along Bay Road, Landing Road area in particular is open to the ocean and FIRMs predict severe damage from large storm events that hit this area.
9	Congress Street	Riverine water overtopping the roadway causes flooding in this area. The culvert structure beneath the roadway is an insufficient size to handle the flow from the unnamed brook below it during heavy rainstorms.
10	Lake Shore Drive	This flood hazard area is at the outlet end of the Lower Chandler Mill Pond on the town's line with Pembroke.
11	Keene Mill and Keene Brook	Overtopping of the roadway during heavy rainfalls causes flooding in this area.
12	North Hill Dam	This town-owned dam could be a flood hazard if it fails. The dam has largely been maintained and has had some reconstruction work done. It is believed to be in good shape now.
13	Chase Reservoir	Flooding here is due to complications from the dam at the reservoir. The dam has partially failed in the past and been repaired. It is believed to be in fair condition at present.
14	South River Reservoir	This is a Town-owned dam, which has failed previously and also caused overtopping of Route 14. The dam was repaired and is reported to be in good condition now. Overtopping of this dam also caused flooding on Plantation Drive. The dam, though currently considered to be sound, may not be capable of handling the volume. There is a control weir installed on the dam to alleviate those concerns and to aid in overtopping.
15	Plantation Drive	Flooding occurs when the South River overtops the dam. The structure cannot handle the volume of the dam, which does have a control weir installed.
16	Blue Fish River	Flooding is the result of the inundation of saltwater, which backs upstream almost to Route 3A during high tides/high rain events.

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Map ID	Site	Description
29	Wirt Way	In March 2018, during Winter Storm Riley, storm inundation crossed Bay Road adjacent to Wirt Way flooding neighborhoods on the landward side of Bay Road.
30	Island Creek outlet	In March 2018 during Winter Storm Riley, inundation flooded Island Creek at Bay Road outlet, causing areas of flooding in the neighborhood upstream of the Island Creek outlet.

REPETITIVE LOSS PROPERTIES

As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of \$1,000 or more in any given 10-year period since 1978. A Severe Repetitive Loss property is a property for which four or more claims of \$5,000 each have been paid, with a cumulative amount exceeding \$20,000; or for which at least two payments were made with a cumulative amount exceeding the value of the property. For more information www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet.

There are 65 Repetitive Loss structures in Duxbury. Duxbury also has 11 Severe Repetitive Loss (SRL) properties. . Table 12 shows Repetitive Losses and Severe Repetitive Losses by type of occupancy. Table 13 summarizes the number of losses and total payments associated with these properties. Total payments for the 65 Repetitive Loss properties were \$4.87 million, while the 11 Severe Repetitive Loss properties totaled \$1.162 million. Combined, just shy of \$6.5 million in NFIP claims have been paid to all 76 insured RL and SRL properties in Duxbury.

Table 12. Summary of Repetitive Losses by Property Type

Development Type	Repetitive Loss Properties	Severe Repetitive Loss Properties
Single family residence	60	11
2-4 family residence	1	0
Non-business Non-residential	2	0
Non-residential commercial	2	0
TOTAL	65	11

Source: Massachusetts Emergency Management Agency

Table 13 Summary of Repetitive Losses and Claims in Duxbury

Repetitive Loss Category	Number of Properties	Number of Losses	Total Building Payments	Total Contents Payments	TOTAL Payments
Repetitive Loss	65	234	\$4,384,178.97	\$488,843.05	\$4,873,022.02
Severe Repetitive Loss	11	55	\$1,412,938.79	\$205,046.41	\$1,617,985.20
TOTAL	76	289	\$5,797,117.76	\$693,889.46	\$6,491,007.22

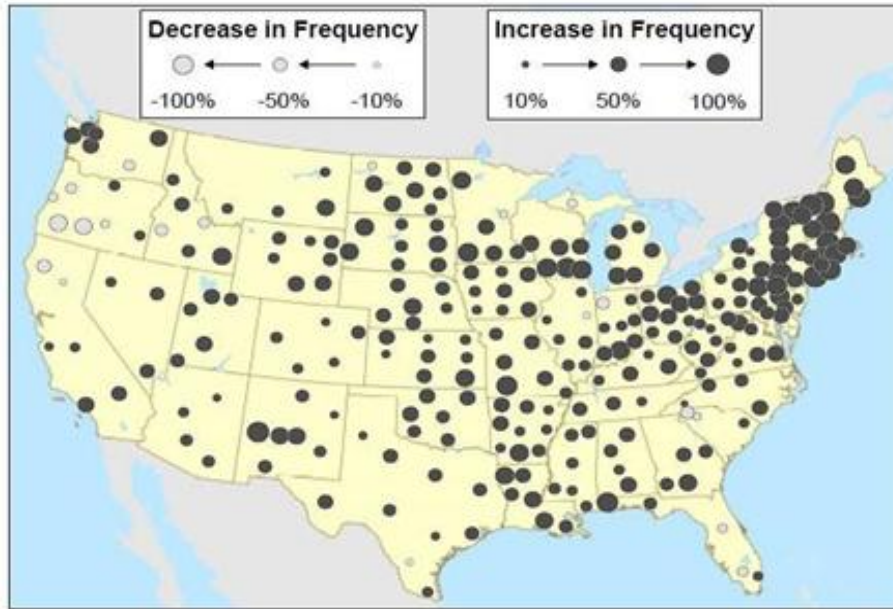
Source: Massachusetts Emergency Management Agency

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CLIMATE CHANGE AND FLOODING FROM PRECIPITATION

Eastern Massachusetts average annual precipitation is 42 inches. While total annual precipitation has not changed significantly, according to the report *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation from 1948 to 2011*, intense rainstorms and snowstorms have become more frequent and more severe over the last half century in the northeastern United States. Extreme downpours are now happening 30 percent more nationwide than in 1948 (see Figure 13).

Figure: 13 Changes in Frequency of Extreme Downpours, 1948 – 2011



Source: *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation*, Environment America Research and Policy Center, July 2012

Not only are these intense storm events more frequent, they are also more severe; the largest annual storms now produce 10 percent more precipitation, on average, than in 1948. In particular, the report finds that New England has experienced the greatest change with intense rain and snow storms occurring 85 percent more often than in 1948.

Data from the 2022 MA Climate Change Assessment related to changes in precipitation patterns is included in an earlier section of this chapter. Those projections suggest that future rain events will be increasingly intense, which could lead to increased inland and stormwater flooding.

Precipitation frequency estimates, which are used for stormwater design standards, were published in 1961 by the U.S. Commerce Department in Technical Paper 40 (TP40). The 10-year, 24-hour storm for eastern Massachusetts was calculated as a 4.5-inch event. Recently the National Oceanic and Atmospheric Administration published updated estimates (NOAA Atlas 14), which increased this design storm by 0.6 inches to 5.14 inches for eastern Massachusetts.

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Future rainfall rates should be considered when designing infrastructure. Communities could consider using NOAA Atlas 14 rainfall rates with an additional allowance to account for projected rainfall during the life of projects permitted today when sizing stormwater infrastructure. DEP takes a similar approach to describe current (not future) rainfall rates, called “NOAA14+”. Mystic River Watershed Association communities propose “NOAA14++”, which they say reflects 2070 projections. The NOAA 14+ number is calculated by multiplying the NOAA 14 precipitation frequency estimate upper confidence interval by 0.9 (i.e., current but extreme precipitation events reflect 90% of upper confidence intervals). The NOAA 14++ number is the upper confidence interval. A comparison of these numbers is summarized in Table 14.

Table 14: Rainfall rates for the 10-year 24-hour storm

NOAA 14	NOAA 14+	NOAA 14++
5.27 inches	5.90 inches	6.56 inches

NOAA, 2023

The 2022 MA Climate Change Assessment also highlights the following flooding climate impacts:

- By 2050, the 1 percent annual chance river flood could be two times more likely to occur
- By 2090, the historical 10 percent annual chance daily rainfall event (2.8 to 4 inches) could occur four times more frequently
- Damage could occur to buildings from heavy rainfall and overwhelmed drainage systems
- Damage could occur to transit service due to flooding
- There could be a reduction in the availability of affordably priced housing from direct damage including from flooding (Commonwealth of Massachusetts, 2022)

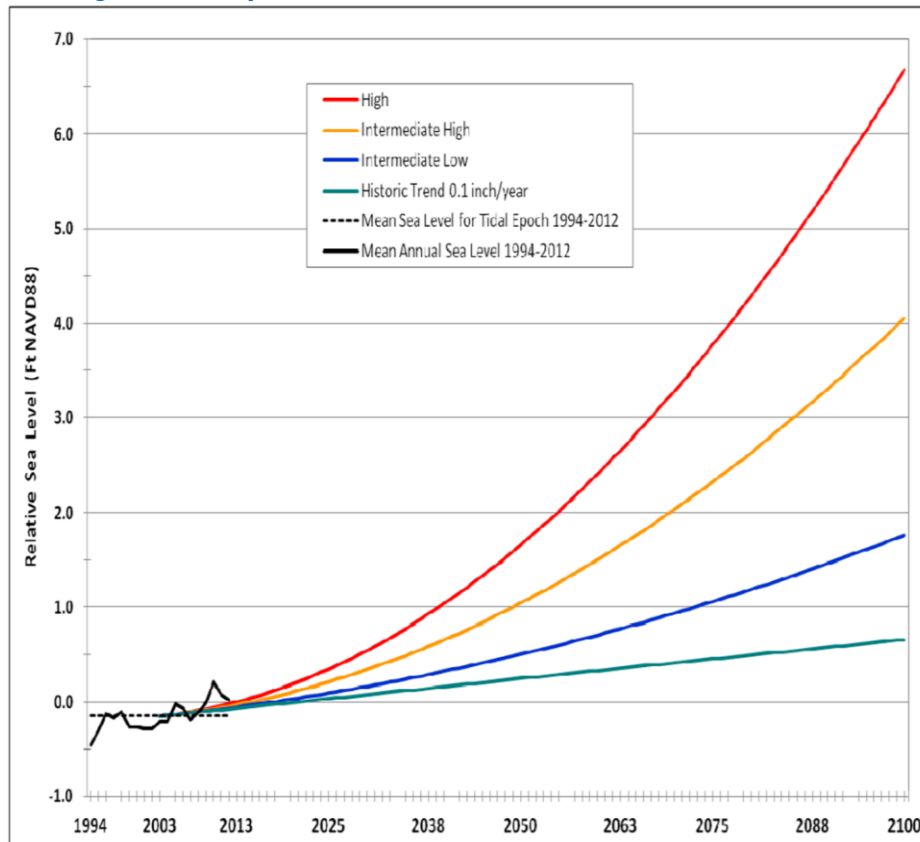
CLIMATE CHANGE IMPACTS: SEA LEVEL RISE

Of all the impacts of climate change, Duxbury is most susceptible to the impacts of sea level rise, as it will magnifies the flooding associated with coastal storms. As shown by records from the Boston Tide Station (see Figure 9) seas have risen the equivalent of 11 inches over 100 years, based on monitoring data from 1921.

The Massachusetts Office of Coastal Zone Management (CZM) adjusted global predictions for future sea level rise, taking into account local subsidence (see Figure 14). The range of projections for the future is quite wide, particularly approaching the end of this century. The High scenario includes ocean warming and a calculation of maximum glacier and ice sheet melt. The Intermediate High scenario averages higher predictions but includes lesser ice sheet melting. The Intermediate Low considers lower sea level rise scenarios and limited ice melt. The Historic Trend reflects a continuation of the current rate of sea level rise.

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Figure 14 Projected Sea Level Rise for Greater Boston Harbor



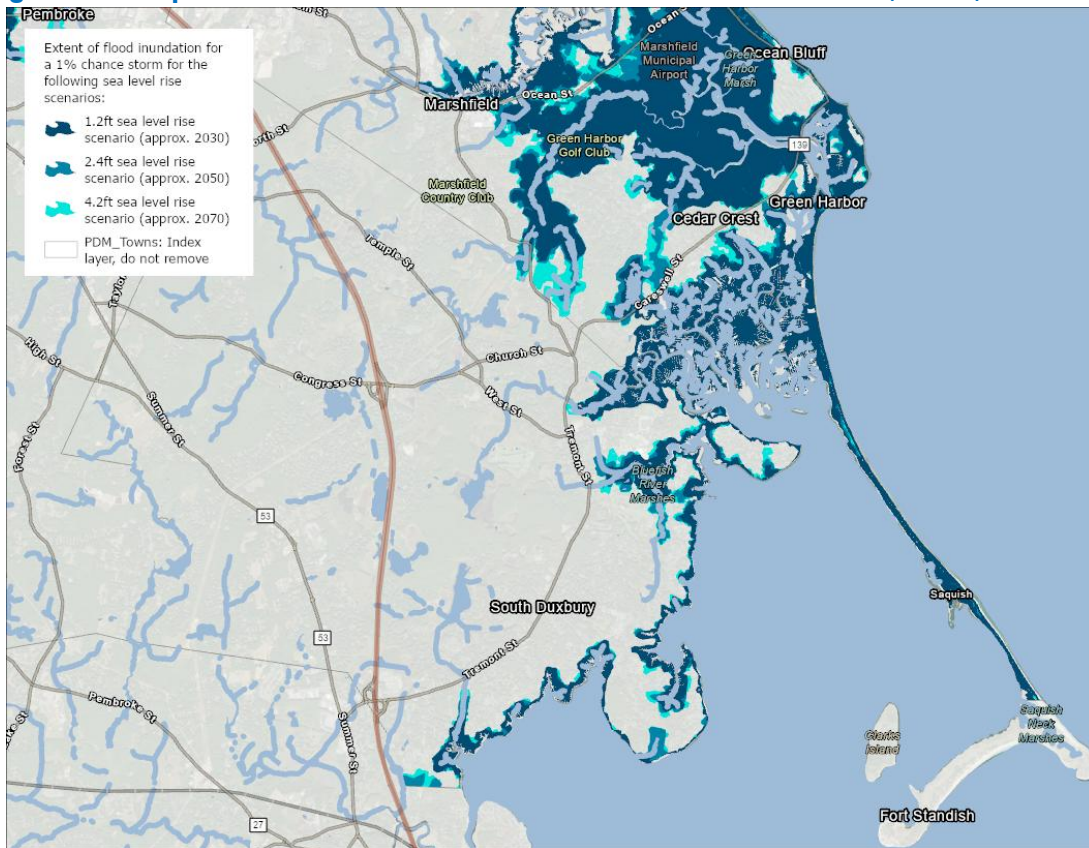
Source: Sea Level Rise: Understanding and Applying Trends and Future Scenarios, MA CZM, December 2013

Several areas of Duxbury are expected to be subject to increased coastal flooding risk in future decades due to climate-driven sea level rise and more severe coastal storms with higher storm surges. Coastal flood risk has been assessed statewide by the Massachusetts Coastal Flood Risk Model (MC-FRM), prepared by the Wood Hole Group. Key results of this assessment for Duxbury are shown in Figure 15, which shows projected areas of coastal flood inundation related to three future sea level rise scenarios. The map shows the extent of flood inundation for a 1% annual chance storm for projected sea level rise scenarios of 1.2 feet, 2.4 feet, and 4.2 feet. These scenarios are approximately equivalent to the levels of sea level rise projected for the years 2030, 2050, and 2070, respectively. This map is also included in the hazard map series in Appendix A.

Fueled by the warming climate, coastal flooding will become more frequent and severe due to the combination of sea level rise and more frequent and intense storms. As shown in the figure below, projections of future sea level rise identify locations that will be subject to flooding in future years. While those areas expand with increasing sea level, another significant impact will be more frequent and deeper flooding in the locations already subject to coastal flooding.

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Figure 15: Projected Inundation Areas for 1% Chance Storm in 2030, 2050, and 2070



Source: Woods Hole Group, Massachusetts Coastal Flood Risk Model

Climate Change Vulnerability Assessment

In 2021, two years after the previous Hazard Mitigation Plan was approved, the Town of Duxbury completed a *Climate Change Vulnerability Assessment and Adaptation Plan*, which was prepared by Woods Hole Group and funded by a Municipal Vulnerability Preparedness (MVP) Action Grant.

The following highlights from the Woods Hole plan provide an overview of the key challenges and adaptation recommendations put forward. There is far more relevant technical detail in this landmark plan than can be directly included in this Hazard Mitigation Plan, so the *Duxbury Climate Change Assessment and Adaptation Plan* should be considered incorporated by reference. Key excerpts from the plan follow. The study had four primary goals:

- 1) Identify areas of the Town that are vulnerable to the combined effects of sea level rise and storm surge from extreme storm events;
- 2) Assess the vulnerability of municipal public infrastructure and natural resources;
- 3) Identify adaptation strategies that will help to mitigate the near- and long-term effects of sea level rise and storm surge; and
- 4) Educate the public, Town officials, and legislators about those potential impacts.

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Sea level rise and storm surge models were used to estimate the probability, extent, and depth of future coastal flooding in Duxbury. Three time horizons were chosen as the basis for planning: 2030 (short-term), 2050 (medium-term) and 2070 (long-term).

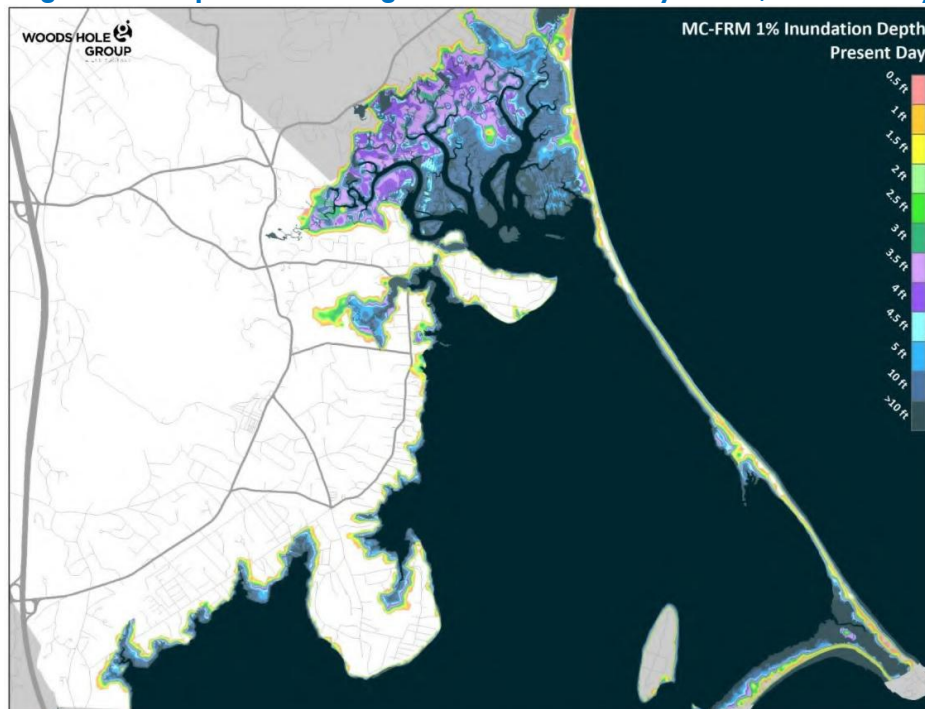
It is estimated that sea level in Massachusetts will rise approximately 0.7 ft. by 2030 and 3.4 ft. by 2070, over 2013 levels. This is according to the high projections from the US National Climate Assessment, adjusted for local conditions. It is anticipated that over the long-term tropical storms will become more powerful and travel further north than in the past, as the warming ocean feeds them with an increasing supply of energy.

To model and map the combined effects of sea level rise and increasing storm surge on coastal flooding in Duxbury, the plan used the hydrodynamic Massachusetts Coastal Flood Risk Model (MC-FRM), which was prepared by Woods Hole Group for the Massachusetts coastline state-wide. The MC-FRM incorporates the sea level rise projections described above and an increase in more powerful tropical storms beginning in 2050.

The maps in Figures 16 and 17 below show the projected location and depth of coastal inundation in Duxbury under a storm event with a 1% (1-in-100) annual chance of occurring for the present day and for the year 2070.

Unlike the map of areas expected to be inundated in Figure 15 above, Figures 16 and 17 illustrate the depth of inundation from a 1% storm for the present day and 2070. These maps show a significant increase in the depth of flooding by 2070. Many of the present day inundated areas would be flooded to a depth of 2 to 3 feet, while in 2070, many of those same areas could be flooded to depths of 5 to 10 feet. The increased extent of damage caused by several more feet of flood depth by 2070 would be significant.

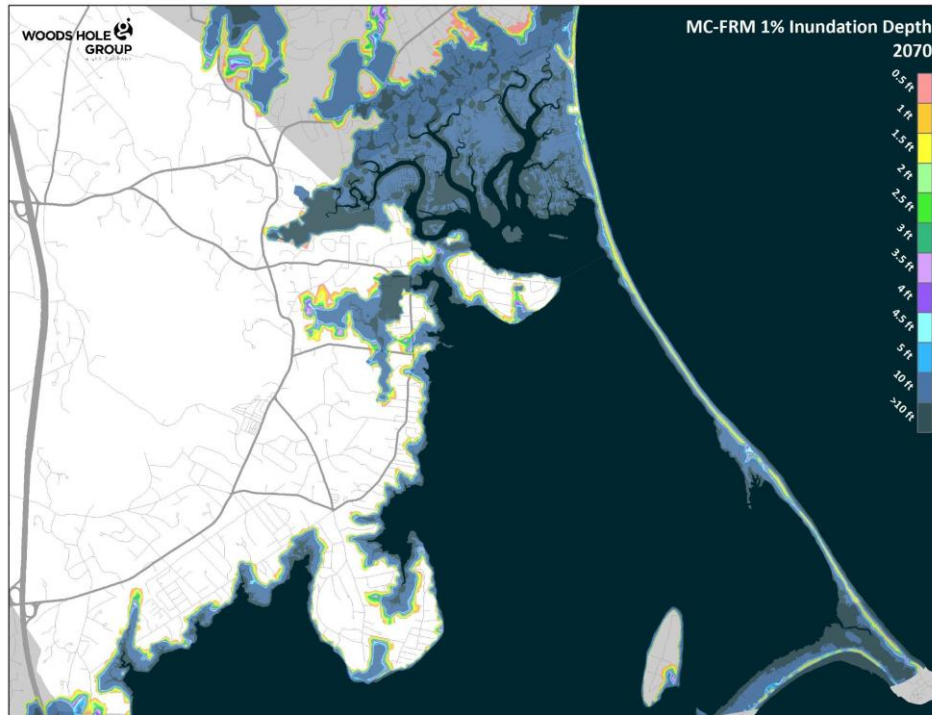
Figure 16: Depth of Flooding with 1% Probability Storm, Present Day



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Source: Duxbury Climate Change Vulnerability Assessment and Adaptation Plan, 2021

Figure 17: Depth of Inundation with 1% Probability Storm in 2070



Source: Duxbury Climate Change Vulnerability Assessment and Adaptation Plan, 2021

A vulnerability and risk assessment was performed by Woods Hole Group on critical municipal infrastructure located within the areas at risk of increased flooding. The types of municipal assets at risk in these areas included bridges, roadways, culverts, parking areas, marine-dependent, and recreational facilities. Based on projected 2070 conditions, the top 10 municipal facilities and assets at risk to storm surge are:

1. Mattakeeset Parking Area
2. Town Pier
3. Harrison St. Bridge
4. Washington St. Bridge
5. Island Creek Bridge
6. Marshall St. Bridge
7. Canal St Bridge (MSH)
8. Harbor Master Float
9. Town Float
10. Duxbury Beach 1 Parking Area

One of the highest risk areas for future flooding, considering both the probability and consequences of flooding, is Snug Harbor. The Woods Hole Group plan notes that:

This assessment highlighted the Snug Harbor area as a highly vulnerable district in the Town of Duxbury with a concentration of important community assets (both public and private). The Harbormaster's center of operations and the Town Pier and boat ramp are at the end of Mattakeeset Court, and project stakeholders

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included organizations with operations (in many cases water-dependent) in Snug Harbor: Bayside Marine, Duxbury Bay Maritime School, Duxbury Yacht Club, Island Creek Oysters, and Sweetser's. The assets in Snug Harbor under the control of these stakeholders and the Town are collectively the driver of significant cultural, recreational, and economic activity.

The plan provides a more detailed look at projected inundation at Snug Harbor, showing areas and assets projected to be inundated in 2030, 2050, and 2070 (Figure 18).

Woods Hole Group provided three phased engineering design strategies to reduce medium- and long-term flood risks for the Snug Harbor District:

1. Protect the Edge and Curate Marsh Migration

There are two contrasting approaches to address mid-term nuisance flooding – at the Town boat ramp, targeted elevation of the ramp and the Mattakeeset lot is recommended to maintain the function of this important waterfront infrastructure; in the basin between DBMS and Bayside, developed areas are pulled back to allow salt marsh to migrate with rising tides. This approach preserves near- to mid-term daily use by ensuring all developed areas level up above the projected 2050 MHHW elevation.

To protect Snug Harbor operations from the impacts of coastal storm surge, a system of modular walls with rising gates and deployable barriers, plus a landscaped berm is proposed to be protective of the 2050 1% chance event, which is also protective of the 2070 10% chance event.

Figure 18: Projected Nuisance Flooding in Snug Harbor (MHHW elevation in feet NAVD88)



Source: Duxbury Climate Change Vulnerability Assessment and Adaptation Plan, 2021

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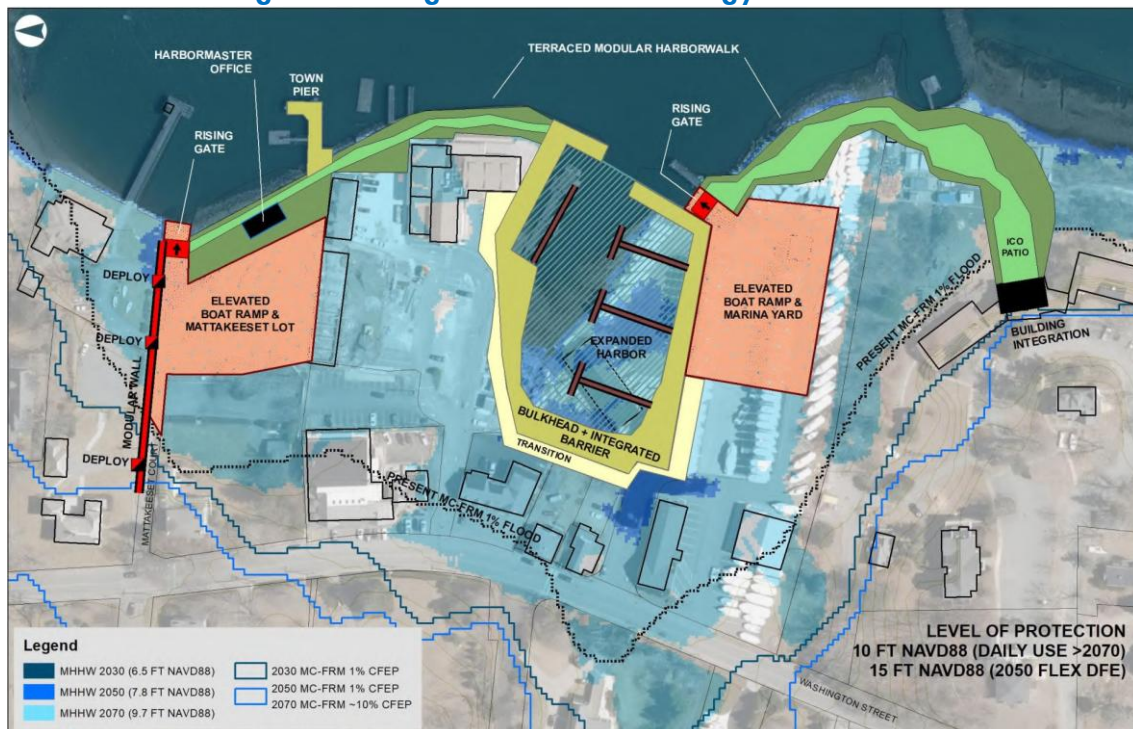
2. Mid-Century Phased Migration

This concept plan minimizes broad and coordinated interventions but provides sustainable daily access through the 2050 sea level rise projections by leveling up low-lying areas to 8.0 feet NAVD88. All vulnerable structures and assets would need individual adaptations (floodproofing) through the 2050 horizon, and then some would need to respond to nuisance flooding as conditions evolve. Those assets exposed to daily flooding would either have to elevate the asset or the landform to maintain usability, or alternatively would have to retreat. Since this strategy does not provide storm surge protection, the Town would need to elevate a portion of Washington Street to solve access issues across this important roadway.

3. Transform

The “Transform” concept plan (Figure 19) reimagines and reorients the harbor in order to maximize its useful life and its scenic amenities. The existing basin between DBMS and Bayside is expanded by un-developing and dredging already vulnerable low-lying areas. This would result in the loss of some of Bayside’s operational areas and facilities, but would potentially be offset by the ability to substitute slips for rack storage, thereby freeing up other land. The expanded harbor would feature an elevated bulkhead, set to accommodate 2070 MHHW and equipped with an additional 5 foot integrated flood barrier in the walkway that could be deployed for storms. The material generated by the expanded harbor could be used to provide elevation to the two layout areas adjacent to the boat ramps (at Mattakeeset and Bayside) as well as to build the living shoreline terraced modular harborwalk on either side of the harbor. The ultimate location of the modular wall to the north and harborwalk to the south could be adjusted to integrate other vulnerable facilities, such as the Duxbury Yacht Club and Island Creek’s Hatchery.

Figure 19: Snug Harbor District Strategy - Transform



Source: Duxbury Climate Change Vulnerability Assessment and Adaptation Plan, 2021

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Probability of Future Occurrence

Based on the record of previous occurrences flooding events in Duxbury are a high frequency event as defined by the Resilient MA Plan. This hazard may occur more frequently than once in five years, or a greater than 20% chance per year.

COASTAL EROSION

Coastal shorelines change constantly in response to storms, seasons, sea level, and human alterations. Coastal erosion is measured as a rate of change over time. These dynamic processes creates a system of erosion (loss) and/or accretion (gain) of coastal land over time. Rising seas and more frequent and intense storms tend to increase erosion, although some areas may actually accrete material due to localized variation in coastal dynamics. Erosion may be exacerbated by efforts to protect shorelines as when engineered hard structures reduce sediment sources to downdrift areas or increase erosion seaward of structures due to interaction with waves. The severity of erosion is related to such factors as exposure to high energy waves, sediment size, sea level rise, near-shore bathymetry, and human interference with sediment supply.

In contrast with seawalls and coastal structures, intact beaches with dunes dissipate wave energy, protecting buildings behind them. This is the case at Duxbury Beach where coastal storms have caused overwash and breach of the barrier beach. Without periodic restoration of the dune height and beach nourishment, a permanent breach could occur, which could cause significant damage to shoreline infrastructure, businesses, and residents, in Duxbury Bay. The Duxbury Beach Reservation, Inc. has continued to restore and maintain dune height, road repairs, and nourishment to ensure coastal shoreline protection, wildlife habitat, and regional recreational/economic asset.

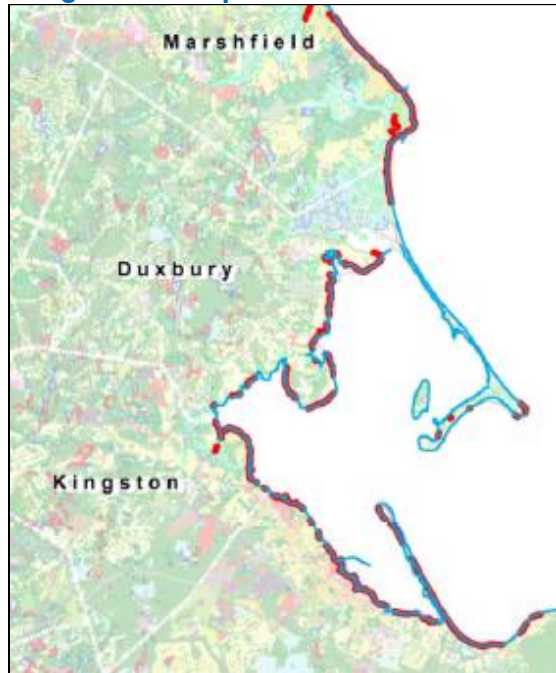
The Massachusetts Coastal Erosion Commission published an assessment of coastal erosion in 2015. A shoreline characterization project was implemented to categorize the land uses and natural resources potentially at risk from coastal erosion. The results of the characterization provide a baseline from which to monitor and identify landscape-level trends and patterns for evaluating adaptation and hazard mitigation strategies for a particular location or region.

The Commission assessed the trends of coastal erosion by examining the results of the Massachusetts Shoreline Change Project and providing a summary assessment of past shoreline changes. Launched in 1989, the Shoreline Change Project analyzed data from historical and modern sources, mapping local high water line and developing shoreline change rates over both a long-term period (from the mid-1800s to 2009) and a short-term period (from 1970-2009) These data provide insight into the historical migration of the shoreline and erosional hot spots.

Figure 20- is a map of assessed shoreline (blue) and coastal engineering structures (red) in Duxbury and neighboring communities on Duxbury Bay.

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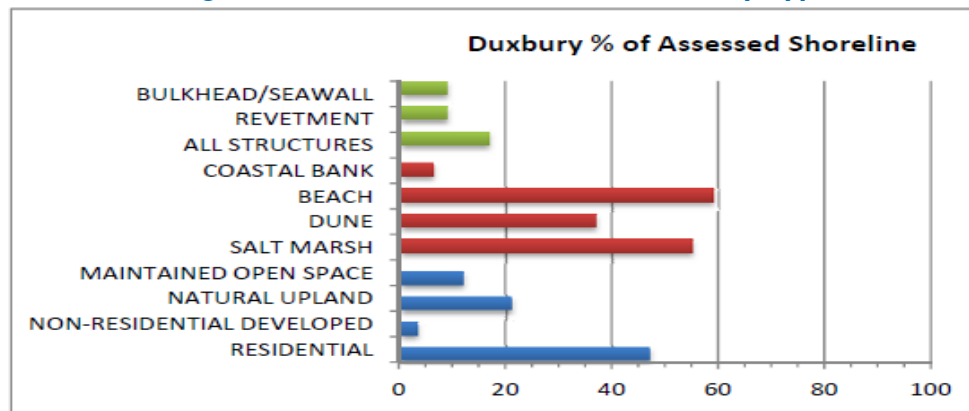
Figure 20: Map of Assessed Shoreline



Source: Report of the Mass. Coastal Erosion Commission, 2015

The results of the shoreline characterization were used to analyze shoreline change rates for Duxbury, including long-term (1844-2009) and short-term (1970-2009) erosion and accretion trends. The analysis took into account various types of shoreline, which are displayed in Figure 21, showing the percent of each type assessed. Duxbury has high percentages of beach, salt marsh, and dune. The most prevalent development categories are residential, 47%, followed by natural upland, 21%.

Figure 21: Percent of Assessed Shoreline by Type



Source: Report of the Mass. Coastal Erosion Commission, 2015

The long- and short-term rates of shoreline change for Duxbury are shown in Table 15. The long-term trend is an erosion rate of -0.6 feet/year since 1844. However short-term shoreline change since 1970 is a trend of accretion at a mean rate of +0.2 feet/year.

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Table 15: Average shoreline change (feet/year) and uncertainty

Town	Town Sub-region	Short-Term Rate		Long-Term Rate	
		Mean (ft/yr)	Std Dev (ft/yr)	Mean (ft/yr)	Std Dev (ft/yr)
Duxbury		0.2	3.7	-0.6	0.8

Source: Report of the Mass. Coastal Erosion Commission, 2015

Table 16 shows both long-term (1844-2009) and short-term (1970-2009) rates of change for six types of shoreline in Duxbury. The highest rates of erosion over the long-term are for Bank and Salt Marsh, which lost a mean of 0.75 and 0.72 feet/year respectively. In the short-term, Bank and Structure had the highest rates of erosion, both over one foot per year, while Beach with Dune demonstrated accretion at a mean rate of 1.89 feet/year, and Beach with Bank at 0.77 feet/year.

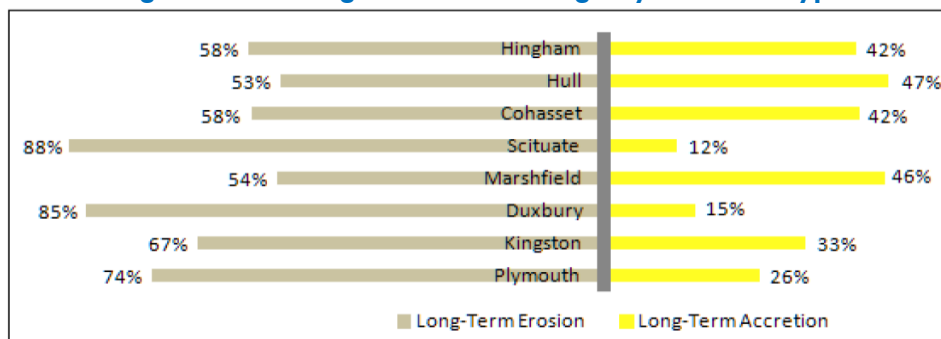
Table 16 Average shoreline change by shoreline type

Town	Shoreline Type	Long-Term Rate		Short-Term Rate	
		Mean (ft/yr)	Std Dev (ft/yr)	Mean (ft/yr)	Std Dev (ft/yr)
Duxbury	Beach	-0.19	0.35	0.19	1.61
	Beach w/ Dune	-0.58	0.86	1.89	4.26
	Beach w/ Bank	-0.22	0.18	0.77	0.60
	Beach w/ Structure	-0.33	0.40	-0.26	1.41
	Bank	-0.75	0.39	-0.71	0.94
	Salt Marsh	-0.72	0.76	-1.46	2.99
	Structure	-0.59	0.51	-1.11	1.22

Source: Report of the Mass. Coastal Erosion Commission, 2015

Figure 22 summarizes the long term shoreline change trends for South Shore communities in terms of erosion vs. accretion. This shows that 85% of Duxbury's shoreline experienced erosion and only 15% showed accretion over that period. This is the second highest rate of erosion on the South Shore, after Scituate.

