May 2020

TOWN OF DARTMOUTH

Municipal Vulnerability Planning Project *and* 2020 Hazard Mitigation Plan Update

Summary of Findings

Prepared for:

Town of Dartmouth
Town Hall, 400 Slocum Road
Dartmouth, MA 02747

Contents

Note: *This report has been prepared in accordance with the Community Resilience Building (CRB) Guide and Municipal Vulnerability Program (MVP) "Summary of Findings Template Guidance" provided by the Massachusetts Executive Office of Energy and Environmental Affairs (MA EEA).*

1. Background Information

1.1 MVP Program Overview

In 2016, Massachusetts Governor Charles Baker issued Executive Order 569 to establish a comprehensive statewide approach to reduce greenhouse gas emissions and prepare for the impacts of climate change. As part of this initiative, the Massachusetts Executive Office of Energy and Environmental Affairs administers the Municipal Vulnerability Preparedness (MVP) Program. The MVP Program provides communities with funding to identify vulnerabilities and develop plans to increase climate change resilience. In 2018, a $2.4 billion Environmental Bond Bill authorized over $200 million to fund climate change adaptation, including both planning and implementation aspects of the MVP Program.

To date, 249 of the Commonwealth's 351 municipalities (71%) have participated in the MVP Program. This has resulted in more than $17 million dollars in Planning Grants and Action Grants to implement high priority actions identified during the planning process. Projects funded through Action Grants are wide ranging, including the following priority project categories:

- More detailed vulnerability and risk assessments;
- Community outreach and education projects;
- Local bylaw updates;
- Redesign and retrofits of infrastructure;
- Nature-based solutions for flood protection, drought mitigation, and water quality improvements;
- Nature-based infrastructure and technology solutions for extreme heat and poor air quality.

1.2 Community Resilience Building Workshop

The Town of Dartmouth (Town) received funding through an MVP Planning Grant to compile data for and conduct a Community Resiliency Building (CRB) workshop. The goal of the CRB workshop was to have community stakeholders work collaboratively to complete a climate change and natural hazard vulnerability assessment and develop prioritized actions to address vulnerabilities and improve strengths. Upon completion of the CRB workshop process, Dartmouth will become an "MVP Community" and will be eligible to apply for MVP Action Grant funding from the Commonwealth.

An interdisciplinary team of Town staff (i.e., "Core Team") worked to implement the CRB process with consulting support from Comprehensive Environmental, Inc. (CEI), a certified MVP provider. The Town's MVP Core Team included the following:

Town of Dartmouth – MVP Core Team
Marc J. Garrett, Town Conservation Officer
Mike O'Reilly, Environmental Affairs Coordinator
Shawn MacInnes, Town Administrator
Christine O'Grady, Planning Director
Deborah Melino-Wender, Director of Development
David Hickox, Director of Public Works

1.3 Workshop Preparation

The following tasks were performed to prepare for the CRB workshop:

- The Core Team and CEI held a kickoff meeting on January 14, 2020 to plan for the workshop.
- CEI conducted interviews with Core Team members to identify potential areas of concern, strengths, and vulnerabilities.
- CEI prepared presentation materials and Town-wide maps to guide the workshop.
- The Core Team scheduled the workshop, invited stakeholders, and handled logistics.

1.4 Workshop Process

A full-day MVP planning workshop was held on March 5, 2020 in accordance with CRB guidance[1]. The workshop participants are listed below.

Name	Organization
Marc Garrett	Dartmouth Conservation Officer
Shawn MacInnes	Town Administrator - Dartmouth
Deborah Wender	Director of Development
David Hickox	DPW Director – Dartmouth
Christine O' Grady	Planning Director – Dartmouth
Michael O'Reilly	Dartmouth Environmental Affairs Coordinator
Roger Race, Vice Chair	Waterways Committee - Dartmouth
James Kiely, Asst. Superintendent	School – Administration - Dartmouth
Tim Barber	Town Engineer - Dartmouth
Paul Pacheco	Hwy. Supt. - Dartmouth
Brian Levesque, Chief	Dartmouth Police Department
Jim Storey, Deputy Chief	Dartmouth Police Department
Troy Vincent, Deputy Chief	Dartmouth Police Department
Tim Andrade, Chief	Dartmouth Fire District 2
Dexter Mead, Executive Director	Dartmouth Natural Resource Trust
Linda Vanderveer, Land Manager	Dartmouth Natural Resource Trust
Leah Howard, Land Steward	Dartmouth Natural Resource Trust
Kendra Murray, Development and Outreach	Dartmouth Natural Resource Trust
Lorraine Granda, BOD President	Dartmouth Natural Resource Trust
Andrew Mellgard, BOD Vice Pres.	Dartmouth Natural Resource Trust
Jim Forbush, BOD	Dartmouth Natural Resource Trust
Gretchen Knowlton, BOD	Dartmouth Natural Resource Trust
Peg Gildersleeve, BOD	Dartmouth Natural Resource Trust
Hans Van Lingen	Eversource
Scott Alfonse, Director	Greater NB Reg. Refuse Mgmt. District
Michael Labossiere	City of Fall River
Tabitha Harkin, Planner	City of New Bedford
David Janik, Coordinator	MA CZM – Southeast Region
Rep. Christopher Markey	State Representative
Justin Downey, Staff	Rep. Christopher Markey's office
Patricio Belloy	UMASS – Boston/Climate Adaptation
Gina Purtell	Mass Audubon – Allens Pond
William Griffin	Round Hill Community Corporation
Parsons Clark	Salters Point Improvement Association
Sharon Work, Manager	Davis & Tripp Marine
Margaret Sweet	Local RE Agent and Planning Board
Mark Gildersleeve	Dartmouth Resident (DNRT associated)
Matthew Tweedie	DHS – Environmental Science Program

[1] CRB Guidance: www.communityresiliencebuilding.com

Hailee Cabral	Dartmouth High School
Nicholas Carnes	Dartmouth High School
Isabella Febbroriello	Dartmouth High School
James George	Dartmouth High School
Camden Lawton	Dartmouth High School
Ian Phillips	Dartmouth High School
Rafael Pereira	Dartmouth High School
Victoria Peltier	Dartmouth High School
Madison McNiel	Dartmouth High School
Hunter Marcovici	Dartmouth High School
Katherine Rosen	Dartmouth High School
Jack Sullivan	Dartmouth High School
Luke Sylvia	Dartmouth High School
Bob Hartzel	CEI
Elisha Musgraves	CEI
David Roman	CEI

The workshop was initiated with introductory presentation materials. Presentation materials included:

- Description of the MVP program and CRB process;
- Summary of Dartmouth's emergency management procedures;
- Introduction to climate change, including Dartmouth-specific climate change projections[2];
- Introduction to nature-based solutions (i.e., green infrastructure);
- Summary of stakeholder interview results.

Workshop participants were then split into three diversified sub-groups (6-7 people per group, see assigned teams in table above) to conduct concurrent guided exercises. As listed below, the exercises solicit and organize input from workshop participants through use of the Risk Matrix presented in Appendix B.

Workshop Exercises

Exercise 1: Identify the Town's top local natural and climate-related hazards of concern.

Exercise 2: Identify the Town's strengths and vulnerabilities relative to top hazards.

Exercise 3: Identify and prioritize actions to reduce vulnerabilities or improve strengths.

Exercise 4: Determine the Town's overall top priority actions.

Note: Exercises 1 and 4 were conducted with all workshop participants. Exercises 2-3 were conducted simultaneously by four sub-groups.

To help generate ideas and discussion during the planning exercises, each sub-group was provided a series of base maps (Appendix C) with information such as FEMA flood hazard areas, critical habitat areas, and conservation land within Dartmouth.

During the discussions between the Core Team and CEI, it was determined that Environmental Studies students from Dartmouth High School should be invited to attend the workshop to assist and gain practical experience in working toward solving environmental issues in a real-world setting. All agreed, and working with the faculty, thirteen (13) Advanced Placement and Honors students were selected to participate in the workshop (see the list of participants above). This occurred in parallel with discussions with EOEEA – MVP

[2] Climate Projections obtained from: www.resilientma.org

staff regarding student participation in the MVP/HMP workshop process. Dartmouth's move was certainly proactive and invaluable, as the students eagerly participated in the workshop breakout sessions and helped developed the hierarchy of priorities for Dartmouth. Also, as a practical matter, these students gained a level of ownership as they may/will be charged with future decision making related to implementing the initiatives identified herein.

This report provides an overview of workshop findings, including a summary of the Town's top hazards related to climate change, current climate resiliency strengths and vulnerabilities, and potential actions to improve the community's resilience to natural and climate-related hazards. The summary of findings described in this report are compiled from feedback from the workshop participants.

2. Top Hazards and Vulnerable Areas

2.1 Summary of Top Hazards

During Exercise 1, workshop participants were divided into four groups to discuss Dartmouth's top natural hazards and areas of concern. The groups then shared their conclusions and reached consensus on these topics.

The following four hazards were identified as presenting the highest direct and indirect risks to the infrastructure, societal, and environmental resources of Dartmouth:

1. **Flooding:** Both coastal and inland **f**looding was the hazard of highest concern to Dartmouth. There are several areas in town that have experienced historical flooding.

2. **Sea Level Rise**: As a coastal community, Dartmouth is subject to infrastructural damage as a result of sea level rise. Historically, flooding due to sea level rise has resulted in multiple closures of roadways critical for emergency response.

3. **Strong Storms:** Extreme weather events such as strong winter storms and heavy rainfall with high winds were another concern due to their potential for damage to infrastructure and other physical, social, and environmental consequences.

4. **Extreme/Increasing Temperatures:** As global temperatures continue along a long-term warming trend, local occurrences of drought and extreme temperature events are predicted to increase (i.e., days greater than 90º F). Drought conditions have the potential to limit water supply availability. Extreme temperatures have the potential to impact vulnerable populations without access to air conditioning.

2.2 Areas of Concern

Prior to the workshop, interviews were conducted with key stakeholders to develop a preliminary list of Dartmouth's primary climate resiliency vulnerabilities and strengths. Interviewees were primarily concerned with vulnerabilities relative to flooding and storm-induced hazards. Vulnerabilities of concern included economic disruption from emergency road closures, potential culvert failures, and loss of floodplain storage from ongoing development.

The table below lists areas of concern that were identified based on stakeholder interviews and feedback during the CRB workshop. Subsequent sections of this report provide more details on strengths and vulnerabilities (and potential solutions to increase resilience) relative to these areas of concern.

Category	Areas of Concern
 **Infrastructure**	• Stormwater management system (town-wide) • Dam management (e.g., Russells Mills, Cornell Pond) • Low-lying roadways (e.g. Round Hill Beach Road, Little River Road) • Public water and wastewater facilities • Sea walls (including Apponagansett Park and Russells Mills Landing) • Smith Neck Road at Conservation Commission Beach
 **Societal**	• Senior Housing: Council on Aging, Cedar Dell, Autumn Glen, others • Villages: Padanaram, Apponagansett, South Dartmouth • Public Amenities: Schools, Housing Authority, Emergency Services, Emergency Sheltering • Regional partnerships (including partnerships with UMass-Dartmouth and Eversource – both seen as strengths and needing improvements in some areas)
 **Environmental**	• Buttonwood Brook Watershed • Slocums River Corridor • Destruction Brook • Noquochoke Lake • Marshlands and wetlands (e.g. Cow Yard Marsh) • Paskamanset River

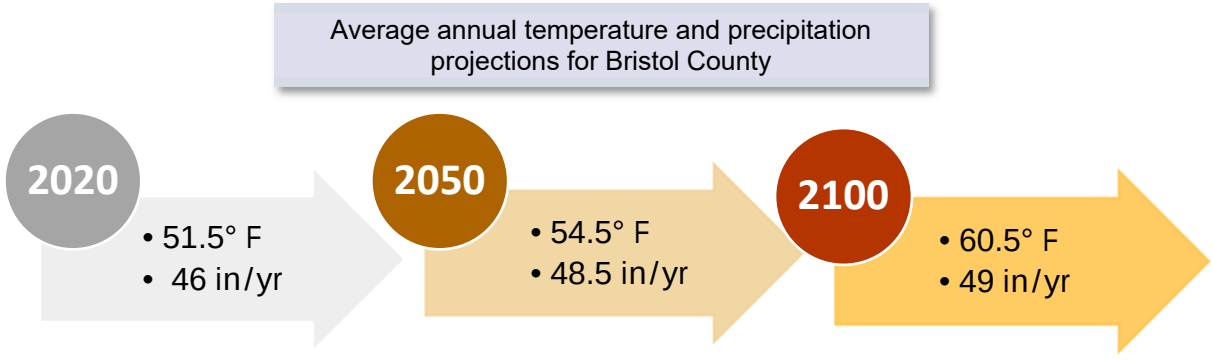
3. Current Concerns and Challenges Presented by Hazards

As a low-lying, south-facing coastal community, Dartmouth faces multiple challenges related to potential impacts from natural hazards. In recent years, the Town has experienced multiple disruptive and damaging weather events, including Tropical Storm Irene (August 2011), Tropical Storm Sandy (October 2012), winter Nor'easter Nemo (February 2013), the October 2017 Sou'easter, winter Nor'easter Quinn (March 2018), and Hurricane Barry (August 2019). These storms brought heavy rain-induced flooding, storm surge, wind damage to trees, and snow that caused widespread damage to Dartmouth and many other Massachusetts communities. Dartmouth was also impacted by the drought experienced across the state in 2016.

The intensity and frequency of extreme weather events has increased awareness of Dartmouth's natural hazards and risks associated with climate change, while motivating communities throughout Massachusetts to comprehensively assess and improve resilience at the local level.

The following is a summary of climate change projections for Bristol County, Massachusetts from the Climate Change Clearinghouse (CCC) for the Commonwealth (www.resilientma.org):

> ***Note**: Climate change projections below are based on median modeled results – some models predict higher and lower outcomes.*



3.1 Categories of Concerns and Challenges

During the guided exercises, workshop participants identified Dartmouth's vulnerabilities and strengths to natural hazards. As in any community, Dartmouth is not uniformly vulnerable to potential hazards and climate change impacts – certain locations, resources, and populations will be affected to a greater degree than others. Workshop participants identified the following as key areas of concern across three categories – infrastructure, societal, and environmental.

3.1.1 Infrastructure Concerns

- **Stormwater Infrastructure**: Workshop participants expressed concerns about the Town's stormwater management system. Specific areas of concern included the following:
  - Aging and undersized culverts and pipes throughout town that pose flooding risks at multiple locations in Town (e.g., Russells Mills Village).
  - Areas adjacent to Apponagansett Bay and Slocums River have a history of flooding. Although the Town has conducted some previous engineering design studies to mitigate

flooding in these areas, these improvements have not been implemented yet.

- Localized flooding historically occurs at Smith Neck Road and near Little River Road/Potomska Road, with road flooding exacerbated by low spots in the roads.
- Sea walls requiring repair and improvements, including the sea walls at Apponagansett Park and Russells Mills Landing.

- **Water and Wastewater Services in Floodplains**: Flooding is a recurring issue at Town sewer pumping stations and at access roads to Town water supply wells. Flooding in these areas presents contamination risks to groundwater, surface water, and public water supply.
- **Electrical Power Lines**: Power lines have historically experienced storm damage, primarily due to fallen limbs from nearby trees. It can take Eversource weeks to restore power after strong storms.

3.1.2 Societal Concerns

- **Vulnerable Communities**: Several densely populated areas with vulnerable populations were identified during the workshop, including senior housing complexes and village areas as identified in Section 2.2 (Areas of Concern).
  - Emergency alerts and planning information may not be fully reaching disabled and elderly demographics (i.e. groups or individuals that may not be on the DPW Snow and Ice Emergency List.
  - Workshop participants indicated that emergency responders are not always aware of hazards unique to each housing complex.
- **Emergency Access**: Concerns related to the repeated flooding of the Padanaram Village Causeway were raised. Specifically, the Bridge Street Fire Station access to properties across Apponagansett Bay is restricted and results in increased response times.
- **Collaboration with UMass Dartmouth:** The Town and UMass Dartmouth have used each other's facilities for emergency sheltering in the past, on an as-needed basis. However, stakeholders felt that communication between the Town and UMass related to the sharing of emergency shelters could be improved, and that further collaboration should take place.

3.1.3 Environmental Concerns

- **Land Availability:** Workshop participants expressed concern that continued land development will result in a reduction in green space and associated climate resiliency benefits. New development can lead to increases in energy usage (and associated greenhouse gas emissions), water quality impairments associated with increased impervious surfaces, loss of forest and other natural vegetation cover, and loss of floodplain storage.
- **Forest and Wetland Management**:
  - Workshop participants indicated that many trees in Town were planted at roughly the same time, resulting in a large number of mature trees that are prone to falling or dropping limbs during storms.

- An increase in nuisance insects (i.e., ticks, mosquitos, emerald ash borer) and invasive plants (e.g. Japanese knotweed)) were also discussed as risks related to increasing temperatures which require active land management measures.
- Coastal erosion and habitat degradation to freshwater and estuarine wetlands, beaches, and salt marshes.

- **Surface Water Impairments:** Workshop participants were concerned with water quality impairments throughout Town. The following waterbodies in Dartmouth are listed for impairments[3].

Waterbody	Impairment
Slocums River	fecal coliform, nitrogen, nutrient/eutrophication biological indicators
Buttonwood Brook	Enterococcus, E. coli, fecal coliform
East Branch Westport River (from Noquochoke Lake)	Enterococcus, E. coli
Turner Pond	Mercury in fish tissue
Apponagansett Bay	Fecal coliform, nitrogen, nutrient/eutrophication biological indicators, PCBs in fish tissue
Buzzards Bay	Fecal coliform, PCBs in fish tissue
Copicut River	Mercury in fish tissue, PCBs in fish tissue
Noquochoke Lake	Non-native aquatic plants, Enterococcus, mercury in fish tissue, PCBs in fish tissue, turbidity
Paskamanset River	Enterococcus, E. coli

Some of these impairments may be worsened by the effects of climate change. For example, increased temperatures during the growing season can exacerbate impairments associated with biological productivity (e.g. algae blooms, low dissolved oxygen), and increased amounts of intense precipitation can increase nutrient loading and turbidity. Specific concerns include:

- Septic systems in some areas of Town are at risk of failure from high groundwater tables and storm surge associated with localized flooding. Areas of particular concern include properties near Destruction Brook, Buttonwood Brook, and Apponagansett Bay.
- High levels of total nitrogen in the Slocums River indicate potential wastewater sources and nonpoint source pollution as a result of stormwater runoff from surrounding properties.

[3] MA Year 2016 List of Integrated Waters: https://www.mass.gov/files/documents/2020/01/07/16ilwplist.pdf.

4. Current Strengths and Assets

Workshop participants identified the following as Dartmouth's key climate change resiliency strengths:

- **Emergency Services:** The Town has a good emergency response track record. The following strengths related to emergency services were noted:
    - The Department of Public Works (DPW) has a Snow and Ice Emergency List of priority residents that require emergency access before the general population. The DPW also has a list of parcels that are within the dam inundation area from the 2019 Emergency Action Plan for the Russells Mills Pond Dam.
    - Emergency sheltering plans were recently updated to accommodate pets and larger farm animals, which helps to promote the use of emergency shelters by people who would otherwise be unwilling to leave their pets and animals.
    - Existing facilities have been recently improved (e.g., the High School was upgraded with a generator for backup emergency power supply).
- **Protected Open Space:** The Town includes approximately 10,200 acres of municipal or state-owned conservation land and protected open space. This includes public drinking supply protection areas with no public access or recreation. Much of this protected land overlaps with wetlands, floodplains, and sensitive ecological features, which provide natural flood storage and resiliency to flooding events and habitat for rare and endangered species. Article 11 of the Dartmouth Zoning Bylaws enables the Town to require developers to meet Open Space Residential Development (OSRD) design criteria, when creating new residential developments.
- **Strong Relationships with Non-Profit Organizations and Utilities:**
    - The Town has a good working relationship with environmental and research groups such as the Buzzards Bay Coalition, the Dartmouth Natural Resources Trust (DNRT), and the Massachusetts Audubon Society. These relationships ensure that critical information is shared between stakeholders and incorporated into Town planning efforts.
    - The Town also has a strong collaborative relationship with Eversource, the power utility for Dartmouth. This has proven to be a benefit with regard to grid expansion and dead tree removal and pruning to prevent outages. The Town has also partnered with Eversource and DNRT to develop an Invasive Species Management Plan.

5. Recommendations to Improve Resilience

As summarized below, the final step of the workshop was to develop recommended actions to address identified vulnerabilities and to improve strengths.

- Each workshop sub-group identified potential actions and assigned each action a priority (i.e., high, medium, low), then differentiated them as short-term, long-term, or ongoing efforts.
- Each sub-group selected their top five actions, then reported out to the entire group.
- The overall stakeholder group then voted to collectively determine the top three actions.

The sections below provide a description of prioritized recommendations developed from the workshop.

5.1 Top Three Recommendations

1. Town-wide Stormwater Resiliency Assessment

There are multiple culverts, roadways, and waterways in Town that frequently flood. These floods lead to the closure of critical roads and evacuation routes, and can prevent emergency services from reaching vulnerable populations. Being a coastal town, Dartmouth is subject to flooding from both large precipitation events and coastal storm surges.

Several flood-prone areas in Dartmouth that have already undergone engineering assessment and/or design for flood mitigation, but improvements in these areas have not yet been implemented. It is recommended that the Town continue to work with MassDOT on funding for a town-wide Transportation Improvement Program. The Town should also continue to work toward implementation of high priority flood mitigation improvements, including completion of additional engineering studies and final designs as needed for locations including those listed below:

- Culvert on Horse Neck Road
- Low-lying roadway along Little River Road
- Padanaram Village Causeway
- Russells Mills Village
- Smith Neck Road

A list of flood-prone areas and flooding types identified by stakeholders is provided below.

Flood-prone Areas	
Stormwater Flooding	**Tidal Flooding**
Destruction Brook (Horseneck Road)	Potomska Road
Smith Neck Road	Clarks Cove
Tucker Road	Rogers Street culverts
Buttonwood Brook watershed	Padanaram Village and Causeway
Little River Road culvert	Round Hill Beach
Russells Mills Village (dam, culverts)	Sol E Mar Street
Chase Road	Gulf Road/Bridge Street
	Smith Neck Road
	Apponagansett (Dias) Landing

In addition to implementing flood mitigation in the areas listed above, the Town of Dartmouth should complete the following tasks to address flooding concerns:

- Assess: Expand previous study areas to include a comprehensive vulnerability and resiliency assessment of all Town drainage and flood-prevention infrastructure (i.e., drainage pipes, culverts, open channels, sea walls). The assessment could include any or all of the following components: interviews with Town personnel, condition inspections, flood modeling relative to projected higher intensity storms and sea level rise, identification of areas of concern, and prioritized recommendations for repairs and replacements.

- Replace: Replace previously identified key infrastructure. Replacement steps would include: engineering feasibility analysis (i.e., modeling, conceptual design), permitting, engineering design, and construction. Consult previously conducted assessments, reports, and designs for critical retrofits that have not yet been implemented.

- Maintain and Restore: Obtain approvals to enable maintenance and restoration of key stormwater infrastructure as identified by the vulnerability assessment (e.g., conveyance channels with reduced function due to sedimentation). Required approvals are expected to include maintenance easements from private landowners and various permitting approvals, such as requirements covered by the Massachusetts Wetlands Protection Act.

- Mitigate: For areas with no stormwater or flood-prevention structures to replace, conduct engineering design to implement controls that mitigate the risks of additional sea level rise or large precipitation events.

2. Acquire Key Parcels for Land Conservation and Restoration

Dartmouth contains critical inland, estuarine, and coastal habitat for a wide variety of species. Some of these habitats also serve as critical floodplains for the Town. As a result of continued land development in flood-prone areas, property damage claims from flooding are increasing. Conserving land within floodplains, as well as parcels that are within other increasingly flood-prone areas, will help mitigate future property damage. It is recommended that the Town continue to take the following actions to ensure resiliency against flooding and habitat loss from sea level rise and large storms:

- Perform a Town-wide floodplain modeling study (current 100-yr floodplain vs. projected future 100-yr floodplain); identify potential economic losses as a result of flooding (i.e., Hazus analysis) and identify parcels in future floodplain (i.e., acquisition targets)

- Assess available parcels for acquisition in the following priority areas:
    - Slocums River corridor
    - Noquochoke Lake floodplain
    - Buttonwood Brook watershed
    - Paskamanset River watershed

In addition to floodplain loss, beaches and salt marshes in Dartmouth are being degraded by continued surrounding development and associated stormwater runoff. This has contributed to coastal erosion and habitat loss. As sea levels continue to rise, it will be critically important to have sufficient open space available to allow for landward migration of coastal dunes, salt marsh, and other coastal wetland features. Restoring existing coastal parcels and acquiring key parcels both surrounding and landward of them will help to protect sensitive coastal and estuarine habitats and allow for adaptation to a changing climate.

A salt marsh in Apponagansett Bay

It is recommended that the Town target the following areas for restoration and conservation, including beach nourishment studies, salt marsh restoration, salt marsh migration studies, coastal erosion assessments, and related vulnerability assessments:

- Apponagansett Bay salt marshes
- Cow Yard Salt Marsh
- Allens Pond
- Round Hill Beach
- Any other top priority sites as identified in the *Atlas of Tidally Restricted Salt Marshes in the Buzzards Bay Watershed*

The Buzzards Bay Coalition and Buzzards Bay National Estuary Program have resources available that document previously conducted studies and assessments that may be useful to the implementation of restoration efforts.

3. Mitigate Town Sewerage Pump Station Flooding

The Dartmouth Water Pollution Control Division identified sewerage pumping stations that are located within the Paskamanset River floodplain. The Paskamanset River has impairments for both Enterococcus and E. coli bacteria. As sea level rises and precipitation events increase, flooding near sewerage pump stations can result in groundwater contamination.

Areas identified as already experiencing repetitive flooding include the Faunce Corner and North Station pump stations. To reduce existing flood risks and prevent future ones, it is recommended that the Town perform a vulnerability analysis of all pump stations and their proximity to existing and projected floodplains. Using data from this analysis, identify pumping stations that are most at-risk and conduct an engineering study to design mitigation measures that address flooding.

These measures may include increased use of green infrastructure, floodproofing of existing structures, and elevating buildings and other infrastructure as necessary.

5.2 Other Prioritized Recommendations

Higher Priority

- Rising temperatures and an increased frequency of extreme temperatures (e.g., days above 90F) are increasing wastewater treatment costs to Dartmouth's municipal wastewater treatment facility. High temperatures also create technical challenges related to the treatment of increasing amounts of nitrogenous bacteria. Obtain grant funding for new treatment technologies for nitrates.
- Develop a renewable energy plan for all Town facilities and properties to be carbon neutral (e.g., solar panels on schools, etc.).
- Storm surge cuts off access to Padanaram Village for emergency services from the Bridge Street Fire Station. Conduct an engineering/design study for the installation of an additional culvert under the causeway to reduce flooding by increasing tidal flow and drainage capacity. Assess feasibility of locating a Fire District 2 substation west of the causeway
- Tree/forest management recommendations include the following:
    - Many trees lost to gypsy moths, other insects and pathogens have not replaced. Conduct a Town-wide tree planting plan to improve forested buffers to increase resiliency.
    - Continue to implement the Key Trees Removal Plan for the Town.
    - Develop forest management plans for private and town-owned forested areas. Work with NRCS, land trusts, etc. to determine which areas need plans.
- Incorporate disposal and removal of disaster debris (e.g. trees, homes, etc.) into the Dartmouth Emergency Management Response Plan (in process) and evaluate as a regional problem.
- Develop a watershed management plan for the Slocums River which uses previous studies and assessments from the Buzzards Bay Coalition, Buzzards Bay National Estuary Program, the Town, and other available data. In addition, any watershed development plan must contribute to water quality improvements in conformance with the requirements set forth the Slocums and Little River TMDL issued by Massachusetts Department of Environmental Protection in September 2019.

Moderate Priority

- Strengthen the ability of Town boards to enforce bylaws requiring Low Impact Development (LID) techniques for new developments and which strengthen floodplain protections.
- Develop Agricultural Resiliency Plans (ARPs) to assist farmers. Work with the Natural Resources Conservation Service, UMass Dartmouth, the Rural Caucus, and other local agricultural organizations to develop ARPs.
- Health issues associated with increasing temperatures (i.e. ticks, mosquitos): Conduct a public education campaign for prevention and work with the Dartmouth Director of Public Health to expand public education. Continue to coordinate with the Bristol County Mosquito Control District.
- To address Town-wide and regional concerns regarding dams on shared waterways:
    - Conduct a feasibility assessment and develop concept plans for potential dam removals, mechanical upgrades, and/or improvements to outlet controls, working from downstream to upstream sites. Include public outreach/education as a key part of this effort.
    - Expand recently completed assessment of dams to include dams on private property.

- Although Russells Mills Dam was recently repaired, flooding still occurs in adjacent roads and other upstream. The 2019 Emergency Action Plan for Russells Mills Pond Dam included an Impacted Area Summary and Inundation Map for impacted parcels. Conduct an engineering study to initiate design and installation of a mechanical flood gate to mitigate repeated flooding.
- Develop a town-wide management plan targeting invasive species present in vegetated stormwater structures (e.g., detention basins) and floodplains.
- The Town's volunteer base for disaster/emergency response is inadequate. Develop and implement a plan to increase the base of volunteers for disaster/emergency response. Options may include obtaining funding sources to pay emergency response volunteers and new public outreach efforts to solicit volunteer commitments.
- Dartmouth offers a "DPW Emergency List" that serves to notify and facilitate emergency response for at-risk individuals during natural hazards. Many community members are not aware of this service. Increase public outreach to vulnerable populations on available services.
- Conduct engineering studies as needed to construct improved stormwater controls and drainage improvements for the High School sport fields.
- Public water and sewer are not provided in parts southern Dartmouth. In these areas, private wells and septic system leach fields are susceptible to saltwater intrusion from sea level rise. Perform a feasibility study for expansion of water supply and sewer networks to unserved areas. Develop a septic system database of private systems and conduct an Environmental Risk Assessment of non-sewered areas to determine flooding risk. Explore requirement for installation of nitrogen removing septic systems in areas where public sewer is not available.

Lower Priority

- Access to Town Well D and Well E can be restricted due to flooding during large storms. Improvements at these locations would include elevating the access road and retrofitting the adjacent stream crossing with an adequately sized box culvert to accommodate flood passage.
- It can take weeks for Eversource to restore power following outages caused by strong storms. Preventative maintenance (tree work) has been good to date, but steps to reduce the length of outages should be addressed when the Eversource 5-year permit is up for renewal. Continue to work with Eversource to install the proposed power line for increased system redundancy.
- Partner with UMass Dartmouth to implement proposed improvements to limit flooding due to runoff at the entrance of the school and Cross Road (e.g., green infrastructure).
- Many of the Town's most expensive properties and properties with the highest tax base are the most vulnerable to flooding. Continuously update town regulations to ensure that building specifications include the latest best practices to accommodate for climate change.

The prioritized recommendations listed above were developed by workshop participants based on identified vulnerabilities and strengths related to climate change.

- It is recommended that the Town create a working group to implement recommendations from this plan. The working group would develop anticipated timelines, determine potential funding requirements, and apply for grant funding to implement prioritized recommendations.
- It is also recommended that this report be reviewed and updated annually as actions are completed and/or new needs are identified.

6. Hazard Mitigation Plan Update

6.1 Background

As part of its MVP Planning Grant, the Town received funding to update the 2015 Dartmouth Hazard Mitigation Plan (HMP). The Massachusetts Emergency Management Agency (MEMA) requires municipalities to submit updates to HMPs every five years. The HMP includes information on a wide range of hazard-related topics as listed below in the Master List of HMP Updates table. Some sections of the 2015 HMP were reviewed, determined to be current and accurate, and required no update. The table below lists the sections of the HMP that have been updated with new information as provided in Sections 6.2 and 6.3 of this report. The 2015 HMP is provided for reference as Appendix D.

Master List of HMP Updates

2015 HMP Section Headers	Summary of 2020 Updates
2.2 Local Planning Team	Updated Table 2.1
2.3 Team Meetings	Updated text
3.5 Land Use and Zoning	Updated (see new maps in Appendix C)
4.0 Natural Hazards	Updated Tables 4.1, 4.5, and 4.8
4.1 Floods	
4.2 Winter Storm Events	
4.3 Hurricanes and Nor'easters	
4.4 Tornadoes and Thunderstorms	
6.0 High Hazard Areas	
6.1 Critical Infrastructure	Updated Tier 1, 2 and 3 Facilities (new maps in Appendix C)
6.3 Repetitive Loss Properties	Updated text and map
8.8 Prioritization and Implementation of Mitigation Actions	Revised Tables 8.3 and 8.4; Updated project status

6.2 Updated HMP Tables and Sections

The information below represents updated information for the 2020 Dartmouth HMP Update. For reference to information that has remained unchanged since the 2015 HMP, please see the complete 2015 HMP Update provided in Appendix D.

Note: The numbering scheme for the revised sections and tables below is based on the section and table numbers in the 2015 HMP, rather than a continuation of the section numbering for this report.

Section 2.2 Local Planning Team

As listed below in Table 2.1, The Local Planning Team (LPT) consisted of various Town officials, business leaders, and other interested agencies and organizations to provide critical local knowledge of the community to facilitate development of this Plan.

Table 2.1 – Local Planning Team Members

Department / Agency	Name	Title / Position
Building Department	Dave Riquinha	Director of Inspectional Services
Community Television	Cynthia Marland	Director of Media
Conservation Commission	Mike O'Reilly	Environmental Affairs Coordinator
Council on Aging	Amy DiPietro	Director
Emergency Management Agency	Edward Pimental, Jr.	Director of the Emergency Management Agency
Executive Administration	Shawn MacInnes	Town Administrator
	Deborah Melino-Wender	Director of Development
Fire District 1	John Judson Marcel Dumont	Fire Chief Retired Fire Chief
Fire District 2	Tim Andre	Fire Chief
Fire District 3	Richard Arruda	Fire Chief
Harbormaster	Steve Melo	Harbormaster
Parks and Recreation	Timothy Lancaster	Director of Parks & Recreation
Planning Board	Christine O'Grady	Planning Director
Police Department	Brian Levesque	Chief of Police
	Jim Storey; Troy Vincent	Deputy Chiefs
Public Health	Christopher Michaud	Director of Public Health
Public Libraries	Lynne Antunes	Director of Libraries
Public Works	David Hickox	Director of Public Works
	Paul Pacheco	Superintendent Services & Infrastructure
School Department	Dr. Bonny Gifford	Superintendent of Schools
	James Kiely	School Business Manager
	Richard Ferreira	Director of Maintenance
Other Agencies and/or Organizations		
Bristol County Sheriff's Office	Thomas M. Hodgson Colonel Dave Gavigan	Sheriff Homeland Security
Eversource	Dennis Galvam Richard Tobin Donald Boudreau	Manager, Community Relations Manager, Emergency Preparedness Director, Electric Operations
UMass Dartmouth	Emil Fioravanti Captain Tim Sheehan	UMass Dartmouth UMass Dartmouth Police

Section 2.3 Team Meetings

In addition to the LPT described in the HMP, CEI coordinated with the LPT to confirm all relevant new information as needed for this 2020 HMP update. Some of this information was gathered between January-March 2020 through the MVP Planning Grant process, including planning meetings and the workshop held on March 5, 2020. Additional data was gathered in March and April 2020 via phone and email due to the 2020 COVID-19 pandemic.

Section 3.5 Land Use and Zoning

An updated Dartmouth Zoning Map and updated Dartmouth Land Use Map are provided in Appendix C.

Section 4.0 Natural Hazards

Table 4.1 – Major Disaster Declarations for Bristol County

Declaration Date	Incident Description	Disaster #
June 24, 2018	Severe Storm and Flooding	4372
April 13, 2015	Severe Storm, Snowstorm, and Flooding	4214
April 18, 2013	Severe Storm, Snowstorm, and Flooding	4110
December 19, 2012	Hurricane Sandy	4097
September 3, 2011	Tropical Storm Irene	4028
March 29, 2010	Severe Storm and Flooding	1895
November 10, 2005	Severe Storms and Flooding	1614
April 10, 2001	Severe Storms and Flooding	1364
June 23, 1998	Heavy Rain and Flooding	1224

Table 4.5 – Major Northeast Winter Storms from 2010 through 2018

Date	NESIS Score	Category - Description
February 4–7, 2010	4.38	3 - Major
February 9–11, 2010	4.10	3 - Major
February 25–27, 2010	5.46	3 - Major
December 26–27, 2010	4.92	3 - Major
January 9–13, 2011	5.31	3 - Major
February 1–3, 2011	5.30	3 - Major
February 7–10, 2013	4.35	3 - Major
March 4–9, 2013	3.05	2 - Significant
December 13–16, 2013	2.95	2 - Significant
December 30, 2013–January 3, 2014	3.31	2 - Significant
January 29–February 4, 2014	4.08	3 - Major
February 11–14, 2014	5.28	4 - Crippling
January 25–28, 2015	2.62	3 - Major
January 29–February 3, 2015	5.42	3 - Major
January 22–24, 2016	7.66	4 - Crippling
March 12–15, 2017	5.03	3 - Major
March 5–8, 2018	3.45	2 - Significant

Table 4.8 – Tornadoes in Bristol County

Date	Strength	Fatalities	Injuries
June 9, 2018	EF0	0	0
July 23, 2008	EF0	0	0
August 6, 1997	F0	0	0
September 14, 1972	F0	0	0
August 28, 1970	F2	0	0
August 2, 1970	F1	0	0
August 9, 1968	F1	0	4
September 7, 1958	F0	0	0
June 9, 1953	F3	0	17

Section 6.3 Repetitive Loss Properties

Nationally, approximately one-fourth of all National Flood Insurance Program (NFIP) claims have been paid to "repetitive loss properties," which, in turn, represent only 1.3% of all policies. Repetitive loss scenarios are as follows:

- Repetitive loss – Properties experiencing two or more losses of at least $1,000 each within any rolling 10-year period since 1978; and
- Severe repetitive loss – Single or multifamily residential properties experiencing 4 or more claims each exceeding $5,000, or properties with 2 separate claims with the cumulative dollar amount exceeding the market value of the property. Either scenario must have at least 2 claims occurring within 10 years of each other.

Repetitive loss properties are those for which two or more losses of at least $1,000 each have been paid under the NFIP within any rolling 10-year period since 1978. FEMA reports that two residential properties in Dartmouth have experienced repetitive losses, as shown on the Repetitive Flood Loss map provided in Appendix C.

Table 8.3 – Prioritization of In-House Mitigation Actions

Proposed Protection Measure	Responsibility	Implementation Timeframe	Status Updates and Notes
High Priority			
Action Item #1 – Petition FEMA to Update FIRMs	Department of Public Works; Conservation Commission	By 2020	Coastal Firms were updated 2009 with no changes anticipated from FEMA in the near future. Inland FIRMS will be adopted at the June 2020 Dartmouth Town Meeting and will become effective July 8, 2020.
Action Item #8 – Address Police Station Property	Special Committee	By 2018	Completed
Action Item #10 – Alleviate Flooding at Eddy Street	Department of Public Works	By 2020	In progress (Tucker Road flooding)
Action Item #12 – Improve Drainage under Padanaram Causeway	Department of Public Works	By 2020	Not completed.
Moderate Priority			
Action Item #2 – Establish an additional Emergency Shelter in North Dartmouth	Emergency Management Agency	2016-2017	Completed
Action Item #3 – Establish an additional Emergency Shelter near Smith Neck Road	Emergency Management Agency, Council on Aging	2016-2017	Completed (High School Shelter)
Action Item #16 – Expand use of Social Media and Other Public Outreach Channels	Emergency Management Agency, DCTV	Continuous yearly updates, by 2020	Ongoing
Action Item #18 – Improve Interdepartmental and Interagency Communications	All departments and boards	Continuous improvements, by 2020	Ongoing
Low Priority			
Action Item #4 – Establish Evacuation Procedures	Emergency Management Agency	2016-2017	Procedures are complete; Evacuation routes have not been clearly marked
Action Item #5 – Ensure Evacuation Routes provide Adequate Traffic Flow	Department of Public Works, Emergency Mgmt. Agency	2017-2019	Not completed; ongoing.
Action Item #6 – Address Recommendations on the Russells Mills Dam	Department of Public Works, Conservation Commission	By 2020	Completed a dam safety study; retired a failing culvert.
Action Item #17 – Prepare and Formalize Mutual Aid Agreements	Emergency Management Agency	2018-2020	Completed.

Table 8.4 – Prioritization of Property and Structural Mitigation Actions

Priority Rank	Proposed Protection Measure	Responsibility	Project Cost[1]	Potential Funding	Timeframe	Status Update
#1	**Action Item #9 –** Make Infrastructure Improvements along Buttonwoods Brook	Department of Public Works	$500,000	Local Funding & FEMA Grant	By 2019	One culvert replaced (Hawthorne); others not completed.
#2	**Action Item #7 –** Provide Flood Protection at Critical Wastewater Pump Stations	Department of Public Works	$200,000	Local Funding & FEMA Grant	By 2017	Pending, not completed.
#3	**Action Item #13 –** Improve Padanaram Bridge and Causeway Flow Capacity	Department of Public Works	$500,000	Local Funding & FEMA Grant	By 2020	Not completed.
#4	**Action Item #11 –** Enlarge Culvert or Raise Old Fall River Road	Department of Public Works	$250,000	Local Funding & FEMA Grant	By 2020	Not completed.
#5	**Action Item #14 –** Address UMass Drainage and Flooding Issues	UMass-Dartmouth, Department of Public Works	To be determined by UMass-Dartmouth	UMass; 319 Grant, Local Funding & FEMA Grant	By 2018	Some progress, still ongoing.
#6	**Action Item #15 –** Address Additional Areas Prone to Periodic Flooding	Department of Public Works	To be determined by Town of Dartmouth	Local Funding & FEMA Grant	Ongoing, high priority projects constructed by 2020	Ongoing; areas addressed include: Conner Corner, Fisher Rd, Solerma Rd

[1]Project cost is approximate, and is only intended to provide a scale of magnitude for estimating purposes.

*Section 10.1-10.3

6.3 HMP Map Updates

In addition to the HMP section and table updates provided in Section 6.2, the following map figures have been updated and are provided in Appendix C.

- Town of Dartmouth Base Map
- Tier 1 Critical Infrastructure
- Tier 2 Critical Infrastructure
- Tier 3 Critical Infrastructure
- Hurricane Inundation Areas, Maximum Extent of Storm Surge
- Dartmouth Parcels – Flood Hazard Areas
- Dartmouth Fire Districts
- Dartmouth Open Space and Protected Lands
- Dartmouth Aquifer Protection Districts – Parcels in Zone II and III
- Dartmouth Town-Owned Properties
- Wetlands of Dartmouth
- Dartmouth Zoning Map (Amended October 16, 2018)
- Dartmouth Land Use Map
- Repetitive Flood Loss Structures

7. Report Citation

Comprehensive Environmental, Inc. (2020). Town of Dartmouth Municipal Vulnerability Planning Project and 2020 Hazard Mitigation Plan Update, Summary of Findings.

APPENDIX A

INTRODUCTORY PRESENTATION MATERIALS

Town of Dartmouth
Municipal Vulnerability Preparedness Program
Community Resiliency Building Workshop

1

Welcome!