Figure 22: Average shoreline change by shoreline type



Source: Report of the Mass. Coastal Erosion Commission, 2015

Coastal Erosion Trends, Long- and Short-Term

Massachusetts Coastal Zone Management (MA CZM) in cooperation with the U. S. Geological Survey (USGS) provides shoreline change trends for the Massachusetts coast through the online Coastal Erosion Viewer. Coastal erosion trends are mapped for long-

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term (1840 – 2014) and short-term (1970-2014) periods. See Figure 23 for the shoreline north of Powder Point Bridge and Figures 24 and 25 for the middle to southern shoreline segments, including Duxbury Beach. The CZM analysis for Duxbury shows high long-term erosion rates (red on maps) along most of the Town's shoreline and low short-term erosion rates (yellow on maps) over most of the town, with some areas shown as stable (green on maps). This is not to say that coastal erosion is not a significant current issue, but that compared to long-trends since 1840, rates of erosion have moderated somewhat in the last 50 years. It is still a significant hazard for the town.

Figure 23: Long Term vs. Short-Term Coastal Erosion in Duxbury (Northern section)

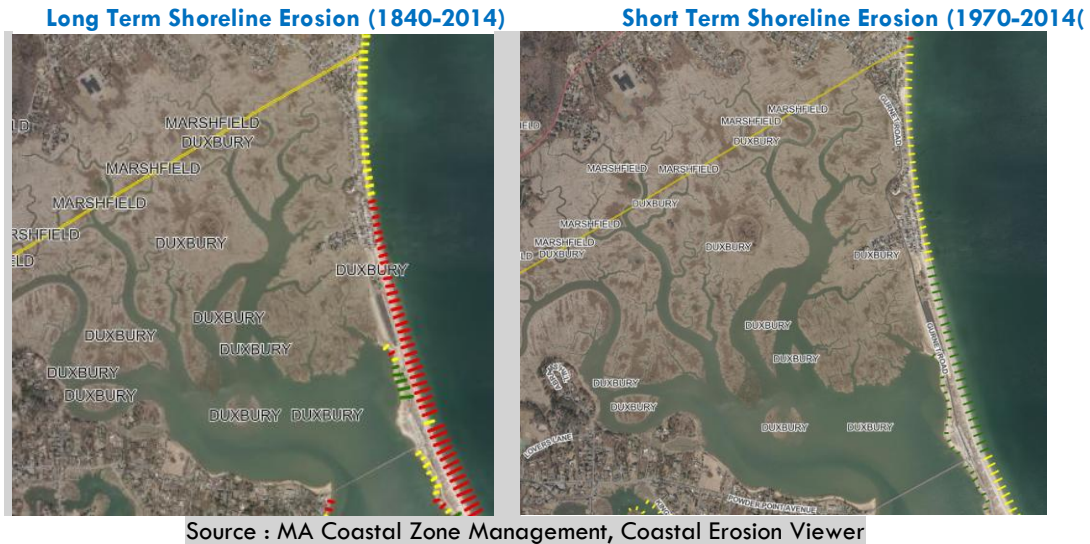
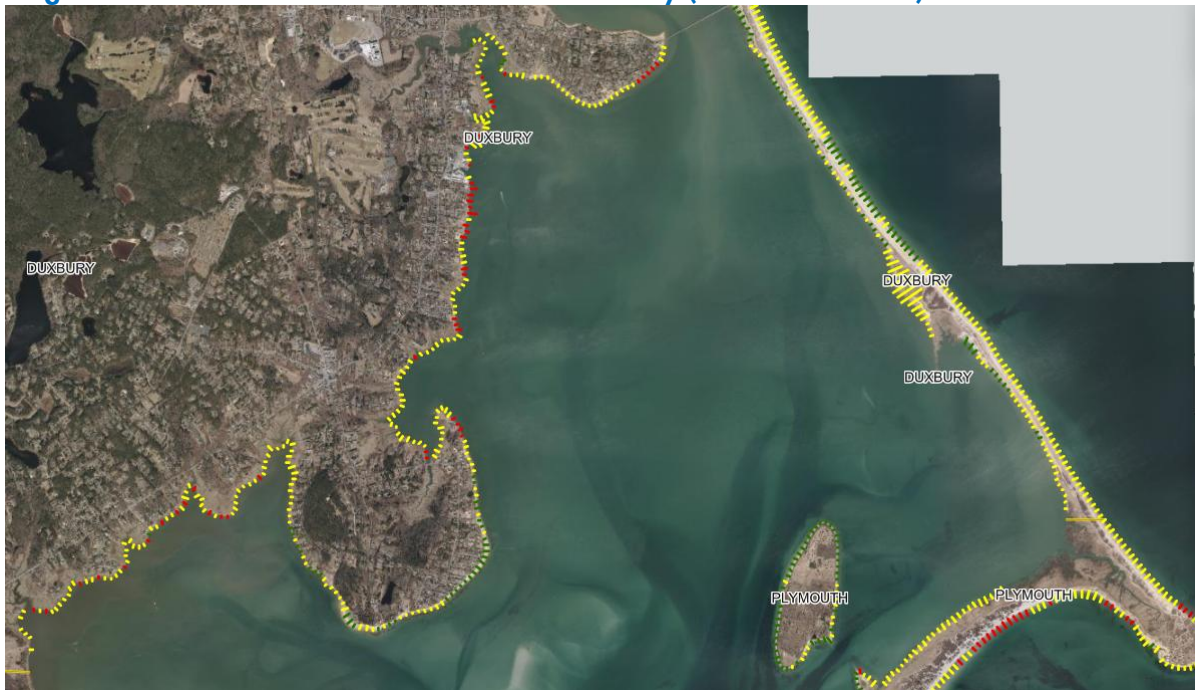


Figure 24: Long-Term Coastal Erosion in Duxbury (Southern section) 1840s-2014



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Figure 25: Short-Term Coastal Erosion in Duxbury (Southern section) 1970s-2014



Source : MA Coastal Zone Management, Coastal Erosion Viewer

However, the Town and the Duxbury Beach Association commissioned the Woods Hole Group to prepare a Coastal Processes study in 2017 that provides a more Duxbury-specific assessment of shoreline change. The study established of 285 shoreline transects at 250 foot intervals. At each transect, distances of shoreline movement were calculated, and average annual rates of shoreline change were determined. Changes in shoreline position (and rates of change) were calculated for three specific time periods, which included:

- **1853 to 2015:** Time period representing long-term rates of change along Duxbury Beach
- **1853 to 1971:** Time period prior to significant Duxbury Beach Reservation restoration measures
- **1996 to 2015:** Time period representing contemporary rates of change that includes Duxbury Beach Reservation restoration.

Compared to the statewide CZM analysis described above, the Wood Group's Duxbury shoreline change analysis represents an enhancement of the CZM data through:

- Addition of more shorelines in time
- Addition of more recent shorelines
- Avoidance of the CZM 1994 shoreline, which is known to be poorly delineated and influences the shoreline change rates, and
- Calculation of distinct time periods for shoreline change that provide more site-specific information, such as the impacts of a coastal structure can be determined by evaluating pre- and post-construction shoreline change conditions.

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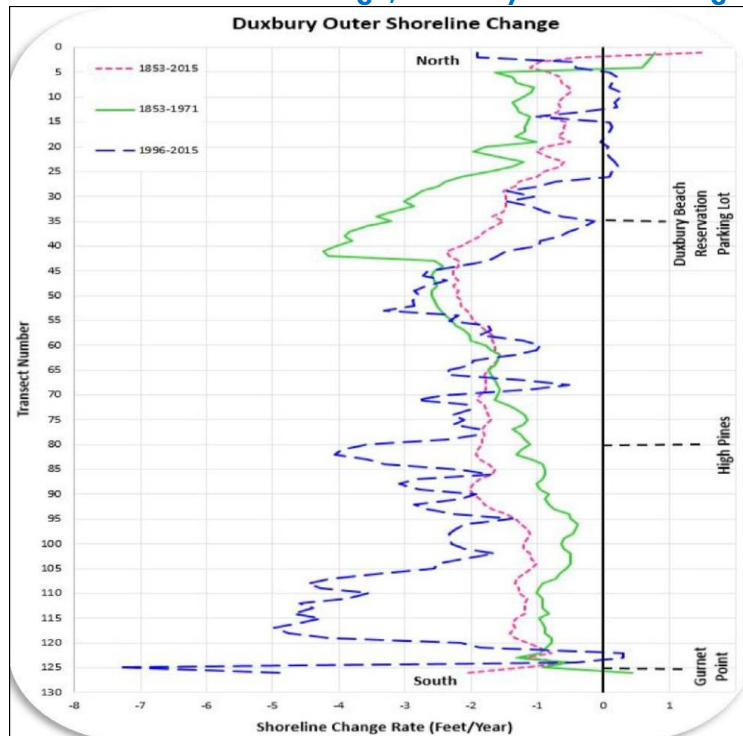
Long-term rates of shoreline change along the southern facing shoreline of Duxbury Beach, including Saquish Beach, were calculated for the period 1853 to 2015. Generally, erosion and accretion rates along this shoreline are lower than the Atlantic Ocean facing shoreline, which is to be expected given the reduced wave exposure for this area. Over the long-term, the shoreline has been relatively stable with erosion rates that are generally less than 1 ft/yr and average -0.3 ft/yr. Contemporary shoreline change rates (1996-2015) show more variability; shoreline retreat has increased to an average rate of -0.8 ft/yr.

For the Atlantic-facing shoreline, the assessment shows that between transects 6-26, a seawall constructed in the 1950s has limited shoreline retreat. Historic rates (1853-1971) in this area were between -1 to -2 ft/year, however, contemporary rates (1996-2015) were reduced to near zero with the seawall in place. While the seawall limits erosion for the area directly landward, the structure also reduces the available sediment supply.

In the area surrounding the Duxbury Beach Park pavilion, the contemporary retreat is significantly less than the historic retreat. Concerted dune restoration efforts completed by the DBR have been effective in reducing erosion rates from -3 to -4 ft/yr down to -1 ft/yr or less. This demonstrates the effective nature of green resiliency adaptations.

Figure 26 shows a comparison of shoreline change rates for 1853-2015 (red broken line), 1853-1971 (green line), and 1996-2015 (blue broken line) time periods along the Atlantic Ocean side of Duxbury Beach. Rates are presented in feet per year. Transect numbers are presented on the vertical axis from Green Harbor Jetty (top) to Gurnet Point (bottom). Negative shoreline change rates indicate shoreline retreat, while positive values indicate shoreline advance.

Figure 26: Historic Shoreline Change, Duxbury Atlantic Facing Shoreline



Source : Wood Hole Group, Coastal Processes Study, 2017

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Coastal Protection Structures

The Massachusetts Coastal Infrastructure Inventory and Assessment Report states that the estimated length of Duxbury's shoreline that is directly exposed to open ocean waves is 4.7 miles with the remaining shoreline semi-protected by offshore structures or landforms. The Town is protected from major coastal storms by both natural and man-made shoreline structures that require maintenance to insure the long-term protection of its coastline. The assessment found that within the Town of Duxbury, there were 14 structures which had public or unknown ownership that provide significant coastal protection. The structures were categorized by their type and by their structural condition based on a preliminary field assessment. The distribution of structures by type and condition can be seen in Table 17.

Table 17 Duxbury Coastal Protection Structures, Type and Condition Rating

Primary Structure (1)	Total Structures	Structure Condition Rating					Total Length
		A	B	C	D	F	
Bulkhead / Seawall	11		6	4		1	3759
Revetment	3		2	1			952
Breakwater							
Groin / Jetty							
Coastal Dune							
Coastal Beach							
	14		8	5		1	4711

Source : Massachusetts Coastal Infrastructure Inventory and Assessment Report, 2015

Within the above table, the total length of each type of structure is also provided. The structures are listed by the type which is providing the primary coastal protection. Many sites have multiple structure types at the same location (i.e. revetment in front of seawall).

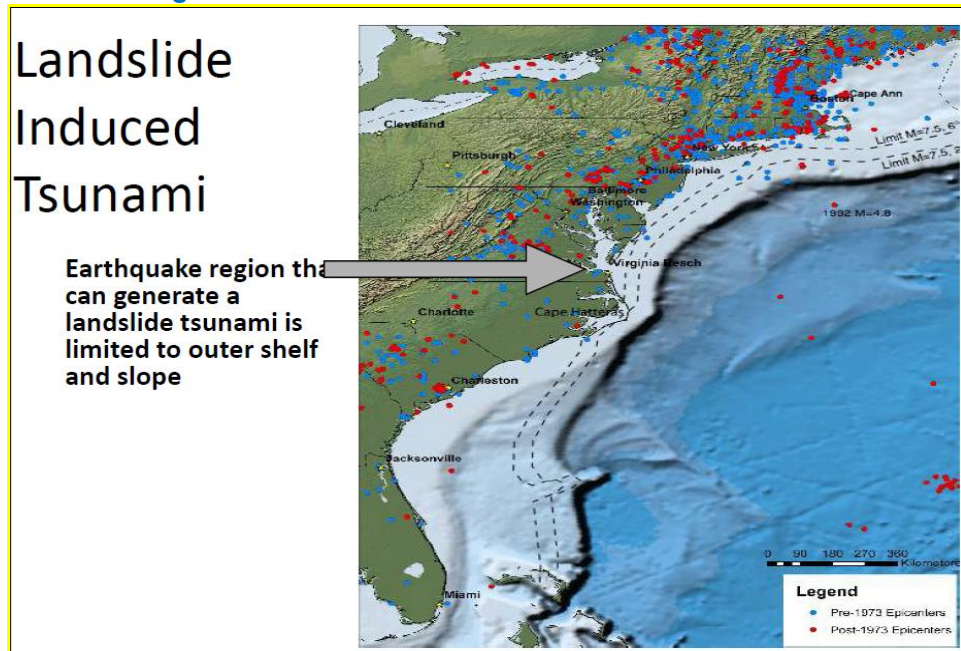
In April 2010, 500 feet of seawall in neighboring Marshfield collapsed due to erosion undermining its foundation. In March 2018 during Winter Storm Riley, Duxbury experienced sea wall collapse at Gurnet. The Town performed emergency measures by guarding the area with boulders as an interim measure before the seawall was later restored.

TSUNAMIS

A tsunami is a surge of ocean water typically caused by an offshore earthquake. FEMA defines tsunami as a series of large seismic sea waves created by an underwater disturbance caused by geologic activity such as earthquakes, volcanic eruptions, or underwater landslides. The most likely source would be a landslide that happens underwater about 215 miles offshore in an area known as the Continental Slope (Figure 27).

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Figure 27 - Atlantic Based Tsunami Potential Threat



The severity of a tsunami is related to its wave height at the shore, and the extent of runup. Tsunamis can cause wave heights of 100 feet or more. Tsunami wave action over the shore is variable and mainly dependent of the combination of both submarine and land topography and the orientation of the arriving waves.

While all of the coast of Massachusetts could potentially be subject to a tsunami, according to the SHMCAP, Massachusetts has never experienced a significant tsunami, although two tsunamis have occurred with no deaths or damages recorded.

Extent and Impacts of Tsunamis

The severity of a tsunami is related to its wave height at the shore, and the extent of runup. Tsunamis can cause wave heights of 100 feet or more. Tsunami wave action over the shore is variable and mainly dependent of the combination of both submarine and land topography and the orientation of the arriving waves. Key Tsunami metrics include:

- **Wave Height (Run-up):** The vertical height a tsunami reaches on land. Most are less than 10 ft, but can exceed 100 ft (30 m) near the source.
- **Inundation Depth:** The depth of water on shore.
- **Inundation Distance (Horizontal):** How far inland the water travels. A massive wave can travel several kilometers inland.

The extent of Tsunamis is classified using a scale that measures their physical magnitude (energy) and intensity (impact on land). The most common scale is the Papadopoulos-Imamura 12-grade intensity scale, which is based on observed effects (Table 19).

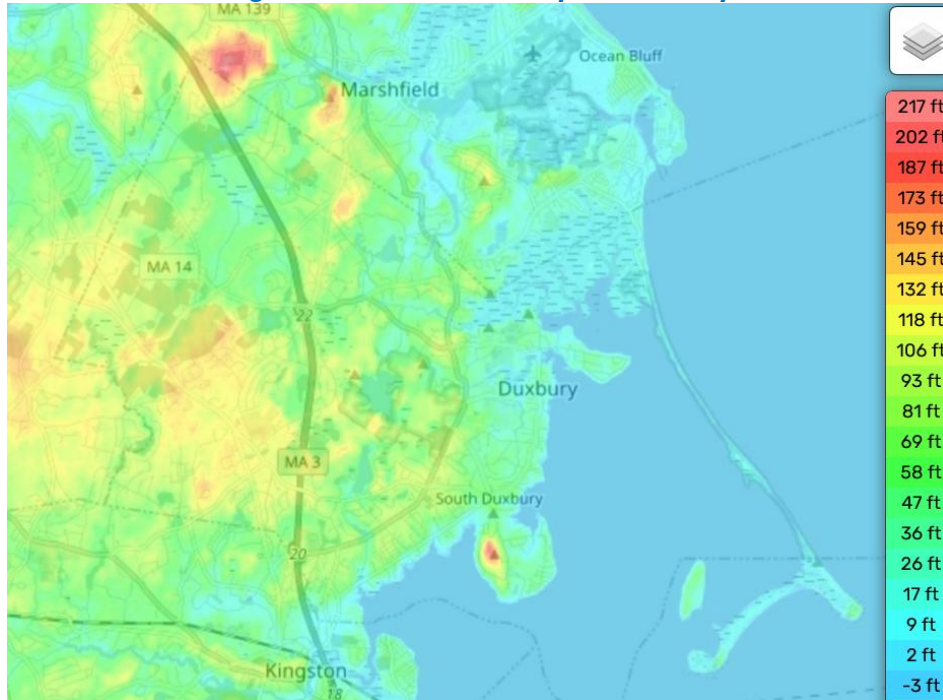
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Table 19: Papadopoulos-Imamura 12-grade Tsunami Intensity Scale

1 Very Light:	Not felt or detected, even under the most favorable circumstances.
2 Light:	Felt by few people on board in small vessels. Not observed in the coast.
3 Small:	Detected by most people, no damage.
4 Largely Observed:	Observed by people on the coast, small vessels move onshore, no damage.
5 Strong:	Dangerous waves with depths over 1 meter (~3 ft) that can damage flimsy buildings, overturn small boats, and cause flooding inland, often by more than a mile.
6 Slightly Damaging:	small vessels move onshore, damage in a few wooden structures
7 Damaging:	Many small vessels damaged; many wooden structures damaged, a few are demolished or washed away
8 Heavily Damaging:	Large buildings damaged, most wooden structures are washed away or demolished; flooding in flat areas extends 1000 ft or more.
9 Destructive:	Many people washed away; damage of grade 3 in many masonry buildings
10 Very Destructive:	Widespread destruction, severe flooding, and structural damage to large buildings, with run-up heights exceeding 100 ft (30 m).
11 Devastating:	Lifelines interrupted; damage of grade 5 in many masonry buildings.
12 Completely Devastating:	Complete destruction of buildings and infrastructure, massive flooding.

The extent of damage and impact from tsunami depends upon the source and severity of onset on the tide cycle. Coastal areas that are potentially at greater risk are less than 25 feet above sea level and within a mile of the shoreline. A significant part of Duxbury is low lying within a mile of the coast, including Duxbury Beach and key waterfront assets like Snug Harbor (Figure 28). These areas would be more vulnerable to being impacted by a Tsunami. In addition, a major tsunami could have regional impacts along the entire coastline and cause disruptions that would also affect Duxbury.

Figure 28 – Elevation Map of Duxbury



Source: <https://en-gb.topographic-map.com>

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Probability of Future Occurrence

According to the West Coast and Alaska Tsunami Warning Center (WCATWC), an Atlantic based tsunami threat level for the US Atlantic coast is low when compared to the Pacific and Caribbean coasts. Geophysics specialists from the U.S. Geologic Survey and the Woods Hole Oceanographic Institute have researched the Georges Bank Lower Slope of the North Atlantic Ocean and the relationship between submarine landslides and earthquakes. The likelihood that a tsunami will hit the Atlantic coast is considered to be fairly low. Based on the record of previous occurrences, Tsunami in Duxbury is a Very Low frequency event as defined by the Resilient MA Plan.

Tsunamis and Climate Change

Unlike most other coastal hazards, Tsunamis are events driven by geological processes, principally earthquakes and undersea landslides, which are not likely to be related to climate change. However, according to the Resilient MA Plan, collapse of glaciers resulting from a warming climate could cause landslides that could generate tsunamis more powerful than those caused by earthquakes.

DAM HAZARDS

Dam failure is the uncontrolled release of impounded water resulting in downstream flooding, which can affect life and property. Dam failure can occur as a result of structural failure, independent of a hazard event, or as the result of the impacts of a hazard event such as flooding associated with storms or an earthquake. In the event of dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters. An issue for dams in Massachusetts is that many were built in the 19th century without the benefits of modern engineering or construction oversight or consideration of changing weather patterns associated with climate change such as more frequent and/or extreme precipitation events

The MA Department of Conservation and Recreation regulates dams and defines dam hazard classifications as follows:

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

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

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

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There are 26 dams in Duxbury listed on the DCR statewide inventory of dams (Table 20). The Town of Duxbury owns nine dams and 17 are privately owned. There are no High Hazard dams in Duxbury and six dams are classified as “Significant Hazard.” Four of those dams are Town-owned, including the Garside Reservoir, Petersons Saw Mill Pond, Mill Pond, and Temple Street Pond Dams. There are four “Low Hazard” dams and 15 dams not classified by DCR; these are typically under six feet in height and/or under 15 acre-feet in storage.

In general, DCR requires that dams rated as low hazards be inspected every ten years, while dams rated as significant hazards must be inspected every five years.

Two of Duxbury’s dams are susceptible to damage from a Category 1 Hurricane and are susceptible to flooding with Sea Level Rise in 2038. These include the Blue Fish River Dam and the Wrights Pond Dike.

Table 20 Duxbury Dams from DCR Dam Inventory

Dam	Owner	Hazard Severity with Dam Failure
Bluefish River Dam	Private	N/A
Lower Chandler Pond Dam	Duxbury	Significant
Garside Reservoir	Duxbury	Significant
Peterson’s Saw Mill Pond Dam	Duxbury	Significant
Boys & Girls Camp #3 Dam	Private	Significant
Round Pond Dam	Private	Low
Pine Lake Dam	Private	Low
Mill Pond Dam	Duxbury	Significant
Boys & Girls Camp #1 Dam	Private	Significant
Temple Street Pond Dam	Duxbury	Significant
Merry Memorial Dam	Private	N/A
Wright Reservoir Dam	Private	Low
Boys & Girls Club #2 Dam	Private	N/A
Golden Reservoir Dam	Duxbury	N/A
Merry Reservoir Dam	Private	N/A
Pit Pond Dam	Private	N/A
Mcissac & Williams #1 Dam	Private	N/A
Mcissac & Williams #3 Dam	Private	N/A
Pink #2 Dam	Private	N/A
Mcissac & Williams Dam	Private	N/A
Reed #2 Dam	Duxbury	N/A
Keith & Adams Reservoir Dam	Private	N/A
Crowell Reservoir Dam	Private	N/A
Wrights Pond Dike	Duxbury	N/A
Mayflower St. Pond Dam	Duxbury	N/A
Upper Chandler Pond Dam	Private	Low

Source: DCR Dam Inventory

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Probability of Future Occurrences

There have been no recorded instances of dam failure in Duxbury. Based on previous occurrences, dam failure in Duxbury is a very low frequency event as defined by the Resilient MA Plan.

Climate Change and Dam Failure

More intense precipitation events driven by climate change can place stress on dams and exceed their design specifications, which can lead to dam failure.

HURRICANES AND TROPICAL CYCLONES

Wind-related hazards include hurricanes, tropical storms, and tornadoes as well as high winds during Nor'easters and thunderstorms. Information on wind related hazards can be found on Map 5 in Appendix A, which indicates that the 100-year wind speed in Duxbury is 110 miles per hour.

A hurricane is a violent wind and rainstorm with wind speeds of 74-200 miles per hour. A tropical storm has similar characteristics, but wind speeds are between 38 and 74 miles per hour. Hurricanes occur between June and November.

Hurricanes begin as tropical storms over warm moist waters of the Atlantic, off the coast of West Africa near the equator. As the moisture evaporates, it rises until enormous amounts of heated, moist air are twisted high in the atmosphere. The winds begin to circle counterclockwise north of the equator or clockwise south of the equator. The center of the hurricane is called the eye.

Tropical cyclones (Tropical Depressions, Tropical Storms, and Hurricanes) form over the warm, moist waters of the Atlantic, Caribbean, and Gulf of Mexico. When water temperatures are at least 80° F, hurricanes can grow and thrive, generating enormous amounts of energy, which is released in the form of numerous thunderstorms, flooding rainfall, and, very damaging winds. The damaging winds help create a dangerous storm surge (rise in the water above the normal astronomical tide).

A Tropical Depression is declared when there is a low pressure center in the tropics with sustained winds of 25-33 mph. A Tropical Storm, which is given a name, is defined as having sustained winds from 34-73 mph. If sustained winds reach 74 mph or greater, it becomes a Hurricane.

Hurricanes can range from compact storms only 50 miles across, to huge storms, as much as 500 miles wide. Hurricane Allen in 1980 took up the entire Gulf of Mexico. There generally are two source regions for the storms that have the potential to strike New England: 1) off the Cape Verde Islands near the west coast of Africa and 2) in the Bahamas. The Cape Verde storms tend to be very large in diameter, since they have a week or more to traverse the Atlantic Ocean and grow. Bahamas' storms tend to be smaller, but they can also be just as powerful and their effects can reach New England in only a day or two.

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A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits the land. The Town's entire area is vulnerable to hurricanes.

Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane. A hurricane storm track is the line that delineates the path of the eye of a hurricane or tropical storm. As shown in Map xx in Appendix A, one tropical storm tracked through Duxbury in 1896 over the Town Hall and the neighboring cluster of historic landmarks. Another tropical storm tracked over western Duxbury in 2004., and many more passed close by in the South Shore region. Duxbury experiences the impacts of hurricanes and tropical storms regardless of whether the storm track passes directly through the Town, and numerous hurricanes have affected the communities of eastern Massachusetts (see Table 21).

Table 21 Hurricane Records for Massachusetts, 1938 - 2025

Hurricane Event	Date
Great New England Hurricane	September 21, 1938
Great Atlantic Hurricane	September 14-15, 1944
Hurricane Doug	September 11-12, 1950
Hurricane Carol	August 31, 1954
Hurricane Edna	September 11, 1954
Hurricane Diane	August 17-19, 1955
Hurricane Donna	September 12, 1960
Hurricane Gloria	September 27, 1985
Hurricane Bob	August 19, 1991
Hurricane Bertha	July 5 - 17, 1996
Hurricane Hanna	August 28, 2008
Hurricane Earl	September 4, 2010
Tropical Storm Irene	August 28, 2011
Hurricane Sandy	October 29-30, 2012
Hurricane Henri	August 21-23, 2021
Hurricane Lee	September 15-17, 2023

Source: National Oceanic and Atmospheric Administration

Hurricane Sandy in 2012 was a Category 3 hurricane at its peak intensity and weakened to a Category 2 off the northeastern Atlantic coast. Sandy became the largest Atlantic hurricane on record with winds spanning 1,100 miles. Strong tropical force winds from the northeast quadrant of the post tropical cyclone, Sandy developed into a super storm nor'easter.

Hurricane intensity is measured according to the Saffir/Simpson scale, which categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. These are combined to estimate potential damage. The following gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

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Scale No. (Category)	Winds(mph) Storm	Surge (ft)	Potential Damage
1	74 – 95	4 - 5	Minimal
2	96 – 110	6 - 8	Moderate
3	111 – 130	9 - 12	Extensive
4	131 – 155	13 - 18	Extreme
5	> 155	>18	Catastrophic

Source: NOAA

Duxbury is particularly vulnerable to both the flooding and wind impacts of tropical storms and hurricanes due to its location on the coast. The town can be directly impacted by storm surges due to its direct exposure to the Atlantic Ocean. And the town can bear the full brunt of hurricane force winds coming directly off the ocean, with no intermediate terrain to slow the winds.

Vulnerable populations may need to be evacuated and could be displaced from their homes. Public safety can be jeopardized when buildings collapse, trees fall on buildings or cars, or emergency response is blocked by fallen trees or flooded roadways. The electric grid may go down during high wind events, affecting those that rely on medical devices at home. Severe storms may cause deaths and injuries. The elderly and those with mobility issues are of particular concern during hurricane or tropical storm events. People may also suffer economic losses associated with reduced value on coastal properties damaged by flooding. Local businesses can be adversely impacted, and relocation costs would be an additional economic burden to anyone forced to rebuild or move.

Hurricanes are a town-wide hazard in Duxbury. Potential hurricane damages to Duxbury have been estimated using HAZUS-MH. Total damages are estimated at \$38 million for a 100-year frequency hurricane and \$163 million for a 500-year frequency hurricane. Other potential impacts such as debris and evacuation needs are detailed in Table xx.

Probability of Future Occurrence

Based on records of previous occurrences, hurricanes in Duxbury are a medium frequency event as defined by the Resilient MA Plan. This hazard occurs from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Hurricanes and Climate Change

Climate models suggest that hurricanes and tropical storms will become more intense as warmer ocean waters provide more fuel for the storms. In addition, rainfall amounts associated with hurricanes are predicted to increase because warmer air can hold more water vapor

TORNADOES

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. These events are spawned by thunderstorms and occasionally by hurricanes and may occur singularly or in multiples. They develop when cool air overrides a layer of warm air, causing the warm air to rise rapidly. Most vortices remain suspended in the atmosphere.

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Should they touch down, they become a force of destruction. Some ingredients for tornado formation include:

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

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 01, 2007, the National Weather Service began rating tornadoes using the Enhanced Fujita-scale (EF-scale), which allows surveyors to create more precise assessments of tornado severity. The EF-scale is summarized in Table 22 below.

The frequency of tornadoes in eastern Massachusetts is low; on average, there are six tornadoes that touchdown somewhere in the Northeast region every year. The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC).

The strongest tornado in Massachusetts history was the Worcester Tornado in 1953. Remains from the deadly 1953 Worcester tornado touched down in Duxbury, having blown over 75 miles across Massachusetts. More recent significant tornado events in Massachusetts include Springfield in 2011 and in Revere in 2014. The Springfield tornado caused significant damage and resulted in 4 deaths in June of 2011. The Revere tornado touched down in Chelsea just south of Route 16 and moved north into Revere's business district along Broadway and ended near the intersection of Routes 1 and 60. The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour. Approximately 65 homes had substantial damages and 13 homes and businesses were uninhabitable.

Although there have been no recorded tornadoes within the limits of the Town of Duxbury, since 1958 there have been 10 tornadoes in surrounding Plymouth County recorded by the The Tornado History Project. One of these was an F2 tornado, and four were F1 tornadoes. The 10 tornadoes resulted in a total of one fatality and two injuries and \$119 thousand to \$1.15 million in damages, as summarized in Table 23 below.

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Table 22: Enhanced Fujita Scale

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

Source: SHMCAP 2018

Table 23: Tornado Records for Plymouth County

Date	Fujita	Fatalities	Injuries	Width	Length	Damage
9/7/1958	0	1	1	10	0.1	\$500-\$5000
7/4/1964	1	0	0	10	2.3	\$50K-\$500K
6/9/1965	0	0	0	10	0.1	<\$50
11/18/1967	2	0	0	17	.1	\$50-\$500
8/9/1968	1	0	0	100	1	\$500-\$5000
9/16/1986	1	0	0	50	.1	\$50K-\$500K
7/10/1989	1	0	1	23	.1	\$5K-\$50K
7/10/1989	0	0	0	23	.1	\$5K-\$50K
8/20/1997	0	0	0	10	0.1	\$5K-\$50K
7/24/2012	0	0	0	15	.03	\$3K

Source: The Tornado History Project

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Buildings constructed prior to current building codes may be more vulnerable to damages caused by tornadoes. Evacuation of impacted areas may be required on short notice. Sheltering and mass feeding efforts may be required along with debris clearance, search and rescue, and emergency fire and medical services. Key routes may be blocked by downed trees and other debris, and widespread power outages are also typically associated with tornadoes.

Although tornadoes are a potential Town-wide hazard in Duxbury, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Duxbury would be highly dependent on the track of the tornado. The Town enforces the Massachusetts building code, but many structures were constructed prior to the recent editions of the code. If a tornado were to occur in Duxbury, damage would most likely be serious due to the prevalence of older construction throughout much of the town.

Probability of Future Occurrence

Based on the record of previous occurrences since 1958, Tornado events in Duxbury are a Low frequency event as defined by the Resilient MA Plan. This hazard is likely to occur from once in 50 years to once in 100 years.

Tornadoes and Climate Change

According to the Resilient MA Plan, it is possible that severe thunderstorms which can include tornadoes may increase in frequency and intensity. However, scientists have less confidence in the models that seek to project future changes in tornado activity. Massachusetts' 2022 Climate Change Assessment does not include information related to tornadoes.

SEVERE WINTER STORMS (NOR'EASTERS / BLIZZARDS / ICE STORMS)

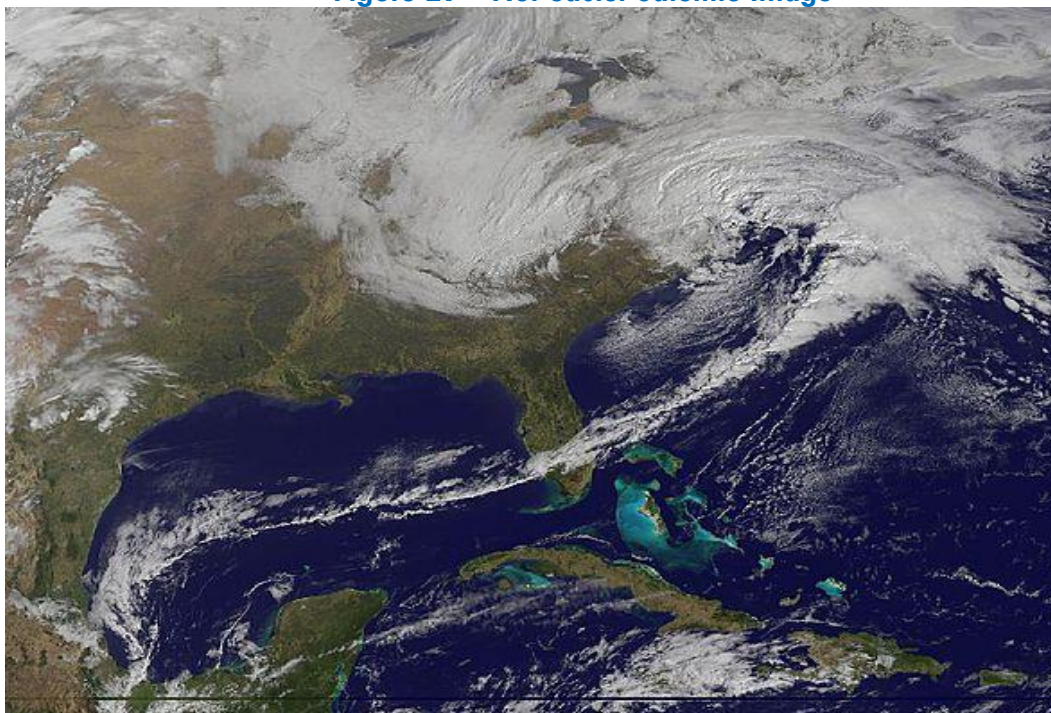
Winter storms, including nor'easters, heavy snow, blizzards, and ice storms, are the most common and most familiar of the region's hazards that affect large geographic areas. The majority of blizzards and ice storms in the region cause more inconvenience than serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response. The strongest among these are typically nor'easters.

NOR'EASTERS

A northeast coastal storm, known as a nor'easter, is typically a large counterclockwise wind circulation around a low-pressure center. Featuring strong northeasterly winds blowing in from the ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 20 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rains or snows, depending on temperatures.

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Figure 29 – Nor’easter Satellite Image



Source: The Geostationary Operational Environmental Satellite Program (GOES), NASA and NOAA

The Dolan-Davis classification system for Nor’easters was developed to complement the Saffir-Simpson scale used for hurricanes. The scale is based on mean wave height caused by the Nor’easter – different from the Saffir-Simpson classification of hurricanes based on wind speed. The scale was developed using data from 1,347 Nor’easters over a forty year time frame. Robert Dolan and Robert Davis developed the scale to classify Nor’easters from Class I through Class V. Table 24 below summarizes each class of storm.

Table 24. Dolan-Davis Classification System for Nor’easters

Storm Class	Mean Wave Height (m)	Beach Erosion	Property Damage
Class I (weak)	2.0	Minor	None
Class II (moderate)	2.5	Moderate	None
Class III (significant)	3.2	Extends across beach	Moderate
Class IV (severe)	5.0	Severe with recession	Loss of structures at community scale
Class V (extreme)	6.8	Extreme	Extensive regional scale losses in millions of dollars

Landsea, C. (2009, February 6). “FAQ: Hurricanes, Typhoons, and Tropical Cyclones.” Retrieved from <http://www.aoml.noaa.gov/hrd/tcfaq/D1.html> Williams, J. (2005, May 17). “Hurricane scale invented to communicate storm danger.” Retrieved from <http://www.usatoday.com/weather/hurricane/whscale>.

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Previous occurrences of significant Nor'easters since 1978 include the storm events shown in Table 25. Many of the historic flood events identified in the previous section were precipitated by Nor'easters, including the Blizzard of 1978 and the "Perfect Storm" event of 1991. Significant Nor'easters also impacted Duxbury in February 2013, January 2015, and March 2018, which caused s coastal damage across much of the South Shore.