- **Opening Remarks**
  - Marc Garrett, Dartmouth Conservation Officer
  - Bob Hartzel, CEI

2

Introductions

- **Name**
- **Organization**

3

Workshop Agenda

- **Introductory Presentations**
- **Group Exercises**

Exercise #1: Identify Top Hazards

Exercise #2: Identify Vulnerabilities and Strengths

Lunch!

Exercise #3: Identify Actions to Reduce Vulnerabilities and Strengths

Exercise #4: Prioritize Top Actions

4

Workshop Overview

5

MVP Program Summary

EXECUTIVE ORDER 569 2016

- Reducing greenhouse gas emissions to combat climate change
- Preparing for the impacts of climate change
  - State Adaptation Plan
  - Climate Coordinators
  - Agency Vulnerability Assessments
  - Municipal Support

ENVIRONMENTAL BOND 2018

- $2.4 billion bond bill with focus on climate change resiliency
- Over $200 million authorized for climate change adaptation
- **Codifies EO 569, including the MVP Program**

Source: https://www.mass.gov/files/documents/2019/07/16/mvp-grant-program-overview-2019-mvp-vendor-training.pdf

6

MVP Process

Obtain Planning Grant

Complete Workshop

- Identify Actions to Address Vulnerabilities
- Write Report

Become Certified MVP Community

- Eligible for Grant Funding to Implement Actions

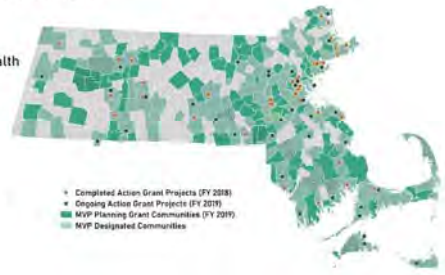
7

Three Years of MVP

MVP Designations
71% of the Commonwealth
249 communities

Action Grant Projects
FY 18: 37
FY 19: 36

Total Awards
$17M+ in planning and action grants to date



8

Workshop Purpose

Use Community Resilience Building Workshop Guide to:

- Complete **baseline assessment** of climate change and natural hazard vulnerability
- Develop **specific actions** to address priority hazards/vulnerabilities

---

- Discuss updates to the **Dartmouth Hazard Mitigation Plan**

9

Action Categories:

Hypothetical Example:
Fire Department floods during extreme storm events

Resiliency	Mitigation	Adaptation
• **Improve floodplain function**: ➢ riparian land conservation ➢ green stormwater infrastructure	• **Actions to reduce GHG** ➢ convert to electric municipal vehicles ➢ install solar panels on municipal buildings	• Flood-proof building • Relocate facility outside of 500-yr floodplain

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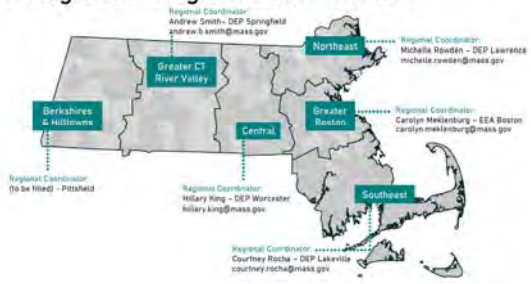
MVP Regions & Regional Coordinators



11

MVP Principles

A community-led, accessible process that

- Employs local knowledge and buy-in
- Utilizes partnerships and leverages existing efforts
- Is based in best available climate projections and data
- Incorporates principles of nature-based solutions
- Demonstrates pilot potential and is proactive
- Reaches and responds to risks faced by EJ communities and vulnerable populations

Why nature-based?
Where appropriate, nature-based solutions can be more cost-effective, protect water quality and quantity, sustain lands that provide food and recreation opportunities, reduce erosion, and minimize temperature increases associated with developed areas and climate change.

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Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) - September 2018

Hazard Mitigation Plan + Climate Adaptation Plan → SHMCAP

- Acknowledges that climate change is already worsening natural hazards, integrating information and planning elements for 14 natural hazards that affect the Commonwealth
- Uses best scientific data and projections to assess risk and vulnerability
- Evaluates the Commonwealth's existing capabilities to implement agency-specific and statewide activities to reduce risk and increase resilience

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MVP Process/ Grant Types

COMMUNITY RESILIENCE BUILDING WORKSHOP(S)

- Define and characterize hazards using latest science and data
- Identify existing and future community vulnerabilities and strengths
- Develop and prioritize community adaptation actions
- Determine overall priority actions
- Receive MVP designation

MVP Planning Grant

MVP Action Grant

Implement priority adaptation actions identified through planning process

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MVP Action Grants: Project Types

- Detailed Vulnerability and Risk Assessment*
- Community Outreach and Education
- Local Bylaws, Ordinances, Plans, and Other Management Measures
- Redesigns and Retrofits***
- Nature-Based Flood Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques**
- Nature-Based, Infrastructure and Technology Solutions to Reduce Vulnerability to Extreme Heat and Poor Air Quality

* Most common project type
** Second-most common project type
***Third-most common project type

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MVP Action Grants: Project Types (cont.)

- Nature-Based Solutions to Reduce Vulnerability to other Climate Change Impacts
- Ecological Restoration and Habitat Management to Increase Resiliency

NEW IN 2019

- Energy Resilience
- Chemical Safety
- Land Acquisition for Resilience
- Subsidized Low-Income Housing Resilience Strategies
- Mosquito Control Districts
- \+ Expanded eligibility of project location

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Nature-Based Solutions

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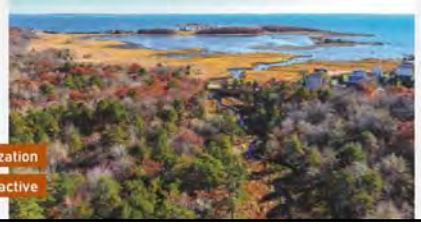
Example Action Grant Projects

Land Acquisition for Resilience

Mattapoisett

Purchasing 120 acres of forest, streams, freshwater wetlands and coastal salt marsh as conservation land to prevent development in vulnerable areas



Data utilization

Proactive

18

Example Action Grant Projects

Nature-Based Flood Protection, Drought Prevention, Water Quality, and Water Infiltration Techniques

Millbury

Utilizing green infrastructure like stormwater planters, bioretention bump outs, rain gardens, and other measures like porous pavers and pervious pavement to reduce heat island effects and stormwater runoff into the Blackstone River.

Nature-based solutions

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Example Action Grant Projects

Local Bylaws, Ordinances, Plans, and Other Management

Boston

Developing its first ever resilient building code so that development in the future floodplain is prepared for at least three feet of sea level rise, the likely scenario by late century.

Proactive

Pilot potential

Retrofitting a major waterfront park into a legacy park that uses nature-based solutions to address climate vulnerabilities while providing important access to recreation for residents.

Nature-based solutions

Community co-benefits

20

Example Action Grant Projects

Nature-Based Flood Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques

Belchertown

Designing and permitting for a replacement water storage tank that would increase storage capacity and resiliency to drought, and completing a feasibility/ concept design of a rainwater harvesting system at Belchertown High School to irrigate the athletic fields.

Nature-based solutions

Pilot potential

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Example Action Grant Projects

Redesigns and Retrofits

Salisbury

Increasing the resilience of the neighborhood of Ring's Island by raising its access/egress roads and by improving tidal flushing through culvert replacements

Vulnerable communities

22

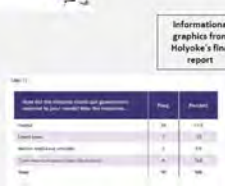
FY18 Action Grant Projects

Detailed Vulnerability and Risk Assessment, Further Planning

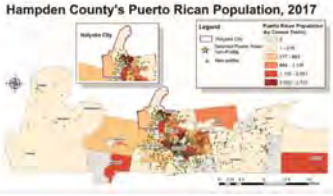
Holyoke

Conducted a detailed demographic analysis of individuals who arrived in Holyoke from Puerto Rico as a result of Hurricane Maria and develop recommendations for planning for future climate change migrants in Holyoke

Informational graphics from Holyoke's final report



Hampden County's Puerto Rican Population, 2017



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Next Steps: Climate Change & the Commonwealth

Bill S.10:

An Act for Climate Change Adaptation Infrastructure Investments in the Commonwealth

- Building on success of existing programs like MVP: Proposed new source of revenue for loans, grants, and technical assistance to municipalities and regional partnerships for priority adaptation projects
  - Proposed deeds excise increase → est. $137M annually ($1B in ten years)
  - Recurring, long-term revenue stream for multi-year project feasibility

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Climate Change 101

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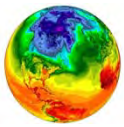
WEATHER vs CLIMATE

Atmospheric observations down to the minute	Weather statistics over a period of time (30 years)
Weather is what you get	Climate is what you expect
EX: Nor'easter, hurricane, heat wave	EX: Average high and low temperatures



https://www.youtube.com/watch?v=cBdxDFpDp_k

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How Does Climate Change Work?

The heat-trapping blanket metaphor

- The atmosphere is like a blanket that surrounds the earth.
- Burning fossil fuels adds more carbon dioxide to the atmosphere and makes the blanket thicker.
- The blanket has become too thick. It's trapping in too much heat, and the planet is warming up too fast.

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Massachusetts Observed Climate Changes

Temperature:	2.9°F	Since 1895 (Statewide)
Growing Season:	15 Days	Since 1950
Sea Level Rise:	11 inches	Since 1922 (Boston)
Heavy Precipitation:	55%	Since 1958

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Consequences

Changes in precipitation
- Inland flooding
- Drought

Rising Temperatures
- Wildfires
- Invasive species/pests

Extreme Weather
- Hurricanes/tornadoes
- Severe winter storms

Human-induced hazards
- Loss of habitat/floodplains
- Overuse of fertilizers/pesticides

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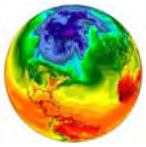
Dartmouth Climate Projections



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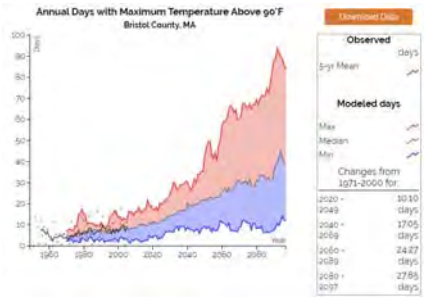
Hotter…by 2040, days per year over 90 F will almost double

TEMPERATURE



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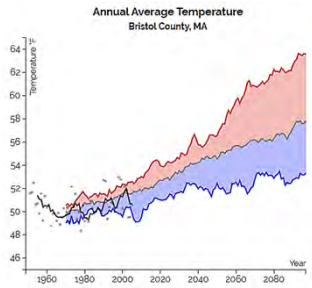
Hotter…average annual temperature steadily increasing

TEMPERATURE



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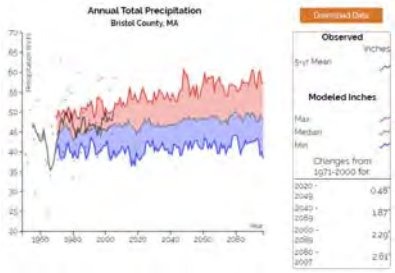
Wetter…more frequent intense precipitation events

PRECIPITATION



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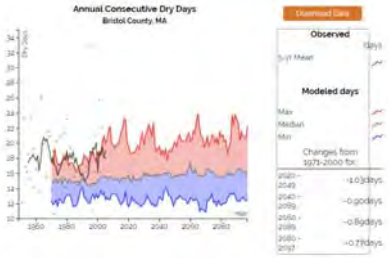
More frequent droughts

DROUGHT



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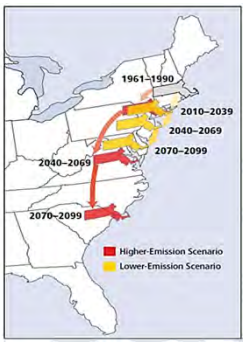
What do these Projections Mean?

(relative to temperature)



Source: https://www.yarmouth.ma.us/DocumentCenter/View/11769/MVP-Listening-Session-Presentation?bidId=

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Nature Based Green Infrastructure

36

Land Protection (acquisition, conservation easements, etc.)

37

Vegetated Buffers
(Reforestation, bank restoration, etc.)

- Pollutant Uptake /Filtering
- Habitat / Wildlife Food Source
- Shading
- Aesthetics
- Flood attenuation

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Improved Stream Crossings

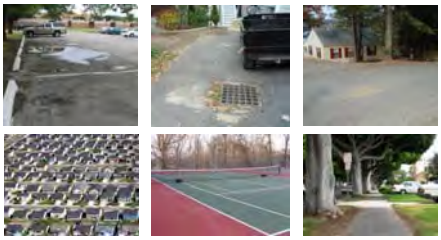
- Flood flow passage
- Streambank stability
- Wildlife passage

39

Low Impact Development (LID)

An ecosystem-based approach to land development and stormwater management

Mimic pre-development site hydrology!



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Example LID Practices

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Raingardens / Bioretention Areas

A bowl-shaped garden designed to capture and absorb stormwater.

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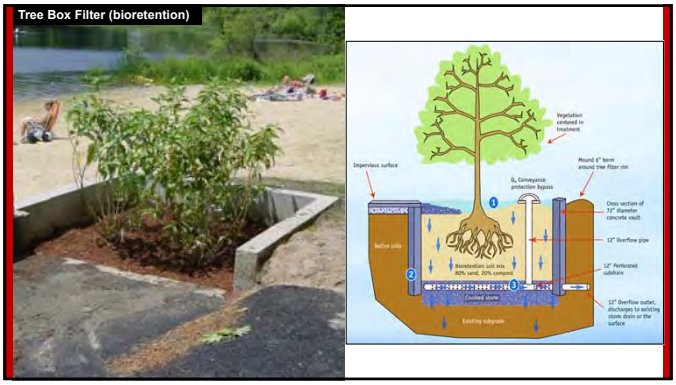

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Workshop Map Resources

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Flood Hazard Areas

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Repetitive Flood Loss Properties

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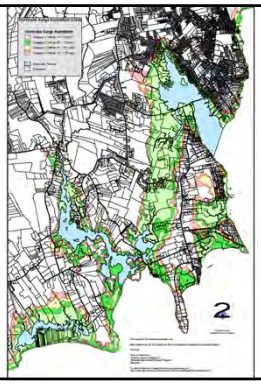
Hurricane Inundation Areas – Maximum Extent of Storm Surge



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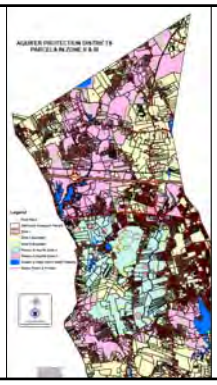
Aquifer Protection Districts



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Town Owned Properties

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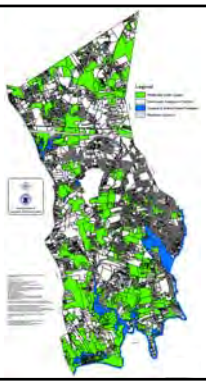
Open Space and Protected Lands



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Wetlands

53

Fire Districts

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Stakeholder Interview Results

55

Stakeholder Interview Results

VULNERABILITIES

Infrastructure	Environmental Damages	Cultural and Historic Sites
• Bridge and roadway closures • Land use and availability • Undersized culverts	• Bank erosion and failure • Invasive species (e.g. Phragmites)	• Coastal sites at risk of flooding (eg. Fort Rodman, historic wharfs) • Flooding in historic villages

Primary concern: Flooding

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Stakeholder Interview Results

STRENGTHS

- Good history of Emergency Response
- History of acquiring key parcels for conservation
- Open Space Residential Development bylaw
- Educational materials access: UMass-Dartmouth, DNRT, Town Library

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Group Exercises

1: Characterize Hazards

2: Identify Community Vulnerabilities and Strengths

3: Identify and Prioritize Community Actions

4: Determine Top Priority Actions

CEI Table Facilitators:

- Bob Hartzel
- David Roman
- Emily DiFranco
- Elisha Musgraves

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Hazard Mitigation Plan Update

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Updates to the 2015 Hazard Mitigation Plan

Planning Process
- Local Planning Team / Team Meetings

Local Profile
- Climate
- Land Use and Zoning
- Demographics
- Infrastructure

Natural Hazards / Vulnerability Assessment
- Floods
- Winter Storm Events
- Hurricanes and Nor'easters
- Tornadoes and Thunderstorms
- Forest Fires/Wildfires
- Drought
- Dam Failures/Breaches
- Future Climate Change / Global Warming
- ***Geologic Hazards***

High Hazard Areas
- Critical Infrastructure
- Hazardous Material Sources
- Repetitive Loss Properties
- High Hazard Areas /Recent Development in HHA

Existing Disaster Mitigation Measures
- Emergency Management Agency
- Emergency Management Plans
- Federal and State Regulations
- Local Regulations and Bylaws
- Backup Power Supplies
- Emergency Shelters and Mutual Aid
- Preventative Maintenance
- Structural Upgrades
- Public Outreach
- National Flood Insurance Program
- UMass-Dartmouth
- Existing Disaster Mitigation Measures Matrix

Planned Disaster Mitigation Measures
- Dartmouth Proposed Mitigation Actions
- Proposed Disaster Mitigation Matrix
- National Flood Insurance Program
- Community Preservation Fund
- Prioritization and Implementation of Mitigation Actions

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Prioritization of In-House (Dartmouth) Mitigation Actions (2015 HMP)

Proposed Measure	Responsibility	Implementation
High Priority		
Action Item #1 – Petition FEMA to Update FIRMs	DPW and ConComm	2020
Action Item #8 – Address Police Station Property	Special Committee	2018
Action Item #10 – Alleviate Flooding at Eddy Street	DPW	2020
Action Item #12 – Improve Drainage under Padanaram Causeway	DPW	2020
Moderate Priority		
Action Item #2: Establish add'l Emergency Shelter in North Dartmouth	Emergency Mgt. Agency (EMA)	2016-2017
Action Item #3: Establish add'l Emergency Shelter near Smith Neck Rd.	EMA; Council on Aging	2016-2017
Action Item #16: Expand use of Social Media/Other public outreach	EMA; DCTV	Continuous yearly updates; 2020
Action Item #18: Improve Interdepartmental/Interagency Communications	All departments and boards	Continuous improvements; 2020
Low Priority		
Action Item #4: Establish Evacuation Procedures	EMA	2016-2017
Action Item #5: Ensure Evacuation Routes provide Adequate Traffic Flow	DPW, EMA	2017-2019
Action Item #6: Address Recommendations on the Russells Mills Dam	DPW, ConComm	2020
Action Item #17: Prepare and Formalize Mutual Aid Agreements	EMA	2018-2020

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Prioritization of Property and Structural Mitigation Actions (2015 HMP)

Priority Rank	Proposed Measure	Responsibility	Project Cost[1]	Potential Funding	Timeframe
#1	Action Item #9 – Make Infrastructure Improvements along Buttonwoods Brook	DPW	$500,000	Local Funding & FEMA Grant	**By 2019**
#2	Action Item #7 – Provide Flood Protection at Critical Wastewater Pump Stations	DPW	$200,000	Local Funding & FEMA Grant	**By 2017**
#3	Action Item #13 – Improve Padanaram Bridge and Causeway Flow Capacity	DPW	$500,000	Local Funding & FEMA Grant	**By 2020**
#4	Action Item #11 – Enlarge Culvert or Raise Old Fall River Road	DPW	$250,000	Local Funding & FEMA Grant	**By 2020**
#5	Action Item #14 – Address UMass Drainage and Flooding Issues	UMass-Dartmouth; DPW	To be determined by UMass- Dartmouth	UMass; 319 Grant, Local Funding & FEMA Grant	**By 2018**
#6	Action Item #15 – Address Additional Areas Prone to Periodic Flooding	DPW	To be determined by Town	Local Funding & FEMA Grant	Ongoing, high-priority projects constructed **by 2020**

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Group Exercise #1: Characterize Hazards

Objective: Develop **top 4 hazards** for facilitated discussions on vulnerabilities and strengths of Dartmouth (infrastructure, natural resources, people, supply chain, etc.)

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Hazard: ultraviolet radiation

- **Strong Storms**
- **Flooding**
- **Drought**
- **Sea level rise**
- **Extreme temps**

Vulnerability: exposed skin

- **Undersized culverts**
- **Crop failure**
- **Low-lying properties**
- **Vulnerable population health**

Actions:

- apply sunscreen
- seek shade

- **Upgrade culverts**
- **Irrigation improvements**
- **Floodproofing**
- **Cooling stations**

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Potential Natural Hazards - Vote on the Top 4!

- Strong Storms
  - Hurricanes
  - Nor'Easters
  - Ice
  - Thunder
- Flooding
  - Inland
  - Storm Surge
- Sea Level Rise
  - Water Table Rise
- Extreme Temperatures
- Drought
- Other Hazards
  - Coastal Erosion
  - Wildfire
  - Tornadoes
  - Geologic

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Group Exercise #2: Identify Community Vulnerabilities and Strengths

Objective: Develop a **profile** of Dartmouth's infrastructural, societal, and environmental components **that are impacted by the Top 4 Hazards.**

1. Begin in first column of the matrix and identify vulnerabilities (V) and strengths (S).
2. Determine location of V/S and list it on the Risk Matrix and mark it on the Base Map
3. Identify ownership of issue/asset/location
4. Report out to large group

Time: Appx. 60-90 Minutes

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Example Vulnerabilities:

- Main road floods, blocking emergency response
- Power outage during heat waves lead to health concerns
- Wildfire and high winds cause supply chain interruptions
- Sewer pump stations become inoperable
- Compromised rail system due to heat-related track warping

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Example Strengths:

- Main road elevated and passable by emergency vehicles
- Hurricane roof installed at school – improved sheltering capacity
- Hardened utility lines reduce ice storm outages
- Undersized culver replaced – reduces flooding at key intersection
- Improvement to communications system during extreme weather

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Lunch!

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Group Exercise #3: Identify and Prioritize Community Actions

Objective: Identify and prioritize **actions** to help reduce vulnerability or reinforce strengths for each of the Top Hazards

1. Begin on right side of the Matrix – "Actions"
2. Under the "Hazards" column, identify the actions needed to reduce V or reinforce S represented by each feature/asset
3. After completing "Hazards" column, consider Priority (High, Medium, Low) and Urgency (Ongoing, Short-term, Long-term) of each action
4. Identify 3-4 Priority Actions per team

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Action Categories:

Hypothetical Example:
Fire Department floods during extreme storm events

Resiliency	Mitigation	Adaptation
• **Improve floodplain function**: ➢ riparian land conservation ➢ green stormwater infrastructure	• **Actions to reduce GHG** ➢ convert to electric municipal vehicles ➢ install solar panels on municipal buildings	• **Flood-proof building** • **Relocate facility outside of 500-yr floodplain**

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Example Actions:

- Improved access to high-risk locations
- Reduce housing stock in vulnerable areas
- Prioritize development in low-risk areas
- Integrate future risks in capital improvement plans
- Flood-proof manhole covers
- Secure new generators for critical facilities

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MVP Action Grants: Project Types

- Detailed Vulnerability and Risk Assessment*
- Community Outreach and Education
- Local Bylaws, Ordinances, Plans, and Other Management Measures
- Redesigns and Retrofits***
- Nature-Based Flood Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques**
- Nature-Based, Infrastructure and Technology Solutions to Reduce Vulnerability to Extreme Heat and Poor Air Quality

* Most common project type
** Second-most common project type
***Third-most common project type

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Group Exercise #4: Determine Top Priority Actions

Objective: Present the findings of each group and collectively discuss identified opportunities to reduce current and future hazard risks and improve resilience

1. Spokesperson from each team presents findings to Large Group
2. Spokesperson presents 3-4 priority action cards to Lead Facilitator
3. Large Group Discussion to further define Highest Priority action list:
   i. **Top 3-5 actions** to implement for Town of Dartmouth

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Prioritization Factors

Consider factors such as:

- Funding availability / terms
- Agreement on outstanding impacts from recent hazard
- Necessity for advancing long-term outcomes
- Contribution to meeting existing local /regional planning objectives

Examples of urgency:

- Current project to install hurricane-proof roof on school is ongoing **(O)** action.
- Ensuring evacuation procedures are updated annually is considered a short-term **(S)** action.
- Reducing housing stock in high-risk areas, elevating a road, or replacing a bridge are long-term **(L)** actions.

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Wrap-Up

Next Steps:

- **Develop Report**
- **Hold Listening Session**
- **Become MVP Community**

Apply for Action Grant Funding!

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Thank you for your time!

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APPENDIX B

COMPLETED RISK MATRICES

Community Resilience Building Risk Matrix

Group 1 (CEI moderator: Bob Hartzel)

www.CommunityResilienceBuilding.org

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Strong Storms	Sea Level Rise	Extreme/Increasing Temperatures	Priority H - M - L	Time Short Long Ongoing
Infrastructural				**Proposed Actions**					
Stormwater infrastructure requiring redesign/retrofit to help mitigate repeated flooding.	multiple high-priority locations	Town	V	Conduct town-wide stormwater/storm surge resiliency study to assess and prioritize areas for re-design and retrofit to mitigate flooding. High priority areas identified by the Town include: Buttonwood Brook watershed (potential regional project with New Bedford); Potomska Rd./Little River Rd. culvert (storm surge issue/road elevation issue); Horseneck Rd. culvert (grant application currently pending); Smith Neck Rd.; Russells Mills Village; Russells Mills Rd./Elem St. culvert; Carks Cove/Rogers St. culverts (storm surge).			H	S
Sewerage pump station located in Paskamanset River floodplain;	Off Tucker Road, west of Friends Academy	Town	V	Conduct engineering study to design mitigation measures to address frequent flooding of the sewerage pump station and associated water quality risks.				H	S
Municipal wastewater treatment facility	Russells Mills Rd.	Town	V				Extreme/increasing temperatures are increasing wastewater treatment costs and creating technical challenges related to treatment of increasing amounts of nitrogenous bacteria. Obtain funding for new treatment technologies for nitrates.	H	S
Russells Mills Dam	Rock O'Dundee Rd.	Town	V	Conduct engineering study as initial step for design and installation of a mechanical flood gate to mitigate repeated flooding.				M	S
Padanaram Village causeway	Gulf Road	Town	V	Storm surge cuts of access to Padanaram Village for emergency services. Conduct engineering/design study for additional culvert under the causeway to reduce flooding by increasing tidal flow and drainage capacity.				M	L
Electrical power infrastructure	Town-wide	Eversource	V		It can take weeks for Eversource to restore power following outages caused by strong storms. Preventative maintenance (tree work) is good, but steps to reduce the length of outages should be addressed when the Eversource 5-year permit is up for renewal.			L	L
Societal									
Volunteer base for disaster/emergency response is inadequate.	Town-wide	N/A	V	Develop and implement plan to increase base of volunteers for disaster/emergency response. Options may include obtaining funding sources to pay emergency response volunteers and new public outreach efforts to solicit volunteer commitments.				M	O
Town emergency sheltering facilities are adequate. Sheltering plan recently upgraded to accommodate pets and larger farm animals. High School recently upgraded with generator.	multiple locations	Town	S	No action required at this time.					
Protocols for identifying and communicating with elderly and at-risk populations during emergencies is adequate.	Town-wide	Town	S	No action required at this time.					
Environmental									
Slocum River corridor, including Demarest Lloyd State Park (water quality and estuarine habitat concerns)		Town, MA-DCR, private	V	Identify key parcels for land conservation through acquisition, conservation restrictions, and other real estate tools, particularly along the eastern side of the Slocum River.				H	O
Salt marsh habitat	multiple coastal locations	multiple owners	V	Conduct salt marsh restoration projects at top priority sites as identified in the *Atlas of Tidally Restricted Salt Marshes in the Buzzards Bay Watershed.* Identify key parcels for land conservation through acquisition, conservation restrictions, and other real estate tools, including parcels that would allow for future inland migration of salt marsh in response to sea level rise.				H	O
Trees/forest habitat	Town-wide	multiple owners	V	Many trees lost to gypsy moths and other insects/pathogens and not replaced. Conduct Town-wide tree planting plan to replace trees and improve forested buffers to increase resiliency.				H	O
Dams	Russells Mills dam (Town); Noquochoke Lake (Fall River); Turners Pond (New Bedford); Smith Mills dam (owned by Midas Muffler)		V	Conduct initial feasibility assessment and develop concept plans for potential dam removals, mechanical upgrades, and/or improvements to outlet controls, working from downstream to upstream sites. Include public outreach/education as key part of this effort.				M	S
Allens Pond (regionally important bird/wildlife habitat area)		Town	S	No actions required at this time.					
Apponagansett Bay (concerns related to loss of eelgrass habitat and shellfishing closures)			V	See action items listed above regarding salt marsh habitat restoration, land conservation efforts, and the Buttonwood Brook watershed study .					

Community Resilience Building Risk Matrix

Group 2 (CEI moderator: Emily DiFranco)

www.CommunityResilienceBuilding.org

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Strong Storms	Extreme/Increasing Temperatures	Priority H - M - L	Time Short Long Ongoing
Infrastructural				**Proposed Actions**				
Stormwater infrastructure requiring redesign/retrofit to help mitigate repeated flooding.	Multiple locations	Town	V	Conduct a town-wide assessment of bridges, crossings, and evacuation routes to assess and prioritize areas for re-design and retrofit to mitigate flooding. High priority areas identified by the town include: Town Landing on Horseneck Road; Round Hill Beach; Padanaram Neighborhood; Patomska Road west of LIttle River Bridge.			M	S
Disaster debris disposal	Town-wide	Town	V	Incorporate disposal and removal of disaster debris (e.g. trees, homes, cars, etc.) into Town Emergency Management Response Plan (in process) and evaluate as a regional problem.			H	S
Private septic systems	Any part of town not serviced by public sewer.	Private	V	Develop a septic system database of private systems and conduct an Environmental Risk Assessment of non-sewered areas to determine flooding risk.			M	S
Dams on private property	Multiple locations	Private	V	Expand recently completed assessment of dams to include dams on private property.			M	S
Town requirements for bridge heights and other engineering specifications	Town-wide	Town	V	Continuously update town regulations to ensure that specifications include the latest best practices to accommodate for climate change.			L	O
Societal								
Expand solar energy in appropriate places throughout town.	Town-wide	Town/Private	V	Continue to identify areas of town that could support solar energy, including commerical properties.			L	O
Cultural resources	Town-wide	Town	V	Conduct a town-wide assessment of cultural resources to assess and prioritize areas that may be flooded.			M	S
Active conservation/agricultural groups	Town-wide	N/A	S	No action required at this time.				
Tax base/property values	Town-wide	Private	V	Town's most expensive properties/properties with the highest tax base are the most vulnerable to flooding. Continously update town regulations to ensure that building specifications include the latest best practices to accommodate for climate change.			L	O
Environmental								
Coastal erosion	Multiple locations	Town	V	Multiple studies on coastal erosion in Dartmouth have been conducted. Town should conduct an assessment of these studies to determine next steps and prioritize actions.			H	S
Health concerns due to increase tick and mosquito populations.	Town-wide	N/A	V			Work with the Director of Public Health to expand education to residents. Include the Bristol County Mosquito Control program in educational efforts.	H	S
Even-age forests throughout town	Town-wide	Town/Private	V	Develop forest management plans for private and town-owned forested areas. Work with NRCS, land trusts, etc to determine which areas need/have plans.			H	S
Agricultural Resiliency Plans	Town-wide	Private	V	Develop Agricultural Resiliency Plans to assist farmers; work with NRCS, regional groups, Umass Darmouth, and the Rural Caucus			M	S

Community Resilience Building Risk Matrix

Group 3 (CEI moderator: David Roman)

www.CommunityResilienceBuilding.org

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Sea Level Rise	Strong Storms	Extreme/Increasing Temperatures	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Condition and Operation of Significant/ High Hazard Dams	Noquochoke Lake, Russell Mills, Cornell Pond	Varies	V	Implement recommendations from previous condition assessments; perform feasibility analysis and incorporate decision support into Russell Mills Dam				M	L
Low-Lying Wastewater Pump Stations	North Station, Faunce Station, Others?	Town	V	Perform vulnerability analysis of pump stations. Include conceptual floodproofing measures in analysis				H	S
UMass Dartmouth - flooding at entrance and Cross Road neighborhood	UMass / Cross Rd	UMass / Town	V	Partner with UMass to implement proposed improvements to limit runoff to these areas (e.g., green infrastructure).				L	L
Flooding caused by Destruction Brook (key access route to Town beaches)	Horseneck Road	Town	V	Perform vulnerability/drainage study and determine potential improvements				L	L
Societal									
Smith Neck Road - flooding and potential isolation of residents	Smith Neck Road	Town	V	Perform vulnerability analysis of area: 1) consider gulf road (i.e., B/C analysis to maintain); 2) evaluate potential Rock O'Dundee Rd evacuation Route; 3) Implement public education and outreach campaign				H	S
Economic impacts of developed and undeveloped land within floodplain	Town-wide	Varies	V	Perform Town-wide floodplain modeling study (current 100-yr floodplain vs. potential future 100-yr floodplain), identify potential economic losses (i.e., Hazus analysis), identify parcels in future floodplain (i.e., acquisition targets)				M	S
Development in Town is leading to increases in greenhouse gas emissions	Town-wide	Varies	V	Develop renewable energy plan for all Town facilities and properties to be carbon neutral (e.g., solar panels on schools, etc.)			Develop renewable energy plan for all Town facilities and properties to be carbon neutral (e.g., solar panels on schools, etc.)	H	S
"Spongy" Town recreation fields	multiple	Town	V	Perform feasibility study to implement nature based solutions to improve drainage				L	L
Town has no public water supply or sewer in portions of Southern Dartmouth - susceptible to saltwater intrusion from sea level rise	multiple	varies	V		Perform feasibility study for expansion of water and sewer networks to unserved areas.			L	L
Environmental									
Noquochoke Lake floodplain preservation	Noquochoke Lake floodplain	Town/Private	V	Continue acquiring key parcels when they come up for sale, or protect through conservation easements and other real estate tools.				L	O
Cow Yard Salt Marsh is degraded (poor tidal exchange and drainage in marsh flats)	Cow Yard	Town	V	Implement recommendations from previous studies to restore salt marsh				M	L
Potential salt marsh loss from sea level rise	e.g., Allens Pond	Town	V	Perform marsh migration study, identify potential parcels for acquisition that may aid migration (i.e., natural vs. aided migration)				M	S
Potential loss of barrier beaches	multiple locations (e.g., Round Hill)	Town	V	Perform beach nourishment feasibility study (i.e., identify suitable candidates for nourishment)				H	S
Fallen trees during storms cause power outages	Town-wide	Town	V		Perform hazardous tree evaluation			L	L
Health issues from steadily increasing temperatures (ticks, poison ivy, mosquitos)	Town-wide	Town	V/S				Perform public education campaign for prevention. Continue Coordination with Mosquito Control District	M	S
Habitat loss from changing temperatures (e.g. coldwater fish) and storm surge / flooding	Town-wide	Town	V	Perform study to identify suitable parcels to protect and maintain native and rare species (e.g., maintain shade along streams)				H	O

Community Resilience Building Risk Matrix

Group 4 (CEI moderator: Elisha Musgraves)

www.CommunityResilienceBuilding.org

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Sea Level Rise	Strong Storms	Extreme/Increasing Temperatures	Priority H - M - L	Time S hort L ong O ngoing
Infrastructural		Town/Private							
Undersized/aging culverts	Smith Neck Road, Horse Neck Road, Tucker Road (near High School and Police Station	Town	V	Continue working with MassDOT on grants for funding/Transportation Improvement Program (TIP) study; Conduct a vulnerability assessment to determine which failing culverts need immediate repairs.				M	O
North Branch Library has flooding issues	211 Cross Road	Town	V/S	Flooding is occurring despite the presence of green infrastructure surrounding the library; conduct an enignerring evaluation of the existing drainage structures to mitigate and prevent flooding				L	S
Flooding causing road closures	Potomska Road, Chase Road	Town	V	Chase Road floods due to stormwater runoff; UMass Dartmouth had been developing a retrofit for the roadway, but was never completed/implemented. Work with UMass to complete retrofit and update previous design as necessary	Potomska Road floods due to tidal influences; Conduct a feasibility assessment to determine potential solutions to address flooding issues			M; Chase Rd: H	O
Access to Town wells is restricted due to flooding	Well D and Well E	Town	V	Retrofit adjacent stream crossing with an adequately sized box culvert to accommodate flood passage				L	L
Bridge Street Fire Station lack of access due to Padanarum Village Causeway flooding	Bridge Street, Causeway	Town	V	Flooding hinders emergency services, forcing them to take a long way around to reach communities they serve across the causeway. Previous design/plan to elevate roadway was never implemented; revisit and redesign previous elevated roadway plan for elevating causeway				H	L
Flooding roadway with culvert and adjacent dam	Russells Mills Road, Paskamanset River, Russells Mills Pond Dam	Town	V/S	Dam was recently repaired, continue to monitor and support structural modifications; conduct a vulnerability assessment to determine direct cause of flooding along Russells Mills Road				M	S
Sol-E-Mar Street flooding and storm surging	Sol-E-Mar Street	Town	V	Stormwater controls are aging, undersized, and outdated; conduct a vulnerability assessment to determine areas where storm surge and runoff require additional evualtion for solutions to mitigate flooding				H	O
Societal									
Emergency services restricted from roadway closures due to flooding	South Dartmouth	Town	V	Develop village/community specific emergency management plans for the affected areas; ensure citizens in these high-risk areas are educated and informed on all emergency and evacuation procedures				M	S/O
Schools in town: 6 public, 2 private; Quinn School has flooding issues	Multiple	Both	V/S	Continue to support emergency services and planning specific to emergency shelters			Feasibility assessment for A/C expansion and update at emergency shelters	L	O
UMass Dartmouth and gaps in emergency response communication	285 Old Westport Road	Private	V/S	Continue to work with planners, committees and Town Gown Compact to improve community involvement, communication and emergency response communication and protocols				L	O
Emergency Shelters: Traffic and communication issues; Shelters proposed in the 2015 Hazard Mitigation Plan were never established	Council on Aging, High school	Town	V	Complete Action Items #2 and #3 from the 2015 Hazard Mitigation Plan			Feasibility assessment for adding solar storage facilities at proposed shelters	H	S
Eversource: new proposed line increases system redundancy		Private	S						
Vulnerable Populations	Cedar Dell, Council on Aging, Champion Terrace, Sol-E-Mar, Brandon Woods, Autumn Glen, Veterans Housing, The Cottages	Both	V/S	Dartmouth offers a "DPW Emergency List" that serves to evacuate/monitor at-risk individuals during natural hazards. Many community members are not aware of this service. Increase public education and outreach to vulnerable populations on available services. Improve emergency access througout town.				M	O
Environmental									
Buttonwood Brook Watershed	Apponagansett to North Dartmouth	Both	V/S	Continue to acquire new parcels; incorporate previous studies into a watershed flooding vulnerability assessment, use data to develop management plan for the region				H/M	O
Invasive Species: Phragmites, Bittersweet, Autumn Olive, Honeysuckle, Hay Seeding	Town-wide	Both	V/S	Develop a town-wide management plan targeting invasive species present in stormwater BMPs, i.e. detention basins, and existing floodplains			Eversource and DNRT Invasive Management Plan currently in place (Strength)	M	O
Drought - tree death and downing; dried up pond	Town-wide	Both	V/S		Continue to inmplement Key Trees Removal Plan (Strength); develop forest management plan targeting open space and recreational areas; continue to monitor dried well behind Umass to determine if well drawdown or drought is contributing			M	O
Sport fields behind High School flood	555 Bakerville Road	Town	V	Conduct feasibility assessment to determine best stormwater control measures for this area; implement design				M	S
Imapired Waters: Slocum River	Slocum River	Both	V	Use previously conducted research and assessments (from Buzzards Bay Coalition) to identify vulnerable areas suited for LID retrofitting				H	O
Development in floodplains	Town-wide; Bourne Place	Private	V	Create and update town bylaws that require the use of LID for all new developments in town and/or that strengthen protections for existing floodplains; encourage acting boards and commissions to practice increased enforcement of existing bylaws				M	O
Round Hill Beach access road flooding	34 Mishaum Point Road	Town	V	Increased public education on stormwater runoff leaving private properties; revisit previous road elvation design that was not implemented and assess for feasibility				M	O

APPENDIX C

MAPS

TOWN OF DARTMOUTH
MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM

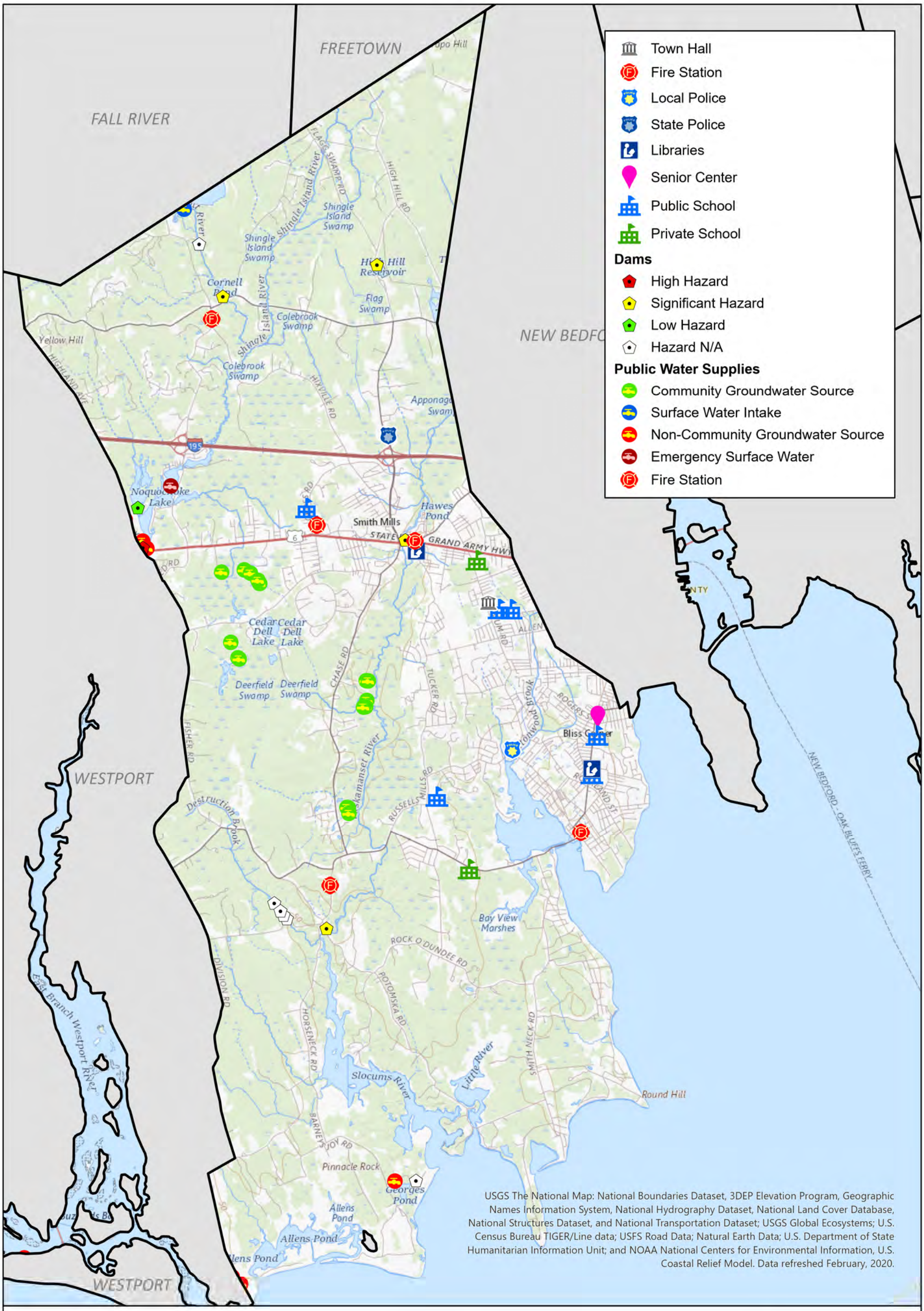
Climate Change and Natural Hazard Vulnerability Assessment