Table 25: Nor'easter Events for Massachusetts, 1978 - 2023

Date	Nor'easter Event
February 1978	Blizzard of 1978
October 1991	Severe Coastal Storm ("Perfect Storm")
December 1992	Great Nor'easter of 1992
January 2005	Blizzard/Nor'easter
October 2005	Coastal Storm/Nor'easter
April 2007	Severe Storms, Inland & Coastal Flooding/Nor'easter
January 2011	Winter Storm/Nor'easter
October 2011	Severe Storm/Nor'easter
February 2013	Blizzard of 2013
January 2015	Blizzard of 2015
March 2015	March 2015 Nor'easters
January 2018	January 2018
March 2018	March 2018

Duxbury is vulnerable to both the wind and precipitation that accompanies nor'easters. High winds can cause damage to structures, fallen trees, and downed power lines leading to power outages. Intense rainfall can overwhelm drainage systems causing localized flooding of streams as well as urban stormwater ponding and localized flooding. Fallen tree limbs as well as heavy snow accumulation and intense rainfall can impede local transportation corridors, and block access for emergency vehicles. Due to its location on the coast, the entire Town of Duxbury could be at risk from the wind, rain or snow impacts from a nor'easter, depending on the track and radius of the storm.

Based on the record of previous occurrences, nor'easters in Duxbury are high frequency events as defined by the Resilient MA Plan. This hazard is almost certain to occur at least once a year.

BLIZZARDS & HEAVY SNOW

Winter storms are a combination hazard because they often involve wind, ice, and heavy snow fall. The National Weather Service defines "heavy snow fall" as an event generating at least four inches of snowfall within a 12-hour period (NOAA, 2009). Blizzards and winter storms are often associated with a nor'easter event (see nor'easters section above).

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A blizzard is a winter snowstorm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow which reduces visibility to or below ¼ mile. These conditions must be the predominant conditions over a three-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of the definition. The hazard related to the combination of snow, wind, and low visibility significantly increases when temperatures drop below 20 degrees.

The Regional Snowfall Index (RSI) characterizes and ranks the severity of northeast snowstorms. RSI has five categories: Extreme, Crippling, Major, Significant, and Notable. RSI scores are a function of the area affected by the storm, the amount of snow, and the number of people living in the path of the storm. The largest RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The RSI categories are shown in Table 26.

Table 26: Regional Snowfall Index

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

Source: 2018 SHMCAP

The best available data on previous occurrences and impacts of heavy snow events in Duxbury is available for Plymouth County from the NOAA National Centers for Environmental Information (NCEI). From 2010 to 2026, Plymouth County experienced 9 blizzard events, resulting in no injuries or deaths, and property damage of \$662,500, as shown in Table 27.

Table 27: Blizzard Events in Plymouth County 2010 –2026

Date	Deaths	Injuries	Damage-\$
2/8/2013	0	0	445,000
1/2/2014	0	0	5000
1/26/2015	0	0	0
2/14/2015	0	0	10,000
1/23/2016	0	0	50,000
2/8/2016	0	0	10,000
3/13/2018	0	0	140,000
1/28/2022	0	0	2500
2/22/2026	0	0	0
TOTAL	0	0	662,500

Source: NOAA, National Centers for Environmental Information

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Another indication of severe winter events is Presidentially declared disasters for blizzards and snowstorms. There have been 14 in Massachusetts since 1978, as shown in Table 28. The most significant single winter storm was the “Blizzard of 1978,” which resulted in over three feet of snowfall and multiple-day closures of roadways, businesses, and schools. The record snowfall of January 2015 resulted from a series of storms over that month. The most recent significant winter event was Winter Storm Kenan (January 29, 2022), which resulted in 30.9” of snow.

Table 28: Winter-Related Federal Disaster Declarations, 1978-2025

Disaster Name	Date of Event
Coastal Storms, Flood, Ice & Snow	February 1978
Winter Coastal Storm	December 1992
Blizzard	March 1993
Blizzard	January 1996
Snowstorm	March 2001
Snowstorm	February 2003
Snowstorm	December 2003
Snowstorm	January 2005
Severe Winter Storm, Snowstorm	January 2011
Severe Winter Storm, Snowstorm, Flooding	February 2013
Severe winter storm, snowstorm, flooding	January 2015
Severe winter storm and Snowstorm	March 2018
Severe winter storm and flooding	March 2018
Severe winter storm and snowstorm	January 2022

Sources: OpenFEMA Dataset: Disaster Declarations and FEMA Declared Disasters

Winter storms are a community-wide hazard in Duxbury. Map 6 in Appendix A illustrates the average annual average snowfall in Duxbury, which is between 48 to 72 inches.

The majority of blizzards and snow storms in the region cause more inconvenience than serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response, such as the Blizzard of 1978 described above. The impacts of winter storms are often related to the weight of snow and ice, which can cause roof collapses and also causes tree limbs to fall. This in turn can cause property damage and potential injuries. Power outages may also result from fallen trees and utility lines.

A number of public safety issues arise during heavy snowstorms. Impassible streets are a challenge for emergency vehicles and affect residents and employers. Large piles of snow can also block sight lines for drivers, particularly at intersections. Refreezing of melting snow can cause dangerous roadway conditions. In addition, transit operations may be impacted.

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Managing snow removal can be an expensive and challenging task for the Town. The Duxbury DPW works to clear roads as requested by emergency service providers and carries on general snow removal operations.

Probability of Future Occurrences

Blizzards are considered high frequency events based on past occurrences, as defined by the Resilient MA Plan. This hazard is almost certain to occur at least once a year.

ICE STORMS

The ice storm category covers a range of different weather phenomena that collectively involve rain or snow being converted to ice in the lower atmosphere leading to potentially hazardous conditions on the ground. 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. 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.

Sleet and hail are other forms of frozen precipitation. 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 (a description of hail is included in a subsequent section of this plan).

Another form of freezing precipitation is ice pellets, which occur 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 sub-freezing air near the surface of the earth.

The extent of ice storms is measured by the Sperry-Piltz Ice Accumulation Index (SPIA®); see Table 29. The SPIA Index is to ice storms what the Enhanced Fujita Scale is to tornadoes, and what the Saffir–Simpson Scale is to hurricanes. The SPIA® Index, is a forward-looking, ice accumulation and ice damage prediction index that uses an algorithm based on three key parameters: 1) Storm total rainfall, converted to ice accumulation; 2) Wind; and 3) Temperatures during the event period. These parameters, when used in conjunction with digital forecasts from local NWS Weather Forecast Offices (WFOs), have been shown to accurately predict the duration, intensity and damage capability of ice storms. The SPIA® Index 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.

Key factors determining severity of ice storms include:

- **Ice Amount:** While triggers warnings, or more brings severe damage.
- **Wind Speed:** High winds coupled with ice buildup cause much higher destruction.
- **Weight:** One half-inch of ice adds about 500 pounds of weight to a power line span.

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- **Accumulation Type:** Often called glaze, the ice sticks to everything, leading to tree failure, power line collapse, and treacherous roads.
- **Location Vulnerability:** Urban areas typically face higher economic damage due to higher utility density.

Table 29: Sperry-Piltz Ice Accumulation Index (SPIA®)

ICE DAMAGE INDEX	DAMAGE AND IMPACT DESCRIPTIONS
0	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
2	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
3	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
4	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
5	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.

Source: SPIA® Index, www.spia-index.com/

The best available data on previous ice storm events are recorded at the county level through NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. Plymouth County, which includes the Town of Duxbury, does not have any ice storms recorded from 1950 to 2025. Ice storms are infrequent in Duxbury because of its location at lower elevations in the relative milder coastal region, which rarely has conditions favorable for ice storms. Regions of Massachusetts that are further inland and at higher elevation are much more likely to experience ice storms.

Should an ice storm occur in Duxbury, the greatest hazard is created by freezing rain conditions, which is rain that freezes on contact with hard surfaces leading to a layer of ice on roads, walkways, trees, and other surfaces. The conditions created by freezing rain can make driving particularly dangerous and emergency responses more difficult. The weight of ice on tree branches can also lead to falling branches causing power outages and blocking roadways. The impacts of winter storms may also include roof collapses and property damage and injuries related to the weight of snow and ice. However these damages have not occurred in Duxbury.

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Probability of Future Occurrence

In Duxbury, ice storms are considered to be very low frequency events based on past occurrences, as defined by the Resilient MA Plan. This hazard is very unlikely to occur as there are no examples of historical occurrences since 1950.

Winter Weather and Climate Change

As with hurricanes, warmer ocean water and air will provide more fuel for winter storms. According to the 2018 SHMCAP it appears that Atlantic coast nor'easters are increasing in frequency and intensity. Further, the SHMCAP notes that research suggests that warmer weather in the Arctic is producing changes to atmospheric circulation patterns that favor the development of winter storms in the Eastern United States. There is also some indication that as winters warm, temperatures may be more likely to produce icing conditions. Massachusetts' 2022 Climate Change Assessment predicts more mild winters, increased precipitation in the winter months, and multiple freeze-thaw cycles every winter due to warming temperatures.

OTHER SEVERE WEATHER (THUNDERSTORMS / HAIL)

THUNDERSTORMS

While less severe than the other types of storms discussed, thunderstorms can lead to localized damage and represent a hazard risk for communities. A thunderstorm typically features lightning, strong winds, and rain and/or hail. Thunderstorms sometime give rise to tornados. On average, these storms are only around 15 miles in diameter and last for about 30 minutes. A severe thunderstorm can include winds of close to 60 mph and rain sufficient to produce flooding. The severity of thunderstorms ranges from commonplace and of short duration to intense storms that cause damage due to high winds, flooding, or lightning strikes.

The extent of damages from high winds is described by the Beaufort Wind Scale (Table 30), which was developed in 1805 by Sir Francis Beaufort of the U.K. Royal Navy.

Table 30 Beaufort Wind Scale

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects	
			On the Water	On Land
0	< 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes

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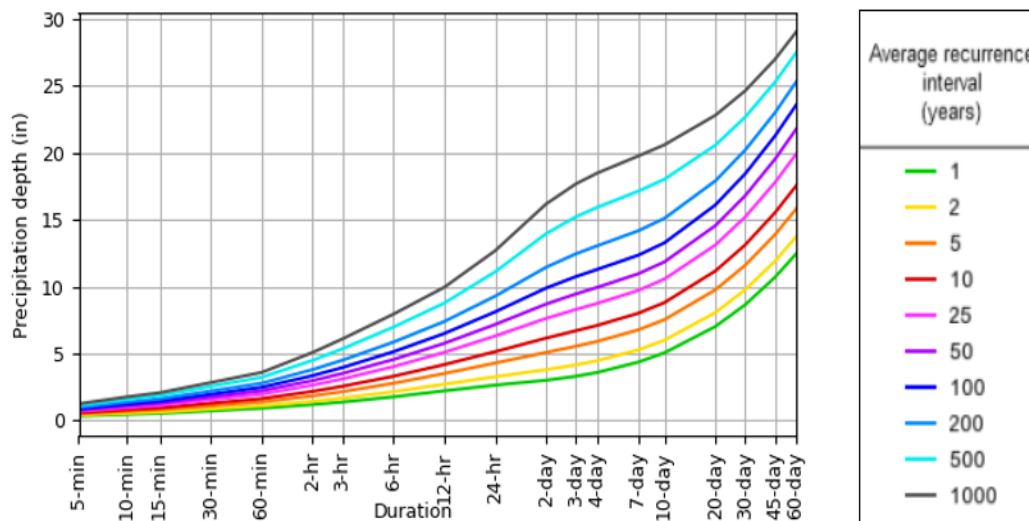
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft, whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-19 ft, white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (18-25 ft) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Twigs breaking off trees, generally impedes progress
9	41-47	Strong Gale	High waves (23-32 ft), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (29-41 ft) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (37-52 ft) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft, sea completely white with driving spray, visibility greatly reduced	

Source: NOAA Storm Prediction Center

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The amount of rainfall expected for storms of various durations and recurrence intervals, from 5 minutes to 60 days, and from annual recurrence to 1,000 years, is provided by NOAA's Atlas 14. The Depth-Duration-Frequency curves are shown in Figure 30.

Figure 30 Depth-Duration-Frequency Curve



For example, the chart shows the range of expected precipitation for a 12-hour rainfall ranges from about 2 inches for annual storm and 10 inches for a storm of 100-year frequency.

The best available data on previous occurrences of thunderstorms in Duxbury are from the NOAA National Centers for Environmental Information (NCEI) for Plymouth County. Between the years 2015 and 2025 NCEI records show 40 thunderstorm events in Plymouth County (Table 31). These storms resulted in a total of \$379,800 in property damages. There were no injuries or deaths.

Table 31 Plymouth County Thunderstorm Events, 2015 - 2025

Date	Magnitude-knots	Deaths	Injuries	Damage-\$
2/25/2016	50	0	0	50,000
7/17/2016	50	0	0	30,000
7/18/2016	50	0	0	53,000
7/22/2016	40	0	0	5000
7/23/2016	40	0	0	14,000
9/11/2016	40	0	0	1000
6/13/2017	49	0	0	2000
7/6/2018	45	0	0	1000
7/17/2018	45	0	0	10000
4/15/2019	48	0	0	4000
6/29/2019	52	0	0	3000

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Date	Magnitude-knots	Deaths	Injuries	Damage-\$
7/17/2019	50	0	0	4000
7/31/2019	58	0	0	0
8/8/2019	50	0	0	300
8/19/2019	50	0	0	300
6/6/2020	50	0	0	3000
6/28/2020	50	0	0	11,200
7/23/2020	50	0	0	500
8/22/2020	50	0	0	94300
10/7/2020	52	0	0	0
6/22/2021	50	0	0	500
6/30/2021	50	0	0	5800
7/7/2021	50	0	0	1000
7/23/2021	50	0	0	300
7/27/2021	52	0	0	500
11/13/2021	50	0	0	1500
7/14/2022	50	0	0	900
8/9/2022	50	0	0	2100
8/26/2022	50	0	0	5000
6/14/2023	50	0	0	2600
7/29/2023	50	0	0	7000
8/8/2023	50	0	0	3000
8/13/2023	50	0	0	1000
8/18/2023	50	0	0	2000
6/26/2024	50	0	0	8800
8/15/2024	50	0	0	200
7/3/2025	50	0	0	4000
7/20/2025	50	0	0	300
7/25/2025	50	0	0	900
8/14/2025	50	0	0	1000
TOTAL		0	0	\$379,800

Source: NOAA, National Centers for Environmental Information
Magnitude refers to maximum wind speed in knots.

Severe thunderstorms are a Town-wide hazard for Duxbury. The Town's vulnerability to severe thunderstorms is similar to that of tropical storms. High winds can cause falling trees and power outages, as well as obstruction of key routes and emergency access. Heavy precipitation may also cause localized flooding due to higher stormwater runoff that exceeds the capacity of portions of the drainage system and/or ponding of low-lying impervious areas. Flooding can result in mold-related public health impacts and power outages can leave people without heat or the use of medical devices. Lightning may cause injury or death to people who are outdoors.

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Probability of Future Occurrence

Based on the record of previous occurrences, severe thunderstorms in Duxbury are very high frequency events as defined by the Resilient MA Plan. This hazard occurs more frequently than once in 5 years (greater than 20% per year).

Thunderstorms and Climate Change

The intensity of rainfall events has increased significantly, and those trends are expected to continue. Neither the SHMCAP, nor the 2022 Massachusetts Climate Change Assessment, specifically address whether climate will affect the intensity or frequency of thunderstorms.

HAIL

Hail and sleet are forms of frozen precipitation. Hail occurs when precipitation falls through subfreezing air thick enough that the raindrops freeze into ice before hitting the ground. While sleet is a wintertime phenomenon, hail falls from convective clouds (usually thunderstorms), often during the warm spring and summer months.

Hail size typically refers to the diameter of the hailstones. Warnings and reports may report hail size through comparisons with real-world objects that correspond to certain diameters, shown in Table 32.

Table 32: Hail Size Comparisons

Description	Diameter (inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.88
Quarter	1.00
Half dollar	1.25
Walnut or ping pong ball	1.50
Golf ball	1.75
Hen's egg	2.00
Tennis ball	2.50
Baseball	2.75
Tea cup	3.00
Grapefruit	4.00
Softball	4.50

Source: NOAA

The best available local data for previous hail events in Duxbury are for Plymouth County through the National Centers for Environmental Information. Plymouth County experienced 14 hail events from 2010-2025 shown in Table 33. There were no injuries, deaths, or property damage reported for these hail events.

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Table 33: Plymouth County Hail Events, 2010-2025

Date	Hail Size (inches)	Deaths	Injuries	Damage
5/26/2010	0.75	0	0	0
6/1/2011	1	0	0	0
9/15/2011	0.75	0	0	0
7/24/2012	1.75	0	0	0
8/7/2014	0.88	0	0	0
7/17/2016	0.88	0	0	0
6/13/2017	0.75	0	0	0
6/22/2019	0.75	0	0	0
6/30/2019	1	0	0	0
8/22/2020	1.75	0	0	0
7/23/2021	0.88	0	0	0
7/14/2022	1	0	0	0
8/26/2024	1.5	0	0	0
8/14/2025	1.5	0	0	0
TOTAL		0	0	0

Source: NOAA, National Centers for Environmental Information
*Magnitude refers to diameter of hail stones in inches

Hail events are a potential town-wide hazard in Duxbury, however the town has not reported any local damage associated with hail. Should a significant hail event occur, the most likely damage would be to vehicles, both town-owned and privately owned, windows, roofs, and other structures, as well as some utility facilities. Damage to vegetation could cause power outages, and damage to some buildings. People outdoors directly exposed to large hail could be at risk of injuries in a severe hail event. Should solar energy facilities be sited in Duxbury in the future, they could be vulnerable to the impacts of hail.

Probability of Future Occurrences

Based on the record of previous occurrences, hail events in Duxbury are a Medium frequency event. This hazard may occur once in five years to once in 50 years, with a 2% to 20% chance of occurring each year.

WILDFIRE/BRUSHFIRE

A brush fire is an uncontrolled fire occurring in a forested or grassland area. In the Boston Metro region these fires rarely grow to the size of a wildfire as seen more typically in the western U.S. As their name implies, these fires typically burn no more than the underbrush of a forested area.

There are three different classes of wildfires:

- Surface fires are the most common type and burn along the floor of a forest, moving slowly and killing or damaging trees;

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- Ground fires are usually started by lightning and burn on or below the forest floor;
- Crown fires spread rapidly by wind, jumping along the tops of trees.

Wildfire season can begin in March and usually ends in late November. The majority of wildfires typically occur in April and May, when most vegetation is void of any appreciable moisture, making them highly flammable. Once "green-up" takes place in late May to early June, the fire danger usually is reduced somewhat.

A wildfire differs greatly from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to unexpectedly change direction, and its ability to jump gaps such as roads, rivers and fire breaks.

The most susceptible fuels are pitch pine, scrub oak and oak forests. Topography can affect the behavior of fires, as fire spreads more easily uphill. Fires can present a hazard where there is the potential to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire to spread into homes. Protecting structures from fire poses special problems and can stretch firefighting resources to the limit. The most common cause of wildfires is the careless disposal of smoking materials and untended campfires.

These fires can present a greater hazard where there is the potential for them to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire the spread into homes, known as the Urban/Wildfire Interface. Protecting structures from fire poses special problems, and can stretch firefighting resources to the limit.

If heavy rains follow a fire, other natural disasters can occur, including landslides, mudflows, and floods. If the wildfire destroys the ground cover, then erosion becomes one of several potential problems.

The National Wildfire Coordinating Group (NWCG) classifies the severity of wildfires based on their acreage as follows:

- Class A - one-fourth acre or less;
- Class B - more than one-fourth 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 (NWCG, 2023).

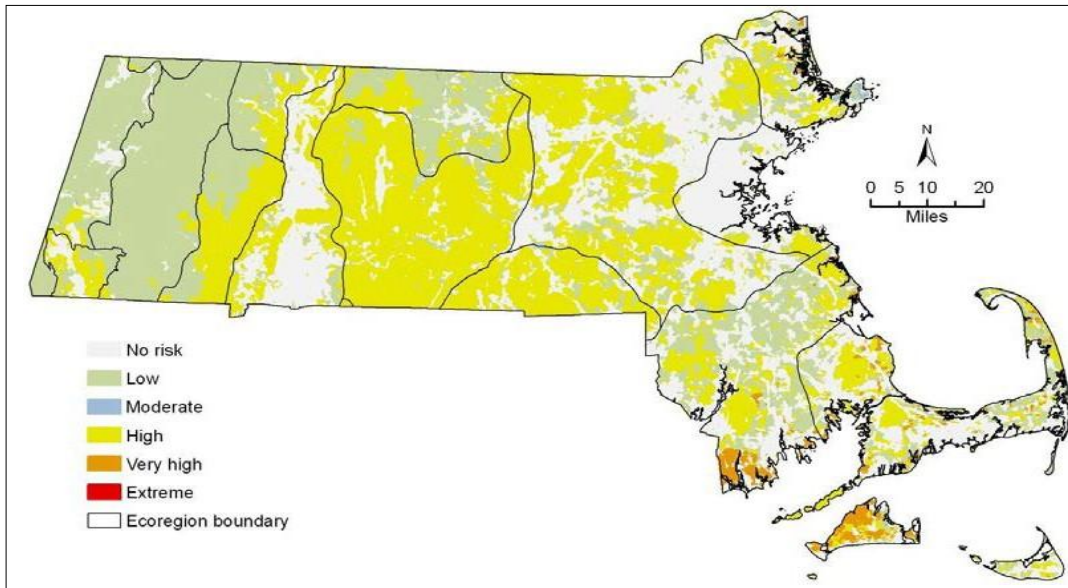
Duxbury is in the Class C category.

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Potential Wildfire Hazard Areas

The 2018 SHMCAP includes a map that depicts statewide fire risk incorporating three risk components: fuel, wildland-urban interface, and topography (Figure 31). The wildland-urban interface reflects communities where housing and vegetation intermingle, and fire can spread from structures to vegetated areas. Duxbury is in the middle of the range of risk on this map.

Figure 31: Wildfire Risk Areas in Massachusetts



Source: 2018 SHMCAP

The Town considers brush fires to be a medium priority natural hazard. Most brush fires are caused by weather conditions such as lack of rainfall, winds and lightning, and a few by youth activities in wooded areas. The Duxbury Fire Department regularly responds to brush fires. Fire Department records include 89 wildfire incidences from 2018 to 2024m which are shown in Appendix XX. None of these fires involved significant damage to residences or commercial properties, and none have resulted in injuries or deaths.

The following areas of Duxbury were identified by the local team as having a higher potential for brush fires based either on higher concentration of brush or forest, or large stands of phragmites. These sites have been mapped and the numbers in the list below correspond to Map 8 in Appendix B.

- Miles Standish Park (17)
- Depot Street, Lapham Woods (18)
- Mayflower Street, Town Forest (19)
- Waiting Hill (20)
- Behind Chandler School on Duxbury Bog (21)
- Autumn Lane, O'Neil Farm, beneath high tension wires (22)

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- King Phillips Path, Lansing Bennett Forest (23)
- Summer and Congress streets, border with Pembroke (24)
- North Street, by Marshfield and Pembroke lines (25)
- Pine Brook area (26)
- Wright Reservation, high tension wires (27)
- Bay Farm area, along border with Kingston (28)
- Cranberry Bogs by Island Creek (31)
- Harrison Street at the open space and forested areas (32)
- Oak Street
- Route 3 North and South between exits 10-12. (34)

Potential damages from wildfires in Duxbury would depend on the extent and type of land affected. Duxbury has over 6,000 acres of forested area and over 3,000 acres of protected open space. Much of this land area contains the Southeastern Massachusetts Pine Barren Forest, known for its sandy soils, scrub oak and pitch pine, a fire-dominated forest which naturally relies on fires for regeneration. Though fires in Duxbury's Pine Barren Forest are few and far between, there is a potential for loss of residences which are often nestled within the forested areas. The Chief of the Duxbury Fire Department has concerns with Duxbury's vulnerability and risk of loss with fire-related hazards:

Among the only trees that thrive in this region's sandy soil are pitch pine and scrub oak; both species are susceptible to fire but pitch pine's resin-rich needles are especially so. With the added fuel from ground covered with dried pinecones, needles, leaves, and twigs, these forests can produce some of the fastest-moving fires in the country. In recent decades, there has been intense residential development surrounding state forests and parks. Dozens of structures have been lost in Southeastern MA., in the 1957 and 1964 fires. Today, even a medium-size wildfire in southeastern Massachusetts would likely destroy hundreds of homes and possibly result in loss of life.

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

Outdoor burning is allowed from January to May with a permit from the Fire Department. The Fire Department reviews all development proposals for fire safety. The Duxbury Fire Chief noted that public education, permitting and monitoring of open air burning, and "prescribed burns" of the Pine Barren Forest can help to mitigate future fires and minimize extensive loss. There could be the need for post-fire revegetation to restore a burned property which could cost from a few thousand dollars to tens of thousands for an extensive area. However, there are no data on actual wildfire damages in Duxbury.

Probability of Future Occurrences

Based on past occurrences brushfires are of high frequency in Duxbury as defined by the Resilient MA Plan. Wildfire events are almost certain to occur at least once a year.

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WILDFIRE AND CLIMATE CHANGE

As the climate warms, drought and warmer temperatures may increase the risk of wildfire as vegetation dries out and becomes more flammable. Increasing drought and increasing damage to trees from pests can also lead to greater fire risk. The 2022 Massachusetts Climate Assessment cites anticipated forest health degradation from increasing wildfire frequency.

EARTHQUAKES

Damage in an earthquake stems from ground motion, surface faulting, and ground failure in which weak or unstable soils, such as those composed primarily of saturated sand or silts, liquefy. The effects of an earthquake are mitigated by distance and ground materials between the epicenter and a given location. An earthquake in New England affects a much wider area than a similar earthquake in California due to New England's solid bedrock geology (NESEC).

Seismologists use a magnitude scale known as the Richter Scale to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized in Table 34. Although each earthquake has a unique magnitude, its effects will vary greatly according to distance, ground conditions, construction standards and other factors. In seismology, a scale of seismic intensity is a way of measuring or rating the effects of an earthquake at different sites. The Modified Mercalli Intensity Scale is commonly used in the United States by seismologists seeking information on the severity of earthquake effects (Table 35). Intensity ratings are expressed as Roman numerals between I at the low end and XII at the high end.

Table 34: Richter Scale and Effects

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

Source: Nevada Seismological Library (NSL), 2005

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Table 35: Measuring Earthquake Magnitude (Modified Mercalli Intensity Scale)

Rating	Seismic Intensity/Effects
I	People do not feel any Earth movement.
II	A few people might notice movement if they are at rest and/or on the upper floors of tall buildings
III	Most people indoors feel movement. Hanging objects swing. Dishes, windows, and doors rattle. The earthquake feels like a heavy truck hitting the walls. A few people outdoors may feel movement. Parked cars rock.
IV	Almost everyone feels movement. Sleeping people are awakened. Doors swing open or close. Dishes are broken. Pictures on the wall move. Small objects move or are turned over. Trees might shake. Liquids might spill out of open containers.
V	Everyone feels movement. People have trouble walking. Objects fall from shelves. Pictures fall off walls. Furniture moves. Wall plaster might crack. Trees and bushes shake. Damage is slight in poorly built buildings. No structural damage.
VI	People have difficulty standing. Drivers feel their cars shaking. Some furniture breaks. Loose bricks fall from buildings. Damage is slight to moderate in well-built buildings; considerable in poorly built buildings
VII	Drivers have trouble steering. Houses that are not bolted down might shift on their foundations. Tall structures such as towers and chimneys might twist and fall. Well-built buildings suffer slight damage. Poorly built structures suffer severe damage. Tree branches break. Hillsides might crack if the ground is wet. Water levels in wells might change.
VIII	Well-built buildings suffer considerable damage. Houses that are not bolted down move off their foundations. Some underground pipes are broken. The ground cracks. Reservoirs suffer serious Damage.
IX	Most buildings and their foundations are destroyed. Some bridges are destroyed. Dams are seriously damaged. Large landslides occur. Water is thrown on the banks of canals, rivers, lakes. The ground cracks in large areas. Railroad tracks are bent slightly.
X	Most buildings collapse. Some bridges are destroyed. Large cracks appear in the ground. Underground pipelines are destroyed. Railroad tracks are badly bent.
XI	Almost everything is destroyed. Objects are thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move.
XII	

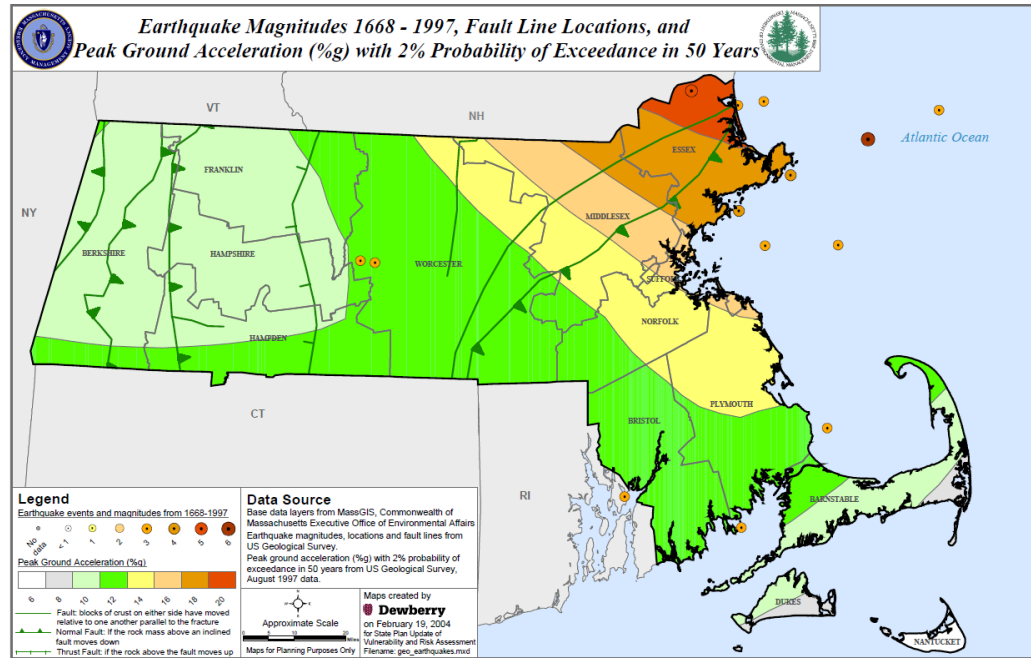
Source: NSL 2005 (Original Source: FEMA)

One measure of earthquake risk is ground motion, which is measured as maximum peak horizontal acceleration, expressed as a percentage of gravity (1 g). The range of peak ground acceleration in Massachusetts is from 10g to 20g, with a 2% probability of exceedance in 50 years, as shown in Figure 32 Duxbury is in the middle part of the range for Massachusetts making it a moderate area of earthquake risk within the state, although the state as a whole is considered to have a low risk of earthquakes compared to the rest of the country.

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

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Figure 32: Massachusetts Earthquake Probability Map



Source: 2018 SHMCP

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2007, 355 earthquakes were recorded in Massachusetts (NESEC). Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault located off the coast of Rockport. The region has experienced several larger earthquakes, including a magnitude 5.0 earthquake in 1727 and a 6.0 earthquake that struck in 1755 off the coast of Cape Anne. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940 and a 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historical records of some of the more significant earthquakes in the region are shown in Table 36.

Table 36: Historic Earthquakes in Massachusetts or Surrounding Area

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6

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Location	Date	Magnitude
MA - Off Cape Cod	11/23/1755	NA
MA – Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA – Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA – Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA – Brewster	8/8/1847	4.2
MA – Boxford	5/12/1880	NA
MA – Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA
MA – Boston	12/27/74	2.3
MA - Nantucket	4/12/12	4.5
ME – Hollis	10/17/12	4.0

Source: Boston HIRA

Earthquakes are a hazard with multiple impacts beyond the obvious building collapse. Buildings may suffer structural damage which may or may not be readily apparent. Earthquakes can cause major damage to roadways and transit lines, making emergency response difficult. Water lines and gas lines can break, causing flooding and fires. Another potential vulnerability is equipment within structures. For example, a building may be structurally engineered to withstand an earthquake, but if the equipment inside the building is not properly secured, it could be severely damaged during an earthquake. Earthquakes can also trigger landslides.

Earthquakes are a potential Town-wide hazard in Duxbury. The Town has some older buildings built prior to the current building code that could be vulnerable in the event of a severe earthquake. Potential earthquake damages in Duxbury have been estimated using HAZUS-MH. Total building damages, including business interruption losses are estimated at \$232 million for a 5.0 magnitude earthquake and \$2.3 billion for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table xx.

Probability of Future Occurrence

There are several ways the probability of future occurrences of earthquakes has been estimated.

According to the Boston College Weston Observatory, in most parts of New England there is a one in ten chance that a potentially damaging earthquake will occur in a 50-year time period. Earthquakes in Duxbury are a low frequency event as defined by the Resilient MA Plan. This hazard is likely to occur at least once by the end of the century; anticipated every 100 years.

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LANDSLIDES

According to the USGS, “The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors.” Among the contributing factors are erosion by rivers or ocean waves over steepened slopes; slopes weakened through saturation by snowmelt or rain; earthquakes create stresses that make weak slopes fail; and excess weight from accumulation of rain or snow, stockpiling of rock or ore, waste piles, or structures.

Landslides can result from human activities that destabilize an area or can occur as a secondary impact from another natural hazard such as flooding. In addition to structural damage to buildings and the blockage of transportation corridors, landslides can lead to sedimentation of water bodies. Typically, a landslide occurs when the condition of a slope changes from stable to unstable. Natural precipitation such as heavy snow accumulation, torrential rain and run-off may saturate soil creating instability enough to contribute to a landslide. The lack of vegetation and root structure can destabilize hilly terrain.

In Massachusetts, the most common cause of landslides are geologic conditions combined with steep slopes and/or heavy rains. Landslides associated with heavy rains typically occur on steep slopes with permeable soils underlain by till or bedrock.

There is no universally accepted measure of landslide extent, but it has been represented as a measure of destructiveness. Table 37 below summarizes the estimated intensity for a range of landslides. For a given landslide volume, fast moving rock falls have the highest intensity while slow moving landslides have the lowest intensity.

The MA State Hazard Mitigation and Climate Adaptation Plan utilized data from the MA Department of Transportation from 1986 to 2006 to estimate that, on average, roughly one to three known landslides have occurred each year in the state. A slope stability map published by the MA Geological Survey and UMass-Amherst indicates that the most significant risk of landslide is in western Massachusetts.

37: Estimated Landslide Intensity

Estimated Volume (m ³)	Expected Landslide Velocity		
	Fast moving landslide (Rock fall)	Rapid moving landslide (Debris flow)	Slow moving landslide (Slide)
<0.001	Slight intensity		
<0.5	Medium intensity		
>0.5	High intensity		
<500	High intensity	Slight intensity	
500-10,000	High intensity	Medium intensity	Slight intensity
10,000 – 50,000	Very high intensity	High intensity	Medium intensity
>500,000		Very high intensity	High intensity
>>500,000			Very high intensity

Source: A Geomorphological Approach to the Estimation of Landslide Hazards and Risks in Umbria, Central Italy, M. Cardinali et al, 2002

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The entire Town has been classified as having a low incidence risk for landslides, less than 1.5 % of the area is involved in land sliding. (Map 4, Appendix A). The town's coastal location, characterized by moderate topography and sandy soils is not conducive to landslide risk. No acreage in Duxbury has been lost to landslides, as the Town does not have records of damages caused by landslides. The Town does not believe that landslides pose a significant risk to Duxbury.

Should a landslide occur in the future, the type and degree of impacts would be highly localized, and the Town's vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Duxbury.

Potential damages would depend on how many and what types of properties were affected. Given the relatively high assessed value of property in Duxbury, damages affecting a single residence could exceed \$500,000, and damages affecting several homes or business properties could theoretically extend to several million dollars. However, there are no records of such landslide damages in Duxbury.

Probability of Future Occurrences

Although the Resilient MA Plan classifies landslides as high likelihood events statewide, based on past occurrences and topographic conditions in Duxbury, landslides are very low frequency events in the town. This hazard is very unlikely to occur and there are no examples of historical occurrences.

Climate Change and Landslides

Changes in precipitation may increase the chance of landslides, as extreme rain events could result in more frequent saturated soils which are conducive to landslides. Drought may also increase the likelihood of landslides if loss of vegetation decreases soil stability.

EXTREME TEMPERATURE HAZARDS

AVERAGE AND EXTREME TEMPERATURES

Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time where there is prolonged period of excessively hot or cold weather. Duxbury has four well-defined seasons. The seasons have several defining factors, with temperature one of the most significant. Extreme temperatures can be defined as those which are far outside of the normal seasonal ranges for Massachusetts. The average seasonal temperatures for Massachusetts are: Winter (Dec-Feb) Average = 31.8°F; Summer (Jun-Aug) Average = 71°F

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EXTREME HEAT

While a heat wave for Massachusetts is defined as three or more consecutive days above 90°F, another measure used for identifying extreme heat events is through a Heat Advisory from the NWS. These advisories are issued when the heat index (Figure 33) is forecast to exceed 100-degree Fahrenheit (F) for 2 or more hours; an excessive heat advisory is issued if forecast predicts the temperature to rise above 105 degree F.

Figure 33: Heat Index Chart

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

Source: National Weather Service

The best available data on past occurrences of extreme heat events is from NOAA's National Centers for Environmental Information (NCEI) for Plymouth County, which includes Duxbury. The NCEI records indicate that since 2010, there have been three excessive heat events recorded, with no reported death, no injuries, and no property damage (see Table 38). The hottest single day temperature recorded in Eastern Massachusetts by the National Weather Service's Norton/Boston regional office was 104 degrees on July 4, 1911.