WORKSHOP MAP PACKAGE – MARCH 2020

List of Maps:

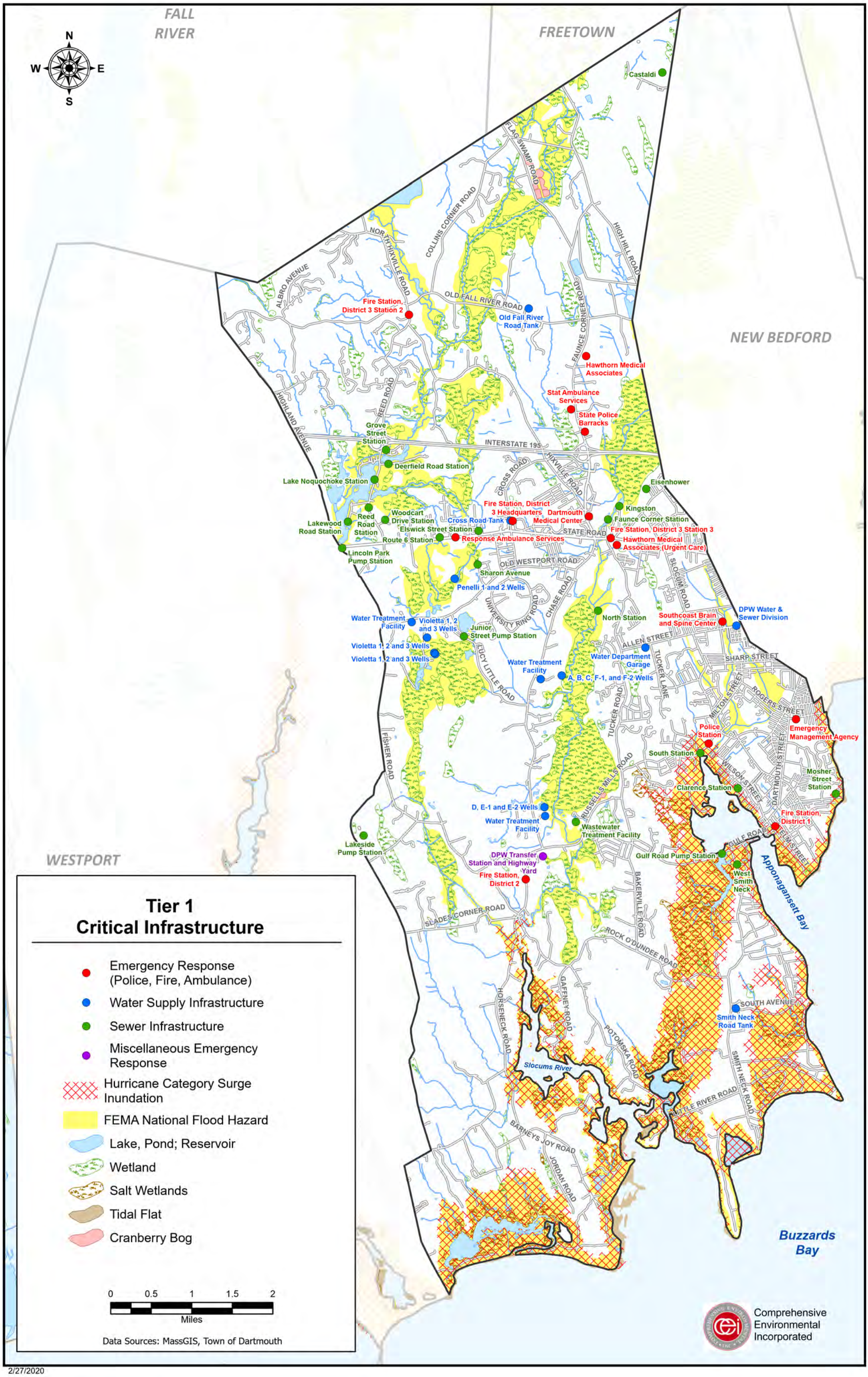
- Town Base Map 24x36
- Town Base Map 11x17
- Tier 1 Critical Infrastructure
- Tier 2 Critical Infrastructure
- Tier 3 Critical Infrastructure
- Hurricane Inundation Map
- Parcels in Floodplain
- Dartmouth Fire Districts
- Open Space and Protected Lands
- Parcels in Aquifer
- Town-Owned Properties
- Wetlands of Dartmouth
- Zoning
- Land Use
- Repetitive Loss Properties

Map Layer:	**Source:**
Senior Center	CEI
Town Hall	MassGIS
Fire Stations	MassGIS
Police Stations	MassGIS
Library	MassGIS
Schools	MassGIS
Dams	MassGIS
Public Water Supplies	MassGIS
Hydrography	MassGIS
Roads	MassGIS
Land Use	MassGIS
FEMA National Flood Hazard	Town of Dartmouth
Wetlands	Town of Dartmouth
Zone I Wellhead Protection Areas	Town of Dartmouth
Zone II Wellhead Protection Areas	Town of Dartmouth
Zone III Wellhead Protection Areas	Town of Dartmouth
Protected Open Space	Town of Dartmouth
Hurricane Surge Inundation Areas	Town of Dartmouth
Town-Owned Properties	Town of Dartmouth
Fire Districts	Town of Dartmouth
Water Distribution Infrastructure	Town of Dartmouth
Sewer Infrastructure	Town of Dartmouth
Zoning	Town of Dartmouth
Repetitive Loss Properties	Town of Dartmouth



USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed February, 2020.

2/27/2020


FALL RIVER
FREETOWN
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FLAG SWAMP ROAD
COLLINS CORNER ROAD
NORTH HIXVILLE ROAD
ALBRO AVENUE
HIGH HILL ROAD
OLD FALL RIVER ROAD
Fire Station, District 3 Station 2
Old Fall River Road Tank
FAUNCE CORNER ROAD
Hawthorn Medical Associates
Stat Ambulance Services
State Police Barracks
HIGHLAND AVENUE
REED ROAD
Grove Street Station
INTERSTATE 195
Deerfield Road Station
Lake Noquochoke Station
CROSS ROAD
HIXVILLE ROAD
Eisenhower
Fire Station, District 3 Headquarters
Dartmouth Medical Center
Kingston
Faunce Corner Station
Reed Road Station
Woodcart Drive Station
Cross Road Tank
Lakewood Road Station
Elswick Street Station
Route 6 Station
Response Ambulance Services
STATE ROAD
Fire Station, District 3 Station 3
Hawthorn Medical Associates (Urgent Care)
Lincoln Park Pump Station
OLD WESTPORT ROAD
Sharon Avenue
Penelli 1 and 2 Wells
SLOCUM ROAD
UNIVERSITY RING ROAD
CHASE ROAD
Water Treatment Facility
Violetta 1, 2 and 3 Wells
Junior Street Pump Station
North Station
Southcoast Brain and Spine Center
DPW Water & Sewer Division
Violetta 1, 2 and 3 Wells
Violetta 1, 2 and 3 Wells
LUCY LITTLE ROAD
ALLEN STREET
Water Department Garage
TUCKER LANE
SHARP STREET
Water Treatment Facility
A, B, C, F-1, and F-2 Wells
MILTON STREET
ROGERS STREET
TUCKER ROAD
Police Station
Emergency Management Agency
FISHER ROAD
South Station
WILSON STREET
DARTMOUTH STREET
Mosher Street Station
Clarence Station
RUSSELLS MILLS ROAD
D, E-1 and E-2 Wells
Water Treatment Facility
Wastewater Treatment Facility
Fire Station, District 1
ELM STREET
GULF ROAD
Lakeside Pump Station
DPW Transfer Station and Highway Yard
Gulf Road Pump Station
West Smith Neck
Fire Station, District 2
BAKERSVILLE ROAD
SLADES CORNER ROAD
ROCK O'DUNDEE ROAD
Apponagansett Bay
SOUTH AVENUE
Smith Neck Road Tank
HORSENECK ROAD
GAFFNEY ROAD
POTOMSKA ROAD
Slocums River
SMITH NECK ROAD
LITTLE RIVER ROAD
BARNEYS JOY ROAD
JORDAN ROAD
Buzzards Bay
Tier 1
Critical Infrastructure
Emergency Response (Police, Fire, Ambulance)
Water Supply Infrastructure
Sewer Infrastructure
Miscellaneous Emergency Response
Hurricane Category Surge Inundation
FEMA National Flood Hazard
Lake, Pond; Reservoir
Wetland
Salt Wetlands
Tidal Flat
Cranberry Bog
0 0.5 1 1.5 2
Miles
Data Sources: MassGIS, Town of Dartmouth
Comprehensive Environmental Incorporated
2/27/2020

Tier 2 Critical Infrastructure

FALL RIVER

FREETOWN

NEW BEDFORD

WESTPORT

Buzzards Bay

Apponagansett Bay

Slocums River

NorthStar Learning Centers

Bristol County House of Corrections

Autumn Glen (Heritage at Dartmouth)

US Post office

George H. Potter Elementary School

Job S Gidley School

Dartmouth Housing Authority

Dartmouth Manor Rest Home

North Dartmouth Library

Bishop Stang High School

UMass Dartmouth

Town Offices / Town Hall

Dartmouth High School

James M. Quinn Elementary School

Dartmouth Middle School

Friends Academy

The Cedars Assisted Living

Sunrise Assisted Living

Brandon Woods Long Term Care facility

Council on Aging (Senior Center)

Joseph DeMello Elementary School

Dartmouth Community Television DCTV

Southworth Library

Andrew B Cushman

Office of the Superintendent of Schools

Office of the Harbormaster

Harborview Manor Nursing Home

ALBRO AVENUE
OLD FALL RIVER ROAD
NORTH HIXVILLE ROAD
COLLINS CORNER ROAD
FLAG SWAMP ROAD
HIGH HILL ROAD
FAUNCE CORNER ROAD
HIXVILLE ROAD
REED ROAD
HIGHLAND AVENUE
INTERSTATE 195
STATE ROAD
CROSS ROAD
HATHAWAY ROAD
OLD WESTPORT ROAD
UNIVERSITY RING ROAD
LUCY LITTLE ROAD
CHASE ROAD
FISHER ROAD
ALLEN STREET
SHARP STREET
TUCKER ROAD
TUCKER LANE
SLOCUM ROAD
DARTMOUTH STREET
RUSSELLS MILLS ROAD
ELM STREET
GULF ROAD
BAKERVILLE ROAD
SLADES CORNER ROAD
ROCK O'DUNDEE ROAD
GAFFNEY ROAD
HORSENECK ROAD
POTOMSKA ROAD
SOUTH AVENUE
SMITH NECK ROAD
BUTTLE RIVER ROAD
BARNEYS JOY ROAD
JORDAN ROAD

Municipal Building
Communications
Correctional Facility
Elderly Care Facility
Education
Transportation
Hurricane Category Surge Inundation
FEMA National Flood Hazard
Lake, Pond; Reservoir
Wetland
Salt Wetlands
Tidal Flat
Cranberry Bog

0 0.5 1 1.5 2
Miles

Data Sources: MassGIS, Town of Dartmouth

Comprehensive Environmental Incorporated

2/27/2020

Tier 3
Critical Infrastructure

- Cultural and Historic Site
- Kindergarten, Preschool and Daycare Facility
- Parks and Recreational Sites
- Veterans Support
- Animal Shelters
- Hurricane Category Surge Inundation
- FEMA National Flood Hazard
- Lake, Pond; Reservoir
- Wetland
- Salt Wetlands
- Tidal Flat
- Cranberry Bog

0 0.5 1 1.5 2
Miles

Data Sources: MassGIS, Town of Dartmouth

FALL RIVER
FREETOWN
NEW BEDFORD
WESTPORT
Buzzards Bay
Apponagansett Bay
Slocums River

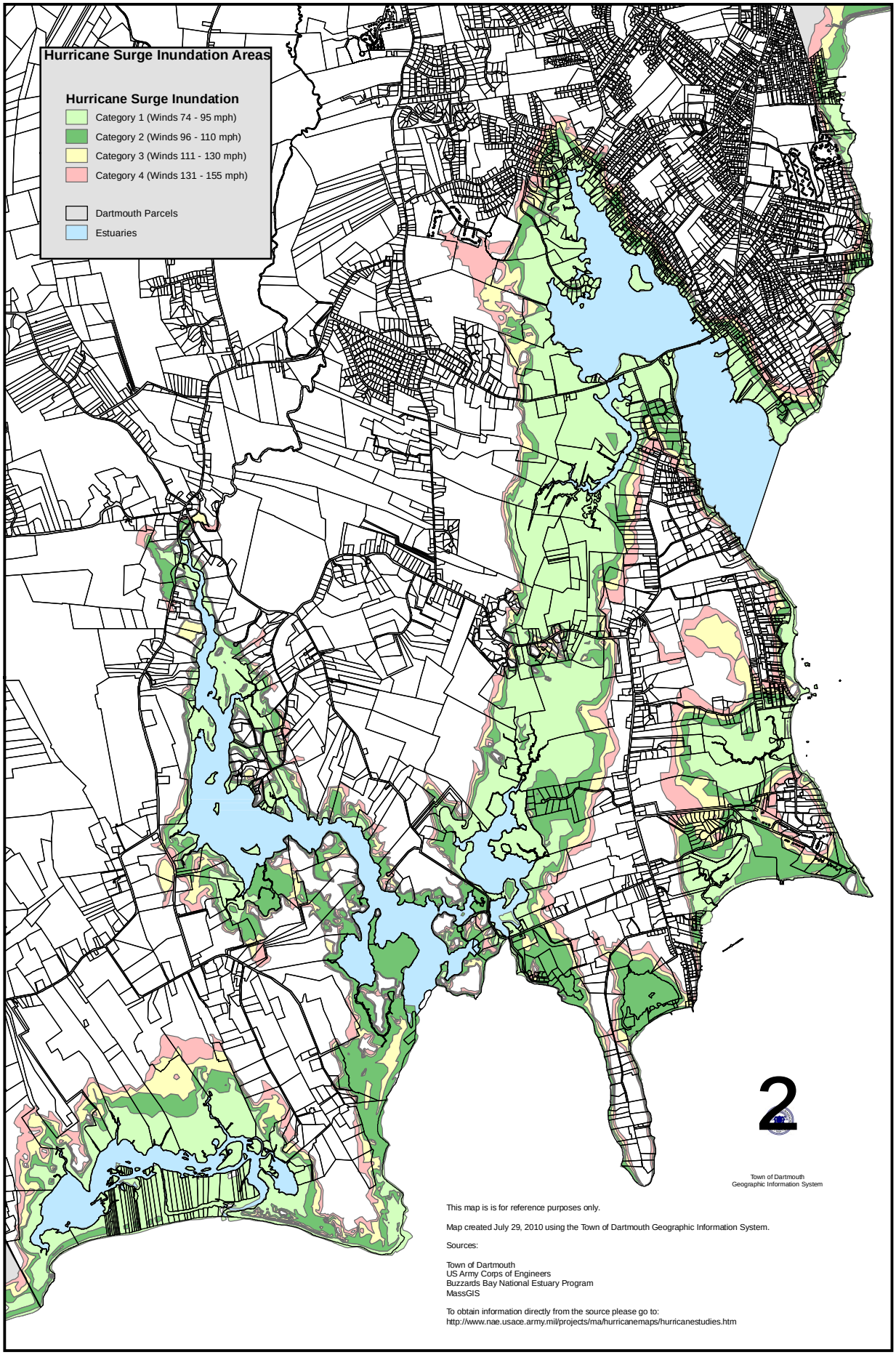
ALBRO AVENUE
NORTHHIXVILLE ROAD
COLLINS CORNER ROAD
FLAG SWAMP ROAD
HIGH HILL ROAD
OLD FALL RIVER ROAD
FAUNCE CORNER ROAD
REED ROAD
HIGHLAND AVENUE
INTERSTATE 195
CROSS ROAD
HIXVILLE ROAD
HATHAWAY ROAD
STATE ROAD
OLD WESTPORT ROAD
UNIVERSITY RING ROAD
SLOCUM ROAD
ALLEN STREET
SHARP STREET
LUCY LITTLE ROAD
CHASE ROAD
TUCKER ROAD
TUCKER LANE
MILTON STREET
ROGERS STREET
FISHER ROAD
RUSSELLS MILLS ROAD
ELM STREET
GULF ROAD
SLADES CORNER ROAD
ROCK O'DUNDEE ROAD
BAKERVILLE ROAD
HORSENECK ROAD
GAFFNEY ROAD
POTOMSKA ROAD
SMITH NECK ROAD
SOUTH AVENUE
BUTTLE RIVER ROAD
BARNEYS JOY ROAD
JORDAN ROAD

Dartmouth Regional Park & Trails
Cornell Pond
Sal's Pals
Humane Society & Shelter
Chase Farm Veterinary Hospital
Kiddie Kampus 3
Dartmouth Children's Center
Veterans Advisory Board (VFW Post 9059)
Smith Mills Preschool & Kindergarten
Anchor Animal Hospital
Kiddie Kampus 1
Paskamansett Landing
Renaissance Kids Academy
Kiddie Kampus 2
Our Sisters School
Hawthorn Hill Preschool
Little People's College
Jones park
Kids Ink Too
Kids Ink
Learning House Pre-School
South Dartmouth Cemetery
Dartmouth Community Park
Hill School
Paskamansett Park
Montha's Park
Apponagansett Park
Apponegansett Meeting House
Dartmouth Early Learning Center
Dartmouth YMCA / Camp Metacomet
Russells Mills Landing
Dartmouth Recreation Center
Round Hill Beach

Comprehensive Environmental Incorporated

2/27/2020

Hurricane Inundation Areas
Maximum Extent of Storm Surge



This map is is for reference purposes only.

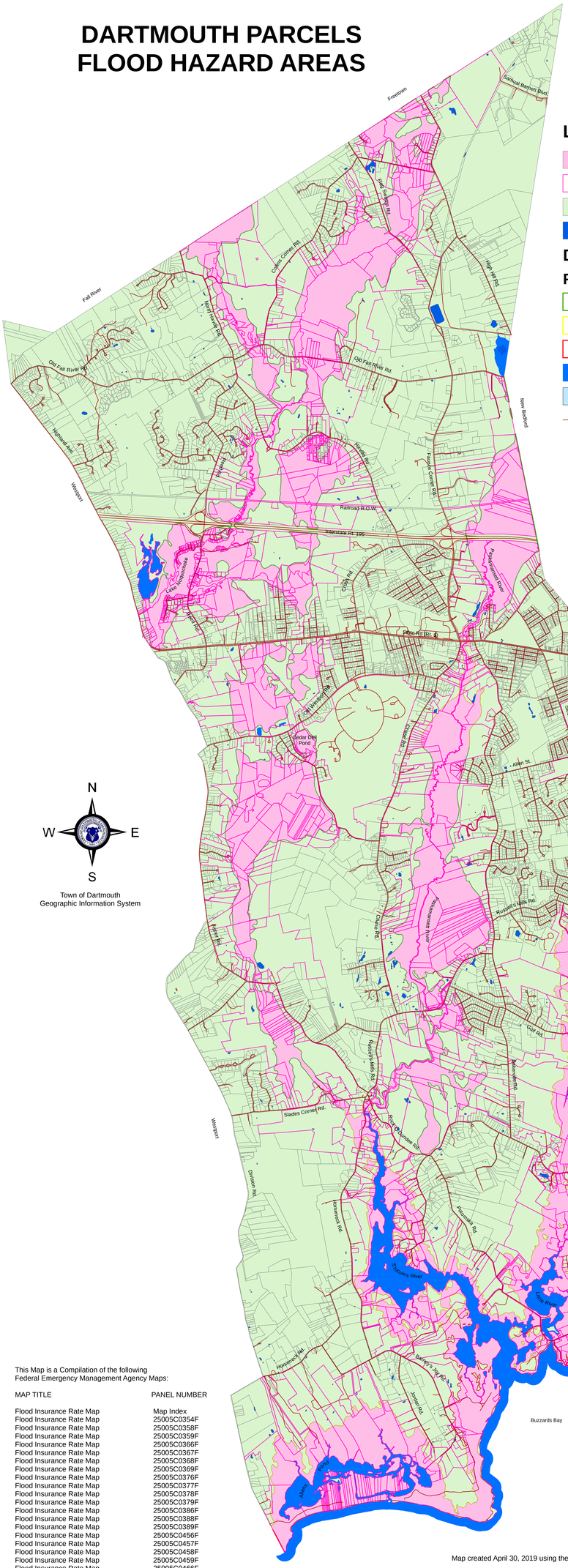
Map created July 29, 2010 using the Town of Dartmouth Geographic Information System.

Sources:

Town of Dartmouth
US Army Corps of Engineers
Buzzards Bay National Estuary Program
MassGIS

To obtain information directly from the source please go to:
http://www.nae.usace.army.mil/projects/ma/hurricanemaps/hurricanestudies.htm

DARTMOUTH PARCELS
FLOOD HAZARD AREAS



Legend

- Portion of Parcel in Flood Zone
- Parcels Located in Flood Zone (Entire Parcel)
- Parcels Not Located in Flood Zone
- Lakes, Ponds & Rivers

Dartmouth FIRM Floodplain July 2009

Flood Zones

- A
- AE
- VE
- Coastal & Major Inland Water Features
- Estuaries
- Roads (Public & Private)

Note:

THIS MAP IS FOR REFERENCE PURPOSES ONLY.

Parcels shown as being within a Flood Zone may only have a portion of the parcel within the Flood Zone. Entire parcel is highlighted for reference. Any structure may, or may not, be actually located within a Flood Zone. Please consult with the Dartmouth Building Department or utilize FEMA procedures for a final determination.

A parcel may also have more than one type of Flood Zone located within its boundaries.

The Flood Zones shown on this map represent areas where there is a 1% chance of flooding in any given year. It is also known as the 100-year flood, or the base flood.

Flood Zone A shown in green is an area where no base flood elevation has been determined.

Flood Zone AE shown in yellow are areas where base flood elevation have been determined.

Flood Zone VE shown in red are coastal flood zones with velocity hazard (wave action). Base flood elevations have been determined.

Please refer to the official Dartmouth Flood Zoning map for further details

N
W E
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Town of Dartmouth
Geographic Information System

This Map is a Compilation of the following
Federal Emergency Management Agency Maps:

MAP TITLE	PANEL NUMBER
Flood Insurance Rate Map	Map Index
Flood Insurance Rate Map	25005C0354F
Flood Insurance Rate Map	25005C0358F
Flood Insurance Rate Map	25005C0359F
Flood Insurance Rate Map	25005C0366F
Flood Insurance Rate Map	25005C0367F
Flood Insurance Rate Map	25005C0368F
Flood Insurance Rate Map	25005C0369F
Flood Insurance Rate Map	25005C0376F
Flood Insurance Rate Map	25005C0377F
Flood Insurance Rate Map	25005C0378F
Flood Insurance Rate Map	25005C0379F
Flood Insurance Rate Map	25005C0386F
Flood Insurance Rate Map	25005C0388F
Flood Insurance Rate Map	25005C0389F
Flood Insurance Rate Map	25005C0456F
Flood Insurance Rate Map	25005C0457F
Flood Insurance Rate Map	25005C0458F
Flood Insurance Rate Map	25005C0459F
Flood Insurance Rate Map	25005C0466F
Flood Insurance Rate Map	25005C0467F
Flood Insurance Rate Map	25005C0468F
Flood Insurance Rate Map	25005C0469F
Flood Insurance Rate Map	25005C0476F
Flood Insurance Rate Map	25005C0477F
Flood Insurance Rate Map	25005C0478F
Flood Insurance Rate Map	25005C0479F
Flood Insurance Rate Map	25005C0481G
Flood Insurance Rate Map	25005C0483F
Flood Insurance Rate Map	25005C0486F
Flood Insurance Rate Map	25005C0487F
Flood Insurance Rate Map	25005C0488F
Flood Insurance Rate Map	25005C0489F
Flood Insurance Rate Map	25005C0491F

EFFECTIVE DATE FOR PANELS JULY 1, 2009 WITH THE EXCEPTION OF PANEL 25005C0481G. NOTE THAT MAP UPDATES ON PANEL 25005C0481G OCCURRED ONLY IN NEW BEDFORD. NO UPDATES TO FLOODPLAIN LOCATIONS OR ELEVATIONS OCCURRED IN DARTMOUTH.

Note:

Parcels shown as being within a the floodplain
may only have a portion of the parcel within the flood zone.

Map created April 30, 2019 using the Town of Dartmouth Geographic Information System.

For a full description of the Flood Hazard Areas, please review the Dartmouth Zoning Bylaw.

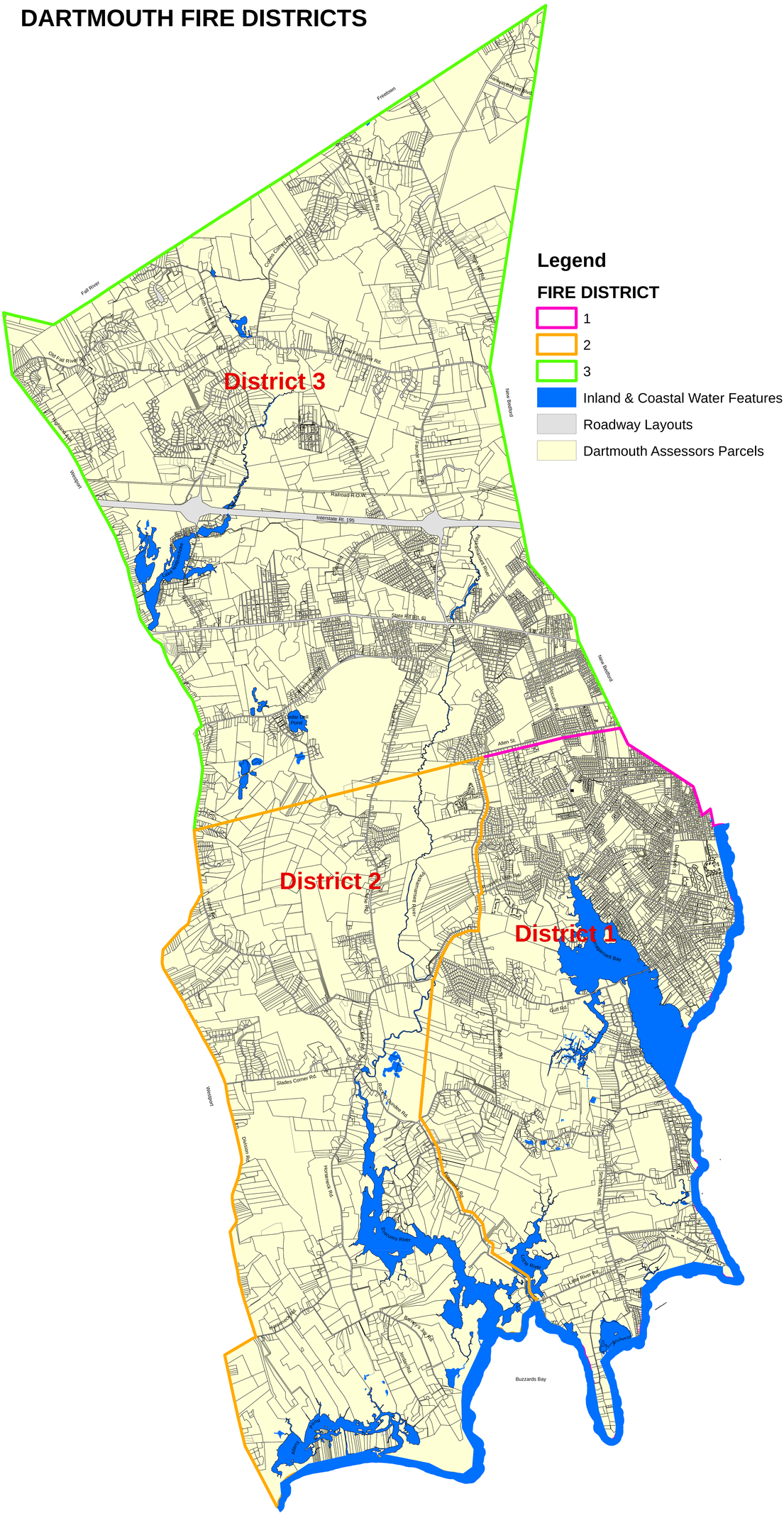
Flood Zones are from the Federal Emergency Management Agency, Flood Insurance Rate Maps effective July 1, 2009. Base flood elevations are not shown on this map. Please refer to the Official Dartmouth Flood Hazard map for elevations.

For more information on Flood Hazard Areas or for questions regarding zoning or construction standards within the Flood Zone please call the Dartmouth Building Department.

0 2,000 4,000 8,000 12,000 16,000 20,000 Feet

1:24000 (USGS Map Scale)
or 1'= 2000'

DARTMOUTH FIRE DISTRICTS



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W E
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Town of Dartmouth
Geographic Information System

0 0.5 1 2 3 Miles
0 1,500 3,000 6,000 9,000 12,000 15,000 Feet
0 0.5 1 2 3 4 Kilometers

1:24000 (USGS Map Scale
or 1" = 2000'

Data Sources:
Town of Dartmouth Geographic Information System
MassGIS

Parcels Updated to January 1, 2018

TOWN OF DARTMOUTH
OPEN SPACE AND PROTECTED LANDS
ALL TYPES OF PROTECTION

Legend

- Protected Open Space
- Dartmouth Assessors Parcels
- Coastal & Inland Water Features
- Roadway Layouts

N W E S

Town of Dartmouth
Geographic Information System

The open space and protected lands shown on this map are protected in several different ways.

Parcels may be protected by:

Fee simple ownership by a conservation organization;
An Agricultural Preservation Restriction;
A Conservation Restriction held by a conservation organization;
A Conservation Covenant;
A Deed Restriction required by municipal subdivision processes;
Protection of municipal drinking water wells and water supply areas;
State or municipal beaches and parks;
Public access points;
Public recreation properties;
Historic preservation properties;
Resource protection required by Federal, State or private grants;
State of Massachusetts wildlife refuges or other protected lands;
A private Deed Restriction.

In many cases a parcel is protected using a combination of the above methods. For the purposes of this map the primary type of protection of the property is shown.

For more information regarding individual properties shown on this map please contact the owner/manager listed in the map legend. To get information on how to gain open space protection for a property not shown as currently protected please contact the Town of Dartmouth Conservation Commission or one of the conservation organizations listed in the map legend.

This map was created on April 16, 2019 using the Town of Dartmouth Geographic Information System.

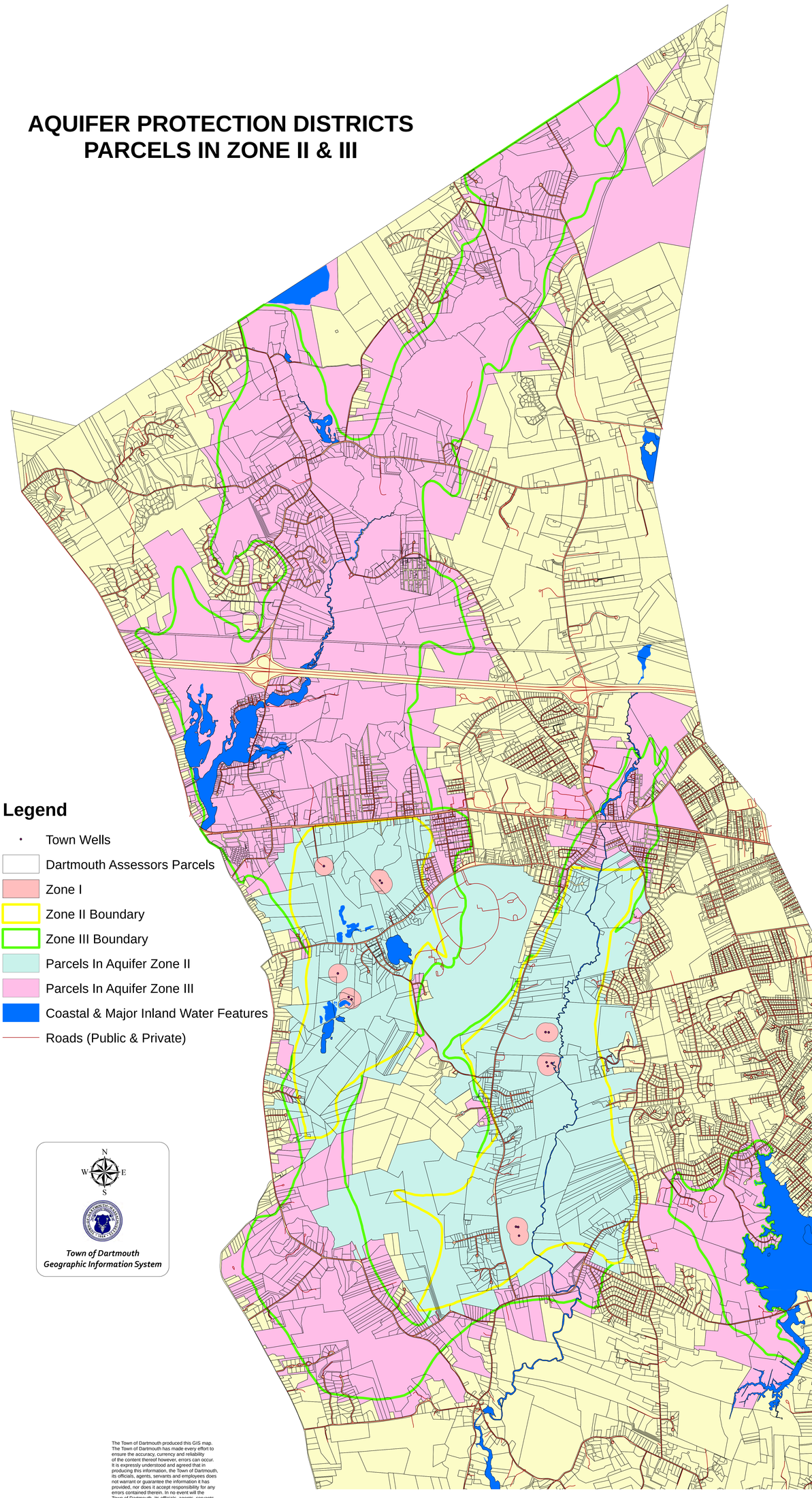
Source:

Town of Dartmouth tax assessment maps (January1, 2018 update)
Town of Dartmouth tax assessment records
The Buzzards Bay National Estuary Program open space data
Massachusetts Geographic Information System

0 0.5 1 2 3 Miles

1:24,000 (USGS Map Scale)
or 1" = 2000'

AQUIFER PROTECTION DISTRICTS
PARCELS IN ZONE II & III



Legend

- Town Wells
- Dartmouth Assessors Parcels
- Zone I
- Zone II Boundary
- Zone III Boundary
- Parcels In Aquifer Zone II
- Parcels In Aquifer Zone III
- Coastal & Major Inland Water Features
- Roads (Public & Private)

N
W E
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Town of Dartmouth
Geographic Information System

Note:

Parcels shown as being within a Zone II or Zone III
may only have a portion of the parcel within the Aquifer Zone.
Entire parcel is highlighted for reference. In addition, a parcel may contain both Zone I and Zone II.

Please refer to the Town of Dartmouth Zoning Bylaws for Aquifer Protection District requirements.

This map was created on October 10, 2019 using the Town of Dartmouth Geographic Information System.

Source:
Town of Dartmouth Geographic Information System
Massachusetts Geographic Information System

Parcels - Dartmouth Tax Assessment Map (January 1, 2019 update)

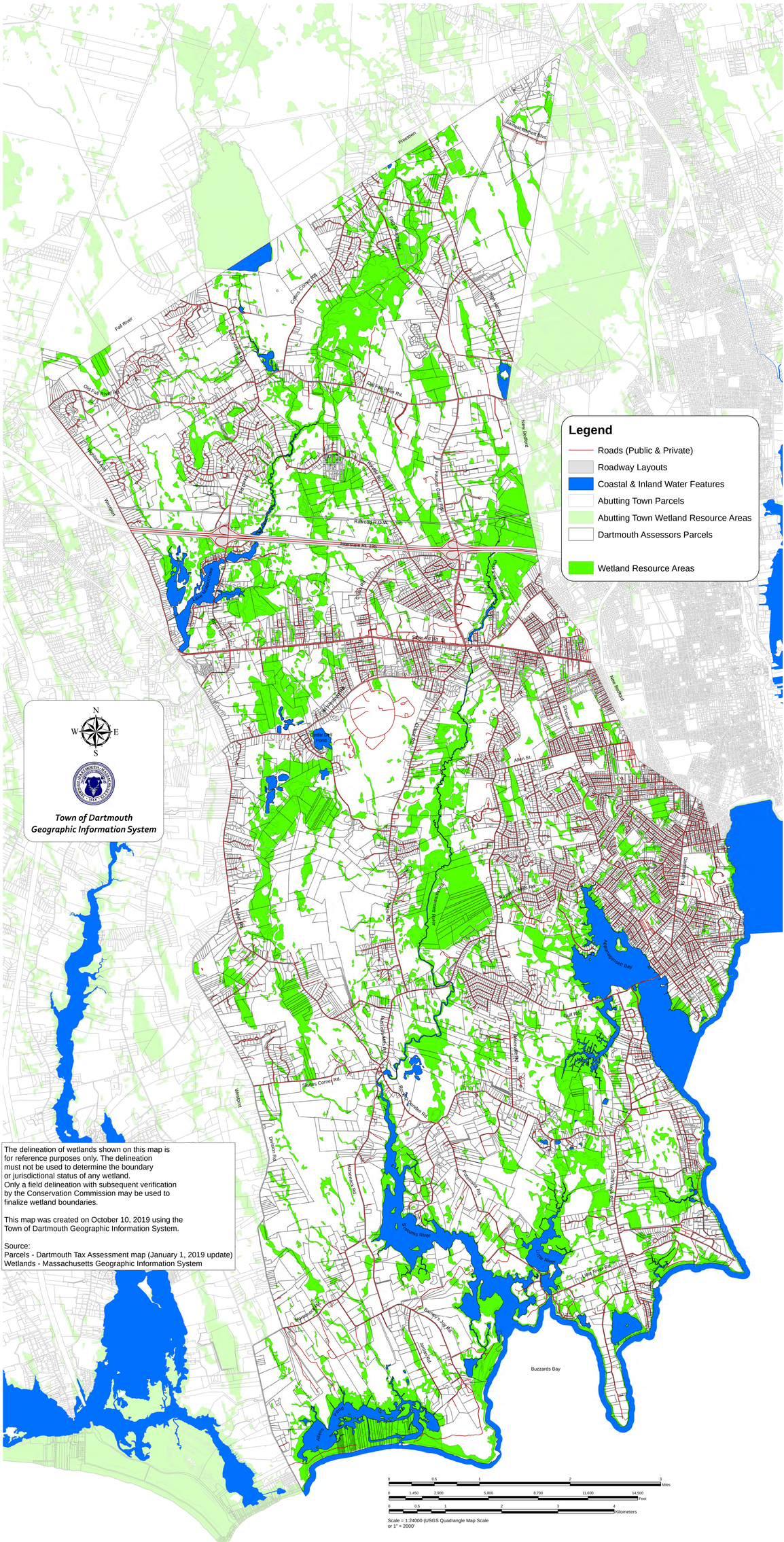
0 0.5 1 2 3 Miles

0 1,625 3,250 6,500 9,750 13,000 16,250 Feet

0 0.5 1 2 3 4 Kilometers

TOWN OF DARTMOUTH
TOWN OWNED PROPERTIES

WETLANDS OF DARTMOUTH



DARTMOUTH ZONING MAP
MARCH 23, 1999
Amended By Town Meeting to October 16, 2018

Please Note

§ 375-2.3. of the Zoning By-Law also identifies the following additional zoning districts:

Dartmouth Zoning Map – Aquifer Protection Districts - § 375-2.3 (B)
Dartmouth Zoning Map – Flood Hazard Areas - § 375-2.3 (C)
Dartmouth Zoning Map – Faunce Corner Overlay District- § 375-2.3 (D)

Please see seperate zoning maps

This map is incorporated into the Dartmouth Zoning By-Law by Reference at 375 - Article 3.

For a full description of the Zoning Districts, please review the Zoning By-Law.

Town of Dartmouth Parcel boundaries are updated to January 1, 2018, are for reference and orientation purposes only and hold no regulatory authority.

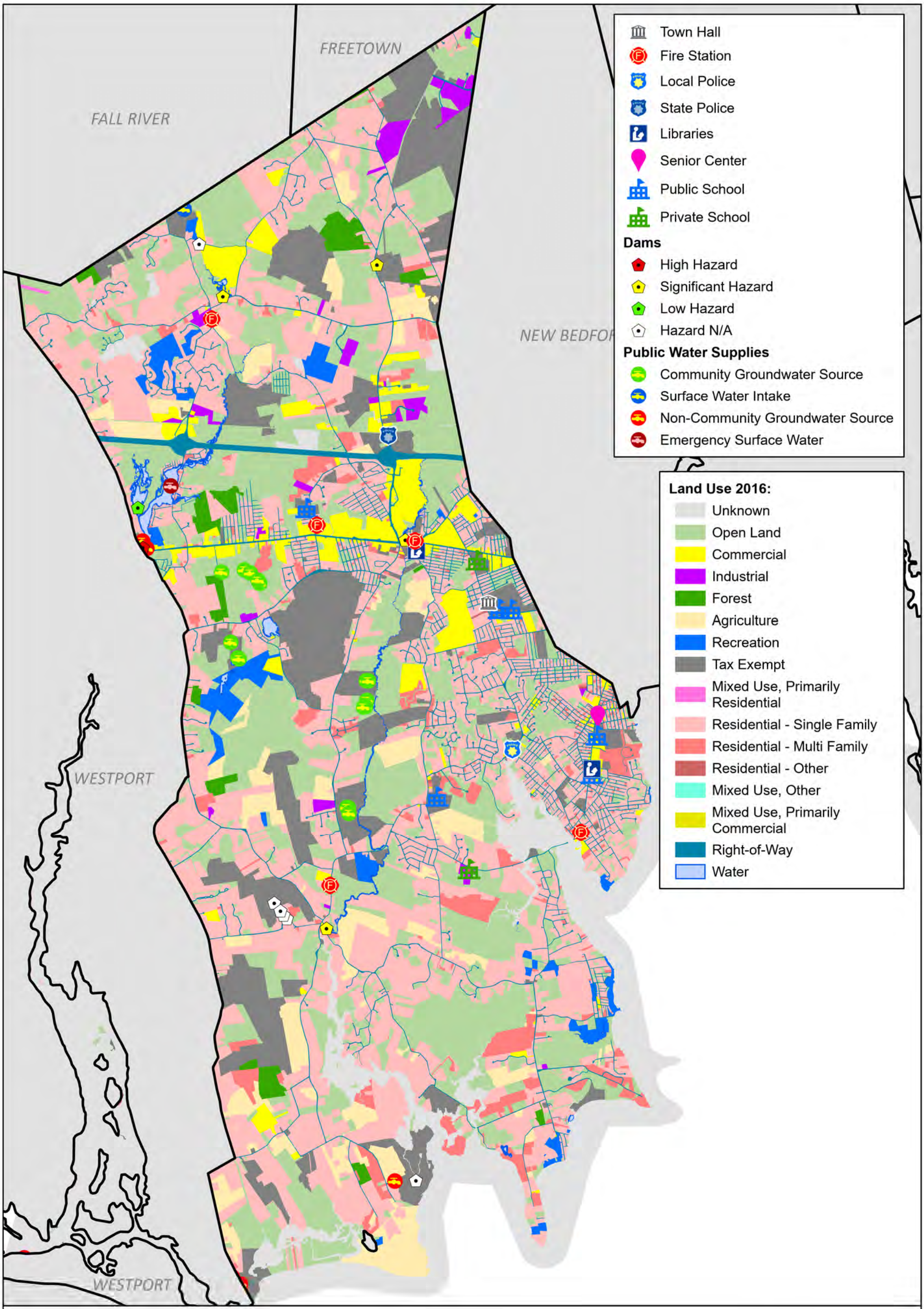
Map created April 5, 2019 - Dartmouth Geographic Information System

For more information on Zoning Districts or for questions regarding zoning please call the Director of Inspectional Services.