Table 38: Plymouth County Extreme Heat Occurrences 2010-2025

Date	Deaths	Injuries	Damage
7/22/2011	0	0	0
7/01/2018	0	0	0
7/03/2018	0	0	0
TOTAL	0	0	0

Source: NOAA, National Centers for Environmental Information

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Extreme temperatures are a community-wide hazard in Duxbury. Extreme heat poses a potentially greater risk to the elderly, children, and people with certain medical conditions. However, even young and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. Older adults are often at elevated risk due to a high prevalence of pre-existing and chronic conditions; in Duxbury, approximately 16.9% of the population is over age 65. People who live in older housing stock and in housing without air conditioning have increased vulnerability to heat-related illnesses.

Power failures can occur during heat waves, where intense heat spikes electricity demand and aging infrastructure. With aging infrastructure, the combination of these factors can lead to equipment failure. Loss of electricity not only impairs a resident's ability to cool, but can cause a significant medical emergency for those who require electronic medical equipment or from food-borne illnesses from contaminated food, ingested after loss of refrigeration. . Key health risks of extreme heat are summarized in Figure 34.

Figure 34 Health Risks Associated with Extreme Heat



Source: Killer Heat in the United States, Union of Concerned Scientists

Areas with less shade and darker surfaces (pavement and roofs) will experience even hotter temperatures; these surfaces absorb heat during the day and release it in the evening, keeping nighttime temperatures warmer as well. Map 9 in Appendix A displays areas that are among the hottest 5% of land in the MAPC region based on land surface temperature derived from satellite imagery on July 13, 2016. Only two small areas of Duxbury are shown as “hot spots.”

Hot summer days can worsen air pollution. With increased extreme heat, urban areas will likely experience more days that fail to meet air quality standards. Power failures are more likely to occur during heat waves, affecting the ability of residents to remain cool. Individuals with pre-existing conditions and those who require medical equipment may be at increased risk.

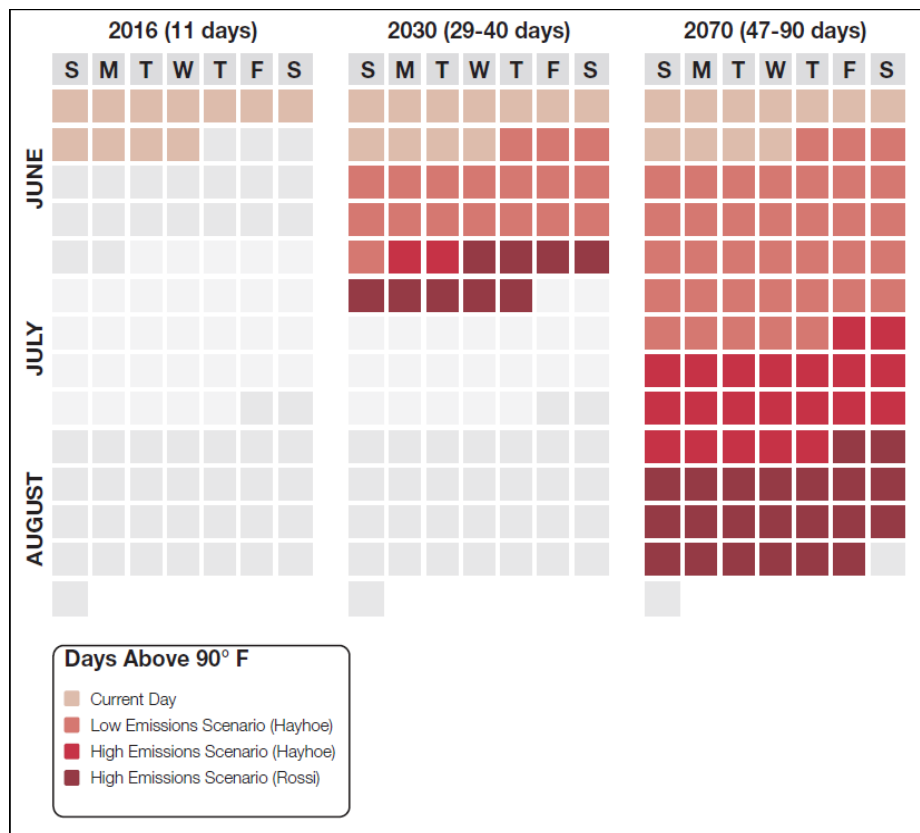
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Ecosystems that are expected to be particularly vulnerable to warming temperatures include cold-water fisheries, vernal pools, spruce-fir forests, northern hardwood forests (Maple, Beech, Birch), Hemlock forests, and urban forests. Other impacts on natural resources include a longer growing season and northern migration of plants and animals, including invasive species.

Extreme Heat and Climate Change

The 2022 MA Climate Change Assessment includes projections of climate-driven future increases in average temperature and in the number of extreme heat days. The assessment also highlights the following climate impacts related to temperatures. Over time our climate will become more similar to areas well to the south of New England (Figure 36 below). Projected number of days above 90°F to the year 2070 is shown in Figure 35.

Figure 35: Comparison of Days Above 90°F for Low and High Emission Scenarios



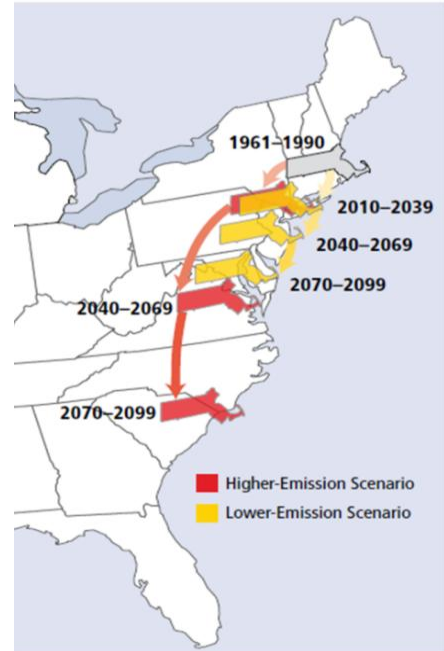
Source: Somerville Climate Change Vulnerability Assessment

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Warmer temperatures and more frequent heat waves are connected to impaired human health, increased droughts, reduced agriculture yields, species range shifts, and damaged infrastructure.

- By 2030, the summer mean temperature could increase by 3.6°F from the historical period (1950-2013), worsening stress on electric transmission and utility distribution infrastructure.
- By 2070, there could be 58 fewer days below freezing, increasing the chance of ticks overwintering and reducing winter recreation opportunities.
- Increase in vector borne diseases and bacterial infections, including West Nile Virus and Lyme disease due to more favorable conditions for ticks and mosquitoes.
- Damage to electric transmission and utility distribution infrastructure associated with heat stress
- Damage to rails and loss of rail/transit service, including flooding and track buckling during high heat events.
- Reduced ability to work, particularly for outdoor workers during extreme heat, as well as commute delays due to damaged infrastructure.
- Freshwater ecosystem degradation due to warming waters.
- Forest health degradation from warming temperatures and increasing pest occurrence

Figure 36: Temperature Scenarios



Source: Union of Concerned Scientists

Probability of Future Occurrences

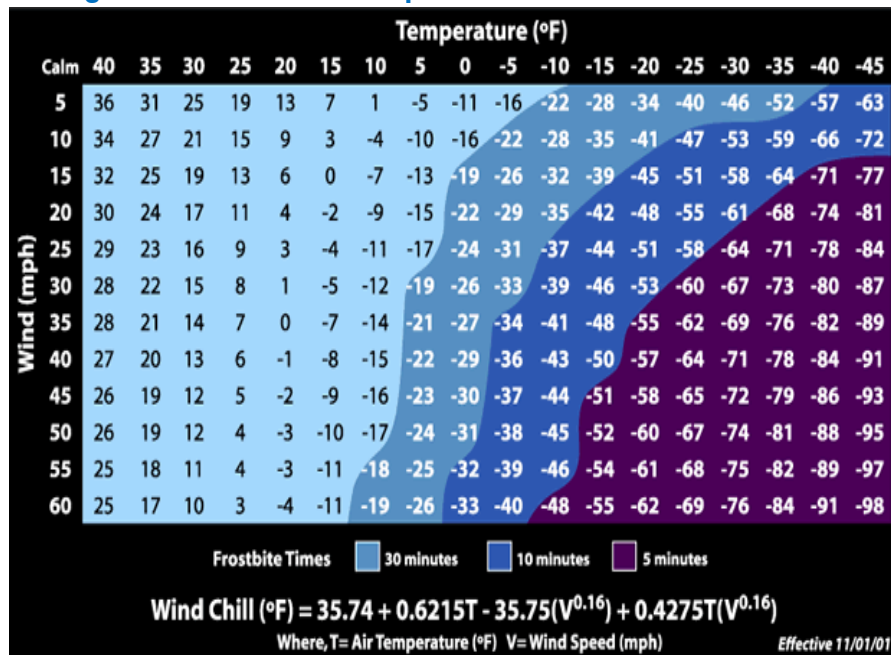
Extreme heat events are classified as very high frequency events as defined by the Resilient MA Plan. Extreme temperature events are almost certain to occur multiple times a year.

EXTREME COLD

Extreme cold is relative to the normal climatic lows in a region. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The severity of extreme cold temperature is typically measured using the Wind Chill Temperature Index, which is provided by the National Weather Service (NWS). The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed. The index is provided in Figure 37 A Wind Chill warning is issued when the Wind Chill Index is forecast to fall below -25 degrees F for at least 3 hours.

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Figure 37. Wind Chill Temperature Index and Frostbite Risk



Source: National Weather Service

The best available data on past occurrences of extreme cold events are from NOAA's National Centers for Environmental Information (NCEI) for Plymouth County, which includes the Town of Duxbury. There were two extreme cold events recorded by NCEI (Table 39), which caused no deaths, no injuries, or property damage. The coldest single day temperature recorded in Eastern Massachusetts by the National Weather Service's Norton/Boston regional office was -18 degrees (F) on February 9, 1933.

Table 39: Plymouth County Extreme Cold and Wind Chill Occurrences, 2010-2025

Date	Deaths	Injuries	Damages
2/16/2015	0	0	0
2/14/2016	0	0	0
TOTAL	0	0	0

Source: NOAA, National Centers for Environmental Information

Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat. The greatest vulnerability to the Town would be a power outage during a winter storm, which could temporarily leave many residents without heat. The elderly and people with disabilities are often most vulnerable. In Duxbury, 16.9% of residents are 65 years old and over and 7.1% have a disability.

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Other damages related to extreme cold in Duxbury relate to the freezing of the bay, which can cause heaves and structural damage to piers, docks and marina structures on the waterfront, including the Powder Point Bridge pilings and other bridges in these bay waters. Access to iced-over waters is prevented during these freezes, affecting shell fishing and fishing activities, and damaged infrastructure must be repaired with closures or significantly reduced usage until these repairs are made.

Probability of Future Occurrences

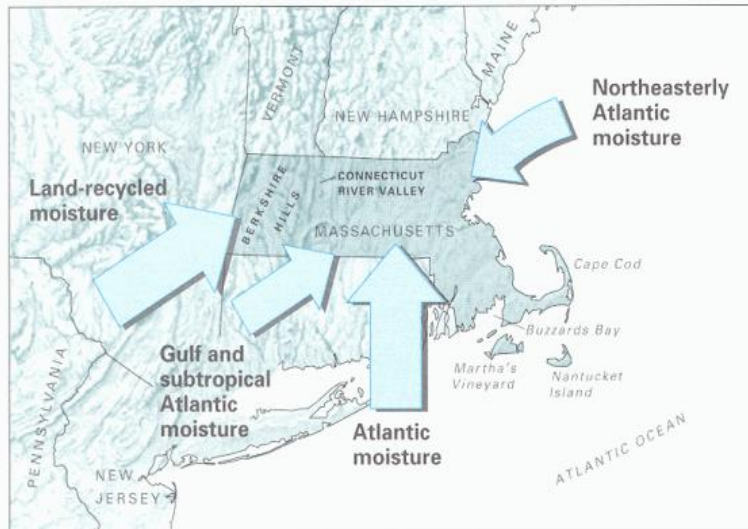
Extreme cold events are classified as very high frequency events as defined by the Resilient MA Plan. Extreme temperature events are almost certain to occur multiple times a year.

DROUGHT HAZARDS

Drought is a temporary irregularity in precipitation and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones, yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life.

In Massachusetts, droughts are caused by the prevalence of dry northern continental air and a decrease in coastal- and tropical-cyclone activity. During the 1960's, a cool drought occurred because dry air from the north caused lower temperatures in the spring and summer of 1962-65. The northerly winds drove frontal systems to sea along the Southeast Coast and prevented the Northeastern States from receiving the normal sources of moisture (see Figure 38). This is considered the drought of record in Massachusetts.

Figure 38: Principal Sources and Pattern of Moisture Delivery to Massachusetts



U.S. Geological Survey Water-Supply Paper 2375, National Water Summary 1988-89

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Average annual precipitation in Massachusetts is 44 inches per year, with approximately 3-to-4-inch average amounts for each month of the year. Regional monthly precipitation ranges from zero to 17 inches. Statewide annual precipitation ranges from 30 to 61 inches. Thus, in the driest calendar year (1965), the statewide precipitation total of 30 inches was 68 percent of average.

Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. The DCR precipitation index divides the state into seven regions: Western, Central, Connecticut River Valley, Northeast, Southeast, Cape Cod, and Islands. Duxbury is located in the Southeast Region. In Duxbury drought is a potential town-wide hazard.

The *Massachusetts Drought Management Plan* was revised in 2019 to change the state's classification of droughts by establishing four levels to characterize drought severity beyond normal conditions:

- Level 0-Normal Conditions (no drought)
- Level 1-Mild Drought (formerly Advisory)
- Level 2-Significant Drought (formerly Watch)
- Level 3-Critical Drought (formerly Warning)
- Level 4-Emergency Drought (formerly Emergency)

The Massachusetts drought levels are shown in comparison to the U.S. Drought Monitor levels in Table 40. The two sets of drought indices are similar, but Massachusetts combines the USDM's level D2 and D3 into one category, Critical Droughts.

Table 40: US Drought Monitor Compared to MA Statewide Drought Levels

USDM Names	Recurrence	Percentile Ranges	MA DMP Levels	MA Percentile Ranges	MA DMP Names
D0: Abnormally Dry	once per 3 to 5 years	21 to 30	1	>20 and ≤30%	Mild Drought
D1: Moderate	once per 5 to 10 years	11 to 20	2	>10 and ≤20%	Significant Drought
D2: Severe Drought	once per 10 to 20 years	6 to 10	3	>2 and ≤10%	Critical Drought
D3: Extreme Drought	once per 20 to 50 years	3 to 5			
D4: Exceptional Drought	once per 50 to 100 years	0 to 2	4	≤2%	Emergency

Source: Massachusetts Drought Management Plan, 2019

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Drought levels are designated based on the conditions of natural resources and provide information on the current status of water resources. As dry conditions can have a range of different impacts, a number of drought indices are available to assess these impacts. Massachusetts uses a multi-index system that takes advantage of several of these indices to determine the severity of a given drought or extended period of dry conditions.

Drought level is determined monthly based on the number of indices which have reached a given drought level. Drought levels are declared on a regional basis for each of seven regions in Massachusetts. County by county or watershed-specific determinations may also be made. A determination of drought level is based on seven indices:

1. The Standardized Precipitation Index (SPI) reflects soil moisture and precipitation.
2. Crop Moisture Index: (CMI) reflects soil moisture conditions for agriculture.
3. Keetch Byram Drought Index (KBDI) is designed for fire potential assessment.
4. The Precipitation Index is a comparison of measured precipitation amounts to historic normal precipitation.
5. The Groundwater Level Index is based on the number of consecutive month's groundwater levels are below normal (lowest 25% of period of record).
6. The Stream flow Index is based on the number of consecutive months that stream flow levels are below normal (lowest 25% of period of record).
7. The Reservoir Index is based on the water levels of small, medium and large index reservoirs across the state, relative to normal conditions for each month.

Table 41 shows the range of values for each of the indices associated with the drought levels. Because drought tends to be a regional natural hazard, this plan references state data as the best available data for previous drought occurrences.

Table 41: Indices Values Corresponding to Drought Index Severity Levels

Index Severity Level	Standardized Precipitation Index	Streamflow	Lakes and Impoundments	Groundwater	Keetch-Byram Drought Index	Crop Moisture Index
0	>30 th percentile				< 200	> -1.0
1	≤30 and >20				200-400	≤-1.0 and > -2.0
2	≤20 and >10				400-600	≤-2.0 and < -3.0
3	≤10 and >2				600-700	≤ -3.0 and > -4.0
4	≤2				700-800	≤-4.0

Source: Massachusetts Drought Management Plan, 2019

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The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions. They begin with a normal situation where data are routinely collected and distributed, move to heightened vigilance with increased data collection during an advisory, to increased assessment and proactive education during a watch. Water restrictions might be appropriate at the watch or warning stage, depending on the capacity of each individual water supply system. A warning level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which mandatory water restrictions or use of emergency supplies is necessary.

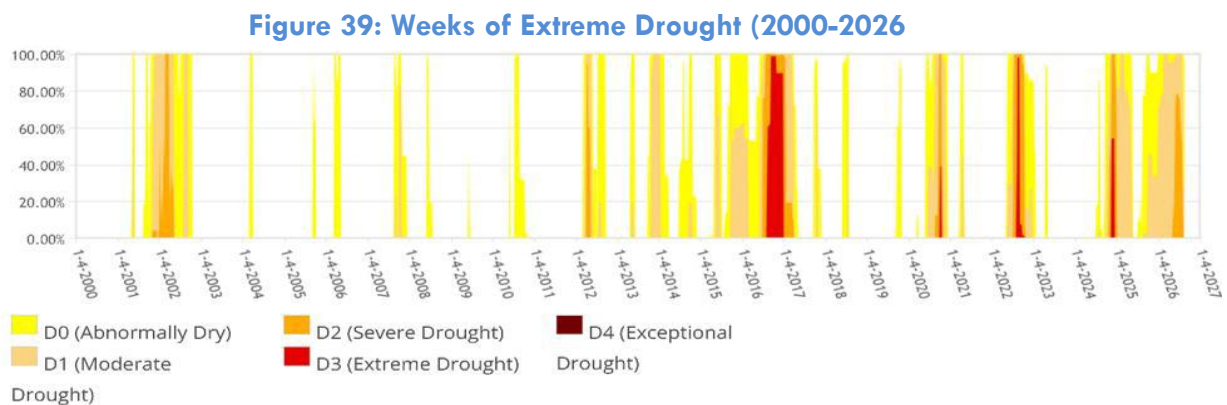
Drought levels are used to coordinate both state agency and local response to drought situations. Determinations regarding the end of a drought or reduction of a drought level focus on precipitation and groundwater levels. These factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture, and forest fire potential.

Previous Occurrences

Because drought tends to be a regional natural hazard, the best available data on previous drought occurrences is state-wide data, summarized below. The Executive Office of Energy and Environment's Drought Management Task Force also provides information on historic drought status for each drought level in Massachusetts. That information is summarized below.

Mild Drought/Advisory	2001, 2002, 2007, 2014, 2016, 2017, 2020, 2021, 2022
Significant Drought/Watch	2002, 2016-17, 2020, 2021, 2022, 2023
Critical Drought/Warning	2016-2017, 2020, 2022
Emergency Drought/Emergency	None

Figure 39 shows the frequency and extent of drought events in Massachusetts since the year 2000. The graphic clearly shows an increase in severe drought events in the most recent years of this period. There have been four droughts at the extreme level in Massachusetts, in 2016-2017, 2020, 2022, and 2025.



Source: MA Drought Management Plan

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A summary of Massachusetts historic drought events from 1879 to 2023 is in Table 42.

Table 42 - Chronology of major droughts in Massachusetts since 1879

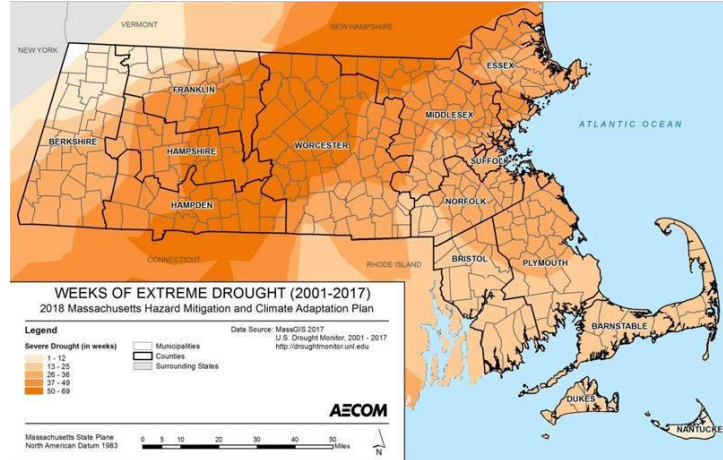
Date	Area affected	Recurrence interval (years)	Remarks	Reference
1879-83	–	–	Kinnison 1931 referenced these periods as two of three worst droughts on record in 1931, the third being the then current drought of 1929-1932.	Kinnison 1931
1908-12	–	–		
1929-32	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.	USGS 1989
1939-44	Statewide	15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.	USGS 1989
1957-59	Statewide	5 to 25	Record low water levels in observation wells, northeastern Massachusetts.	USGS 1989
1961-69	Statewide	35 to >50	Water-supply shortages common. Record drought. Multistate.	USGS 1989
1980-83	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.	USGS 1989
1985-88	Housatonic River Basin	25	Duration and severity as yet unknown. Streamflow showed mixed trends elsewhere.	USGS 1989
1995	–	–	Based on statewide average precipitation	DMP 2013
1998-1999	–	–	Based on statewide average precipitation	DMP 2013
Dec 2001 - Jan 2003	Statewide	–	Level 2 drought (out of 4 levels) was reached statewide for several months	DCR 2017
Oct 2007 - Mar 2008	Statewide except West and Cape & Islands regions	–	Level 1 drought (out of 4 levels)	DCR 2017
Aug 2010 - Nov 2010	Connecticut River Valley, Central and Northeast regions	–	Level 1 drought (out of 4 levels)	DCR 2017
Oct 2014 - Nov 2014	Southeast and Cape & Islands regions	–	Level 1 drought (out of 4 levels)	DCR 2017
Jul 2016 - Apr 2017	Statewide	–	Level 3 drought (out of 4 levels)	DCR 2017
Jul 2016 - Apr 2017	Statewide	–	Level 3 drought	EEA 2016-2017
Sep 2019	Connecticut River Valley	–	Level 1 drought	EEA 2019
May 2020- Nov 2020	Statewide	–	Level 2 in all regions except the Southeast, Charles basin (Northeast) and Millers (Central) basin at Level 3	EEA 2020
Feb 2021 – Oct 2021	Statewide except Islands region	–	Level 1 in all affected regions except the Southeast at Level 2	EEA 2021
Apr 2022- Jan 2022	Statewide	–	Level 2 for Western and Islands and Level 3 for Cape Cod, Northeast, Southeast, Central, and Connecticut River Valley	EEA 2022
May 2023	Western and Cape Cod regions	–	Level 1 for Western and Cape Cod regions	EEA 2023
Nov-Dec 2023	Islands region	–	Level 2 drought	EEA 2023

Source: Massachusetts Drought Management Plan

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As shown in Figure 40, the geographic extent of droughts from 2001 to 2017 varied greatly in different parts of the state. Duxbury experienced between 37 and 49 weeks of severe drought between 2001 and 2017.

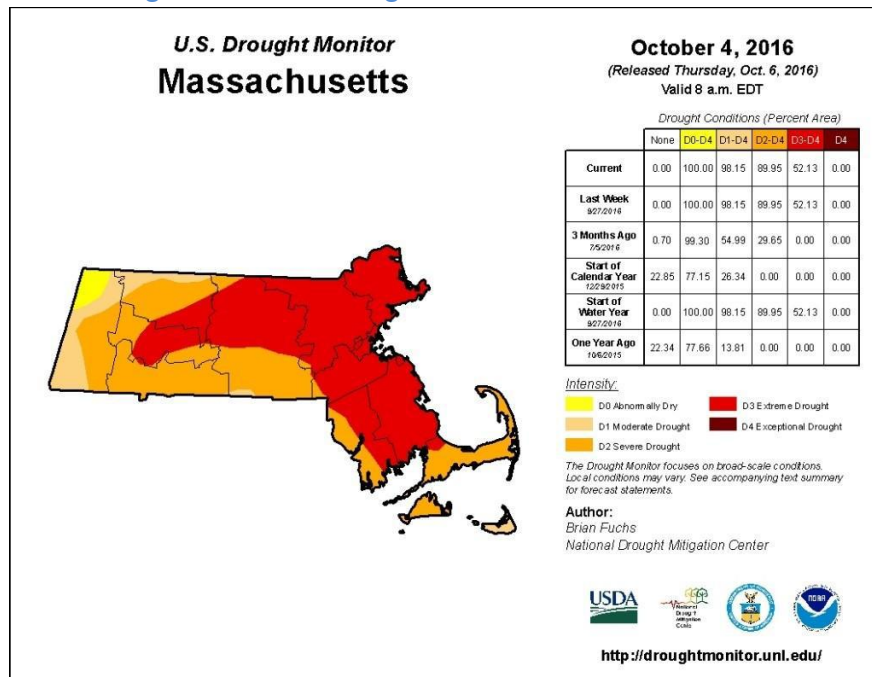
Figure 40: Weeks of Extreme Drought (2001-2017)



Source: SHMCAP 2018

Figure 41 shows the geographic extent of the drought of 2016. This was the worst drought since 2002, with more than half of the state reaching the Extreme Drought stage for several months due to a 15-inch rainfall deficit. The 2016 drought affected 6.5 million people, forced some communities to buy drinking water from the Massachusetts Water Resources Authority, and prompting State aid to farmers for crop losses.

Figure 41: The Drought of 2016 in Massachusetts

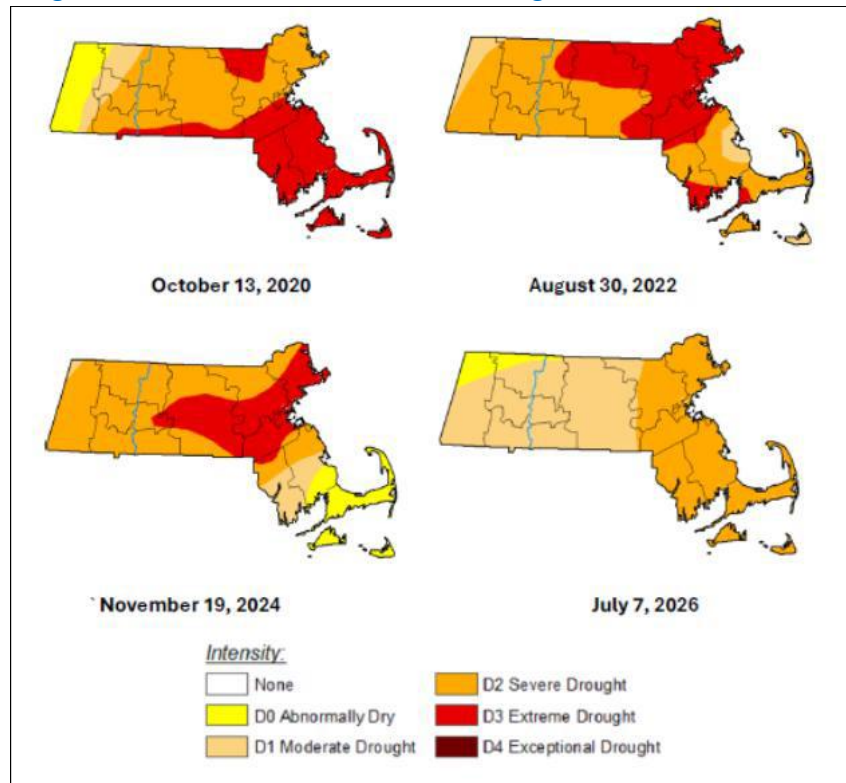


Source: US Drought Monitor, 2016

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Since 2016 there have been several other extreme droughts in Massachusetts, including 2020, 2022, and 2024, and a severe drought in 2026 (Figure 42). The recent pattern of repeated droughts at much shorter intervals stands in contrast to previous decades, as Figure 42 illustrates. In the 14-year period between the droughts of 2002 and 2016 there were no droughts that reached the level of extreme drought, but in just eight years from 2016 to 2024 there have been three extreme droughts.

Figure 42: Recent Massachusetts Drought Events (2020-2026)



Source: US Drought Monitor, 2020-2026

Potential Drought Vulnerability

The entire Town of Duxbury is potentially vulnerable to the impacts of drought. Under a severe long term drought, the Town of Duxbury could be vulnerable to restrictions on water supply. Potential damages of a severe drought could include losses of landscaped areas if outdoor watering is restricted and potential loss of business revenues if water supplies were severely restricted for a prolonged period. As this hazard has never occurred to such a severe degree in Duxbury, there are no data or estimates of potential damages, but under a severe prolonged drought scenario it would be reasonable to expect a range of potential damages from several million to tens of millions of dollars.

Aside from water supply impacts, a severe drought could also negatively impact aquatic ecology and wildlife in Duxbury and could also increase the risk of wildfires on forested lands and vegetated areas.

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Probability of Future Occurrence

Using data collected since 1850, the SHMCAP calculated that statewide there is a 1% chance of being in a drought emergency in any given month. For drought warning and watch levels, the chance is 2% and 8% respectively in any given month. See Table 43 for more information.

Table 43: Frequency of Massachusetts Drought Levels

Drought Level	Frequency Since 1850	Probability in a Given Month
Drought Emergency	5 occurrences	1% chance
Drought Warning	5 occurrences	2% chance
Drought Watch	46 occurrences	8% chance

Source: 2018 SHMCAP

Droughts are a medium frequency event as defined by the Resilient MA Plan, likely to occur at least once every 50 years (two or more occurrences in the next century)

Droughts And Climate Change

Droughts are projected to increase in frequency and intensity in the summer and fall as weather patterns change. Factors contributing to this include increasing evaporation as a result of warmer weather, earlier snow melt, and more extreme weather patterns. Information from the 2022 Massachusetts Climate Change Assessment related to drought is included in the “Climate Change Observations and Projections” section of this report. Additionally, the 2022 Assessment highlights the following drought-related impacts:

- Freshwater ecosystem degradation due to drought and other impacts
- Increased contaminant concentrations in freshwater during drought conditions
- Loss of tree cover due to drought and other impacts

INVASIVE SPECIES

The MA State Hazard Mitigation and Climate Action Plan defines invasive species as “non-native species that cause or are likely to cause harm to ecosystems, economies, and/or public health”. As they move into new habitats, invasive species displace native species because they have competitive advantages including no biological controls from their native habitat. Some of the more recognizable invasive plant species in Massachusetts as noted in the SHMCAP include Norway maple, garlic mustard, Japanese barberry, black swallowwort, buckthorn, purple loosestrife, water milfoil, Japanese knotweed, and phragmites. Invasive pests include emerald ash borer, hemlock wooly adelgid, and the Asian long-horned beetle. The Massachusetts Invasive Plant Advisory Group categorizes invasive species in four categories. These are listed below with the number of species in each category:

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Invasive (36)
Likely Invasive (33)
Potentially Invasive (3)
Not Currently Meeting Criteria (34)

According to Duxbury's State of the Bay report, more than 60 invasive species have been documented in the coastal waters of New England, though this is likely an underestimate. Notable invasives that are being observed in Duxbury Bay include:

- **European Green Crab (*Carcinus maenas*):** Introduced in the 19th century, has caused significant harm to shellfish populations and eelgrass beds. Green crabs have been observed by shell fishermen and are known to feed on young oysters. Their presence poses a threat to natural and cultivated shellfish populations. Green crabs multiply rapidly due to the absence of natural predators, making them a significant concern for the ecosystem.
- **Asian Shore Crab (*Hemigrapsus sanguineus*):** First documented in the 1980s, it competes with native crabs for habitat and food³.
- **Tunicates:** Various species have colonized docks and aquaculture equipment, threatening ecosystems. They are concerning because they can cover the bay bottom and harm both natural and cultivated shellfish and eelgrass. These include
 - *Ascidella aspersa* and *Palaemon elegans*, also called sea-squirts;
 - *Botrylloides violaceus*, also called chain tunicate;
 - *Botryllus schlosseri*, also called the star tunicate; Note- there are native forms of this tunicate and distinguishing them requires genetic analysis which has not been performed.
 - *Didemnum vexillum*, also called pancake batter tunicate;
 - *Diplosoma listerianum*, gray encrusting compound tunicate
- **Bryozoa**
 - **Bugula:** This is a stationary marine animal that is normally found in temperate and tropical waters but has recently been observed in Duxbury. It can form dense mats on hard substrates including docks and aquaculture gear.
 - *Membranipora membranacea*, also called coffin box: is a type of bryozoan: simple, invertebrates characterized by a thin, mat-like encrustation.
 - *Tricellaria inopinata*, these form erect, bushy, branched colonies which are cream-to-buff in color and hatched to hard substrates by rhizoids
- **Caprella Muca**, known as Japanese skeleton shrimp,
- *Palaemon elegans*, also called rock pool shrimp, is native to the eastern north Atlantic but considered invasive in our waters.

The State of the Bay report includes recommendations to address invasive species:

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Combat Invasive Species

- Remove green crabs and tunicates that damage habitats and aquaculture gear.
- Support resilient aquaculture activities that improve water quality, provide economic benefits, and can better withstand climate changes.

Probability of Future Occurrences

Based on the record of previous occurrences, invasive species in Duxbury are a Very High frequency hazard as defined by the Resilient MA Plan. Invasive species are almost certain to occur multiple times a year.

Invasive Species and Climate Change

Massachusetts' 2022 Climate Change Assessment also states that climate change will lead to an increase in pests and pathogens. Rising temperatures increase the warm seasons when invasive species thrive. The 2022 Assessment cites anticipated forest health degradation from increasing pest occurrence. According to Carolyn Tepolt of the Woods Hole Oceanographic Institute (WHOI) warming waters due to climate change allow green crabs to survive the winter, which means a species that was previously kept in check is now thriving.

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LAND USE AND DEVELOPMENT TRENDS

EXISTING LAND USE

The most recent land use statistics available from the state are from aerial photography done in 2016. Table 44 shows the acreage and percentage of Duxbury's land use in 29 categories. The largest single land use category is Forest, at 6535 acres making up 42.4% of the Town. If the five residential categories of different densities are combined, residential uses make up 3341 acres, or 21.7% of the Town's area. This is followed by several wetlands categories (forested, non-forested, and saltwater), which combined occupy 3197.1 acres or 20.8% of Duxbury. Commercial land use, at 79.6 acres, make up 0.5% of the Town.

Table 44: Duxbury Land Use

Land Use Type	Acres	Percent
Forest	6534.6	42.4%
Low Density Residential	2734.5	17.8%
Forested Wetland	1521.6	9.9%
Saltwater Wetland	1041.1	6.8%
Non-Forested Wetland	634.4	4.1%
Very Low Density Residential	515.4	3.3%
Cranberry Bog	487.5	3.2%
Water	402.1	2.6%
Saltwater Sandy Beach	280.8	1.8%
Golf Course	177.2	1.2%
Transportation	175.8	1.1%
Urban Public/Institutional	170.1	1.1%
Pasture	121.0	0.8%
Multi-Family Residential	105.1	0.7%
Cropland	91.8	0.6%
Powerline/Utility	79.8	0.5%
Commercial	79.6	0.5%
Participation Recreation	77.0	0.5%
Open Land	68.6	0.4%
Brushland/Successional	23.8	0.2%
Cemetery	23.6	0.2%
Nursery	14.7	0.1%
Waste Disposal	12.0	0.1%
Transitional	10.0	0.1%
Marina	7.6	0.0%
High Density Residential	5.1	0.0%
Industrial	3.3	0.0%
Water-Based Recreation	1.2	0.0%
Medium Density Residential	1.0	0.0%

Source: MassGIS

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Economic Elements

The Town of Duxbury has multiple neighborhood business districts, though commercial uses make up a small proportion of the municipality's land area. Hall's Corner is Duxbury's main commercial area, and it contains a mixture of retail stores, dining options, and offices. Other commercial areas include Snug Harbor, Cox Corner, Millbrook Landing, Bennett's Area, and Kings Town Way. Of all the neighborhood business districts, Snug Harbor is most impacted by flooding and will be most susceptible to the impacts of sea level rise.

Historic, Cultural, and Natural Resources

Duxbury has a plethora of historic, cultural, and natural resource areas that give the town its unique character. The second municipality to be incorporated in Massachusetts (in 1637), Duxbury has many historic homes like the John Alden House and King Caesar House. Most of the buildings with historical significance were built during the Shipbuilding Era (late 1700s to mid-1800s) and Summer Tourism Era (mid-1800s to mid-1900s).

Duxbury, the second municipality to be incorporated in Massachusetts in 1637, is rich with cultural assets contributing significant culture and beauty to the Town. Duxbury has 792 historic assets registered in the Massachusetts Historic Structures Inventory, the earliest dating to 1632, the Myles Standish (Chestnut Street) burial ground and many first period colonial homes such as the 1700 John Alden House. Other notable historic assets beloved by the community and visitors alike are Snug Harbor, Powder Point Bridge, the Girl Scout House, the King Caesar House, the Nathaniel Winsor, Jr. House and the Bradford House. The iconic Powder Point Bridge was built in 1891, about 30 years before local families came together to purchase Duxbury Beach and protect it from development pressure.

Duxbury has the Duxbury Rural & Historical Society, a local non-profit located at the historic Nathaniel Winsor, Jr. house, which maintains four historic properties, archival library, museum collections, and 150 acres of conservation land. The society runs approximately 70 programs, events, and rentals a year and reported that 2017 was its most successful year to date. The Town also has a Historical Commission, established in 1975, to "Identify, document, and protect, Duxbury's historic resources, to increase public awareness of Duxbury's heritage and the value of historic preservation." The Historical Commission also oversees the Demolition Delay Bylaw for any structure over 75 years old. 83 Since 2002, the Town of Duxbury has approved and implemented 23 historic preservation projects using Community Preservation Act funds. The Town's Local Historic District Commission has been actively adding single-parcel Local Historic Districts in 2016, 2017 and 2018, with more planned for 2019. There is demonstrated community value to Duxbury's historic and cultural assets and these are important to consider in future planning, growth, and natural hazard mitigation/ climate change resilience.