0 0.5 1 2 3 4 5

Miles

1:24000 (USGS Quadrangle Map Scale)
or 1" = 2000'



Land Use Map

Municipal Vulnerability Preparedness Program
Dartmouth, MA

Comprehensive Environmental Incorporated

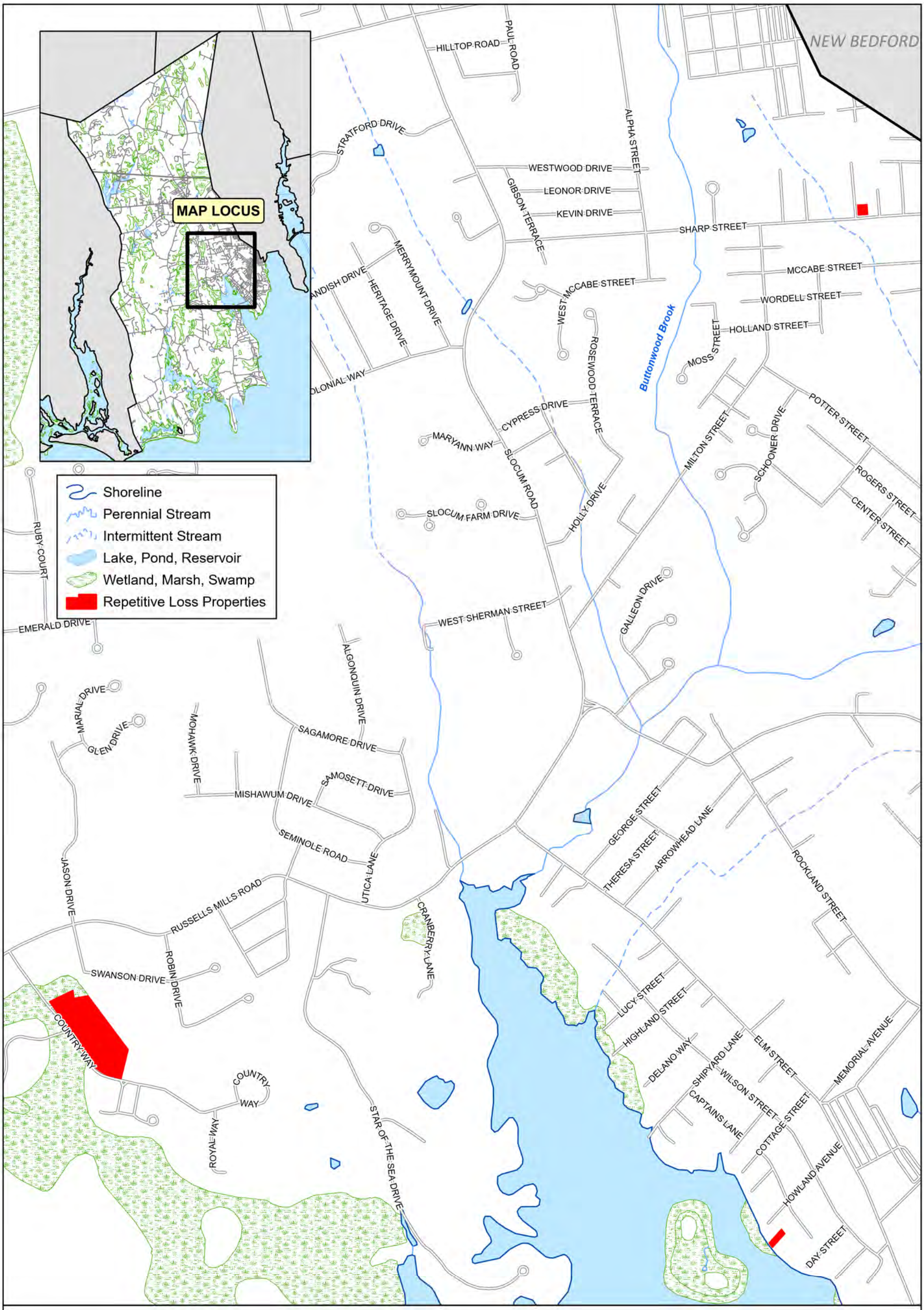
N

0 0.5 1 1.5 2

Miles

Data Source: MassGIS, Town of Dartmouth

4/7/2020



Repetitive Loss Properties

Municipal Vulnerability Preparedness Program
Dartmouth, MA

Comprehensive Environmental Incorporated

N

0 500 1,000 1,500
Feet

Data Source: MassGIS, Town of Dartmouth

4/7/2020

APPENDIX D

Dartmouth Local Multi-Hazard Mitigation Plan, 2015 Update

Dartmouth, MA

Local Multi-Hazard Mitigation Plan, 2015 Update

July 7, 2015

Prepared for:

Town of Dartmouth
400 Slocum Road
Dartmouth, MA 02747

Prepared by:

Comprehensive Environmental Inc.
225 Cedar Hill Street
Marlborough, MA 01752

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1.0 INTRODUCTION

1.1 Introduction

Coastal New England is notoriously difficult to predict, and virtually every type of weather has been and will be experienced in southeastern Massachusetts. From freezing temperatures and blizzard conditions in the winter to stifling heat and humidity in the summer, Dartmouth must plan for the worst. The old adage of "if you don't like the weather, wait a minute" certainly applies.

Dartmouth's location along the Atlantic coast is situated near the intersection of the warm-water Gulf Stream flowing north from the Gulf of Mexico and the cold-water Labrador Current flowing south from the Arctic Ocean. These ocean currents, coupled with a variable jet stream capable of bringing any combination of cold, warm, dry and moist air masses results in a constantly changing climate capable of producing any number of natural hazards.

In addition to these regional weather factors, Dartmouth has approximately 55 miles of shoreline abutting Buzzard's Bay. The combination of these factors results in the potential for unique natural hazards associated with ocean based storm events.

1.2 Purpose

The Federal Emergency Management Agency (FEMA) defines hazard mitigation as "any sustained action taken to reduce or eliminate the long-term risk to human life and property from (natural) hazards", such as floods, hurricanes, winter storms, tornadoes, earthquakes, etc. Hazard mitigation may include both structural measures, such as flood control structures, and nonstructural measures, such as regulations and bylaws, to prevent flooding. Local planning and mitigation efforts allow communities to evaluate existing critical infrastructure susceptible to hazards and identify improvements to reduce damage from natural disasters.

This plan is provided as an update to the Southeastern Regional Planning & Economic Development District (SRPEDD) Natural Hazard Pre-Disaster Regional Mitigation Plan prepared in 2004. The 2004 regional plan largely focused on mitigation measures to be taken by the entire area. The Town of Dartmouth and Comprehensive Environmental, Inc. (CEI) developed this updated Local Multi-Hazard Mitigation Plan through a FEMA grant obtained as part of the Hazard Mitigation Grant Program (HMGP) to focus specifically on the local issues affecting the Town. The plan has been developed for the entire Town with the goal of providing sustained actions to reduce or eliminate risk to human life and property damage from a natural hazard event.

Objectives of this plan are as follows:

- Describe the planning process including formation of the Local Planning Team (LPT) and input from the general public;
- Identify relevant background information on the Town, including geography, climate, land use, and infrastructure;
- Identify natural hazard risks and areas in town most likely to be impacted;
- Complete a risk assessment to profile hazard events, inventory assets, and estimate potential losses;

- Identify existing disaster mitigation measures already in place;
- Develop proposed mitigation measures and a mitigation strategy based on the risk assessment;
- Design a mechanism to keep the plan updated to reflect current conditions and establish a schedule for monitoring, evaluating, and updating the plan; and
- Define the process where Dartmouth formally adopts the mitigation plan.

Preparation of this Local Multi-Hazard Mitigation Plan before a major disaster occurs can help the community prevent property damage and loss of life and associated with natural hazards, save money by instituting mitigation measures to protect against natural hazards, allow funding through FEMA for post-disaster remediation, and expedite disaster recovery. The Plan will also help to reduce or eliminate repetitive flood losses.

2.0 PLANNING PROCESS

2.1 Planning Process Goals

An open public involvement process is essential to the development of an effective plan, and the most successful mitigation plans are developed after participation by a wide range of stake-holders who play a role in identifying and implementing mitigation actions. During preparation of this Local Multi-Hazard Mitigation Plan, the planning process included the following:

- An opportunity for the public to comment on the plan during the drafting state and prior to final approval;
- An opportunity for local and regional agencies, academic institutions, and other private industries to be involved in the planning process; and
- Review and incorporation of existing plans, studies, reports and information.

2.2 Local Planning Team

An initial kickoff meeting was held with members of the Town and representatives of CEI to establish a preliminary LPT. The LPT consisted of various Town officials, business leaders, and other interested agencies and organizations to provide critical local knowledge of the community to facilitate development of this Plan. Throughout the planning process, the LPT was modified and updated, ultimately comprising the members listed in **Table** 2.1.

Table 2.1 – Local Planning Team Members

Department / Agency	Name	Title / Position
Town Departments / Boards		
Building Department	Paul Murphy	Director of Inspectional Services
Community Television	Cynthia Marland	Director of Media
Conservation Commission	Mike O'Reilly	Environmental Affairs Coordinator
Council on Aging	Debra Raymond	Director
Emergency Management Agency	Edward Pimental, Jr.	Director of the Emergency Management Agency
Executive Administration	David Cressman	Town Administrator
	Deborah Melino-Wender	Director of Development
Fire District 1	John Judson Marcel Dumont	Fire Chief Retired Fire Chief
Fire District 2	Tim Andre	Fire Chief
Fire District 3	Richard Arruda	Fire Chief
Harbormaster	Steve Melo	Harbormaster
Parks and Recreation	Timothy Lancaster	Director of Parks & Recreation
Planning Board	Donald Perry	Planning Director
Police Department	Timothy Lee	Chief of Police
	Robert Szala	Deputy Chief
Public Health	Wendy Henderson	Director of Public Health
Public Libraries	Lynne Antunes	Director of Libraries
Public Works	David Hickox	Director of Public Works
	Paul Pacheco	Superintendent Services & Infrastructure

Table 2.1 (continued) – Local Planning Team Members

Department / Agency	Name	Title / Position
Town Departments / Boards		
School Department	Ana Riley	Superintendent of Schools
	James Kiely	School Business Manager
	Richard Ferreira	Director of Maintenance
Other Agencies and/or Organizations		
Bristol County Sheriff's Office	Thomas M. Hodgson Colonel Dave Gavigan	Sheriff Homeland Security
NSTAR	Dennis Galvam Richard Tobin Donald Boudreau	Manager, Community Relations Manager, Emergency Preparedness Director, Electric Operations
UMass Dartmouth	Emil Fioravanti Captain Tim Sheehan	UMass Dartmouth UMass Dartmouth Police

The bulk of the LPT consisted of representatives of Town departments and boards, including Executive Administration, Public Works, Planning, Fire, Health, etc. Several other critical organizations located within Town boundaries were also represented, including the University of Massachusetts, the Dartmouth Mall, and Bristol County House of Corrections.

2.3 Team Meetings

The LPT and representatives from CEI participated in a number of meetings over a 10 month period of time, during which information was provided to and input was solicited from team members. As mentioned previously, the planning process commenced with a kickoff meeting on July 18, 2012 between select members of the Town and CEI to establish a preliminary LPT.

A follow-up meeting was conducted on August 22, 2012 where representatives of CEI and the Director of Public Works conducted site visits to a number of high hazard areas in Town as discussed in Section 5.0. The meeting then continued with a discussion between CEI and sixteen members of the LPT. CEI provided background information on the planning process and solicited feedback from the LPT on the plan, particularly concerning high hazard areas and critical infrastructure, as well as proposed mapping efforts.

The third meeting was held on September 20, 2012 where members of the LPT reviewed maps outlining areas subject to inland flooding and inundation as a result of a hurricane. These maps were then overlaid with critical infrastructure locations to outline important structures potentially subject to damage during a hurricane, which was identified as the most likely natural disaster for the Town of Dartmouth. The Team then outlined existing mitigation measures in place, as well as currently proposed measures.

The fourth meeting was held on October 23, 2012 where the LPT reviewed the prioritization and "tiering" of critical infrastructure for mapping and response purposes. A map and list of Tier 1 critical infrastructure located in a hazard-prone area were then reviewed, and any planned upgrades to these facilities were identified. The LPT then discussed existing emergency shelters and evacuation routes for use during an emergency situation, before ultimately discussing the vulnerability assessment performed for properties located in hazard areas.

An additional meeting was then held on January 11, 2013 with select LPT members, CEI and a representative of NSTAR to coordinate emergency response efforts. This meeting focused on reviewing the Town's critical infrastructure locations to prioritize disaster response measures. This will facilitate better communication and response during an emergency between local emergency response agencies, the Dartmouth DPW and NSTAR, such as removing debris and downed power lines to allow access to critical infrastructure, and restoring power to critical Town infrastructure as a first priority.

The sixth LPT meeting was held on February 5, 2013 that reviewed existing mitigation measures identified thus far during the planning process, and identified goals for implementing proposed disaster mitigation measures. The LPT then reviewed and modified proposed measures identified during the previous five meetings, and prioritized each measure for implementation. Finally, the upcoming public participation and input session was discussed.

The seventh meeting was held on April 29, 2013 and consisted of a public information and input session. The event was held in conjunction with a Dartmouth Select Board meeting and was advertised on the Town's website and DCTV public access channel. During the meeting, CEI provided a presentation outlining the work performed to date, including background information on the plan, development of the LPT, potential natural hazards to Dartmouth, critical infrastructure within Town, existing and proposed mitigation measures, and a schedule for plan approval. Upon completion of the presentation, the floor was opened for public comment. Several audience members expressed their appreciation for the Plan, and gratitude towards the LPT for their hard work during the planning process. The Plan was also made available for a period of 30 days following the meeting on the Town's website for public comment.

After the above meeting, the draft plan was sent to MEMA for review. Once comments were received and incorporated into the plan, a final public meeting was held on March 24, 2014 prior to approving the final plan for dissemination to MEMA and FEMA for review. The event was advertised in advance on the Town's website and DCTV public access channel. Additionally, a final draft of the plan was made available for download on the Town's website in advance of the meeting for public review. During the meeting, CEI went through the new additions to the plan and answered any final comments. Once complete, the Dartmouth Select Board was updated on plan progress the evening of March 24, 2014. Following the completion of both meetings, the plan was made available for an additional 30 days on the Town's website for public comment.

Further documentation of the planning team meetings is provided in **Appendix A**.

2.4 Planning Process

In general, the following steps were taken during the planning process.

Step 1. Outline a Local Planning Team in charge of completing this Plan;
Step 2. Define the potential natural hazards that could affect Dartmouth;
Step 3. Determine high hazard locations and critical infrastructure potentially affected;
Step 4. Conduct a vulnerability assessment of buildings and infrastructure;
Step 5. Outline existing hazard mitigation measures in place;
Step 6. Determine gaps in hazard mitigation preparedness;

Step 7. Define proposed hazard mitigation measures to fill these gaps; and
Step 8. Evaluate the feasibility of proposed measures and prioritize mitigation measures.

The above steps will allow implementation of proposed mitigation measures with a goal of reducing damage and improving public safety during a natural disaster.

2.5 Plan Update and Other Relevant Studies

In 2004, the SPREDD prepared a Natural Hazard Pre-Disaster Regional Mitigation Plan for southeastern Massachusetts. The planning committee worked with all 27 communities, including Dartmouth to assess hazards, evaluate vulnerable areas, and recommend planning and infrastructure improvements. This Local Multi-Hazard Mitigation Plan is intended as an update to the 2004 regional plan with an emphasis on local issues that were unable to be addressed at a regional level.

During preparation of this Plan, several existing studies and documents relative to Dartmouth and the surrounding area were also reviewed. Preparation of this plan borrowed from the following plans and documents where appropriate:

- Massachusetts State Hazard Mitigation Plan (2010);
- Dartmouth Master Plan (2007); and
- Relevant local ordinances and regulations.

In 2010, the State Hazard Mitigation Team, comprised of staff from the Massachusetts Emergency Management Agency and Department of Conservation and Recreation, updated its existing Commonwealth of Massachusetts State Hazard Mitigation Plan. This is the plan's seventh revision from its initial preparation in 1986. The planning team worked with a number of state and federal agencies to develop a plan outlining actions that should be taken by federal, state, local governments and the general public to manage the risks of natural hazards.

The Dartmouth Master Plan was prepared by SRPEDD with input from residents of the Town as a tool to communicate aspirations to Town boards, departments, committees, commissions, and other interested parties. The document outlines a policy on growth management goals and recommends specific implementation steps for translating goals into achievements.

Various town departments and boards have implemented and updated bylaws and regulations as necessary throughout the years to control development and ensure safe construction methods that adhere to current best management practices. Bylaws and regulations are discussed further in Section 7.4.

3.0 LOCAL PROFILE

The following sections outline the local profile of the Town. Topics include:

- Area history and town historic properties;
- Natural features, including geography, climate, and waterbodies;
- Summary of the town, including land use, zoning, infrastructure and demographics; and
- Miscellaneous additional institutions vital to the community

Additionally, expected development trends over the coming years are outlined as necessary in each section, particularly concerning land use and population growth.

3.1 History

On March 7, 1652, a group of 34 Plymouth colonists purchased the territory known as Dartmouth from the Wampanoag Indian tribe, encompassing approximately 170 square miles. At that time, Dartmouth also comprised the surrounding areas of Acushnet, Fairhaven, New Bedford, and Westport. Dartmouth was settled in November 1652 and officially incorporated in 1664. During King Phillip's War in 1675, Dartmouth was almost totally wiped out, however was rebuilt in subsequent years. In 1787, Dartmouth was divided into the towns of Dartmouth, Westport and New Bedford, with Fairhaven and Acushnet later splitting from New Bedford in 1812 and 1860, respectively[1].

Early industries included agriculture, shipbuilding, grain mills, and general shops and stores. Dartmouth slowly became home to many wealthy citizens of the surrounding towns, including whaling ship owners and sea captains. Over time, the shipbuilding industry dwindled due to a relatively small harbor and limited labor force; however the wooden ships of the eighteenth and nineteenth century have given way to large numbers of modern-day pleasure crafts populating Padanaram Harbor[2]. Current industry still includes agriculture, as well as general retail shops, restaurants and offices typical of southeastern New England.

Interstate 195 (I-195) was constructed between 1958 and 1960 and brought a modern highway to the Town, running parallel to US Route 6 in an east-west orientation. In 1960, the Southeastern Massachusetts Technological Institute (SMTI) was established in Dartmouth, later becoming to the University of Massachusetts, Dartmouth in 1991. Despite increasing commercial and industrial development along these primary transportation corridors, over 350 years of development has not changed the basic makeup of the Town. Dartmouth is still a generally suburban community consisting largely of rural homes. Many early American homes, churches and buildings survive to this day, indicative of Dartmouth's rich history.

3.2 Geography

The Town of Dartmouth is located in Bristol County, Massachusetts, and contains the villages of Hixville, Bliss Corner, Padanaram, Smith Mills and Russell Mills. The following communities border the Town of Dartmouth: the Town of Westport to the west, the City of Fall River to the northwest, the Town of Freeport to the north, the City of New Bedford to the East, and a portion

[1] Town of Dartmouth http://www.town.dartmouth.ma.us/Pages/DartmouthMA_Webdocs/darthistory
[2] Dartmouth Police Department http://www.dartmouthpd.org/dhistory.html

of the Atlantic Ocean known as Buzzards Bay to the South. The Town occupies a total area of approximately 97.8 square miles, of which approximately two-thirds is land with the remaining one-third water[3]. It is the fifth largest town by land area in Massachusetts. The Town is unofficially divided into two sections by ZIP code: North Dartmouth (02747) and South Dartmouth (02748). **Figure 1** provides a locus map of the area.

The northern part of Dartmouth is a historic rural environment, comprised of forest lands and residential homes nestled within the area. The coastal environment to the south is bordered by a number of agricultural farms, and is supplemented by beaches for public recreation. The commercial district (located along the central corridor of the Town) is comprised of a number of businesses and serves as a regional shopping area. The community is also home to the University of Massachusetts Dartmouth and the Southern New England Law School[4], located just south of the central commercial district.

3.3 Climate

Dartmouth averages approximately 46 inches of rain per year[5] with an average annual snowfall of 33 inches. Average temperatures range from highs in the upper 70's and low 80's during the summer months to lows in the low to mid 20's during winter months[6]. Dartmouth's location along the Atlantic Ocean generally keeps temperatures cooler in the summer and warmer in the winter than other nearby, inland Massachusetts communities.