Duxbury is a coastal community shaped by its extensive natural assets that define the values and cultural richness of the Town. With 37 miles of tidal shoreline, 1,200 acres of

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salt marshes, over 3,500 acres of protected open space, and prime forest land, Duxbury is well-served by the ecological services and resilience these natural features provide. Intact natural systems support clean drinking water, clean air, important agricultural and recreation amenities, flood control, beautification, economic benefits and carbon sequestration. Since 1963, Duxbury has been aggressive in acquiring and protecting land for its drinking water and this effort has restored many endangered and sensitive wildlife habitats. Some conservation lands include North Hill Marsh & Wildlife Sanctuary, Lansing Bennett Forest, and cranberry bogs.

The Town contains 10,356 acres of BioMap2 Core Habitat and Critical Natural Landscape and nearly 70% of that total area is protected. BioMap2 is a program created by the MA Department of Fish and Game Natural Heritage and Endangered Species Program (NHESP) and The Nature Conservancy to map important natural resource areas that will protect biodiversity and the nature of Massachusetts in the face of climate change. The large expanse of intact natural lands, ensures strong ecosystem function to protect the community from the impacts of climate change. These areas also support 17 rare, endangered or threatened wildlife species or natural communities. This includes the over 200 acres along 4 miles of coastal, sandy dunes on Duxbury Beach owned by the Duxbury Beach Reservation, Inc. who manages the Endangered Species Program for the Piping Plover, Least Tern, and others. Core Habitats are areas required to sustain rare wildlife and their exemplary natural ecosystems and habitat. Critical Natural Landscape describes areas that support these exemplary ecosystems or habitats to endure stressors from climate change or development.

DEVELOPMENT TRENDS

Recent and Potential Future Development

As a relatively low density suburb, Duxbury's population grew dramatically between 1960 and 1990, largely due to the completion of Route 3 in 1963. Little developable land remains in Duxbury today as a great deal of the open space in town has been permanently protected and one-acre zoning constrains much growth. New growth in Duxbury is primarily limited to teardowns and redevelopment.

MAPC consulted with the Duxbury Hazard Mitigation Team to determine areas that have been developed since the 2019 plan and those that may be developed in the future, based on the Town's comprehensive planning efforts and locally identified projects. These developments are shown in Table 45 and 46 and their locations are shown on the maps in Appendix A. Since 2019, 13 new developments have been completed, one is currently under construction, and one has received a 40B permit. The developments are predominantly residential in nature (13 of 15). There are also eight new pending developments in permitting or under construction listed in Table 46.

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Table 45: Duxbury Developments since the 2019 Plan

MAP #	New Developments since the 2019 Plan	2026 STATUS Completed/Revised/Not completed
A	30 Tremont Street Island Creek Village	Complete
B	Kingston Way	Complete, Expansion of a family-owned commercial turkey processor
C	McLean's Way	Complete
D	Littleton Way	Complete
E	Brewster Commons(Duxbury Woods)	Complete
F	Lincoln Street	Complete--40B Checkerberry Estates In process--40B Fieldstone Farm, 32 Units
G	Island Creek Oysters	Complete
H	Freeman Farm	Complete, 17 Single family homes
I	Railroad Ave., Alden and St. George streets	40B Comprehensive Permit Issued. No building applications received.
J	Webster Point Village (40B)	Not on my radar.
K	Island Creek Oysters	Complete (reuse of existing buildings for office and agricultural use)
	Freeman Farms	Duplicate, See Above
	Nash Road	Complete, 5 Single family homes
	Webster Point	Duplicate, see above. 20-unit 40B project with multifamily housing
	Feinberg Bog	Complete, 6 Townhouse condos
	Dogwood Drive	Complete, 10 Single family homes
	The Paddock, Cooper Hill	Complete, 5 Single family homes

Source: Duxbury Hazard Mitigation Team

Table 46: Duxbury Pending New Developments 2026

MAP #	LOCATON / NAME	DEVELOPMENT TYPE	STATUS
M	The Village @ Harlow Brook	40 units, 2,3,4 unit Townhouses, 40B	Road work and infrastructure in process.
	Summer House Lane	Small ANR Subdivision	In progress
O	LaCoss Road (off Summer Street)	3 Lot Subdivision	In progress
P	Glynn Way (off Tremont Street)	3 Lot Subdivision	No building applications received.

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MAP #	LOCATON / NAME	DEVELOPMENT TYPE	STATUS
Q	47 Harden Hill	2 Lot Subdivision (paper street, not constructing a new road)	Permit application received to raze the existing structure. Permit not issued yet.
R	Hawthorn Hill (off St. George Street)	6 Lot Subdivision	In progress
S	Parkside Subdivision, Red Hawk Lane, Snowy Owl Circle (off Keene Street)	12 Lot Subdivision (2 roads)	In progress
T	Sunrise Pond Road (333 Franklin Street)	3 Lot Subdivision	In progress
U	32 Surplus Street	3 Lot Subdivision	Permitting

Source: Duxbury Hazard Mitigation Team

Population Growth and Vulnerability to Natural Hazards

Flood Hazards: Since the Town has a robust Floodplain Zoning District that was recently updated, most development in town is either located outside of designated flood hazard areas, or complies with the bylaw’s protective special permit development standards.

Wind and Winter Hazards: The addition of a few new residential developments may lead to a modest increase in hazards related to wind impacts on the power grid serving new homes, and winter hazards due to additional residential roads requiring plowing and winter road treatments.

Drought Hazards: The recent modest increase in population does slightly increase water demand on the municipal water supply. Some of that increased residential demand may be summertime water use for lawn irrigation and other outside water use. As climate change fuels more droughts in the future, this additional water demand could make drought management more challenging and might require more restrictions on non-essential water use during peak demand periods of the summer.

Extreme Temperatures: Increased frequency of extreme heat is already a concern in the region. While extreme cold is becoming less frequent, it can also be a hazard for vulnerable populations in Duxbury. For extreme temperatures, the greatest concern related to population trends is not the absolute number of people, but the changing age profile of the community, which reflects a greater proportion of older residents, and possibly a greater number of people with disabilities. Senior citizens and people with disabilities are more vulnerable to the negative impacts of both extreme heat and extreme cold. Not only in Duxbury, but throughout the region, most communities are experiencing an aging population, and that trend is likely to continue over the next decade or two due to the large cohort of the aging “Baby Boom” generation.

Brushfire Hazards: Although the Town has identified significant areas with the potential for brushfires, the Town’s modest changes in population, mostly within existing residential areas, have not resulted in significantly increased risks. However, the impacts of future

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climate change, particularly more extreme heat and more droughts, could drive an increase in brushfires over what the town has historically experienced.

Earthquake and Landslides: Neither of these are directly related to climate change, and the Town does not consider them to be high priority hazards. The modest growth in population since 2000 does not raise significant concerns related to these hazards in Duxbury.

Hazard Impacts affected by changes in Land Use

Duxbury is a predominantly residential community, but it also has a significant amount of undeveloped land, primarily forested and wetlands. As shown in Table 44, nearly two-thirds of the Town's area (62%) is forested or wetlands. Residential is the largest developed land category at 22%. Duxbury's undeveloped land can serve as a buffer to the impacts of many natural hazards, particularly flooding and heat. Of the remaining nonresidential developed land, only 0.5% is in commercial uses. Those commercial uses located in the Snug Harbor area are the most vulnerable to coastal flooding impacts.

Residents appreciate the coastal residential nature of Duxbury, and the Town's land use planning and zoning encourages focusing future residential, commercial, and other development in a manner that protects its natural and coastal resources.

The changes to land use in Duxbury in recent years have predominantly been increased residential development, with very little growth in commercial uses. The Town has undertaken revisions to its zoning to update the Floodplain District, has a current Open Space and Recreation Plan, and preparing a Master Plan in 2019. Additional modest growth of residential land use is not likely to significantly increase the Town's impacts from natural hazards, especially considering the Floodplain District. There could be an incremental localized increase in drainage issues related to increased impervious surfaces, but the Town's Stormwater Bylaw, as required by the EPA MS4 Stormwater Permit, requires that new development mitigate any surface runoff onsite for the first one inch of precipitation during storm events. This should limit any increase in localized stormwater flooding from new developments or redevelopments.

The addition of more residential units could also incrementally increase the impacts of winter storm and wind hazards, primarily due to vulnerability to power outages caused by winds or winter snow and ice.

Additional residential and commercial land use will increase demand on the Town's water supply, which could make the town somewhat more vulnerable to the impacts of drought. Drought management measures might be required in the event of a severe drought.

Changes in land use in Duxbury are not likely to pose significant impacts related to earthquakes and landslides, particularly since newer development must meet the more stringent requirements of the current Massachusetts State Building Code. These hazards are very low frequency and have never caused damages in Duxbury.

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CRITICAL FACILITIES

Inventory of Duxbury Critical Facilities and Infrastructure

Critical infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, public works facilities, etc.) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). There are 68 facilities identified in Duxbury, which were updated for the 2026 plan by the Duxbury Hazard Mitigation Team. These are listed in Table 47 and are shown on the maps in Appendix A.

Table 47– Duxbury Critical Facilities

MAP#	FACILITY NAME	FACILITY TYPE
3	Chandler Elementary School	School; Generator
4	Alden School	School
5	Duxbury Middle School	School; Emergency Shelter
6	Duxbury High School	School
7	Fire Department	Fire Station
8	Fire Department Sta. 2	Fire Station
9	Animal Shelter	Municipal
10	Sand/Salt Shed	Municipal
14	Town Hall	Municipal
15	DPW	Municipal
16	Selectmen's Office	Municipal
17	DPW Barn	Municipal
18	Mayflower Crematory	Crematory
19	Mayflower Cemetery	Cemetery
20	Transfer Station	Municipal
21	Council on Aging	Senior Center; Warming and Cooling Center
23	Mayflower 1 Well	Well
24	Mayflower 2 Well	Well
25	Police Station	Police Station
26	Duxbury Free Public Library	Municipal
27	Birch Street Water Storage Tank	Water Storage Tank

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MAP#	FACILITY NAME	FACILITY TYPE
28	Captain Hill	Communication Tower; Standpipe, Scada Antenna
32	Bay Path Nursing Home	Elder Housing
33	Village at Duxbury	Elder Housing
34	Duxbury House	Special Needs
35	Mass Highway DPW Barn District 5	Salt Shed
43	Depot Street Water Pump Station	Water Pump Station
44	Partridge Road Pump Station	Water Pump Station
45	Evergreen 1 Water Pump Station	Water Pump Station
46	Evergreen 2 Water Pump Station	Water Pump Station
47	Tremont 2 Water Pump Station	Water Pump Station
48	Tremont 1 Water Pump Station	Water Pump Station
49	Lake Shore Drive Water Pump Station	Water Pump Station
50	Snug Harbor Shared Septic	Shared Septic
51	Lovers Lane Shared Septic	Wastewater Treatment
52	Long Point Marine	Marina
53	Powder Point Bridge	Bridge
54	Blue Fish Shared Septic	Shared Septic
55	Regional Old Colony Comm Center	Regional 911
56	Steele Field House	Field House;-Power for schools
57	DHA Group Home 1	Duxbury Housing Authority
58	DHA Group Home 2	Duxbury Housing Authority
59	Verizon	Data/Telephone Facility
60	Duxborough Village	Independent Living, DHA
61	Bay Road Shared Septic	Pump Station
62	Damon Shared Septic	Pump Station
63	Harbor Master Building	Municipal
64	Delano Barn	DPW & Conservation shared barn
65	Duxbury Beach	Duxbury Beach Reservation
66	Duxbury Seawall	Municipal Seawall
67	Marshall St. Bridge	Municipal Bridge
68	Communications Tower	Communications Facility

Source: Duxbury Hazard Mitigation Team

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VULNERABILITY ASSESSMENT

The purpose of the vulnerability assessment is to estimate the extent of potential damages from natural hazards of varying types and intensities. A vulnerability assessment and estimation of damages was performed for hurricanes, earthquakes, and flooding. The methodology used for hurricanes and earthquakes was the HAZUS-MH software. The methodology for flooding was developed specifically to address the issue in many of the communities where flooding was not solely related to location within a floodplain.

[Introduction to HAZUS-MH](#)

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The following overview of HAZUS-MH is taken from the FEMA website. For more information on the HAZUS-MH software, go to <http://www.fema.gov/plan/prevent/hazus/index.shtm>

“HAZUS-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). Loss estimates produced by HAZUS-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing and evaluating mitigation plans and policies as well as emergency preparedness, response and recovery planning.

HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods and earthquakes on populations.”

There are three modules included with the HAZUS-MH software: hurricane wind, flooding, and earthquakes. There are also three levels at which HAZUS-MH can be run. Level 1 uses national baseline data and is the quickest way to begin the risk assessment process. The analysis that follows was completed using Level 1 data. Level 1 relies upon default data on building types, utilities, transportation, etc. from national databases as well as census data. While the databases include a wealth of information on the Town of Duxbury, they do not capture all relevant information. In fact, the HAZUS training manual notes that the default data is “subject to a great deal of uncertainty.”

However, for the purposes of this plan, the analysis is useful. This plan is attempting to generally indicate the possible extent of damages due to certain types of natural disasters and to allow for a comparison between different types of disasters. Therefore, this analysis should be considered to be a starting point for understanding potential damages from the hazards.

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ESTIMATED DAMAGES FROM HURRICANES

The HAZUS-MH software was used to model potential damages to the community from a 100-year and 500-year hurricane event; storms that are 1% and .0.2% likely to happen in a given year, and roughly equivalent to a 100-year and 500-year return frequency hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the Town, bringing the strongest winds and greatest damage potential. The results are summarized in Table 48

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

Table 48- Estimated Damages from Hurricanes

	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	5,932	
Estimated total building replacement value (2014 \$)	\$2,341,000,000	
Building Damages		
# of buildings sustaining minor damage	674	1,776
# of buildings sustaining moderate damage	80	532
# of buildings sustaining severe damage	4	91
# of buildings destroyed	4	69
Population Needs		
# of households displaced	0	28
# of people seeking public shelter	0	15
Debris		
Building debris generated (tons)	1,816	8,988
Tree debris generated (tons)	3,886	8,646
# of truckloads to clear building debris	72	359
Value of Damages		
Total property damage (buildings and content)	\$38,299,980	\$1,162,776,540
Total losses due to business interruption	\$1,687,830	\$14,632,600

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ESTIMATED DAMAGES FROM EARTHQUAKES

The HAZUS-MH earthquake module allows users to define an earthquake magnitude and model the potential damages caused as if its epicenter had been at the geographic center of the study area. Two earthquakes were selected: magnitudes 5.0 and 7.0. The results are summarized in Table 49.

Table 49 - Estimated Damages from Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	5,932	
Estimated total building replacement value (2014 \$)	\$2,341,000,000	
Building Damages		
# of buildings sustaining slight damage	1,747	237
# of buildings sustaining moderate damage	877	1,415
# of buildings sustaining extensive damage	215	1,799
# of buildings completely damaged	51	2,463
Population Needs		
# of households displaced	93	2,282
# of people seeking public shelter	49	1,184
Debris		
Building debris generated (tons)	40,000	340,000
# of truckloads to clear debris (@ 25 tons/truck)	1,480	13,760
Value of Damages		
Total property damage	\$232,170,000	\$2,093,300,000
Total losses due to business interruption	\$38,740,000	\$251,196,000

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ESTIMATED DAMAGES FROM FLOODING

The HAZUS-MH flood risk module was used to estimate damages to the municipality at the 100 and 500 return periods. These correspond to flooding events that have a 1% and a 0.2% likelihood of occurring in any given year. The results are summarized in Table 50.

Table 50 - Estimated Damages from Flooding

	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	5,932	
Estimated total building replacement value	\$2,854,000,000	
Building Damages		
# of buildings sustaining slight damage (<10%)	15	9
# of buildings sustaining moderate damage (10-50%)	22	22
# of buildings sustaining substantial damage (>50%)	0	1
Population Needs		
# of households displaced	11	16
# of people seeking public shelter	536	648
Value of Damages		
Total property damage (buildings and content)	\$20,660,000	\$22,860,000
Total losses due to business interruption	\$17,380,000	\$14,440,000

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SECTION 5: HAZARD MITIGATION GOALS

The Duxbury Hazard Mitigation Team reviewed and discussed the goals from the previous 2019 Hazard Mitigation Plan. The Team modified the goals to reflect a more comprehensive approach and to incorporate climate resiliency. Goals # 10 to 12 are new goals added by the Team for this 2026 plan update. All of the goals are considered critical for the Town, and they are not listed in order of importance.

Goal 1: Reduce and mitigate the loss of life, injury, public health impacts, property damages, and critical services resulting from all major natural hazards.

Goal 2: Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

Goal 3: Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.

Goal 4: Reduce and mitigate the damage to public infrastructure resulting from all hazards.

Goal 5: Encourage the business community, major institutions and non-profits to work with the Town to develop, review and implement the hazard mitigation plan.

Goal 6: Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

Goal 7: Ensure that future development meets federal, state and local standards for mitigating and reducing the impacts of natural hazards.

Goal 8: Take maximum advantage of resources from FEMA and MEMA to educate Town staff and the public about hazard mitigation.

Goal 9: Consider the potential impacts of climate change and incorporate climate mitigation and resilience in all planning efforts.

GOAL 10: Incorporate environmental justice considerations into hazard mitigation, including outreach to climate vulnerable populations, identification of hazard impacts, and mitigation measures.

GOAL 11: Increase public awareness through education on potential hazards that threaten the community and outline mitigation measures to reduce impacts.

GOAL 12: Ensure that mitigation measures are sensitive to the natural features, historic resources, and community character of Duxbury.

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SECTION 6: EXISTING MITIGATION MEASURES

The existing protections in the Town of Duxbury are a combination of infrastructure maintenance and drainage infrastructure improvement projects as well as zoning, land use, and environmental regulation. Infrastructure maintenance generally addresses localized drainage clogging problems, while large scale capacity problems may require pipe replacement or invert elevation modifications. These more expensive projects are subject to the capital budget process and lack of funding is one of the biggest obstacles to the completion of some of these. The Town's existing mitigation measures are described below and summarized in Table 52 below.

Flood Mitigation

Duxbury employs a number of practices to help minimize potential flooding and impacts from flooding, and to maintain and enhance drainage infrastructure. Existing Town-wide mitigation measures include the following:

National Flood Insurance Program (NFIP) – Duxbury participates in the NFIP with 229 policies in force as of April 2, 2025.

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 Duxbury Building Inspector is responsible for enforcing the town's floodplain regulations.

The town is covered by the following 22 panels of Flood Insurance Rate Maps, which are referenced in the Town's amended Floodplain Protection Zoning District: 0207K, 0209K, 0216K, 0217K, 0219K, 0226L, 0228L, 0229L, 0233K, 0234K, 0236K, 0237L, 0238L, 0239L, 0241L, 0242K, 0243K, 0244K, 0263K, 0275J1, 0356L, 0357K. Most of these panels have an effective date of July 6, 2021, but several panels are dated November 4, 2016, primarily those immediately along the coast (a major re-mapping of the coast was done by FEMA that year). The Flood Insurance Study is effective July 6, 2021, and key data from that report is summarized in Section 4 above.

Following is information on the National Flood Insurance Program for Duxbury:

Flood insurance policies in force (as of April 2, 2025)	229 (212 SF; 1 2-4 Fam; 16 Non-Res.)
Total Premiums	\$362,548
Coverage amount of flood insurance policies in force	\$70,493,000
Total Number of Closed Paid Losses	485
Number of Substantial Damage Closed Paid Losses	40
Total Losses Paid	\$6,993,169

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Since 1978 there have been 40 claims paid for substantial damage in Duxbury(see table above). The Town implements the Substantial Improvements/Substantial Damages provisions of the floodplain management regulations as required per the NFIP (CFR Title 44, Parts 59 through 65) and Massachusetts State Building Code (780CMR). 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 Substantial Improvements/Substantial Damages provisions.

Zoning Regulations – The Town’s zoning regulations include a section on Subdivisions Rules and Regulations, which contain a number of requirements that address flood hazard mitigation. Some of these provisions also relate to other hazards. The zoning by-law also includes provisions for Flood Hazard Areas, Ground Water Protection Districts, Site Plan Approval, and Open Space Requirements.

Public Works Operations/Maintenance Activities – The Public Works Department actively maintains the Duxbury’s storm drain system. The following specific activities serve to maintain the capability of the drainage system through the reduction of sediment and litter build up and proper maintenance and repair.

- *Street sweeping* – The town streets are swept two to three times per year. Other downtown areas such as the main business district can be swept more frequently as needed from May through September. Poor draining streets can also be swept as needed following rainstorms.
- *Catch basin cleaning* – The Town of Duxbury contracts to have catch basin cleaning done each year, with all catch basins in town being cleaned each year.
- *Roadway treatments* – The Town uses a mixture of one part sand to one part salt for de-icing purposes to minimize the amount of sand that enters catch basins and streams.
- *Other* – Continued repair and rehabilitation of check valves and back-flow preventers.

Public Safety – the town recently acquired a high water rescue truck from a military surplus in January of 2018 to facilitate rescues and responses during flood emergencies.

Wetlands Protection Act – Duxbury enforces the State Wetlands Protection Act through the permitting authority of the Conservation Commission. Enforcement of the Act serves to protect the Town’s shores, ponds, rivers, and wetlands for, among other reasons, flood control, erosion and sedimentation control, and storm damage prevention. It also prevents any new development in a VE Zone.

Living Shoreline capital improvements on Duxbury Beach. Since its creation, the Duxbury Beach Reservation, Inc has worked with the Town of Duxbury to restore, maintain, and steward the coastal sandy barrier beach/dune habitat along Duxbury beach. These include large scale sacrificial dunes and beach nourishment projects over the last several decades. DBA has completed significant projects over the last decade (Table 51), and similar projects will continue in the coming years.

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Table 51: Duxbury Beach Nature Based Solutions Projects Implemented by Duxbury Beach Association

Project Name	Completed	Time Period	Main Project Goal	Main Project Goal
High Pines Dunes	2025	Oct 2024 - March 2025	Dune nourishment to enhance coastal resiliency	To mitigate against salt water intrusion within the High Pines area, 15,3050 T of locally, donated sand. Nourishing the area between CO 2 and CO 3, more than 1,877' of sand fencing and 8,750 culms of American beach grass was planted in the area.
Northern Plum Hills	2025	Oct 2024 - March 2025	Dune nourishment to enhance coastal resiliency	More than 17,278 T of mixed material (sand and cobble) was added to an area that has experienced multiple overwashes with increasing frequency.
Bayside Cobble Berm	2025	Jan 2025 - March 2015	Cobble berm nourishment to enhance coastal resiliency	Nearly 1,100 linear feet of bayside cobble berm was nourished with 424 T of locally sourced, donated cobble to maintain the existing cobble berm.
Powder Point Cobble Berm	2024	Oct 2023 - March 2024	Increase resiliency of bayside beach using nature-based approaches	DBR constructed a mixed cobble and sand berm north and south of the Powder Point Bridge to protect the parking lots and bridge abutment, where the swift bayside current erodes the barrier beach. Two swales were created around the small parking lot south of the bridge to capture stormwater runoff and reduce erosion. Construction of the berm and swales helps maintain access to the shoreline and critical infrastructure.
Resident Beach	2024	Oct 2023 - March 2024	Dune nourishment to enhance coastal resiliency	In the winter of 2024, dune nourishment spanning 4,300' from Powder Point Bridge to Crossover 1 connected the 2023 nourishment in the north to the 2019 nourishment project between Crossovers 1 and 2. Utilizing more than 108,000 T of locally sourced, donated sand to raise the elevation between 16.5' and 17.5' NAVD88. Vegetation was planted to secure the new sediment with 24,000 culms of American beachgrass and 320 woody plants.

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Project Name	Completed	Time Period	Main Project Goal	Main Project Goal
Bayside Berm & Swales	2024	Oct 2023 - March 2024	Nourishment	What began as a cobble berm nourishment project, turned into a stormwater management in addition to nourishment. To reduce the amount of stormwater runoff washing over the bayside dune, two swales were constructed to help in collection of the increasing frequency of rainfall. The bayside dune was nourished with 744 Tons of mix sand and cobble material along 300' of shoreline.
Cobble Berm Comprehensive Monitoring	2023-2024	2023 - 2024	Evaluate the performance, morphology, and ecological impacts of recently constructed cobble berms	DBR partnered with four other cobble berm locations to conduct comprehensive monitoring of recently constructed cobble berms with the goal of understanding of the design and performance of these nature-based approaches to shoreline management.
North End Beach and Dune Nourishment	2023	Oct 2022 - March 2023	First proactive nourishment project including below-high tide to above-high tide line to increase resiliency	DBR constructed a 2,750 linear-foot dune and beach restoration using 119,000 tons of beach-compatible sand. The work spanned north of Duxbury Beach Park (home to Blakemans restaurant) to the main pedestrian pathway across from the Powder Point Bridge. This was the first proactive dune AND beach nourishment that DBR has taken on and provides increased storm damage protection and flood control to Duxbury Bay. The new sand will eventually move south and help nourish the rest of the barrier beach through natural coastal processes. This fresh supply of sand is vital for the sand-starved barrier beach.
High Pines Road Elevation	2022	Mar-22	Reduce flooding impacts with establishment of salt water tolerant species for additional slope stabilization	DBR raised a quarter-mile section of roadway around "High Pines" six feet in elevation to bring it above the high tide line. The project was designed to preserve the marsh to the west by minimizing encroachment and planting the new roadway side slopes with compatible vegetation. Salt tolerant vegetation was seeded post construction to stabilize the slope. Salt tolerant species were used here instead of dune grass due to the high water table of the salt marsh

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Project Name	Completed	Time Period	Main Project Goal	Main Project Goal
Plum Hills Dune Restoration	2022	Dec 2021 - March 2022	Re-establishment after substantial overwash event	Following extensive storm alterations at the Plum Hills area, the elevation was reduced to 1' in elevation. DBR restored two areas totaling over 600 linear feet through dune nourishment, sturdy drift fencing construction, sand fence installation and plantings. A mix of sand and cobble was utilized to address the unique needs of this high wave velocity area.
Resident Lot South End Planting Event 2022	2022	March & April 2022	Revegetating dune for sand dune stabilization	Close to 200 woody shrubs and over 5,000 culms of American beach grass were planted at the north and south ends of the Resident Parking Lot and west of Blakemans Restaurant on bayside to help strengthen the barrier beach. Planting efforts included areas where vegetation had failed to thrive or been destroyed by foot traffic through the dunes, leaving weak points in the dunes.
Bayside Pathway Improvements	2022 & 2024	March & April 2022, March & April 2024	Reconstruction pedestrian path through and revegetated former pathway	Before 2022, there were multiple pathways leading from the small paved lot behind the guardhouse to the bayside beach. This area suffers from erosion for the swift-moving channel as well as stormwater runoff over the parking area. In 2022, the center pathway was widened to improve access and the narrow, eroded pathway to the south was closed and replanted to restore the bayside dune. In 2024 when a sand and cobble berm was constructed in this area, erosion at the center pathway was addressed and the northern pathway was closed and replanted.
Stormwater Drainage Bars & Speed Humps	2022	2022	Roadwork	As part of the comprehensive planning and permitting program for Duxbury Beach, DBR worked with scientists and engineers at Woods Hole Group to develop nature-based solutions to address stormwater scouring and other adverse impacts to adjacent wetlands. The Reservation implemented this work in Spring 2022 by installing five stormwater drainage areas. This work included traffic calming components to make travel on Duxbury Beach safer for pedestrians, wildlife, and motorists.

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Project Name	Completed	Time Period	Main Project Goal	Main Project Goal
Shark Sensors	2021 - receivers first year installed	2021 to ongoing	Aquatic monitoring	In 2021, DBR purchased an acoustic receiver buoy to detect tagged white sharks. Set out in front of the swimming area at Duxbury Beach. Utilizing acoustic telemetry, a tagged shark will emit a high frequency sound that is picked up by an acoustic receiver if within 1,000' . Data collect includes: date, time of day and individual shark identification. Buoys are deployed each year in the Spring and retrieved, along with the data collected in the late Fall.
Invasive Plant Management	2020 - ongoing	ongoing	Managing invasive species for dune resiliency	Each year, DBR staff and volunteers work to remove invasive plants (Japanese Knotweed and Spotted Knapweed) From the beach. Invasive species often outcompete native plants for space and have shallow root systems, which can increase erosion and weaken the barrier beach. DBR's vegetation technician maps invasive plant patches annually and organizes volunteer days throughout the season to aid removal. The primary focus is on Japanese knotweed and spotted knapweed, however, additional plants are monitored and removed as needed.
Crossover 1 to Crossover 2 Dune Restoration Project	2019	Nov 2018 - March 2019	First pro-active dune nourishment project	Following completion of design and permitting, DBR constructed a dune restoration project constructed dune restoration project between the first and second oversand vehicle crossovers. The work included 76,663 tons of dune nourishment, beach grass and woody shrub planting, and sand fence installation over 3,500 linear feet. In 2022, this project earned Duxbury Beach one of the Best Restored Beaches in America awards through the American Shore & Beach Preservation Association.
Coastal Processes Study and Resiliency Recommendations for Duxbury Beach and Bay	2015	Oct 2014 - Dec 2017	Determine coastal processes that shape Duxbury Beach and develop nature based adaptations to increase resiliency.	DBR partnered with Woods Hole Group to study the effects of waves, tides, and the movement of sediment on both the ocean and bay sides of Duxbury Beach to understand existing conditions and potential impacts from future storms and sea level rise. The final report included an outline of near-term and long-term recommended coastal resilience projects to protect Duxbury Beach.

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Dam Failure Mitigation

- DCR dam safety regulations – All dams are subject to the Division of Conservation and Recreation's dam safety regulations. The dams must be inspected regularly and reports filed with the DCR Office of Dam Safety.
- Permits required for construction – State law requires a permit for the construction of dams.
- Comprehensive Emergency Management Plan – The CEMP addresses dam safety.

Wind Hazard Mitigation

- Massachusetts State Building Code – The town enforces the Massachusetts State Building Code whose provisions are generally adequate enough to mitigate most wind damage. The code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence. If a tornado were to occur, the potential for severe damages would be extremely high. The 10th Edition of the MA State Building Code went into effect in 2024.
- Tree-Trimming– Duxbury's Land and Natural Resources Department within the Department of Public Works and Tree Warden conducts tree trimming where necessary. It also responds to downed tree limbs caused by winds, lightning strike reports and other weather related incidents. The local electric company, Eversource, conducts regular tree trimming. Since the 2019 plan the DPW acquired a new bucket truck (2024) and a new chipper (2025).

Winter-Related Hazard Mitigation

- Snow disposal – The town does not do any snow disposal except for removing snow at the library. The DPW removes snow from Halls Corner during most standard plowing operations.
- Roadway Treatments – The town uses a mixture of sand and salt with a bit more salt in the mix. This is done to minimize the amount of sand that enters catch basins and streams.
- Building Snow Loads: The town monitors snow loads on flat roofs-schools, Police, Fire, Steele, DPW, Transfer Station

Fire-Related Hazard Mitigation

- Burn Permits – Duxbury Fire Department requires a written permit for outdoor burning, which includes explanation of the related regulations and precautions for the permit-holder to take. The permit-holder must call the fire department on the proposed burn day to confirm weather conditions are suitable for outdoor burning.
- Subdivision/Development Review – The Fire Department participates in the review of new subdivisions and development projects.
- Forest Fire Hazards- The Duxbury Fire Department has four vehicles to manage forest fires. These include one Maxim Brush Breaker Vehicles that carry 750 gallons of water with gasoline-powered pumps and fire hoses. They also have a

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Ford F550 Brat that was obtained by a federal grant in 2015 that has a 300 gallon water tank with a pump in order to fit in tight areas to fight forest fires. The Fire Dept acquired a new 759-gallon forestry vehicle with pumping capabilities

- Public Education: The Fire Dept conducts public education using social media.

Geologic Hazard Mitigation

- Massachusetts State Building Code – The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is “to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake”. This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be “prudent and economically justified” for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, cannot be achieved economically for most buildings. The 10th Edition of the MA State Building Code went into effect on xxx, 2024.

Multihazard Mitigation

- Comprehensive Emergency Management Plan (CEMP) – Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain important information regarding flooding, hurricanes, tornadoes, dam failures, earthquakes, and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to all of the hazards discussed in this plan.
- Communications Equipment – Duxbury has full coverage of the Town with emergency services radio. The Town is addressing compatibility issues that will allow for regional dispatch during emergency events. Incident command units are available through Plymouth County and MEMA.
- Emergency Power Generators – The Town maintains emergency power generators for warming and cooling stations, shelters and critical public infrastructure (water well pumps, package wastewater treatment facilities, police and fire). Generators have been installed at the Alden/Chandler Elementary School, the Steele Field House, and Town Hall. Currently plowing and debris clearing to provide access is required in advance of hauling of individual portable generators to some water pumps and package plants. Design work for these is currently ongoing.
- Local and Regional Emergency Management – The Town of Duxbury has an Emergency Management Agency staffed by a Director and Deputy Director, located at the Fire Department. This agency oversees the implementation of the Comprehensive Emergency Management Plan for natural and man-made disasters. The town coordinates its efforts through the Local Emergency Management Committee (LEPC), and participates in Mutual Aid with other communities.

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- Public Information & Outreach – The Town provides information to residents and business owners relating to a range of potential natural hazards, most especially with regard to flooding, hurricanes, and nor'easters. The Town uses CivicReady to send emergency alerts and other notifications. Subscribers can register to receive emergency alerts and other notifications via phone call, text message, and/or email. The Duxbury Fire Department maintains an active social media account with a significant following, particularly during natural-hazard related emergencies that has been recognized the Commonwealth of Massachusetts. In addition, Duxbury maintains up to date flood information on its website, particularly as it is related to residents in flood zones.
- Inter-Municipal Coordination and Cooperation – The Town of Duxbury is contributing to emergency repairs to the Canal Street Bridge (aka the “Rainbow Bridge”) in Marshfield in order to maintain safe access for plows, fire trucks, school buses, and emergency response and repairs to the Gurnet/Saquish region of Duxbury, Marshfield and Plymouth. This bridge is located in Marshfield but is one of three failing bridges that provide access to this area, the other two being the Powder Point Bridge and the state-owned Beach Street Bridge in Marshfield. Efforts to replace the Powder Point bridge are underway. The project is on the MPO Transportation Improvement Plan (TIP) priorities for state funding
- The Town actively participates in regional meetings with the CZM, Cape Cod region and MAPC South Shore communities to learn about mitigation activities in other towns and states, and to look for ways to cooperate regionally to help mitigate hazards described in this plan. Coordination has included modeling of sea level rise for zoning, planning and public education related to the same.

Table 52: Existing Mitigation Updated Since the 2019 Hazard Mitigation Plan

Mitigation Measure	Updates since 2019 Plan
FLOOD HAZARDS	
1. <u>National Flood Insurance Program</u> --the town participates in the NFIP and has adopted the effective FIRM maps. The town actively enforces the floodplain regulations.	New Flood Insurance Rate Maps and Flood Insurance Study effective July 9, 2021
2. <u>Street Sweeping</u> - two to three times per year	Complies with MS4 Stormwater Permit
3. <u>Catch Basin Cleaning</u> -contracted for annual cleaning	Complies with MS4 Stormwater Permit
4. <u>Community Preservation Act</u>	Surcharge on property transfers increased from 1% to 3%
5. <u>Infrastructure improvements</u> – repair of check valves and back-flow preventers	15 projects identified by the DPW; 9 have been completed
6. <u>Public Safety</u> – The town has a high-water rescue truck with fire fighting capability	New truck acquired 2025 Town has drone capacity

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Mitigation Measure	Updates since 2019 Plan
7. <u>Zoning Bylaw</u> -- Flood Hazard Areas, Open Space Requirements, Drinking Water Protection Districts	The Floodplain Zoning bylaw was amended to incorporate the FIRM maps effective July 9, 2021
8. <u>Wetlands Protection</u> – enforcement of Wetlands Protection Act	Wetlands Bylaw amended in 2023, developments are consistently reviewed
9. <u>Coastal Protection: Living Shoreline Improvements</u> -Sacrificial dunes, beach nourishment <u>Seawall</u>	Duxbury Beach Association has implemented xxx projects (see Table 51) The Town has repaired the seawall
DAM HAZARDS	
10. <u>DCR dam safety regulations</u>	The Town is working to remove the Temple Street Dam; seeking grants and has matching funds available
11. <u>Permits required for dam construction</u>	No changes
12. <u>Comprehensive Emergency Management Plan</u>	DEMA is working with the Board of Health to add a component Infectious Disease
WIND HAZARDS	
13. <u>MA State Building Code</u> enforced by the Town	New MA state Building Code, 10th edition effective 2024
14. <u>Tree trimming</u> —Tree Warden, Land and Natural Resources Department and Eversource	The DPW conducts pro-active tree management. The Town acquired a bucket truck (2024) and chipper (2025)
15. <u>Building snow loads</u>	The town monitors snow loads on flat roofs-schools, Police, Fire, Steele, DPW, Transfer Station
WINTER HAZARDS	
16. <u>Snow Removal</u> – Snow disposal at the Library	The DPW removes snow from Halls Corner during most standard plowing operations.
17. <u>Roadway Treatments</u> -- mixture of sand and salt	No changes
BRUSH FIRE HAZARDS	
18. <u>Burning Permits</u> --Outdoor burning is allowed by permit only.	Burning Permits are now issued online
19. <u>Subdivision Review by Fire Department</u>	75-foot setbacks are recommended, but can't be mandated

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Mitigation Measure	Updates since 2019 Plan
20. <u>Forest Fires</u> —The town has 4 vehicles with water storage	The Fire Dept acquired a 750-gallon forestry vehicle with pumping capability
21. <u>Public Education</u>	The Fire Dept conducts public education using social media
GEOLOGIC HAZARDS	
22. <u>MA State Building Code</u> —the Town enforces the Building Code	New MA state Building Code, 10th edition effective 2024
MULTIPLE HAZARDS	
21. <u>Comprehensive Emergency Management Plan (CEMP)</u>	DEMA is working with the Board of Health to add a component Infectious Disease
22. <u>Communications Equipment</u>	No changes
23. <u>Emergency Power Generators</u>	Generators installed for Steele Field House, Chandler Elementary School and Town Hall
24. <u>Local and Regional Emergency Management</u>	Local Emergency Planning Committee; Mutual Aid with Duxbury Emergency Planning Group
25. <u>Public Information & Outreach</u>	Social Media / Civic Ready
26. <u>Inter-Municipal Coordination and Cooperation</u>	Emergency repairs completed for Canal Street Bridge
NEW MITIGATION SINCE THE 2019 PLAN	
27. <u>Snug Harbor Resilience Plan</u>	Completed December 2019
28. <u>Coastal Resilience Task Force</u>	Established by the Select Board in 2022
29. <u>Duxbury Bay Management Commission</u>	Updating 2019 Report
30. <u>Duxbury-Kingston-Plymouth Coalition</u>	Established to coordinate the 3 towns on Duxbury Bay
31. <u>South Shore Resilience Network</u>	Coordinates coastal resilience issues among 12 South Shore towns with MA Coastal Zone Management and MAPC.
32. <u>Powder Point Bridge</u>	Efforts to replace the bridge are underway. Project is on the MPO Transportation Improvement Plan (TIP) priorities for state funding

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Local Capacity for Implementation

Under the Massachusetts system of “Home Rule,” the Town of Duxbury is authorized to adopt and from time to time amend a number of local bylaws and regulations that support the town’s capabilities to mitigate natural hazards. These include Zoning Bylaws, Subdivision and Site Plan Review Regulations, Stormwater Regulations, Wetlands Bylaws, Health Regulations, Fire Safety Regulations, Public Works regulations, and local enforcement of the State Building Code and the Massachusetts Wetlands Protection Act.

Local Bylaws may be amended each year at the annual Town Meeting to improve the town’s capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission, such as the Planning and Board or Conservation Commission. For example, the Town adopted an amended Floodplain Zoning District Bylaw to reflect the updated Flood Insurance Rate Maps that went into effect in July 2021, and to meet the requirements of the Massachusetts Model Floodplain Bylaw prepared by the MA Dept. of Conservation and Recreation.

When the Town of Duxbury recognizes existing mitigation measures that require implementation or improvements, the Town has the capacity within the legal authority of several of its municipal boards and departments to address these. The Public Works Dept, Planning Board, Building Dept, Facilities Management, and Conservation Commission all have roles in addressing the many planned infrastructure projects. New strategies including paving reduction and drought resistant planting will be stewarded by the Conservation Commission. Many projects, including public education, encouragement of building elevation, open space planning, and incorporating climate issues into capital and other planning documents will be jointly pursued by departments and town leadership.

The Department of Public Works will address the need for repairs and upgrades to drainage infrastructure. DPW will also implement the Stormwater Management Plan to comply with the EPA MS4 Stormwater Permit. The Planning Board will address the updates to the Master Plan and implementation of the Zoning Ordinance, Floodplain District, and Subdivision Rules and Regulations. The Building Commissioner will enforce the provisions of the Massachusetts State Building Code and the Floodplain District Zoning Bylaw. The Conservation Commission will oversee implementation of the Wetlands Protection Act and the Open Space Plan.

Opportunities to Expand and Improve the Capacity to Reduce Risk

Moving forward into the next five year plan implementation period there will be more opportunities to incorporate hazard mitigation into the Town’s decision making processes. The challenges the Town faces in implementing these measures are primarily due to limited funding and available staff time. This plan will help the Town prioritize the best use of its limited resources for enhanced mitigation of natural hazards.

The Town of Duxbury can build on its existing planning tools by more fully integrating hazard mitigation and climate resilience into future updates of key plans, including the next Master Plan and Open Space and Recreation Plan. A comprehensive review of local

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land use codes (zoning, subdivision, and stormwater regulations) could introduce stronger climate-adaptive measures such as Low Impact Development (LID), green infrastructure, and nature-based solutions. Incorporating hazard data from this plan into the next Comprehensive Emergency Management Plan (CEMP) would also improve coordination and preparedness.

To strengthen administrative capacity, Duxbury could expand training opportunities for municipal staff and create protocols to retain institutional knowledge during staff transitions to support long-term continuity. Enhanced GIS capabilities and a system for tracking local hazard losses would further improve planning and risk analysis.

Financially, the Town can embed resilience priorities into its annual budget and capital planning process to support infrastructure upgrades, including as local matches for state and federal grants.

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SECTION 7: MITIGATION MEASURES FROM THE 2019 PLAN

Implementation Progress on the Previous Plan

At a meeting of the Duxbury Hazard Mitigation Planning Committee, Town staff reviewed the mitigation measures identified in the 2019 Duxbury Hazard Mitigation Plan and determined whether each measure had been implemented, partially completed, or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be carried forward into this Hazard Mitigation Plan 2026 Update or deleted from the updated plan. The team also considered the option of retaining but modifying an existing mitigation measure to reflect changing circumstances or a better understanding of the kind of mitigation needed to address a vulnerability. The decision on whether to retain, modify, or delete each mitigation measure was based on the local team's assessment of the continued relevance or effectiveness of the measure and whether the deferral of action on the measure was due to the inability of the Town to take action on the measure, lack of funding or other issue. Table 53 summarizes the status of mitigation measures.

As indicated on Table 53 Duxbury made progress on implementing many mitigation measures identified in the 2019 Hazard Mitigation Plan. Of the xx recommended measures, xx have been completed and xx have been partially completed. Mitigation measures that have been completed and partially completed include the following:

Completed Mitigation Measures

- Regulatory revisions for stormwater management
- Updated FIRM mapping and bylaws
- Provide public information on NFIP compliance
- Establish and maintain a Coastal Resilience Task Force that works across departments and commissions for a multi-disciplinary approach toward climate resilience.

Partially Completed Mitigation Measures

- Culvert replacements townwide
- Provide Beach Nourishment related to seawall on Plymouth Avenue
- Land acquisition program in flood areas, including easement for seawall
- Seawall restoration and improvement
- Perform Coastal Erosion/Accretion Littoral Study
- Maintain Duxbury Beach to a minimum elevation of 16.5 feet NGVD 88
- Increase public information and awareness about fire hazards
- Dam management and maintenance plan
- Increase public information and awareness about fire hazards

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- Implement the Town of Duxbury Climate Vulnerability Assessment and Action Plan and incorporate these recommendations into Comprehensive Planning for the Town
- Incorporate climate resilience into all local and regional plans as well as capital improvement plans.
- Monitor health of submerged aquatic vegetation such as eelgrass beds, and salt marshes, and restore as necessary.
- Collaborate with the residents and businesses in the near- and long-term most vulnerable areas to examine potential zoning, regulatory, incentive, mitigation or cooperative-based approaches on sea level rise.

Mitigation not completed; Retain in 2026 Plan Update

Of the measures that were not completed, the Team decided to retain or revise all but one in the 2026 plan update:

- Assess earthquake vulnerability of all public buildings and implement upgrades if feasible
- Assess municipal structures for susceptibility to snow loads
- Promote drought tolerant landscaping and site design measures
- Encourage site design to increase tree plantings near buildings, increase the percentage of tree used in parking areas and along public ways

Mitigation not completed; Delete for 2026 Plan Update

Just one mitigation not completed will be deleted from the 2026 updated plan, as the Team determined it is not a priority concern in Duxbury:

- Hire a consultant to evaluate in greater detail Duxbury's susceptibility to salt water intrusion of its aquifer

Moving forward into the next five-year plan implementation period there will be more opportunities to incorporate hazard mitigation into the Town's decision-making processes. The challenges the Town faces in implementing these measures are primarily due to limited funding and available staff time. This plan should help the Town prioritize the best use of its limited resources for enhanced mitigation of natural hazards.

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Table 53: Status of Mitigation Measures from the 2019 Duxbury Hazard Mitigation Plan

	RECOMMENDED MITIGATION FROM THE 2019 HAZARD MITIGATION PLAN	PRIORITY IN 2019 PLAN	CURRENT STATUS 2026 1. Completed 2. Partially Completed 3. Not Completed	2026 PLAN UPDATE 1. KEEP in the 2025 Plan 2. REVISE for the 2025 Plan 3. DELETE from the 2025 Plan
FLOODING				
1	Maintain Duxbury Beach to a minimum elevation of 16.5 feet NGVD 88	High	2 Partially Completed – ongoing 17 projects have been completed since 2015 (see Table attached)	2. REVISE for the 2026 plan
2	Culvert replacements townwide	High	2 Partially Completed - ongoing	2. REVISE for the 2026 plan
3	Provide Beach Nourishment to seawall on Plymouth Avenue	High	2 Partially Completed - ongoing	2. REVISE for the 2026 plan
4	Land acquisition program in flood areas, potentially along the coast, including easement for seawall	High	2 Partially Completed - ongoing	1. KEEP in the 2026 Plan
5	Regulatory revisions for stormwater management	High	1. Completed	N/A
6	Updated FIRM mapping and bylaws	High	1. Completed	N/A
7	Provide public information on NFIP compliance	Medium	1. Completed	N/A
8	Seawall restoration and improvement	High	2. Partially completed – will be completed in 2026	1. KEEP in the 2026 Plan
9	Perform Coastal Erosion/Accretion Littoral Study	High	2 Partially Completed – Report done in 2017, now being updated	2. REVISE for the 2026 plan
GEOLOGIC HAZARDS				
10	Assess earthquake vulnerability of all public buildings and implement upgrades if feasible	Low	3. Not Completed	1. KEEP in the 2026 Plan

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	RECOMMENDED MITIGATION FROM THE 2019 HAZARD MITIGATION PLAN	PRIORITY IN 2019 PLAN	CURRENT STATUS 2026 1. Completed 2. Partially Completed 3. Not Completed	2026 PLAN UPDATE 1. KEEP in the 2025 Plan 2. REVISE for the 2025 Plan 3. DELETE from the 2025 Plan
BRUSHFIRES				
11	Increase public information and awareness about fire hazards	Medium	2. Partially completed – town uses social media for notifications / Updated Open Burning Permit	1. <u>KEEP in the 2026 Plan</u>
WINTER STORM HAZARDS				
12	Assess municipal structures for susceptibility to snow loads	Medium	3. Not Completed	1. KEEP in the 2026 Plan
13	Acquire adequate emergency generators for public safety (water pumps, package plant pumps, town hall)	High	2 Partially Completed – Town has trailer-mounted generator	???
DROUGHT				
14	Promote drought tolerant landscaping and site design measures	Medium	3. Not Completed	1. KEEP in the 2026 Plan
EXTREME TEMPERATURES				
15	Encourage site design to increase tree plantings near buildings, increase the percentage of tree used in parking areas and along public ways	Medium	3. Not Completed	2. REVISE for 2026 Plan: Increase public notification for cooling center at the Senior Center and regional cooling center.
DAM HAZARDS				
16	Dam management and maintenance plan	Medium	2 Partially Completed - ongoing	2. REVISE for 2026 Temple Street Dam scheduled to be removed
CLIMATE CHANGE				

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	RECOMMENDED MITIGATION FROM THE 2019 HAZARD MITIGATION PLAN	PRIORITY IN 2019 PLAN	CURRENT STATUS 2026 1. Completed 2. Partially Completed 3. Not Completed	2026 PLAN UPDATE 1. KEEP in the 2025 Plan 2. REVISE for the 2025 Plan 3. DELETE from the 2025 Plan
17	Implement the Town of Duxbury Climate Vulnerability Assessment and Action Plan and incorporate these recommendations into Comprehensive Planning for the Town	High	2 Partially Completed – Seawall project completed; ongoing implementation	1. KEEP in the 2026 Plan
18	Establish and maintain a Coastal Resilience Task Force that works across departments and commissions for a multi-disciplinary approach toward climate resilience.	Medium	1. Completed	N/A
19	Incorporate climate resilience into all local and regional plans as well as capital improvement plans.	High	2 Partially Completed: Snug Harbor Plan completed; Seawall, Bridge replacement, roof replacement in Capital Plan.	1. KEEP in the 2026 Plan
20	Hire a consultant to evaluate in greater detail Duxbury's susceptibility to salt water intrusion of its aquifer.	Medium	3. Not Completed	3. DELETE from 2026 Plan
21	Monitor health of submerged aquatic vegetation such as eelgrass beds, and salt marshes, and restore as necessary.	Medium	2 Partially Completed: Mass Bays project – eelgrass planted; survey of Duxbury Bay	1 KEEP in the 2026 Plan
22	Collaborate with the residents and businesses in the near- and long-term most vulnerable areas to examine potential zoning, regulatory, incentive, mitigation or cooperative-based approaches on sea level rise.	High	2 Partially Completed: The Town completed a plan, considering raising building and relocation in high hazard areas	1. KEEP in the 2026 Plan

NEW MITIGATION SINCE THE 2019 PLAN

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23	Increase the width of Misquiset Court to allow emergency vehicle access; move utility poles?			ADD to 2026 Plan
24	Salt Marsh management and protection: Town has CZM grant; drones used to survey marshes			ADD to 2026 Plan
WIND HAZARDS				
25	Wind damage from trees: discourage tree planting near homes			ADD to 2026 Plan
INVASIVE SPECIES				
26	Implement Invasive species management: European Green Crab, Asian Shore Crab, Tunicates, Bryozoa, Caprella Musca, Palaemon elegans (Manage fertilizers, other measures?)			ADD to 2026 Plan

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SECTION 8: HAZARD MITIGATION STRATEGY

What is Hazard Mitigation?

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects and other activities. FEMA currently has three mitigation grant programs: Building Resilient Infrastructure and Communities (BRIC), the Hazards Mitigation Grant Program (HGMP), and the Flood Mitigation Assistance (FMA) program. The three links below provide additional information on these programs.

<https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities>

<https://www.fema.gov/hazard-mitigation-grant-program>

<https://www.fema.gov/flood-mitigation-assistance-grant-program>

Hazard Mitigation Measures can generally be sorted into the following groups:

- **Prevention:** Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection:** Actions that involve the modification of existing buildings or infrastructure to protect them from a hazard or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.
- **Public Education & Awareness:** Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.
- **Natural Resource Protection:** Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Structural Projects:** Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls (e.g., culverts), floodwalls, seawalls, retaining walls, and safe rooms.
- **Emergency Services Protection:** Actions that will protect emergency services before, during, and immediately after an occurrence. Examples of these actions include protection of warning system capability, protection of critical facilities, and protection of emergency response infrastructure.

(Source: FEMA Local Multi-Hazard Mitigation Planning Guidance)

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Regional and Inter-Community Considerations

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

Regional Partners

In many communities, mitigating natural hazards, particularly flooding, is more than a local issue. The drainage systems that serve these communities are a complex system of storm drains, roadway drainage structures, pump stations and other facilities owned and operated by a wide array of agencies including but not limited to the Town of Duxbury, the Department of Conservation and Recreation (DCR), and Massachusetts Department of Transportation (MassDOT). The planning, construction, operations, and maintenance of these structures are integral to the flood hazard mitigation efforts of communities. As such, these agencies must be considered the community's regional partners in hazard mitigation. These agencies also operate under the same constraints as communities do, including budgetary and staffing constraints and numerous competing priorities. In the sections that follow, the plan includes recommendations for activities where cooperation with these other agencies may be necessary. Implementation of these recommendations will require that all parties work together to develop solutions.

Overview of Regional Facilities within Duxbury

Major facilities owned, operated and maintained by federal, state, regional or private entities in Duxbury include:

- Massachusetts Routes 3, 3A, 14, 53, and 139 (MassDOT)
- Duxbury Beach (Duxbury Beach Reservation, Inc.)
- Myles Standish Monument State Reservation (DCR)
- Gurnet – Shared Drinking and Wastewater Systems with the Town of Marshfield.
- Powder Point Bridge- Access point for the Saquish neighborhood in the Town of Plymouth located at the terminus of Duxbury Beach. This is the only point of access and egress during emergencies. The neighborhood is highly vulnerable to coastal flooding.
- Kingston Bay-Bay system shared with the Town of Kingston, important for boating regulation, boating management, commercial fish industry, and water quality to uphold the Clean Water Act.

Inter-Community Considerations

1. **Living and Hardened Shoreline Environment** – The coastal shoreline of the South Shore area is a dynamic environment where forces of erosion and deposition of sand are

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constantly at work changing the beach profile. This process disregards municipal boundaries as sand and other materials are moved along the coast. Shoreline protection measures such as living shorelines, dunes, beaches, sea walls, jetties, and others have an impact on this process with the potential of building up sand in some areas while stripping it away from others. Municipalities along the South Shore should work to understand how these processes are at work locally and consider mutually beneficial means of protecting their shore side communities from the impacts of storm damage. Collaboration on coastal shoreline protection, such as seawalls, beach nourishment, and marshes is critical for mitigating coastal flood hazards and infrastructure damage.

2. **Duxbury Beach-** Duxbury Beach, a barrier beach, protects the shorelines of Duxbury, Kingston, and Plymouth Bays from high energy waves during coastal storm events. Its protection and nourishment is critical in minimizing coastal shoreline erosion and infrastructure damage from flooding natural hazards. The three communities should collaborate on mitigating coastal flood damage and invest in nourishment and other flood and erosion control measures.

3. **Shared Water Systems-**The Gurnet neighborhood is serviced by the Town of Marshfield for wastewater and drinking water. This neighborhood is in a AE Zone and highly vulnerable to intense wave energy and coastal storms. Collaboration between the Towns of Duxbury and Marshfield on the maintenance and resilience of these systems is critical.

4. **Stormwater Management in Kingston Bay**
Duxbury lies along Kingston Bay, an important area for living shorelines, commercial fishing, and recreational boating. The Towns of Kingston and Duxbury should continue to collaborate and coordinate on stormwater management strategies for National Pollution Discharge Elimination Program for the Clean Water Act to uphold the commercial, recreational, and natural systems important for the economy and shoreline protection of both communities.

New Development and Infrastructure

As part of the process of developing recommendations for new mitigation measures for this plan update, the Town considered the issues related to new development, redevelopment, and infrastructure needs in order limit future risks. Taking into consideration the Zoning and By-law changes adopted in recent years, the Wetlands Act enforced by the Conservation Commission, the Stormwater Management Plan implemented by the Department of Public Works, the Subdivision Rules and Regulations and Site Plan Review enforced for new development, and the Open Space and Recreation Plan, the town determined that existing regulatory measures are taking good advantage of local Home Rule land use regulatory authority to minimize natural hazard impacts of development. Priorities for the future include updating the Open Space and Recreation Plan, updating the Wetlands regulations, and participating in the state's pending Municipal Vulnerability Preparedness 2.0 program.

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Overview of the Town's Mitigation Strategy

The Duxbury Hazard Mitigation Team identified a number of mitigation measures that would serve to reduce the Town's vulnerability to natural hazard events, with a focus on flooding and coastal flooding.

The Town has a high priority goal of addressing the most pressing coastal flooding issues facing the Town, as highlighted by the Woods Hole Vulnerability Assessment described above. The Town will also engage the Massachusetts office of Coastal Zone Management (CZM), which has recently introduced the Resilient Coasts Plan. The Town will seek to leverage this new state initiative to address the issues of coastal flooding.

This Hazard Mitigation Strategy is intended to provide the Town with a "roadmap" of key mitigation actions that will improve its resilience to natural hazards in both the short and long term. The plan's recommendations will be incorporated into other relevant plans and policies, such as the Master Plan, the Open Space and Recreation Plan, the Capital Investment Plan, and Municipal Vulnerability Preparedness.

Process for Setting Priorities for Mitigation Measures

The last step in developing Duxbury's mitigation strategy is to assign a level of priority to each mitigation measure so as to guide the focus of the Town's limited resources towards those actions with the greatest potential benefit. At this stage in the process, the Local Hazard Mitigation Planning Team had limited access to detailed analyses of the cost and benefits of any given mitigation measure, so prioritization is based on the local team members' understanding of existing and potential hazard impacts and an approximate sense of the costs associated with pursuing any given mitigation measure.

Priority setting was based on local knowledge of the hazard areas, including impacts of hazard events, the extent of the area impacted, and the relation of a given mitigation measure to the Town's goals. In addition, the local Hazard Mitigation Planning Team also took into consideration factors such as the number of homes and businesses affected, whether or not road closures occurred and what impact closures had on delivery of emergency services and the local economy, anticipated project costs, whether any environmental constraints existed, and whether the Town would be able to justify the costs relative to the anticipated benefits. The prioritization criteria are summarized below:

Estimated Benefits	
High	Action will result in a significant reduction of hazard risk to people and/or property from a hazard event
Medium	Action will likely result in a moderate reduction of hazard risk to people and/or property from a hazard event
Low	Action will result in a low reduction of hazard risk to people and/or property from a hazard event

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Estimated Costs	
High	Estimated costs greater than \$250,000
Medium	Estimated costs between \$50,000 and \$250,000
Low	Estimated costs less than \$50,000 and/or staff time
Overall Priority	
High	Action very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure
Medium	Action may have political and public support and necessary maintenance has potential to occur following the project. . Medium priority measures would address a hazard of concern to the town, but costs may not be in proportion to the benefits achieved.
Low	Not clear if action has political and public support and not certain that necessary maintenance can occur following the project. . Low priority measures would not address significant or high priority hazards and/or the cost would not be in proportion to the benefits.

Table 54 demonstrates the prioritization of the Town's recommended hazard mitigation measures. For each mitigation measure, the geographic extent of the potential benefiting area is identified as well as an estimate of the overall benefit and cost of the measures.

Table 54: Prioritization of Recommended Mitigation Measures

Mitigation Measure	Geographic Coverage	Estimate Cost	Estimated Benefit	2029 Priority
Flooding				
1. Implement Beach Nourishment and Nature Based Solutions projects identified in the Duxbury Beach Reservation's resiliency plans	Protects the shoreline of Duxbury, Plymouth, and Kingston Bays	High	High	High
2. implement culvert replacements identified in the Culvert and Bridge Assessment	West Duxbury	High	High	High
3 Provide Beach Nourishment related to seawall	Gurnet	High	High	High
4. Land acquisition program in flood areas, potentially along the coast , including easement for seawall	Townwide	High	High	High
5. Implement Seawall restoration and improvement (Phase 2 completed)	Coastal Zone	High	High	High

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Mitigation Measure	Geographic Coverage	Estimate Cost	Estimated Benefit	2029 Priority
6. Perform Coastal Erosion/ Accretion Littoral Study	Coastal Zone			
Geologic Hazards				
7. Assess earthquake vulnerability of all public buildings and implement upgrades if feasible	Townwide	Low	Low	Low
Fire-Related Hazards				
8. Conduct regional forest management planning for conservation lands	Townwide	Medium	High	High
9. Increase public information and awareness about fire hazards year round	Townwide	Low	Medium	Medium
Winter Hazards				
10. Assess municipal structures for susceptibility to snow loads	Townwide	Medium	Medium	Medium
11. Acquire adequate emergency generators for public safety (water pumps, package plant pumps, town hall)	Townwide	High	High	High
Drought				
12. Develop and implement a water conservation plan; public education	Townwide	Medium	Medium	Medium
13. Promote drought tolerant landscaping and site design measures	Townwide	Low	Medium	Medium
Extreme Temperatures				
14. Increase public notification for cooling and warming centers at the Senior Center and regional cooling center as needed	Townwide	Low	Medium	Medium
Dam Hazards				
15. Temple Street Dam scheduled to be removed	Temple Street	Medium	Medium	Medium
Wind Hazards				
16. Coordinate with electric utility to manage trees to reduce risk of power outages	Townwide	Medium	High	High

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Mitigation Measure	Geographic Coverage	Estimate Cost	Estimated Benefit	2029 Priority
17. Assess public buildings for vulnerability to wind damage	Townwide	Medium	Medium	Medium
18. Discourage tree planting near homes and critical infrastructure	Townwide	Low	Low	
Invasive Species				
19. Implement Invasive Species management: Potential species include European Green Crab, Asian Shore Crab, Tunicates, Bryozoa, Caprella, Musca, Palaemon elegans	Townwide	Medium	Medium	Medium
20. Guidelines to encourage use of native species in landscaping and development	Townwide	Low	Medium	Medium
Climate Change				
21. Implement the Town of Duxbury Climate Vulnerability Assessment and Action Plan and Snug Harbor Resiliency Plan; incorporate climate resilience into the Town’s comprehensive planning, CEMP, and capita improvement plan	Townwide	High	High	High
22. Incorporate climate resilience into all local and regional plans as well as capital improvement plans.	Townwide	Low	Medium	Medium
22. Incorporate climate resilience into all local and regional plans as well as capital improvement plans.	Townwide	Low	Medium	High
23. Salt Marsh management and protection: Monitor health of submerged aquatic vegetation such as eelgrass beds, and salt marshes; drones used to survey marshes; and restore marshes as necessary.	Coastal Zone	Medium	High	High

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Mitigation Measure	Geographic Coverage	Estimate Cost	Estimated Benefit	2029 Priority
24. Collaborate with the residents and businesses in the near- and long-term most vulnerable areas to examine potential zoning, regulatory, incentive, mitigation, or cooperative-based approaches on sea level rise.	Coastal Zone	Medium	High	High
25. Increase the width of Mattakeeset Court to allow emergency vehicle access; move utility poles and sewer/drainage	Snug Harbor, Mattakeeset Court	High	High	High

Introduction to Recommended Mitigation Measures Table (Table 55)

The recommended mitigation measures are shown in Table 54 along with the following parameters for each measure, which are described below:

Description of the Mitigation Measure – The description of each mitigation measure and cost information is given if cost data were already available from the community. The cost data represents a point in time and would need to be adjusted for inflation and for any changes or refinements in the design of a particular mitigation measure.

Priority – As described above and summarized in Table 48, the designation of high, medium, or low priority was done considering potential benefits and estimated project costs, as well as other factors in the STAPLEE analysis.

Implementation Responsibility – The designation of implementation responsibility was done based on a general knowledge of what each municipal department is responsible for. It is likely that most mitigation measures will require that several departments work together and assigning staff is the sole responsibility of the governing body of each community.

Time Frame – The time frame was based on a combination of the priority for that measure, the complexity of the measure and whether or not the measure is conceptual, in design, or already designed and awaiting funding. Because the time frame for this plan is five years, the timing for all mitigation measures has been kept within this framework. The identification of a likely time frame is not meant to constrain a community from taking advantage of funding opportunities as they arise.

Potential Funding Sources – This column attempts to identify the most likely sources of funding for a specific measure. The information on potential funding sources in this table is preliminary and varies depending on a number of factors. These factors include whether or not a mitigation measure has been studied, evaluated or designed, or if it is still in the conceptual stages. MEMA and DCR assisted MAPC in reviewing the potential eligibility for hazard mitigation funding. Each grant program and agency have specific eligibility

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requirements that would need to be taken into consideration. In most instances, the measure will require a number of different funding sources. Identification of a potential funding source in this table does not guarantee that a project will be eligible for or selected for funding. Upon adoption of this plan, the local team responsible for its implementation should begin to explore the funding sources in more detail.

Abbreviations Used in Table 55

FEMA Mitigation Grants includes:

FMA = Flood Mitigation Assistance Program.

HMGP = Hazard Mitigation Grant Program.

ACOE = Army Corps of Engineers.

DHS/EOPS = Department of Homeland Security/Emergency Operations

DEP (SRF) = Department of Environmental Protection (State Revolving Fund)

USDA = United States Department of Agriculture

MA DOT = Massachusetts Department of Transportation

DCR = MA Department of Conservation and Recreation

CIP= Capital Improvement Plan

MVP= MA Municipal Vulnerability Preparedness Program

NCRF= National Coastal Resilience Fund

MA CRG= MA Coastal Resilience Grants

CRMAG= MA Dept. of Environmental Restoration Culvert Replacement Municipal Assistance Grant

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Table 55: Recommended Mitigation Measures

Recommended Mitigation Measures		Priority	Lead Agency	Time Frame Years 1-5 (2026-31)	Estimated Cost	Potential Funding Sources
FLOODING HAZARDS						
1	Implement Beach Nourishment and Nature Based Solutions projects identified in the Duxbury Beach Reservation's resiliency plans	High	Duxbury Beach Reservation, Inc. / Planning Dept.	1-5	\$1-\$2 million a year	NFWF / Coastal Zone Management
2	Implement culvert replacements identified in the Culvert and Bridge Assessment	High	DPW	1-5	\$100,000	Town General Fund- DPW / Chapter 90 / Capital Investment Program
3	Provide Beach Nourishment related to seawall	High	DPW/Conservation	2-4	>\$2 million	Town General Fund/DPW, CZM, NOAA NFWF
4	Land acquisition program in flood areas, potentially along the coast, including easement for seawall	High	Conservation Commission	1-5	>\$1 million	Duxbury CPA, EEA
5	Implement Seawall restoration and improvements (Phase 2 completed)	High	DPW/Planning Dept.	1-5	\$26 million	Town General Fund/DPW Betterment
6	Perform Coastal Erosion/Accretion Littoral Study	High	Duxbury Beach Reservation	1-2	\$130,000	CZM
GEOLOGIC HAZARDS						
7	Assess earthquake vulnerability of all public buildings and implement upgrades if feasible	Low	Facilities Dept.	3-5	\$100,000	Town General Fund/Facilities Dept

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Recommended Mitigation Measures		Priority	Lead Agency	Time Frame Years 1-5 (2026-31)	Estimated Cost	Potential Funding Sources
WILDFIRE HAZARDS						
8	Conduct regional forest management planning for conservation lands	High	Fire Dept/Conservation	1-3	>\$50,000	Town General Fund-Fire/Conservation
9	Increase public information about fire hazards year-round	Medium	Fire Dept.	1-5	Staff time	Town General Fund/Fire
WINTER STORM HAZARDS						
10	Assess municipal structures for susceptibility to snow loads	Medium	Building Dept.	3-5	\$50,000 Staff Time	Town General Fund /Building
11	Acquire emergency generators for public safety (water pumps, package plant pumps, town hall)	High	Facilities, DPW	1-3	>\$2 million	Town General Fund/DPW
DROUGHT						
12	Develop and implement a water conservation plan; public education	High	Duxbury DPW / North & South Rivers Watershed Association	1-2	<\$50,000 Staff Time	Town General Fund-DPW
13	Promote drought tolerant landscaping and site design measures	Medium	Planning/Conservation	1-5	Staff Time	Town general Fund-Planning/Conservation
EXTREME TEMPERATURES						
14	Increase public notification for cooling and warming centers at the Senior Center and regional cooling center as needed	Medium	Emergency Management	1-2	Staff Time	Town General Fund/ Emergency Management
DAM HAZARDS						
15	Temple Street Dam scheduled to be removed	Medium	Conservation	1-3	\$700,000	Town General Fund-Conservation / DER Dam Removal Grants

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Recommended Mitigation Measures		Priority	Lead Agency	Time Frame Years 1-5 (2026-31)	Estimated Cost	Potential Funding Sources
WINDHAZARDS						
16	Coordinate with electric utility to manage trees to reduce risk of power outages	High	Dept of Public Works	1-5	Staff time >\$50,000	Town General Fund- DPW
17	Assess public buildings for vulnerability to wind damage	Medium	Facilities Dept	2-3	<\$50,000 Staff Time	Town General Fund/Facilities Dept
18	Discourage tree planting near homes and critical infrastructure	Low	Planning/Conservation	1-5	Staff Time	Town General Fund- Planning/Conservation
INVASIVED SPECIES						
19	Invasive species management: Potential species include European Green Crab, Asian Shore Crab, Tunicates, Bryozoa, Caprella, Musca, Palaemon elegans	Medium	Conservation Commission	2-3	>\$50,000 Staff Time	Town General Fund- Conservation
20	Guidelines to encourage use of native species in landscaping and development	Medium	Conservation Commission	1-2	Staff Time	Town General Fund- Conservation
CLIMATE CHANGE						
21	Implement the Duxbury Climate Vulnerability Assessment and Action Plan and Snug Harbor Resiliency Plan; incorporate climate resilience into the Town's comprehensive planning, CEMP, and capita improvement plan	High	Dept of Public Works / Planning / Conservation	1-5	TBD	CZM, CPA, Town General Fund- DPW/ Planning/Conservation
22	Incorporate climate resilience into all local and regional plans as well as capital improvement plans.	High	Planning, Conservation	1-5	Staff Time	Town General Fund- Conservation/Planning, Capital Improvement

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Recommended Mitigation Measures		Priority	Lead Agency	Time Frame Years 1-5 (2026-31)	Estimated Cost	Potential Funding Sources
23	Salt Marsh management and protection: Monitor health of submerged aquatic vegetation such as eelgrass beds, and salt marshes; drones used to survey marshes; and restore marshes as necessary;	High	Conservation/Duxbury Bay Management Comm.	1-5	TBD	CZM, MDFW, MassBays National Estuary Program,
24	Collaborate with the residents and businesses in the near- and long-term most vulnerable areas to examine potential zoning, regulatory, incentive, mitigation or cooperative-based approaches on sea level rise.	High	Planning	1-5	\$50,000 Staff Time	CZM, MVP, MAPC
25	Increase the width of Mattakeeset Court to allow emergency vehicle access; move utility poles and sewer/drainage	High	Planning/DPW	1-5	TBD	Town General Fund- Planning /DPW

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SECTION 9: PLAN ADOPTION AND MAINTENANCE

Plan Adoption

The *Duxbury Hazard Mitigation Plan 2026 Update* was adopted by the Board of Selectmen on [ADD DATE]. See Appendix E for documentation. The plan was approved by FEMA on [ADD DATE] for a five-year period that will expire on [ADD DATE].

Plan Maintenance

MAPC worked with the Duxbury Hazard Mitigation Planning Team to prepare this plan. After approval of the plan by FEMA, this group will continue to meet on a regular basis, at least annually, to oversee the implementation and updating of this Hazard Mitigation Plan, with the Planning Director designated as the Team coordinator. Additional members could be added to the local Team from businesses, non-profits and institutions. The Town will encourage public participation during the next 5-year planning cycle. As updates and a review of the plan are conducted by the Hazard Mitigation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Team will be publicly noticed in accordance with Town and state open meeting laws.

Implementation and Evaluation Schedule

Mid-Term Survey on Progress— The coordinator of the Hazard Mitigation Team will prepare and distribute a survey in year three of the plan. The survey will be distributed to all of the local implementation group members and other interested local stakeholders. The survey will poll the members on any changes or revisions to the plan that may be needed, progress and accomplishments for implementation, and any new hazards or problem areas that have been identified.

This information will be used to prepare a report or addendum to the local hazard mitigation plan in order to evaluate its effectiveness in meeting the plan's goals and identify areas that need to be updated in the next plan. The Hazard Mitigation Implementation Team, coordinated by the Planning Director, will have primary responsibility for tracking progress and updating the plan.

Begin to prepare for the next Plan Update -- Given the lead time needed to secure funding and conduct the planning process, the Hazard Mitigation Team will begin to prepare for an update of the plan in year three. The team will use the information from the Mid-Term progress review to identify the needs and priorities for the plan update and seek funding for the plan update process. Potential sources of funding may include FEMA grants such as the Hazard Mitigation Grant Program. FEMA grant programs can pay for 75% of a planning project, with a 25% local cost share required.

Prepare and Adopt an Updated Local Hazard Mitigation Plan – FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the Town's approved plan status and its eligibility for FEMA mitigation grants. Once the resources have been secured to update the plan, the Hazard Mitigation Team may decide to undertake the update themselves, contract with the Metropolitan

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Area Planning Council to update the plan, or hire another qualified consultant. If FEMA funds are used to prepare the updated plan, the Town must follow FEMA's procurement guidelines, which require seeking three quotes from service providers qualified to prepare the plan. The local team will also need to review the current FEMA hazard mitigation plan guidelines for any changes. The next draft Duxbury Hazard Mitigation Plan Update will be forwarded to MEMA and DCR for review and to FEMA for approval.

Integration of the Plans with Other Planning Initiatives

This Hazard Mitigation Strategy is intended to provide the Town with a "roadmap" to key actions that will improve its resilience to natural hazards. This updated plan will be incorporated into other relevant plans and policies, such as the Master Plan, the Open Space and Recreation Plan, the Capital Investment Plan, and Municipal Vulnerability Preparedness 2.0 and/or MVP Action Grant projects.

Upon approval of the Duxbury Hazard Mitigation Plan 2026 Update by FEMA, the Local Hazard Mitigation Team coordinator will provide all interested parties and implementing departments with a copy of the plan and will initiate a discussion regarding how the plan can be integrated into each department's ongoing work. The plan will be reviewed and discussed with the following departments during the first six (6) months following plan adoption. During updates of any town department's plans or policies, the relevant portions of this mitigation strategy will be incorporated.

- Fire Department
- Emergency Management
- Police Department
- Public Works Department
- Engineering
- Building Department
- Planning Board
- Conservation Commission
- Public Health
- Harbormaster

Other groups that will be coordinated with include large institutions, Chambers of Commerce, land conservation organizations and watershed groups. The plan will also be posted on a community's website. The posting of the plan on a web site will include a mechanism for citizen feedback such as an e-mail address to send comments.

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SECTION 10: REFERENCES

Blue Hills Observatory
Town of Duxbury, Coastal Resilience Task Force Report, 2022
Town of Duxbury Vulnerability Assessment and Climate Adaptation Plan, 2021
Town of Duxbury, *Open Space and Recreation Plan*, 2021
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Town of Duxbury Zoning By-Laws
Environment America Research and Policy Center, *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation*, July 2012
FEMA, *Disaster Declarations for States and Counties*, 2025
FEMA, HAZUS-MH, 2023
FEMA, *Local Mitigation Planning Policy Guide*, 2025
FEMA, *Flood Insurance Study*, Plymouth County
FEMA *Flood Insurance Rate Maps for Plymouth County, MA*
Kleinfelder Inc., *Sea Level Rise Study*, 2013
MAPC, *Duxbury Climate Resiliency Assessment and Action Plan* 2018
MAPC, *Snug Harbor Resilience Plan*, 2019
MAPC, *South Shore Coastal Adaptation Study* 2011
Massachusetts Climate Change Assessment, 2022
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MA Office of Coastal Zone Management, *Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning*, December 2013
MA Geographic Information System, *Land Use Statistics*
MA DCR, Office of Dam Safety, *Inventory of Massachusetts Dams*
Massachusetts Report of the MA Coastal Erosion Commission, 2016
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Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018
Massachusetts Climate Vulnerability Assessment, 2022
Metropolitan Area Planning Council, GIS Lab, *Regional Plans and Data*
New England Seismic Network, Boston College Weston Observatory
NOAA National Centers for Environmental Information,
Northeast States Emergency Consortium (NESEC)
US Census, 2020, *American Community Survey*
USDA Forest Service, *Wildfire Risk to Communities*
USGS, *National Water Information System*,
U.S. Global Change Research Program, *Fourth National Climate Assessment*, 2018

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APPENDIX A: HAZARD MAPPING

The MAPC GIS (Geographic Information Systems) Lab produced a series of maps for each community. Some of the data came from the Northeast States Emergency Consortium (NESEC). More information on NESEC can be found at <http://www.serve.com/NESEC/>. Due to the various sources for the data and varying levels of accuracy, the identification of an area as being in one of the hazard categories must be considered as a general classification that should always be supplemented with more local knowledge.

The map series consists of eight maps as described below. The maps in this appendix are necessarily reduced scale versions for general reference.

Map 1.	Population Density
Map 1A	Environmental Justice Areas
Map 2.	Land Use
Map 3.	Flood Zones
Map 3B	2010 Flood Claims
Map 4.	Earthquakes and Landslides
Map 5.	Hurricanes and Tornadoes
Map 6.	Average Snowfall
Map 7.	Composite Natural Hazards
Map 8.	Hazard Areas
Map 9	Land Surface Temperature
Map 10	Wildfire Risk
Map 11	Coastal Flooding

Map 1: Population Density – This map uses the US Census block data for 2020 and shows population density as the number of people per acre in seven categories with 60 or more people per acre representing the highest density areas.

Map 1b: Environmental Justice areas – This map shows Environmental Justice (EJ) populations using 2020 data. EJ designations from the State include English isolation, income, and minority residents.

Map 2 Land Use – This map shows land cover and land use from MassGIS' 2016 [Land Cover/Land Use](#) dataset.

Map 3: Flood Zones – The map of flood zones used the FEMA NFIP Flood Zones for Middlesex County as its source. For more information, refer to the FEMA Map Service Center website <http://www.msc.fema.gov>. The definitions of the flood zones are described in detail on this site as well. The flood zone map for each community also shows critical infrastructure and municipally owned and protected open space.

Map3b: 2010 Flood Claims – This map shows flood insurance and disaster claim records from March 2010. The March 29, 2010 federal disaster declaration associated with severe rainfall and flooding triggered the launch of the Federal Emergency Management Agency's (FEMA's) Individual Assistance Program through which residential property

TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE

owners, businesses, and institutions without flood insurance were eligible to apply for relief to pay for storm-related expenditures and repairs. Across the seven counties, over 27,000 individual claims were approved for nearly \$59 million in disaster assistance, while reimbursements to state and local governments totaled \$25 million. In the MAPC region, 18,400 claims were approved for \$30 million dollars in disaster assistance.

Map 4: Earthquakes and Landslides (Regional) – This map depicts landslide risk and recorded earthquake epicenters in the community and surrounding region. This information came from NESEC. For most communities, there was no data for earthquakes because only the epicenters of an earthquake are mapped.

The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to <http://pubs.usgs.gov/pp/pp1183/pp1183.html>.

Map 5: Hurricanes and Tornadoes (Regional) – This map shows the spatial characteristics of several different meteorological properties and past events in the community and surrounding region. The map includes the storm tracks for both hurricanes and tropical storms. This information must be viewed in context. A storm track only shows where the eye of the storm passed through. In most cases, the effects of the wind and rain from these storms were felt in other communities even if the track was not within that community. This map also shows the location of tornadoes with a classification as to the level of damages. What appears on the map varies by community since not all communities experience the same wind-related events. These maps also show the 100-year wind speed and areas that could be inundated by storm surge during a hurricane, if any.

Map 6: Average Snowfall (Regional) - This map shows the average snowfall in the community and the surrounding region.

Map 7: Composite Natural Hazards (Regional) - This map shows four categories of composite natural hazards for areas of existing development. The hazards included in this map are 100-year wind speeds of 110 mph or higher, low and moderate landslide risk, FEMA Q3 flood zones (100 year and 500 year) and hurricane surge inundation areas. Areas with only one hazard were considered to be low hazard areas. Moderate areas have two hazards present. High hazard areas have three hazards present and severe hazard areas have four hazards present.

Map 8: Local Hazard Areas – For each community, locally identified hazard areas are overlaid on an aerial photograph/ The critical infrastructure sites and planned development areas are also shown. The source of the aerial photograph is Mass GIS.

Map 9: Land Surface Temperature – MAPC's Statewide Land Surface Temperature (LST) Index was created by combining estimates of surface temperature from days in 2018, 2019, and 2020 where the daily air temperature maximum exceeded 70 degrees Fahrenheit. The Statewide LST Index "Hot Spots" data depicts the 5% highest LST index areas in each Regional Planning Agency (RPA) region. The data was generated by identifying pixels whose LST index values are equal to or greater than 95% of LST index values in the region, and then delineating cohesive regions where pixels meet this criterion

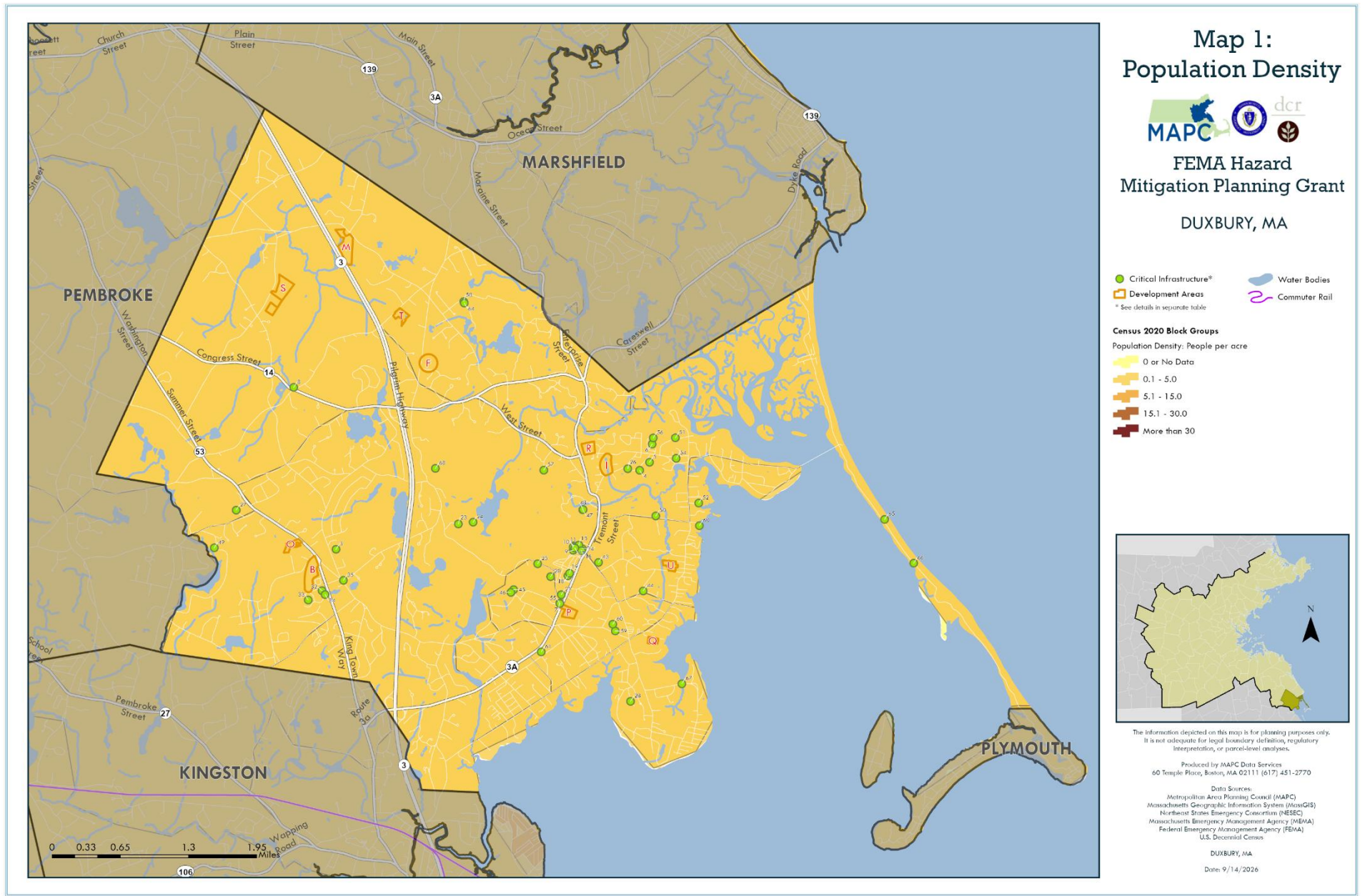
TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE

as polygons. Map 9 represents the “Hot Spots” relative to the MAPC region, mapped on top of the National Land Cover Database’s [2016 30-m tree canopy data](#).

Map 10: Wildfire Risk – This map shows wildfire risk to the community using USDA data. Wildfire risk is classified as very low, low, moderate, high, and very high.

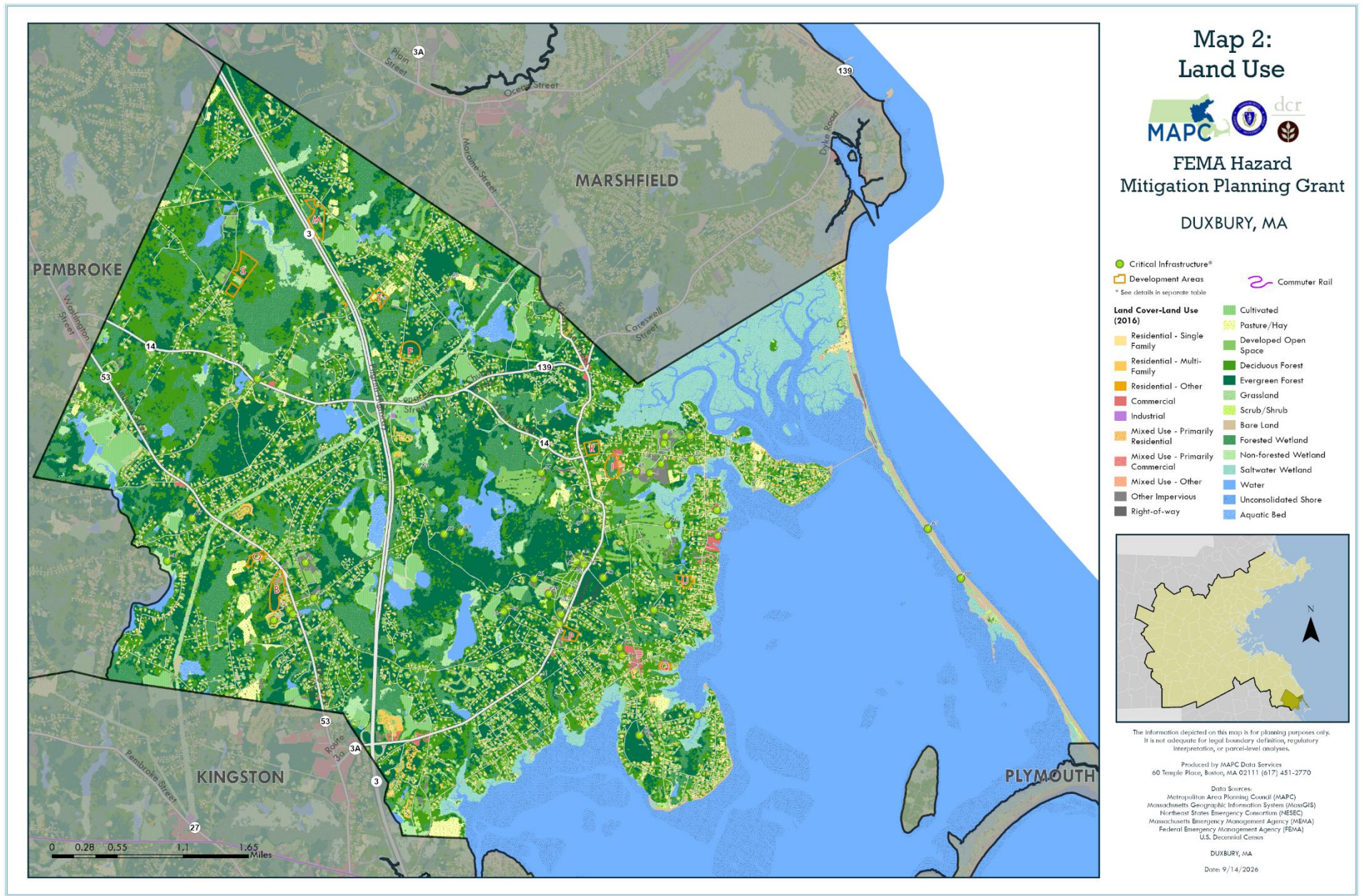
Map 11: Coastal Flooding – This map presents projections for three future sea level rise scenarios developed for the Massachusetts Coastal Flood Risk Model (MC-FRM) by the Wood Hole Group. The map shows the extent of flood inundation for a 1% annual chance storm for projected sea level rise scenarios of 1.2 feet, 2.4 feet, and 4.2 feet. These scenarios are approximately equivalent to the levels of sea level rise projected for the years 2030, 2050, and 2070, respectively.

TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE



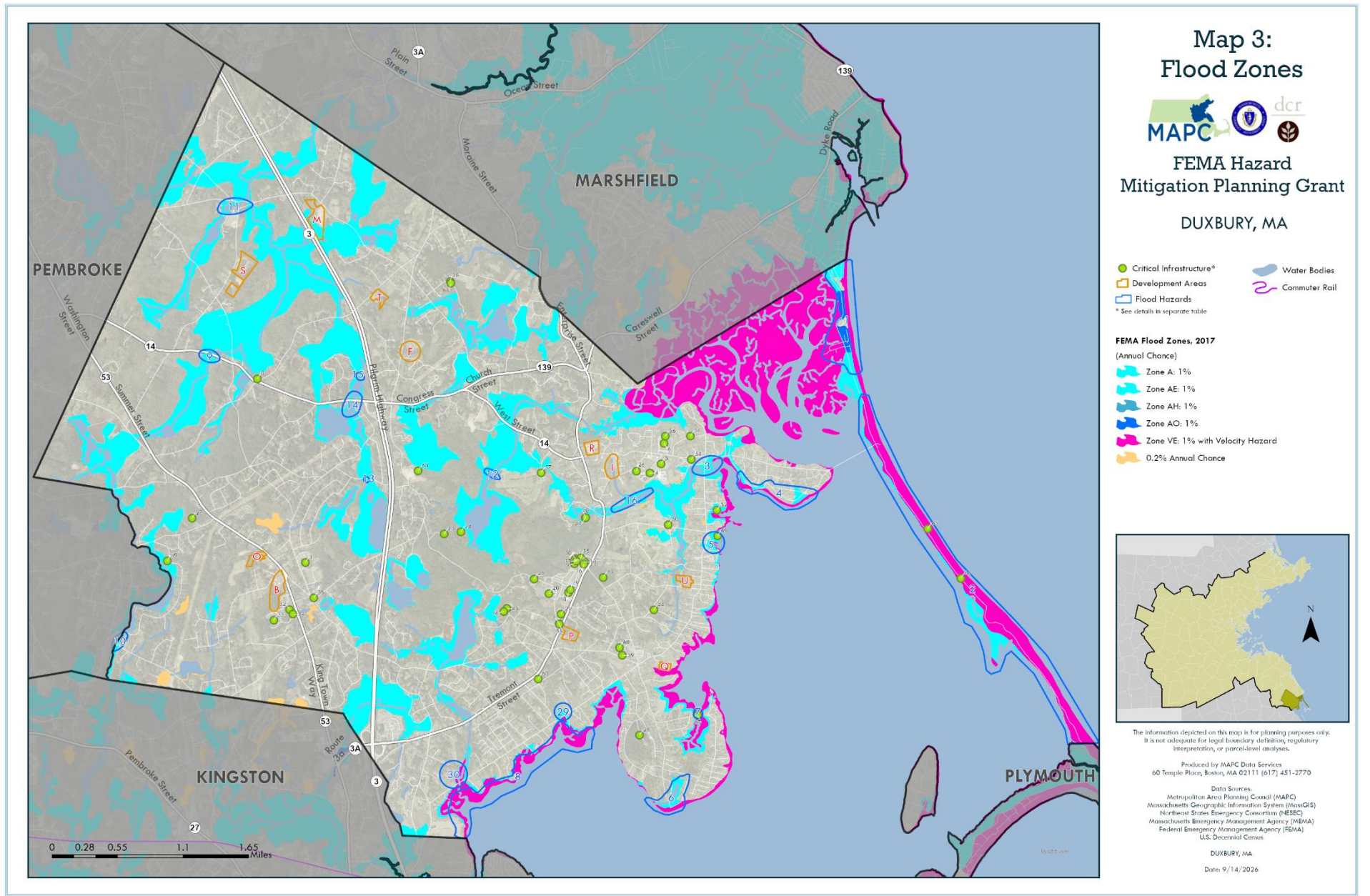
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TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE



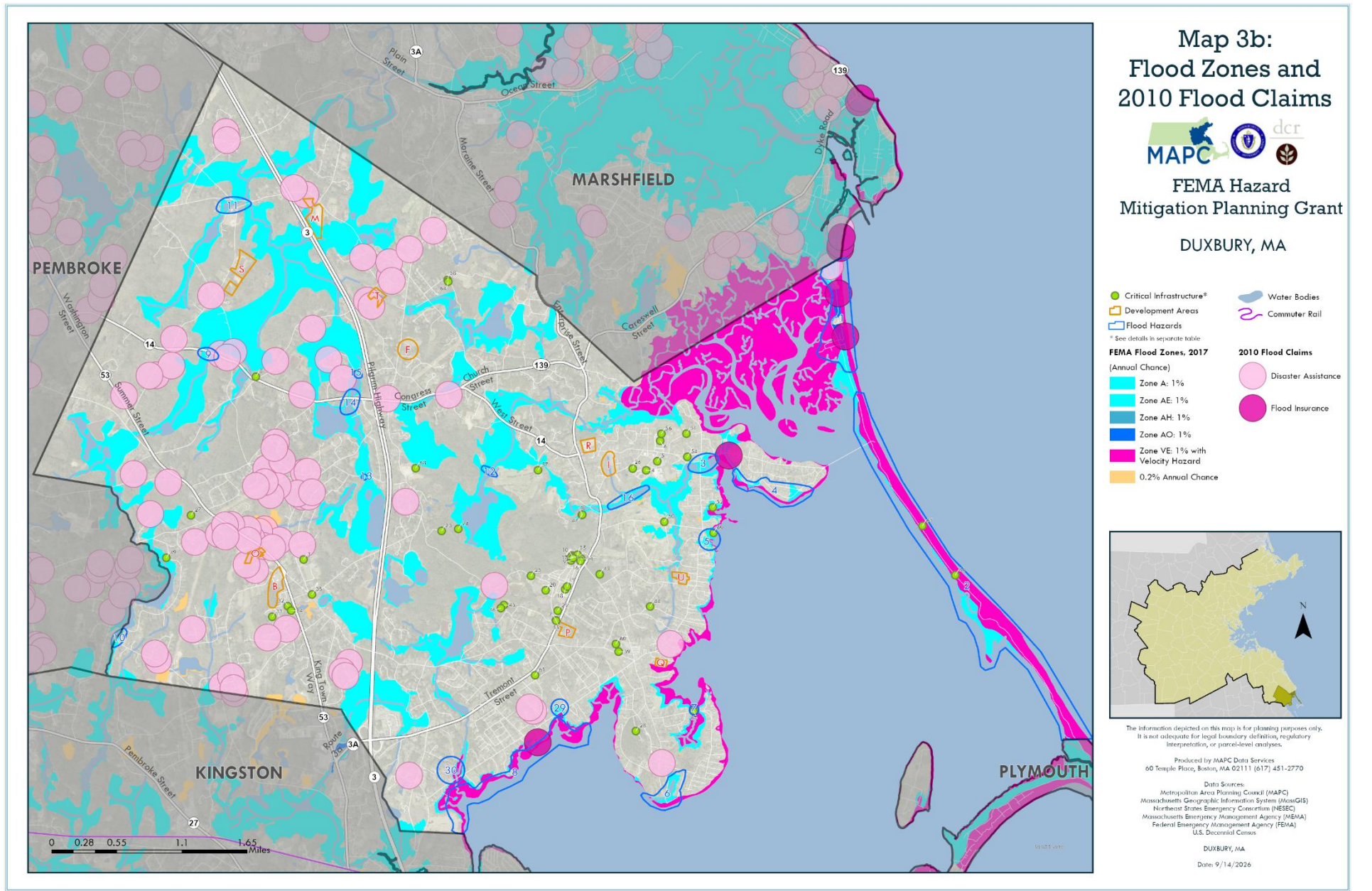
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TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE



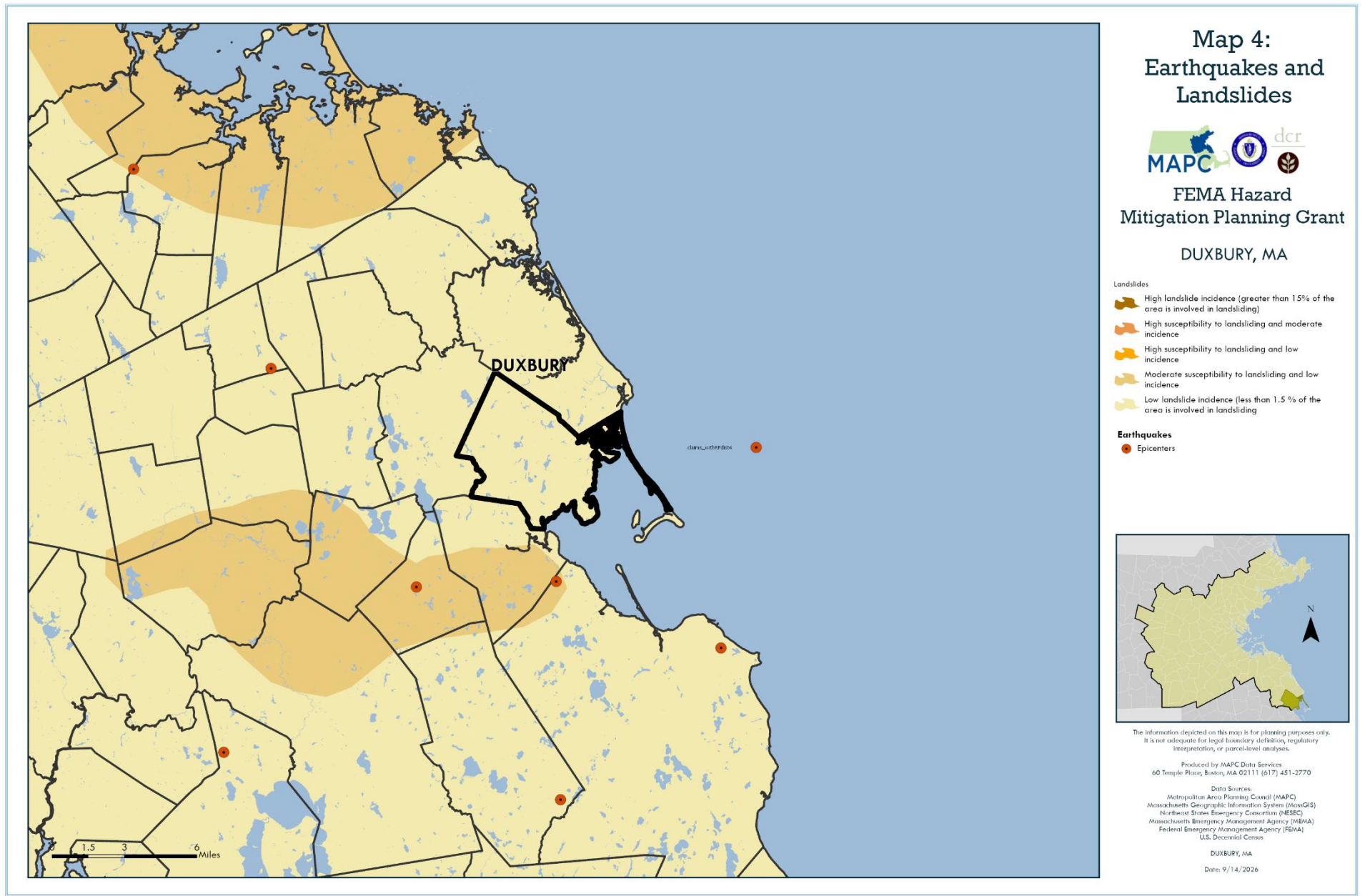
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TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE



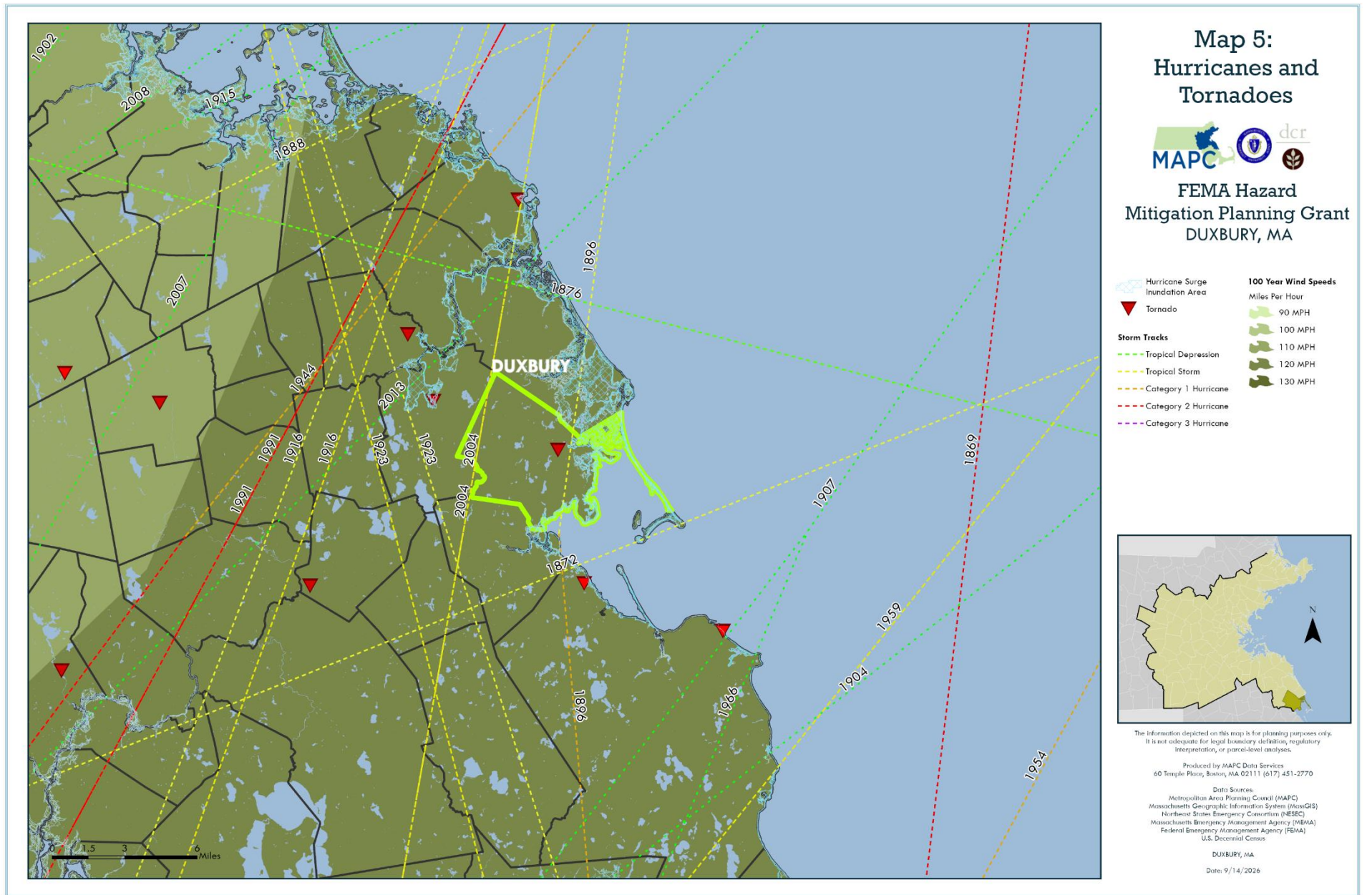
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TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE

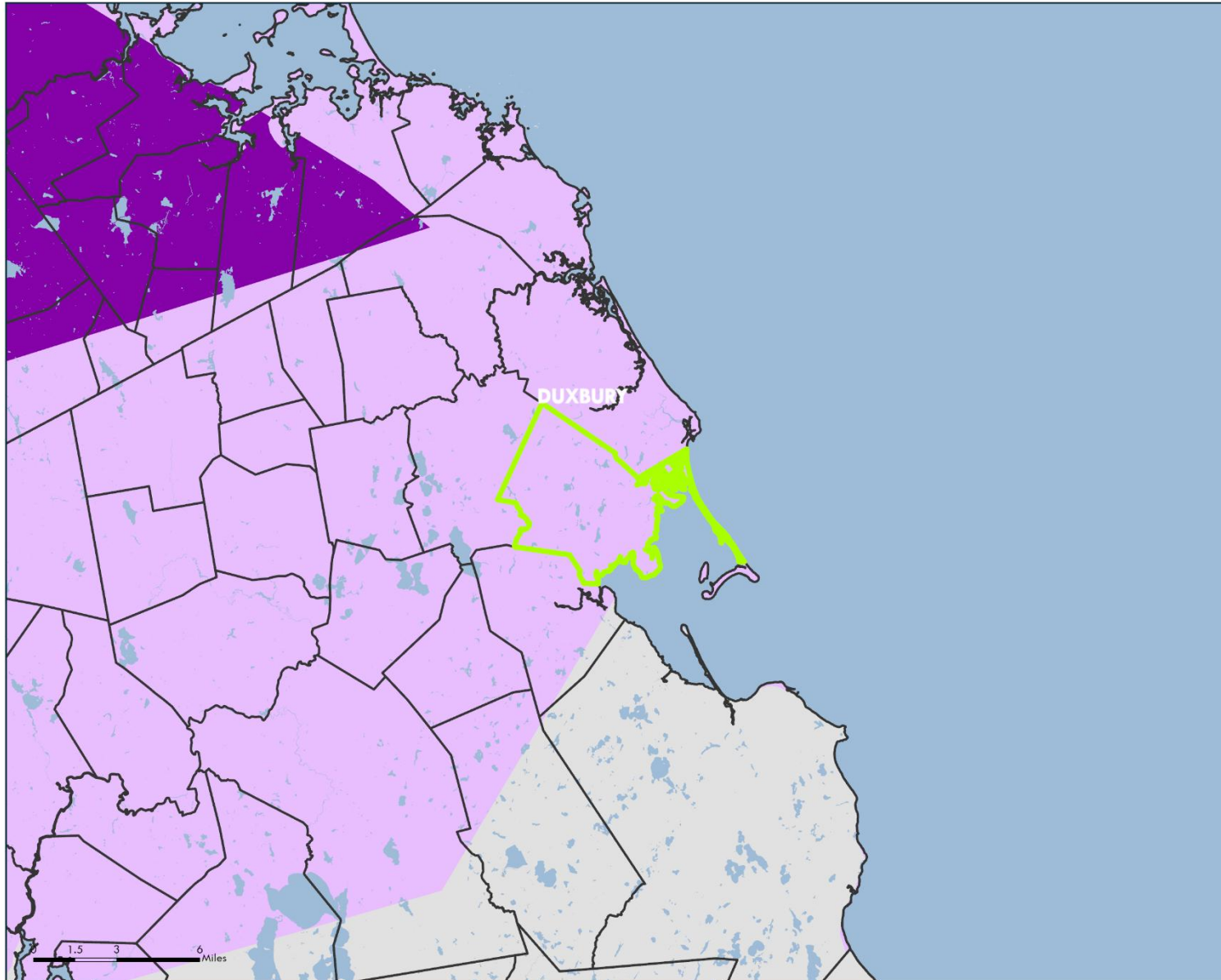


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**TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE**



TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE



Map 6:
Average Snowfall

MAPC dcr

FEMA Hazard
Mitigation Planning Grant

DUXBURY, MA

Average Annual Snowfall
Inches

G 36.1 - 48.0

H 48.1 - 72.0



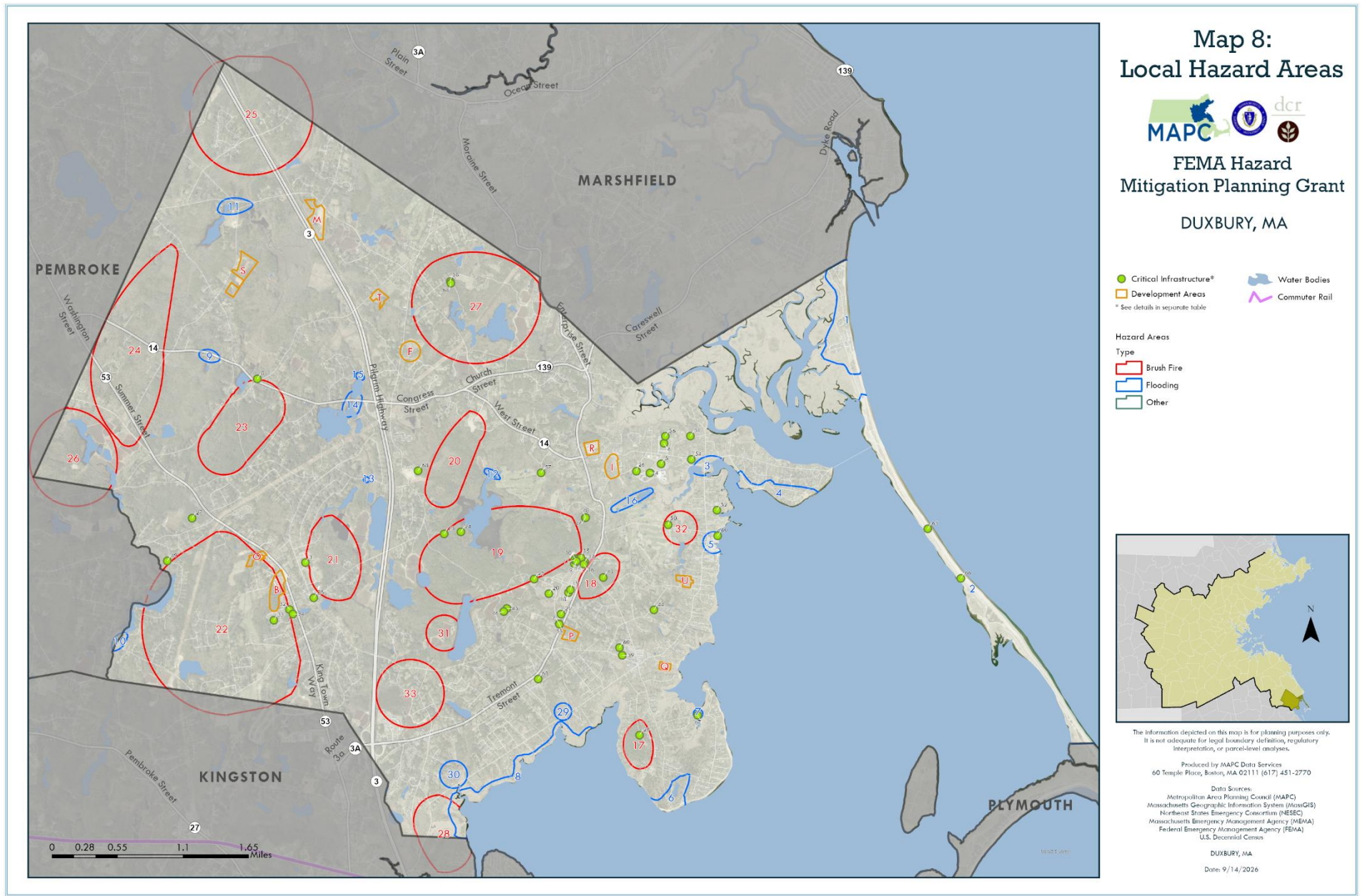
The information depicted on this map is for planning purposes only.
It is not adequate for legal boundary definition, regulatory
interpretation, or parcel-level analyses.

Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

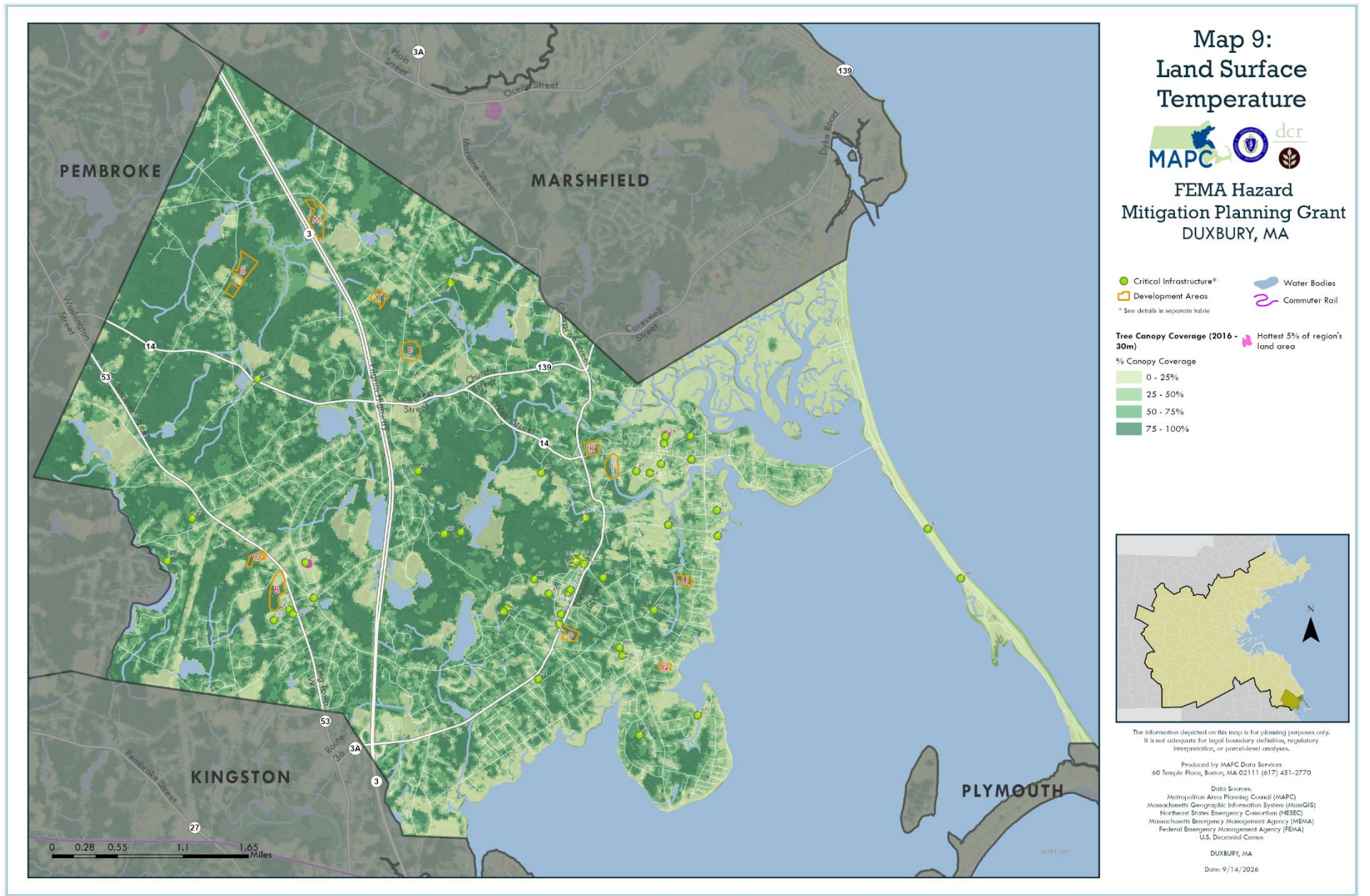
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NASEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
U.S. Decennial Census

DUXBURY, MA
Date: 9/14/2026

TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE

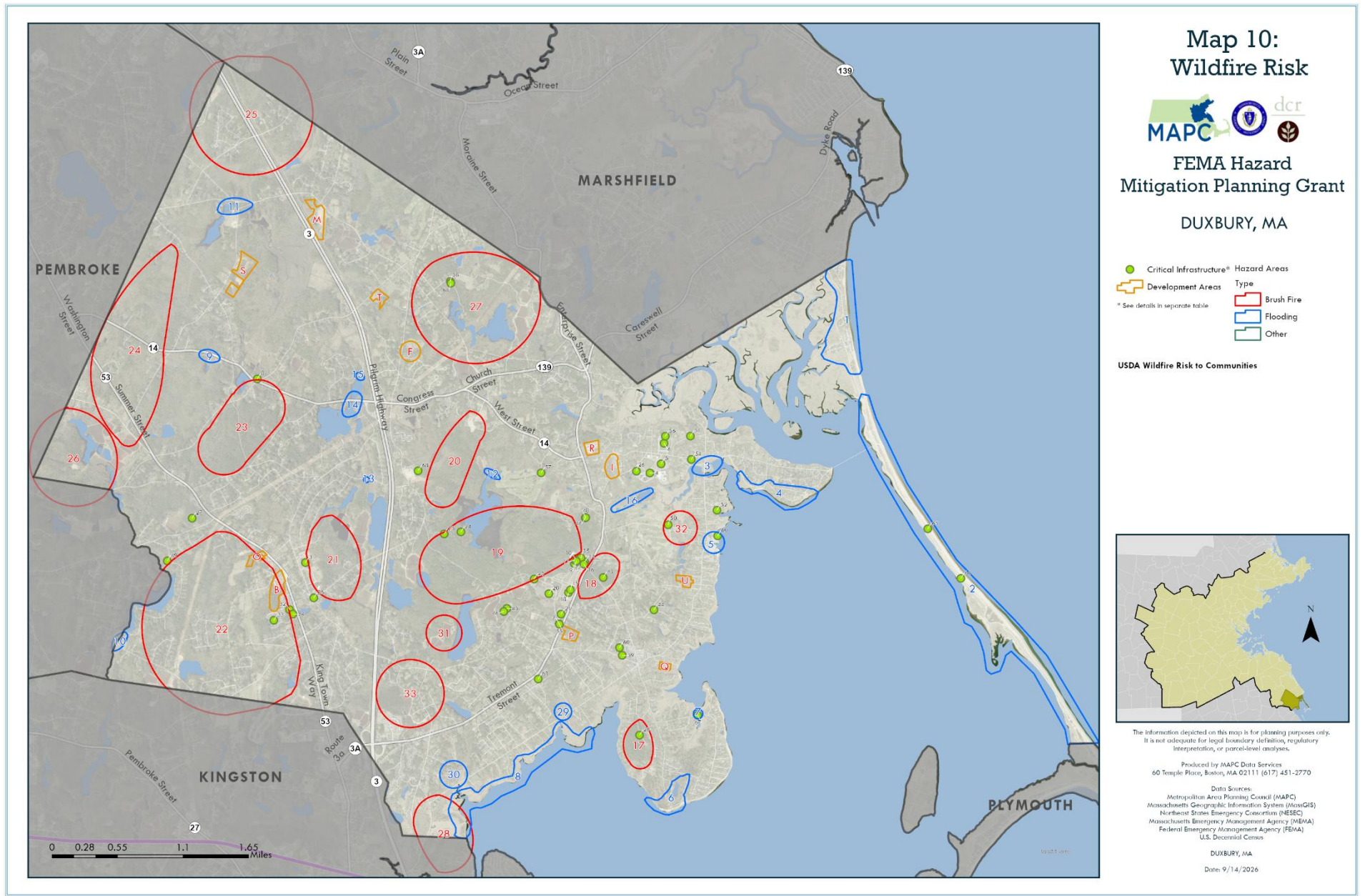


TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE

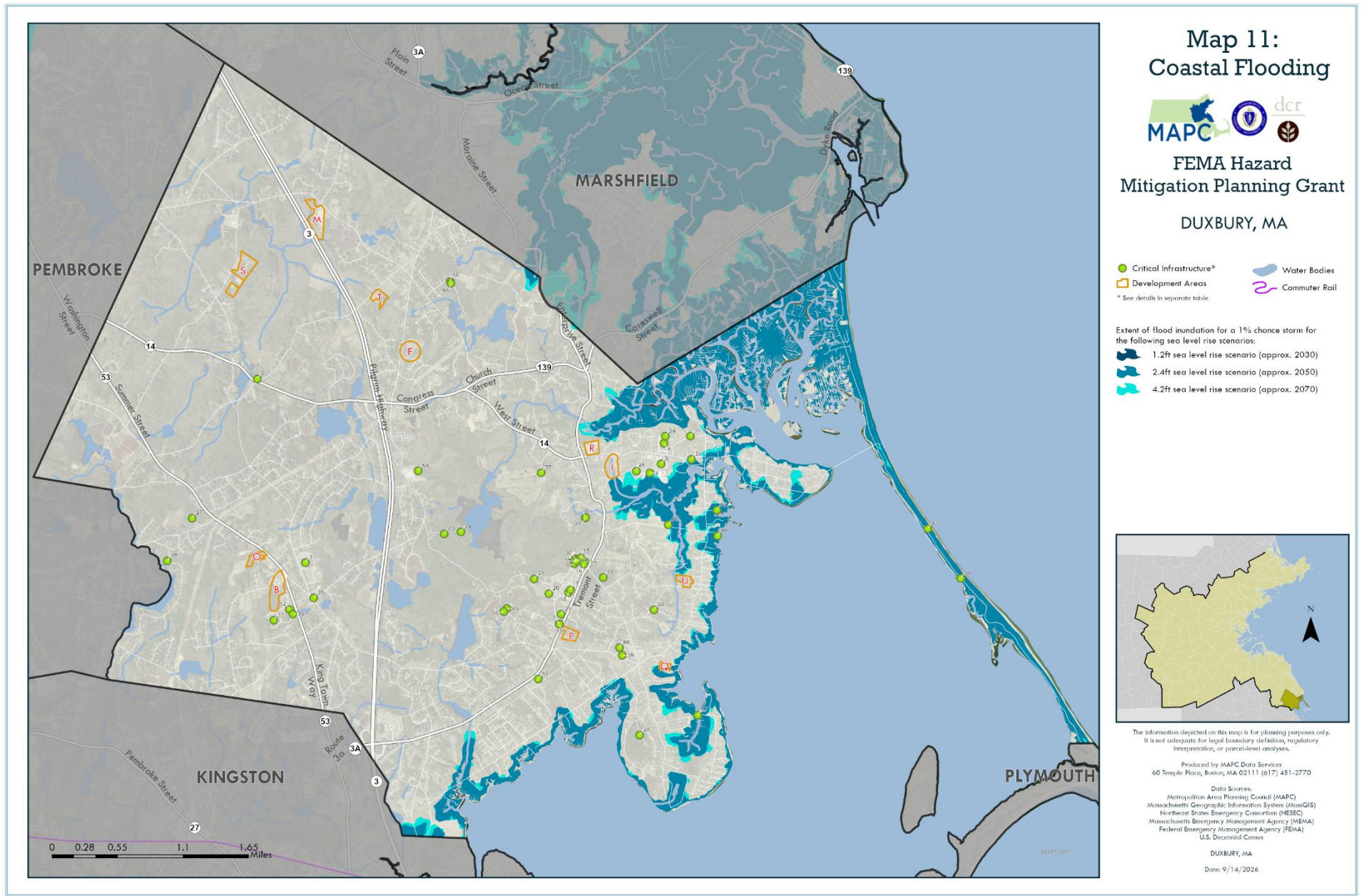


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TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE



TOWN OF DUXBURY HAZARD MITIGATION PLAN DRAFT 2026 UPDATE



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**TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE**

APPENDIX B: HAZARD MITIGATION TEAM

Duxbury Hazard Mitigation Plan Update

Team Meeting #1

Thursday, December 12, 2024

10:00 – 11:30 AM

Duxbury Town Hall
Mural Room

AGENDA

1. Welcome and Introductions

2. Review of Planning Process and Schedule (see attached timeline)

3. Getting Started: Local Data Updates from the 2019 Plan

- *The Team will update 3 types of local data from the 2018 plan (see attached worksheets):*
 1. Local Hazard Areas (Flooding, Wildfire, etc.)
 2. Critical Facilities
 3. New Development sites
- *MAPC's GIS Planner Alexa DeRosa will join via Zoom to map new or revised sites using the online platform Google MyMaps*

4. Next steps: Preparing for Public Meetings and Outreach

- **We will hold 2 Public Meetings during development of the plan:**
 - 1st public meeting during the planning process (Spring 2025)*
 - 2nd public meeting on the draft plan and invite comments (Fall 2025)*
- The HMP Team to identify local stakeholders to invite
- Next HMP Team meeting in March

TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE

APPENDIX B: HAZARD MITIGATION TEAM

Duxbury Hazard Mitigation Plan Update

Team Meeting #2

Thursday, March 13, 2025

10:00 – 11:30 AM

Duxbury Town Hall

Mural Room

AGENDA

1. Welcome and Introductions

2. Review and Update of Mitigation Goals for the Plan

- See Worksheet #4 – Goals from the 2018 Plan
- The Team will review and update the goals and add new goals as needed

3. Review Status of Existing Mitigation Measures

- See Worksheet #5 – Existing Mitigation from the 2018 Plan
- The Team will review changes to mitigation measures
- Add any new mitigation measures adopted since the 2018 plan
- Note Effectiveness and Improvements Needed to mitigation measures

4. Prepare for First Public Meeting

- Set date and host board or commission (target: April/May)
- HMP Team to identify local stakeholders to invite:
 - Businesses, Community groups, NGO's, etc.
 - Focus on vulnerable populations/EJ
 - Refer to MVP Workshop invitees
 - Public outreach on Town website, social media

5. Next HMP Team Meeting: June 2025

**TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE**

APPENDIX B: HAZARD MITIGATION TEAM

**Duxbury Hazard Mitigation Plan Update
Team Meeting #3**

**Monday, July 28, 2025
10:00 – 11:30 AM**

**Duxbury Town Hall
Mural Room**

Please let us know if you will be travelling but could meet on Zoom

AGENDA

1. Welcome and Introductions

2. Update Status of Mitigation Strategies from the 2018 Plan

The Team will review the recommended mitigation measures from the 2018 plan.

We will note which mitigation measures:

- (1) Have been completed
- (2) Are still in Progress
- (3) Have not been implemented, and why

We'll note any mitigation measures to be revised or deleted for the 2025 plan

3. Review of Next Steps

- **Final Team Meeting–October**
 - Finalize mitigation recommendations for the 2025 plan
- **Final Public Presentation–November**
 - MACP Presentation of the draft plan at a public meeting
 - Draft plan to be posted online for public review
- **Submit draft plan to MEMA & FEMA for review–December**
 - Respond to MEMA & FEMA comments/revisions if any
 - After FEMA approval, final plan to be adopted by the Select Board

**TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE**

APPENDIX B: HAZARD MITIGATION TEAM

Duxbury Hazard Mitigation Plan Update

Team Meeting #4

Wednesday, November 19, 2025

10:00 – 11:30 AM

Duxbury Town Hall

Mural Room

AGENDA

1. Review and Finalize the Mitigation Strategies for 2025 Plan

- The Team will review the draft mitigation measures for the 2025 plan
- We will confirm the priorities, lead agencies, timeframes, costs, and funding sources
- *See Worksheet#6 Draft Mitigation Strategies, attached*

2. Prepare for the final Public Presentation

- Confirm host board and set date in January/early February
- MAPC will prepare meeting notice, social media post, press advisory
- MAPC will prepare PowerPoint and give a public presentation
- Draft plan will be posted online for public review and comment after the presentation
- HMP Team please identify local stakeholders to invite:
 - Businesses, Institutions, Civic Organizations, Neighborhood groups, NGO's, etc.
 - Focus on vulnerable populations

**TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE**

APPENDIX C: DOCUMENTAION OF PUBLIC MEETINGS



Meeting Notice
Town of Duxbury, Massachusetts

Pursuant to MGL Chapter 50A, §18-25
All meeting notices and agenda must be filed and time stamped
in the Town Clerk's Office and posted at least 48 hours prior to
the meeting (excluding Saturdays, Sundays and Holidays)

TOWN CLERK'S STAMP

RECEIVED

TOWN CLERK

5/1/2025, 3:48:39 PM

DUXBURY, MA

Committee: Selectboard

Meeting Location: Mural Room, 878 Tremont Street and via Zoom

Day & Date of Meeting: Monday, May 5, 2025 **Time:** 6:00 p.m. Executive Session

Posted by: M. Seda-Stotts 6:30 p.m. Open Session

Pursuant to Chapter 2 of the Acts of 2023, and as amended as of March 28, 2025, this meeting will be conducted in person and, as a courtesy, via remote means in accordance with applicable law. Please note that while an option for remote attendance and/or participation is being provided as a courtesy to the public and board members, the meeting/hearing will not be suspended or terminated if technological problems interrupt the virtual broadcast, unless required by law.

This meeting will be recorded by The Local Seen (formerly known as PACTV). Members of the public who wish to watch the meeting may do so by viewing the Duxbury Government Access Channels – Verizon 39 or Comcast 9. Viewers can visit <https://thelocalseen.media/duxbury/> for information about Duxbury programming including streaming and watching replays on Duxbury YouTube.

Join Webinar at www.zoom.us
Webinar ID: 945 7805 3101
Passcode: 565677
Phone: 1 301 715 8592

AGENDA

1. CALL TO ORDER
2. PLEDGE OF ALLEGIANCE
3. 6:00 P.M. EXECUTIVE SESSION – COLLECTIVE BARGAINING

To discuss strategy with respect to collective bargaining or litigation if an open meeting may have a detrimental effect on the bargaining or litigating position of the public body and the chair so declares;

- *Presented by Russell Dupere, Esq. and Jeannie Horne, HR Director*

4. OPEN FORUM
5. NEW BUSINESS

- Presentation regarding Hazard Mitigation Plan Update

Presented by Martin Pillsbury, Director of Environmental Planning with MAPC

APPENDIX C: DOCUMENTAION OF PUBLIC MEETINGS

4

DUXBURY CLIPPER

New rules limit watering

Continued from page 1

Residents can use a hand-held hose to water outdoors any day of the week provided it has an automatic shut-off device like a pistol trigger that stops the water flow when it's released. This means car washing, flower watering and even lawn watering are allowed by this method.

"I know we talked about the potential for a one-day restriction for watering. I didn't recall we actually made that decision. I'm not objecting to it. I think it's a move in the right direction," said Vice Chairman Amy MacNab.

These restrictions do not apply to residents who use private well water.

The Selectboard announced the new outdoor watering restrictions at its meeting Monday at Town Hall, however, this change took the board by surprise.

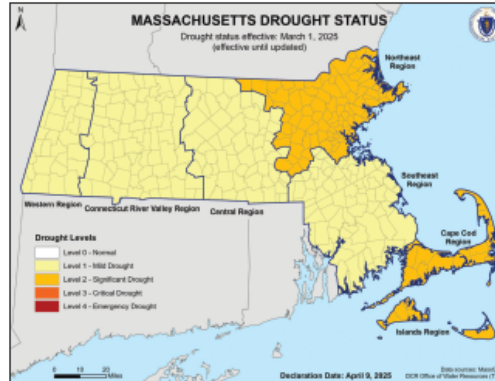
"This is a significant change to what the residents are used to," said Vice Chairman Amy MacNab. "I know we talked about the potential for a one-day restriction for watering. I didn't recall we actually made that decision. I'm not objecting to it. I think it's a move in the right direction."

In past years, residents in odd-numbered house were allowed to water on Tuesdays, Thursdays and Saturdays. Those in even-numbered houses could water outdoors on Mondays, Wednesdays and Fridays.

MacNab asked about the reason behind the change.

While Water Superintendent Mark Cloud was not at the meeting, Selectboard member Fernando Guitart reasoned that it was an attempt to bring the town in compliance with the Department of Environmental Protection requirements that the town reduce its water consumption to meet a 65 per gallon per person limit.

The town's per capita daily water use is well over that – closer to 85 gallons a day. The town has been trying to meet the DEP requirements



Duxbury and surrounding towns are currently in a mild drought.

Graphic courtesy MASS DCR

for almost 10 years without success. Back in 2016, then-Water Superintendent Peter Mackin wanted outdoor watering restricted to only two days.

"I think it's to do with trying to reach the target of 65 gallons of water per day per resident," said Guitart. "That's what's driving this. We are below that demand in the winter months and we exceed that demand in the summer months."

Another reason behind the tighter restrictions is that parts of Massachusetts are in drought conditions. According to the state's drought status website, Duxbury, as part of the Southeast region, is in a level one, "mild drought" status. As of April 7, this and other regions were downgraded by the Energy and Environmental Affairs Secretary Rebecca Tepper from the level two status of "significant drought."

However, watering restrictions are still being recommended.

"Above-average precipitation over the last couple of months has helped improve streamflow and raise groundwater levels in several regions," stated an April 9 announcement from the EEA. "However, drought conditions are still affecting the regions in the eastern part of the state due to ongoing precipitation deficits."

The EEA is recommending that any communities with a level one drought sta-

tus only allow outdoor watering one day a week from 5 p.m. to 9 a.m.

"It's a first step," said Guitart. "I think this is all heading in the right direction."

Board Chairman Brian Glennon asked Town Manager René Read where residents could find more information on the new rules. Read said to check the town's water and sewer department webpage.

Previously outdoor watering restrictions have been in place until Sept. 30, but on Monday no end date was given by the board.

Public presentation on hazard plan

The Selectboard will be hosting a presentation about the Town's Hazard Mitigation Plan on Monday, May 5 at 6:30 p.m. during its regular meeting in the Mural Room at Town Hall.

Duxbury experiences natural hazards that can affect residents and businesses, including flooding, coastal storms, and hurricanes. The Town is updating its FEMA Hazard Mitigation Plan to assess its vulnerability to natural hazards and strategies to increase resilience.

The meeting can also be attended online at zoom.us Meeting ID: 945 7805 3101. Passcode: 565677. Phone: 1 301 715 8592.

TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE

APPENDIX C: DOCUMENTAION OF PUBLIC MEETINGS

Hazard Ready Duxbury!
Public Presentation, May 5, 6:30 PM



When: Monday, May 5, 2025, 6:30 PM

Where: Duxbury Selectboard Meeting
Town Hall, Mural Room, 878 Tremont Street, Duxbury

Hybrid: www.zoom.us / Meeting ID 945 7805 3101
Passcode: 565677 / Phone: 1 301 715 8592

Duxbury experiences natural hazards that can affect residents and businesses, including **flooding, coastal storms, and hurricanes**.

The Town is updating its FEMA Hazard Mitigation Plan to assess its vulnerability to natural hazards and strategies to increase resilience.

Join us on May 5 at the Selectboard for a presentation about Town’s Hazard Mitigation Plan



If you have questions or comments, please email
DuxburyResilience@mapc.org



TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE

APPENDIX C: DOCUMENTAION OF PUBLIC MEETINGS



Hazard-Ready Duxbury!

Duxbury is updating its Hazard Mitigation Plan

Join the town for a Public Presentation

Monday, May 5, 6:30 PM
Duxbury Selectboard
Town Hall, Mural room

- Natural Hazards such as floods and coastal storms can affect residents and businesses
- Come hear about the Town's Hazard Mitigation Plan to address these hazards.

Hybrid: [www.zoom.us](https://www.zoom.us/j/94578053101) / Meeting ID 945 7805 3101 / Passcode: 565677 / Phone: 1 301 715 8592

TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE

APPENDIX C: DOCUMENTAION OF PUBLIC MEETINGS



Hazard Ready Duxbury!
Presentation on the Draft Hazard Mitigation Plan
September 28, 6:30 PM

When: Monday, September 28, 2026, 6:30 PM

Where: Duxbury Selectboard Meeting

Town Hall, Mural Room, 878 Tremont Street, Duxbury

(To confirm the location, see www.town.duxbury.ma.us/duxbury-selectboard)

Hybrid: www.zoom.us / Meeting ID 945 7805 3101

Passcode: 565677 / Phone: 1 301 715 8592

Govt Access TV Channels Verizon 39 or Comcast 9

Duxbury experiences natural hazards that can affect residents and businesses, including **flooding, coastal storms, and hurricanes**.

The Town has updated its FEMA Hazard Mitigation Plan to assess its vulnerability to natural hazards and strategies to increase resilience.

The Draft Plan will be presented and available to download. Comments on the draft plan are welcome by email at DuxburyResilience@mapc.org

Join us on September 28 at the Selectboard meeting for a presentation about the Draft Hazard Mitigation Plan



If you have questions or comments, please email
DuxburyResilience@mapc.org



**TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE**

APPENDIX C: DOCUMENTAION OF PUBLIC MEETINGS

NOTICE IN DUXBURY CLIPPER

Public Presentation About Hazard Mitigation Plan

The Duxbury Selectboard will host a presentation about the Town’s Hazard Mitigation Plan on Monday, September 28, 2026, at 6:30 pm during its regular meeting in the Mural Room at Town Hall. (The location of the meeting may be confirmed by checking the Selectboard’s agenda.) Duxbury experiences natural hazards that affect residents and businesses, including flooding, coastal storms, hurricanes, snowstorms, droughts and extreme temperatures. The Town is updating its FEMA Hazard Mitigation Plan to assess its vulnerability to natural hazards and describe strategies to improve its resilience. The meeting can also be attended online: Zoom Meeting ID (Webinar ID) 945 7805 3101; Passcode 565677; Phone 1-301-715-8592.

**TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE**

APPENDIX D: WILDFIRE INCIDENCE RECORDS 2018-2024

**Incident Run Log
Duxbury Fire Department**

Date Range: From 01/01/2018 to 12/12/2024
Incident Type: Natural vegetation fire, other
Company: All Companies
Sorted by: Date of Incident

Date	FDID	Incident#	Alarm	###	Address	Suite	Zip	Type	Lgth
02/10/2018	23082	2018-000350	21:58	240	HARRISON ST		02332	Brush or brush-and-grass mixture fire	0.5
02/28/2018	23082	2018-000451	11:23	130	UNION BRIDGE RD		02332	Brush or brush-and-grass mixture fire	1.1
03/06/2018	23082	2018-000731	15:40	691	TREMONT ST		02332	Brush or brush-and-grass mixture fire	0.2
03/12/2018	23082	2018-000782	17:39	235	HARRISON ST		02332	Brush or brush-and-grass mixture fire	0.9
03/12/2018	23082	2018-000785	20:54	235	HARRISON ST		02332	Brush or brush-and-grass mixture fire	0.6
04/24/2018	23082	2018-001171	12:51	145	TEMPLE ST		02332	Brush or brush-and-grass mixture fire	0.9
05/23/2018	23082	2018-001386	17:20		RTE 3 SB N EXIT 11		02332	Brush or brush-and-grass mixture fire	0.4
05/25/2018	23082	2018-001402	12:37	56	CRESCENT ST	CRE	02332	Natural vegetation fire, other	0.8
07/08/2018	23082	2018-001774	18:23	870	SUMMER ST		02332	Brush or brush-and-grass mixture fire	0.5
09/04/2018	23082	2018-002205	12:04	164	ELM ST		02332	Brush or brush-and-grass mixture fire	3.4
09/05/2018	23082	2018-002215	08:02	209	ELM ST		02332	Forest, woods or wildland fire	0.6
12/11/2018	23082	2018-002927	06:18	423	CHANDLER ST		02332	Brush or brush-and-grass mixture fire	0.6
03/24/2019	23082	2019-000651	11:42	21	DANA CT		02332	Brush or brush-and-grass mixture fire	0.4
03/29/2019	23082	2019-000679	12:08	31	WINTER ST		02332	Brush or brush-and-grass mixture fire	0.6
03/30/2019	23082	2019-000688	11:42	273	TREMONT ST		02332	Forest, woods or wildland fire	1.7
03/31/2019	23082	2019-000697	13:03	35	GARDNER RD		02332	Brush or brush-and-grass mixture fire	0.4
06/03/2019	23082	2019-001123	13:18	1538	TREMONT ST		02332	Brush or brush-and-grass mixture fire	2.3
06/03/2019	23082	2019-001127	16:31	10	WASHINGTON ST		02332	Natural vegetation fire, other	0.2
06/08/2019	23082	2019-001155	15:19	542	KEENE ST		02332	Brush or brush-and-grass mixture fire	3.0
02/22/2020	23082	2020-000396	12:01	161	CHESTNUT ST		02332	Brush or brush-and-grass mixture fire	0.4
02/23/2020	23082	2020-000399	12:23	1	APPLE HILL LN		02332	Brush or brush-and-grass mixture fire	0.9
02/23/2020	23082	2020-000402	13:51	287	SUMMER ST		02332	Grass fire	0.2
02/24/2020	23082	2020-000407	13:48	917	KEENE ST		02332	Brush or brush-and-grass mixture fire	1.6
02/28/2020	23082	2020-000431	05:03	190	WASHINGTON ST		02332	Brush or brush-and-grass mixture fire	0.3
03/22/2020	23082	2020-000573	11:13	200	CRESCENT ST		02332	Grass fire	1.0
03/26/2020	23082	2020-000597	14:05	435	BAY RD		02332	Grass fire	0.5
04/20/2020	23082	2020-000809	10:26	1	WASHINGTON ST		02332	Natural vegetation fire, other	1.7
04/23/2020	23082	2020-000828	12:57	440	LAKE SHORE DR		02332	Brush or brush-and-grass mixture fire	0.4
04/23/2020	23082	2020-000831	18:14	68	NORTH ST		02332	Brush or brush-and-grass mixture fire	0.6
05/13/2020	23082	2020-000959	14:28	19	DEPOT ST		02332	Natural vegetation fire, other	0.4
05/22/2020	23082	2020-001013	16:40		RTE 3 SB N EXIT 11		02332	Brush or brush-and-grass mixture fire	0.2
06/04/2020	23082	2020-001096	13:09	656	WEST ST		02332	Brush or brush-and-grass mixture fire	1.8
06/04/2020	23082	2020-001098	15:29		BAYRIDGE LN		02332	Natural vegetation fire, other	0.2
06/25/2020	23082	2020-001249	03:25		RTE 3 NB N EXIT 11		02332	Brush or brush-and-grass mixture fire	0.2
08/12/2020	23082	2020-001666	01:25	45	BAY RD		02332	Natural vegetation fire, other	0.2
09/20/2020	23082	2020-001962	16:11	35	LAUREL ST		02332	Brush or brush-and-grass mixture fire	0.9
10/30/2020	23082	2020-002288	07:31	194	ALDEN ST		02332	Forest, woods or wildland fire	0.1
03/10/2021	23082	2021-000459	13:20	150	CHANDLER ST		02332	Brush or brush-and-grass mixture fire	1.2
03/11/2021	23082	2021-000469	08:54		RTE 3 SOUTH		02332	Grass fire	0.3
03/17/2021	23082	2021-000522	15:28	105	ALDEN ST		02332	Brush or brush-and-grass mixture fire	1.4
03/18/2021	23082	2021-000530	08:09	34	BAY RD		02332	Brush or brush-and-grass mixture fire	0.8
03/22/2021	23082	2021-000565	12:40	24	REYNOLDS WAY		02332	Brush or brush-and-grass mixture fire	0.2
03/27/2021	23082	2021-000598	11:13	198	KEENE ST		02332	Grass fire	0.3
03/27/2021	23082	2021-000601	13:21	91	ROGERS WAY		02332	Brush or brush-and-grass mixture fire	1.0
04/23/2021	23082	2021-000784	16:50	626	TEMPLE ST		02332	Grass fire	0.0
04/24/2021	23082	2021-000791	14:57	31	STATION ST		02364	Brush or brush-and-grass mixture fire	0.0
04/24/2021	23082	2021-000794	21:15	606	UNION ST		02332	Brush or brush-and-grass mixture fire	1.4
04/24/2021	23082	2021-000795	22:23	201	PINE ST		02332	Brush or brush-and-grass mixture fire	1.1
04/26/2021	23082	2021-000808	16:06	612	TEMPLE ST		02332	Brush or brush-and-grass mixture fire	0.2
05/14/2021	23082	2021-000937	18:58	10	OLD BARN RD		02332	Brush or brush-and-grass mixture fire	1.6
05/16/2021	23082	2021-000950	03:52	280	TEMPLE ST		02332	Brush or brush-and-grass mixture fire	2.0
05/22/2021	23082	2021-000989	13:43		RTE 3 NORTH EXIT 22		02332	Grass fire	0.0
05/24/2021	23082	2021-001016	13:19	870	SUMMER ST		02332	Brush or brush-and-grass mixture fire	0.0
07/20/2021	23082	2021-001546	18:26	333	CHURCH ST		02332	Grass fire	0.0
12/03/2021	23082	2021-002985	23:34	84	DUCK HILL RD		02332	Brush or brush-and-grass mixture fire	1.5
03/29/2022	23082	2022-000761	19:19		RABOTH RD		02364	Forest, woods or wildland fire	2.1
04/10/2022	23082	2022-000849	14:16	39	CRANBERRY DR		02332	Brush or brush-and-grass mixture fire	0.7
04/15/2022	23082	2022-000890	15:23		MM23.2 RTE 3 SB EXIT 22-27		02332	Brush or brush-and-grass mixture fire	5.3
04/16/2022	23082	2022-000902	16:48	1008	UNION ST		02332	Brush or brush-and-grass mixture fire	0.4

**TOWN OF DUXBURY HAZARD MITIGATION PLAN
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APPENDIX D: WILDFIRE INCIDENCE RECORDS 2018-2024

Date	FDID	Incident#	Alarm	###	Address	Suite	Zip	Type	Lgth
04/22/2022	23082	2022-000943	16:58	1500	TREMONT ST		02332	Brush or brush-and-grass mixture fire	0.2
04/23/2022	23082	2022-000950	12:40	53	TAYLOR ST		02332	Forest, woods or wildland fire	0.8
04/28/2022	23082	2022-000995	15:02	100	ATWELL CIR		02050	Brush or brush-and-grass mixture fire	1.5
05/02/2022	23082	2022-001031	13:11	120	BUCKBOARD RD		02332	Brush or brush-and-grass mixture fire	0.7
05/07/2022	23082	2022-001087	15:35	1502	TREMONT ST		02332	Brush or brush-and-grass mixture fire	0.2
05/22/2022	23082	2022-001211	17:43	11	RESERVE WAY		02332	Brush or brush-and-grass mixture fire	0.7
07/29/2022	23082	2022-001821	12:53	462	WEST ST		02332	Natural vegetation fire, other	0.2
08/08/2022	23082	2022-001929	14:54		MM20.2 RTE 3 SB EXIT 20-22		02332	Grass fire	0.4
11/05/2022	23082	2022-002717	14:16	60	OAK ST		02332	Forest, woods or wildland fire	0.6
11/22/2022	23082	2022-002861	03:34	7	LANTERN LN		02359	Forest, woods or wildland fire	1.9
11/26/2022	23082	2022-002905	14:21		RTE 3 SOUTH		02332	Grass fire	0.5
03/20/2023	23082	2023-000603	17:40	580	CENTER ST		02359	Forest, woods or wildland fire	1.8
04/10/2023	23082	2023-000750	10:42	60	SOUTH RIVER LANE WEST		02332	Forest, woods or wildland fire	0.7
04/13/2023	23082	2023-000784	12:06	101	GURNET RD		02332	Natural vegetation fire, other	0.3
04/20/2023	23082	2023-000839	13:30	52	WOODRIDGE RD		02332	Forest, woods or wildland fire	1.7
04/29/2023	23082	2023-000900	10:50	186	CRESCENT ST		02332	Brush or brush-and-grass mixture fire	0.5
05/11/2023	23082	2023-000965	07:16	9	PRISCILLA AVE		02332	Natural vegetation fire, other	0.2
05/30/2023	23082	2023-001100	12:13	581	TREMONT ST		02332	Natural vegetation fire, other	0.1
06/21/2023	23082	2023-001267	13:54	65	ENTERPRISE ST		02332	Grass fire	0.2
02/26/2024	23082	2024-000435	13:38	1	APPLE HILL LN		02332	Forest, woods or wildland fire	0.8
04/23/2024	23082	2024-000843	13:36		INDIAN POND RD		02360	Forest, woods or wildland fire	5.3
04/23/2024	23082	2024-000845	17:26		MM20.8 RTE 3 NB EXIT 20-22		02332	Brush or brush-and-grass mixture fire	0.9
04/27/2024	23082	2024-000874	14:28	36	BAY VIEW RD		02332	Brush or brush-and-grass mixture fire	0.6
04/27/2024	23082	2024-000875	15:24	27	CAROLINA TRL		02050	Brush or brush-and-grass mixture fire	5.2
09/16/2024	23082	2024-002158	16:09	418	SUMMER ST		02332	Grass fire	0.6
10/29/2024	23082	2024-002482	06:22		RANDOLPH ST		02021-	Brush or brush-and-grass mixture fire	5.7
11/19/2024	23082	2024-002665	05:59	695	HILLSIDE ST		02186-	Forest, woods or wildland fire	12.0
11/19/2024	23082	2024-002667	13:25		CONNELL ST		02184-	Brush or brush-and-grass mixture fire	3.6
11/19/2024	23082	2024-002670	16:56	209	ROCKLAND ST		02351-	Forest, woods or wildland fire	2.7
11/24/2024	23082	2024-002703	10:40	355	TEMPLE ST		02332	Brush or brush-and-grass mixture fire	0.4

Total Number of Incidents: 89

**TOWN OF DUXBURY HAZARD MITIGATION PLAN
DRAFT 2026 UPDATE**

APPENDIX E: DOCUMENTATION OF PLAN ADOPTION

<PRINT ON TOWN LETTERHEAD>

**CERTIFICATE OF ADOPTION
SELECT BOARD
TOWN OF DUXBURY, MASSACHUSETTS**

A RESOLUTION ADOPTING THE
TOWN OF DUXBURY HAZARD MITIGATION PLAN 2026 UPDATE

WHEREAS, the Town of Duxbury established a Hazard Mitigation Planning Team to prepare the *Town of Duxbury Hazard Mitigation Plan 2026 Update*; and

WHEREAS, the *Town of Duxbury Hazard Mitigation Plan 2026 Update* contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Duxbury, and

WHEREAS, duly-noticed public meetings were held by the Duxbury Select Board on March 23, 2025, and September 28, 2026 and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Duxbury Select Board adopts the *Town of Duxbury Hazard Mitigation Plan 2026 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Duxbury.

ADOPTED AND SIGNED this Date. _____

Name(s)

Title(s)

Signature(s)

ATTEST