3.4 Waterbodies

Buzzards Bay is approximately 28 miles long by 8 miles wide and forms Dartmouth's southern border. Dartmouth has over 60 miles of coastline along Buzzards Bay, as a result of its numerous inlets. The bay opens to Rhode Island Sound to the southwest and connects to Cape Cod Bay via the Cape Cod Canal, completed in 1914. Other salt waterbodies include Apponagansett Bay, and Clarks Cove.

Several rivers are also present in Dartmouth, including the Copicut River, Shingle Island River, Paskamanset River, Slocums River, Destruction Brook, Little River, and Buttonwood Brook, all of which flow north-south. Lakes, ponds include Turner Pond, Copicut Reservoir, Cornell Pond, Noquochoke Lake, and Cedar Dell Lake.

3.5 Land Use and Zoning

As mentioned previously, Dartmouth occupies approximately 97.8 square miles, of which approximately two-thirds is land and one-third water. The vast majority is zoned as Single Residence B, or lots with a minimum size of 80,000 square feet designed to preserve the rural character of the Town. Smaller portions of Dartmouth located near New Bedford are zoned as Single Residence A or General Residence with minimum lot sizes of 40,000 square feet and 15,000 square feet, respectively. Zoning along much of the Route 6 corridor and Interstate 195 belt are zoned for General Business and Limited Industrial to establish a commercial base along the most heavily traveled roadways.

[3] Wikipedia http://en.wikipedia.org/wiki/Dartmouth,_Massachusetts
[4] Town of Dartmouth http://www.town.dartmouth.ma.us/Pages/DartmouthMA_Webdocs/profile
[5] Sperling's Best Places http://www.bestplaces.net/climate/city/massachusetts/dartmouth
[6] The Weather Channel, http://www.weather.com/weather/wxclimatology/monthly/graph/02747

Large lot development remains the predominant form of residential development in Dartmouth today, originally instituted for environmental protection. Of the 29,315 acres of land zoned SR-B, 17% is developed and 27.5% is permanently protected, leaving 55% undeveloped (although a large portion of this is wetlands)[7].

Agriculture is a rich part of Dartmouth's history; however, the land use changes note a decline in farmland of 23% during 1971-1999. Although farms provide jobs and add to the rural character to the Town, farmland area is expected to continue declining over the coming years due to the present economics of farming and land development pressures[8].

3.6 Demographics

Dartmouth has grown to a total population of 34,032 according to the 2010 US Census[9], up from a population of 30,666 in 2000 as applicable to the 2004 SRPEDD Plan, with a population density of approximately 552 persons per square mile. A total of 12,435 households are present in the Town, of which 8,826 are owner-occupied, 2,411 are renter occupied, and 1,198 are vacant. In addition to fulltime residential growth, Dartmouth expects a continued influx of seasonal residents during summer months. The 2010 Census indicates that 660 housing units of the Town's total 12,435 housing units were for seasonal use[10]; however some portion of those categorized as "vacant" may well be seasonally occupied.

Dartmouth has experienced steady growth over the past twenty years, and is expected to continue growing over the next several decades. Projections completed by SRPEDD in the development of the 2004 SRPEDD Plan[11] indicate that Dartmouth is expected to reach a population of 36,907 in 2020 and 38,838 in 2025, with an average population growth of approximately 9% per decade. A build-out analysis, commissioned by the Executive Office of Environmental Affairs (EOEA) in 2000 estimated that if all undeveloped lands in Dartmouth were to be built out according to existing zoning and environmental regulations, Dartmouth could obtain a population of 56,871 persons. However, the Planning Board believes that the actual build-out population will be closer to 42,000 due to the increased presence of wetland areas[12]. Based on current population growth, Dartmouth could achieve full build-out in as early as 20 to 25 years.

The aging population and changing household composition in Dartmouth (as well as the state and nation) has implications for future growth and development. As the baby boomers age, the desire for different housing types and the demand for services may shift. Trends noted include increased second home purchases, return to urban areas, and a desire for no maintenance living[13].

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[7] SRPEDD. "2007 Dartmouth Master Plan". 2007.
http://www.town.dartmouth.ma.us/Pages/DartmouthMA_BComm/Planning/DartmouthMasterPlan.pdf
[8] SRPEDD. "2007 Dartmouth Master Plan". 2007.
http://www.town.dartmouth.ma.us/Pages/DartmouthMA_BComm/Planning/DartmouthMasterPlan.pdf
[9] US Census Bureau http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml
[10] US Census Bureau http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml
[11] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[12] SRPEDD. "2007 Dartmouth Master Plan". 2007.
http://www.town.dartmouth.ma.us/Pages/DartmouthMA_BComm/Planning/DartmouthMasterPlan.pdf
[13] SRPEDD. "2007 Dartmouth Master Plan". 2007.
http://www.town.dartmouth.ma.us/Pages/DartmouthMA_BComm/Planning/DartmouthMasterPlan.pdf

3.7 Government

The Town of Dartmouth is governed by a charter which grants power to a Representative Town Meeting with 369 representatives elected by residents at an election held each year. Town Meetings are typically held two or three times a year to act on the legislative needs of the community. The Town has a full time administrative governmental structure that operates on a day-to-day basis at the Town Hall. The Executive Branch of Government is comprised of a 5 member Select Board that meets weekly. Town departments and boards are headed by both elected and appointed officials.

3.8 Infrastructure

Dartmouth contains approximately 4.51 miles of interstate highways, 27.06 miles of arterial roadways, and 41.03 miles of collector roads, and 131.92 miles of local roadways[14]. The Town is accessible via US Route 6 and Interstate 195, both of which run in an east-west direction. Two exits, Reed Road (Exit 11) and Faunce Corner Road (Exit 12), are the major access points from Interstate 195. Massachusetts Routes 88 and 140 are located just over the town borders in Westport and New Bedford, respectively, and run north-south.

Limited bus service is provided by the Southeastern Regional Transit Authority (SRTA) serving to connect portions of Dartmouth to New Bedford and Fall River. A railroad runs east-west parallel to Interstate 195, just to the north serving as a freight corridor through the Town; however no passenger service is offered in Dartmouth.

The Town operates three water treatment facilities servicing 13 municipal wells, one wastewater treatment plant, and related infrastructure such as drinking water and sewage pipes, pump stations, etc. The Town receives gas and electric service provided by NSTAR, and communication services provided by Verizon, Comcast, and AT&T.

3.9 Historic Properties

The National Register of Historic Places is the official list of the Nation's historic places worthy of preservation, and is part of a national program to coordinate and support efforts to identify, evaluate, and protect America's historic and archeological resources. The National Register of Historic Places lists the following locations within Dartmouth:

- Apponegansett Meeting House;
- Hill School;
- Hixville Village Historic District;
- Padanaram Village Historic District;
- Russells Mills Village Historic District; and
- Tucker Farm Historic District.

Both the Apponegansett Meeting House and Hill School are included in the list of Critical Infrastructure as described further in Section 6.1. Historic Districts are included with the rest of the Town in evaluating potential losses from natural hazards.

[14] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.

As per the SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan, Dartmouth has passed the Community Preservation Act (CPA), which allows communities to create a local Community Preservation Fund for open space protection, historic preservation, affordable housing and outdoor recreation. Therefore, local funding may be available for improvements under the historical provision of the locally controlled CPA fund.

3.10 UMass-Dartmouth

Due to its size and prevalence within the community, UMass-Dartmouth deserves special attention when coordinating emergency response due to natural disasters. UMass is situated on a 710-acre campus with 13 primary buildings. The university has a total enrollment of approximately 9,500 students, with approximately 4,500 living on campus and 5,000 commuters[15], as well as several hundred faculty. The campus is accessible off of Old Westport Road; however emergency access is also available via Lucy Little Road and Chase Road. The University continues to grow in prestige and expand in programming and size, and will continue to play a major role in the development of the community by bringing in additional residents, visitors the related impacts.

3.11 Bristol County House of Corrections

As with UMass-Dartmouth, the Bristol County House of Corrections houses a relatively large population. The facility contains approximately 1,100 beds, housing male and female inmates in various security levels[16]. Inmates housed within typically held either pre-trial or have sentences of 30 months or less. The facility is located off of Faunce Corner Road.

[15] University of Massachusetts, Dartmouth http://www.umassd.edu/about/
[16] Bristol County House of Corrections, http://www.bcso-ma.us/facilities.htm

4.0 NATURAL HAZARDS

FEMA defines a hazard as an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing. All natural disasters pose hazards to property damage and loss of human life, and have the ability to limit access to electrical power, telecommunication services, potable water, wastewater collection/treatment and transportation. Downed trees and tree limbs may also limit emergency access and hinder cleanup efforts. Dartmouth must take steps to protect its infrastructure from natural disasters as much as possible, such that essential utilities and services continue when needed most.

Hazards associated with natural disasters typically encountered (e.g. flood events, hurricanes, winter storms) in Dartmouth include high winds, heavy rains and localized flooding. Natural disasters occurring less frequently (e.g. tornadoes, earthquakes, forest fires) may pose other hazards, presenting unique challenges to residents and community officials, as hazards may not have been encountered before in recent memory.

Table 4.1 and **Table** 4.2 depict major disaster declarations and emergency declarations, respectively, for Bristol County[17].

Table 4.1 – Major Disaster Declarations for Bristol County

Date	Incident Description	Disaster Number
December 19, 2012	Hurricane Sandy	4097
September 3, 2011	Tropical Storm Irene	4028
March 29, 2010	Severe Storm and Flooding	1895
November 10, 2005	Severe Storms and Flooding	1614
April 10, 2001	Severe Storms and Flooding	1364
June 23, 1998	Heavy Rain and Flooding	1224
January 24, 1996	Blizzard	1090
August 26, 1991	Hurricane Bob	914
October 28, 1985	Hurricane Gloria	751
February 10, 1978	Coastal Storms, Flood, Ice, Snow	546

Table 4.2 – Emergency Declarations for Bristol County

Date	Incident Description	Disaster Number
October 28, 2013	Hurricane Sandy	3350
August 26, 2011	Hurricane Irene	3330
September 2, 2010	Hurricane Earl	3315
December 13, 2008	Severe Winter Storm	3296
October 19, 2005	Severe Storms and Flooding	3264
September 13, 2005	Hurricane Katrina Evacuation	3252
February 17, 2005	Snow	3201
January 15, 2004	Snow	3191
March 11, 2003	Snowstorm	3175
March 16, 1993	Blizzards, High Winds & Record Snowfall	3103

[17] FEMA http://www.fema.gov/disasters/grid/state/2?field_disaster_type_term_tid_1=All

In order to outline the natural disasters and associated hazards potentially afflicting Dartmouth, the following sources were used:

- A review of the 2010 Massachusetts State Hazard Mitigation Plan;
- A review of the 2004 SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan;
- A review of FEMA emergency declarations;
- A review of past events documented in news articles and internet sources; and
- Conversations with members of the LPT and other local stakeholders.

Based on information obtained from the sources described above, the following natural disasters and associated hazards have been identified as a threat to Dartmouth as shown in **Table** 4.3. Natural disasters are described in detail in the following sections.

Table 4.3 – Natural Disasters and Associated Hazards

Natural Disaster	Potential Hazards
Floods	Coastal flooding, inland flooding
Snowstorms and Blizzards	Heavy snowfall, coastal flooding, high winds
Ice Storms	Ice buildup
Ice Dams	Inland flooding
Hurricanes	High winds, coastal flooding, inland flooding
Nor'easters	High winds, coastal flooding, inland flooding
Tornadoes	High winds
Thunderstorms	High winds, lightning, inland flooding
Earthquakes	Damaging ground movement
Forest Fires / Wildfires	Fire
Droughts	Increased fire danger, limited water
Dam Failures / Breaches	Inland flooding

4.1 Floods

Floods are an overflow of water submerging land not typically covered by water. Dartmouth historically experiences flooding in a number of areas multiple times a year, with flooding limited to a localized area or widespread depending on the cause. Flooding may be experienced along inland areas such as rivers and streams, and/or along coastal bays, inlets or other areas. Floods are typically associated with heavy rainfall events such as severe thunderstorms or hurricanes, and may affect (or overload) both natural resources such as rivers, or stormwater infrastructure such as catch basins and pipes. Flood damage can be widespread, and range from relatively minor in nature (flooded basements, water ponding in roadways) to extreme (severe riverbank erosion, flooded buildings and cars, etc.). In extreme cases, roadway or culvert washouts may occur, potentially limiting emergency access to portions of the town. For example, inland flooding of the Paskamanset River and Buttonwoods Brook in March 2010 rendered east-west travel within Dartmouth virtually impossible for several days.

Coastal Flooding and Storm Surge

Coastal floods are typically the result of powerful coastal storms, such as hurricanes or nor'easters. These storms may bring a storm surge, or an abnormal swell of water associated with a low pressure system or high winds pushing on the ocean's surface. Storm surges are easily capable of inundating low-lying coastal areas. Typical storm surges are only a few feet of

water; however major hurricanes are capable of creating a storm surge of as much as 25 feet depending on a number of factors such as wind speed, forward speed, size, angle of approach, and local topography. A storm surge coinciding with a high tide event can devastate coastal features such as piers, docks, boats, and virtually any natural or manmade infrastructure located in low-lying areas. The Massachusetts Hazard Mitigation Plan reports that southeastern Massachusetts is particularly vulnerable to storm surge due to the presence of Buzzards Bay. This document states, "…the configuration of the bay can cause a funneling phenomenon on tidal surges. Ocean waters entering Buzzards Bay become more restricted causing higher flood levels with continued movement into the upper reaches of the bay"[18]. No detailed information is available specific to Dartmouth on past storm surge events.

Riverine (Inland) Flooding

Within the southeastern Massachusetts region, 17% of the land area is within the 100 year floodplain, and an additional 4% is located in the 500 year floodplain[19]. Floodplains are formed naturally as rivers and streams periodically overflow their banks and erode the surrounding areas, generally creating large, relatively flat areas adjacent to the watercourse. Throughout history, these areas have been highly sought after for their benefits, including highly fertile soil for agriculture, access to waterpower and transportation for industry, and generally easily developable land. However, this very infrastructure is at risk of flooding from rivers and streams that will inevitably seek to reoccupy the original floodplain.

Typical flooding events are the result of days or even weeks of wet weather, and may be brought on by a number of factors including prolonged heavy rains, numerous rainfall events over a short timeframe, high groundwater conditions or rapid snowmelt. Flash floods typically occur as a result of very heavy rainfall in a short period of time, typically over a period of minutes or hours. These flash floods are typically brought on by powerful, yet brief weather events such as hurricanes or summer thunderstorms; however these can also be the result of a dam breach or failure. During flood events, rivers or stream flows will greatly increase, possibly causing the waterbody to overflow its banks and damaging resources located within the natural floodplain. Actual damage will depend on a number of local factors, such as topography, river hydrology, precipitation characteristics, soil types, land use, etc. No detailed information is available specific to Dartmouth on past riverine flooding events.

Flooding from Storm Runoff

Floods impacting a stormwater system may overwhelm the carrying capacity of pipes, swales and other stormwater conveyance, typically causing localized flooding in problem areas. Impacts can be exacerbated if the storm system is not properly maintained (e.g. clogged pipes, full catch basins, etc.). One example is Buttonwoods Brook, which periodically causes localized flooding of Hawthorn Street and Allen Street due to culvert capacity limitations.

Erosion

All flooding events have the potential to cause erosion. Depending on the scale of damage, erosion can be limited to a nuisance, such as eroding soil onto roadways, to catastrophic, such as the loss of a coastal seawall or river culvert crossing.

[18] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[19] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.

Summary

Hazard Location:

- Coastal Flooding and Storm Surge:
  - Storm surge and wave action occurring along the coast
  - Small, localized areas to moderate area depending on the magnitude of the storm
- Riverine (Inland) Flooding:
  - General flooding occurring along rivers and streams
  - Generally small, localized areas depending on rainfall received
- Flooding from Storm Runoff:
  - Occurs at vulnerable storm sewer locations such as those with undersized pipes
  - Generally small, localized areas depending on rainfall received
- Erosion:
  - Occurs in the same vicinity as the flood event

Potential Damage (All Hazards):

- Flooded basements, buildings, parking lots, roadways, and other infrastructure
- Impassible or washed out roads

Scale / Extent:

- Coastal Flooding and Storm Surge:
  - Storm surge potentially in excess of 18 feet
- Riverine (Inland) Flooding:
  - Flooding caused by 24 hour rainfall typically ranging from 2 inches up to 7 inches (100 year storm)
  - Potentially caused by rainfall up to and in excess of 12 inches
- Flooding from Storm Runoff:
  - Flooding caused by 24 hour rainfall typically ranging from 2 inches up to 7 inches (100 year storm)
  - Potentially caused by rainfall up to and in excess of 12 inches
- Erosion:
  - Severity of erosion due to coastal flooding and storm surge increases proportional to the flood event and storm surge magnitude
  - Severity of erosion due to inland flooding and/or stormwater runoff increases proportional to the flood event magnitude

Previous Occurrences:

- Coastal Flooding and Storm Surge:
  - See previous occurrences of Hurricanes and Nor'Easters
- Riverine (Inland) Flooding:
  - Minor inland flooding occurs yearly, typically associated with strong summer thunderstorms or spring snowmelt
  - Major inland flooding occurs every few years, typically associated with heavy rainfall events in excess of 2 inches. Major inland flooding may also be associated with strong thunderstorms and minor to major hurricanes
- Flooding from Storm Runoff:
  - Minor flooding from storm runoff occurs almost yearly, typically associated with

strong summer thunderstorms
    - Major flooding from storm runoff occurs every few years, typically associated with heavy rainfall events in excess of 2 inches, typically associated with strong thunderstorms and minor to major hurricanes
- Erosion:
    - Minor erosion of both inland and coastal features occurs approximately yearly from storms associated with rainfall events, hurricanes, nor'easters, etc.
    - Major coastal events occur in conjunction with coastal storms. See previous occurrences of Hurricanes and Nor'Easters
    - Major inland events have not been recorded in Dartmouth

Likelihood of Future Occurrences (All Hazards):

- Limited flood events occur nearly every year, typically during warmer months
- Major events occur less frequently, with moderate events occurring every several years and severe events once a decade

4.2 Winter Storm Events

Snowstorms and Blizzards

Snow storms and blizzards are also a common winter event in New England. These storms bring the added dangers associated with high winds and sustained heavy snowfall, typically over a prolonged period of 12 hours to 3 days[20]. Limited travel is expected, as well as potential disruptions to utilities and other services. Severe winter storms may also exacerbate coastal flooding issues, as high coastal winds can drive seawater against the coast and result in coastal flooding as described above. High winds (>35 mph) associated with blizzard conditions may also make travel difficult, if not impossible, due to limited visibility and drifting snow.

On average, Dartmouth receives approximately 33.4 inches of snow per year[21]. According to the National Oceanic and Atmospheric Administration (NOAA), the greater Providence area which covers Dartmouth has a 20% chance each year of having at least 1 snow event larger than 12 inches, and is likely to experience slightly fewer than 10 snowstorms each year of varying size[22]. To quantify potential storm impacts, members of the National Weather Service have created the Northeast Snowfall Impact Scale[23] to quantify winter storm impacts based on snowfall received, size of the area, and population affected. NESIS values are shown in **Table** 4.4.

Table 4.4 – NESIS Winter Storm Intensity

Index Category	NESIS Value	Description
1	1-2.499	Notable
2	2.5-3.99	Significant
3	4-5.99	Major
4	6-9.99	Crippling
5	10+	Extreme

[20] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[21] Weather Underground http://www.wunderground.com/climate/local.html?id=USC00192451&var=SNOW
[22] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[23] Zielinski, Gregory A. American Meteorological Society. "A Classification Scheme for Winter Storms in the Eastern and Central United States with an Emphasis on Nor'easters". January 2002.

Winter storms occur quite frequently, and thanks to preparation by the Town and its residents, typically amount to no more than a minor inconvenience. Though school delays and slow travel may occur, crippling winter storms are a rarity. However, in 2005 a three-day winter storm hit Massachusetts, dropping more than three feet of snow in parts of southern New England. Logan Airport was shutdown and roadways were impassable for more than 36 hours in parts of the state. Estimated costs of snow removal statewide exceeded $40 million[24]. **Table** 4.5 provides a list of major winter storms in the Northeast from 1990 through 2010[25].

Table 4.5 – Major Northeast Winter Storms from 1990 through 2010

Year	Date	NESIS Score	Category	Description
2009	December 18-21	4.03	3	Major
2007	March 15-18	2.55	2	Significant
2007	February 12-15	5.63	3	Major
2006	February 12-13	4.10	3	Major
2005	January 21-24	6.80	4	Crippling
2003	February 15-18	8.91	4	Crippling
2000	January 24-26	2.52	2	Significant
1996	January 6-8	11.78	5	Extreme
1994	February 8-12	5.39	3	Major
1993	March 12-14	13.20	5	Extreme

In addition to the hazards posed by all natural disasters, winter storms have the added hazards associated with cold weather for prolonged periods of time. Unlike disasters typically occurring during the summer months such as hurricanes, tornadoes and forest fires, power outages may result in extended periods of no heat. The resulting prolonged contact with low temperatures can cause causing pipes to freeze and burst, thereby damaging homes and businesses. Icy or snow covered roadways may also lead to added traffic accidents and resultant injuries. Winter storms may also pose added health problems, particularly to members of the community most susceptible to the added strain of contact with freezing temperatures such as the very young or elderly. Heart attacks while shoveling snow may also occur in susceptible individuals.

Winters with heavy snowfalls may also lead to spring flooding events as a result of snowmelt runoff, particularly if unseasonably warm conditions occur when substantial snow remains on the ground. This can lead to rapidly melting snow, potentially causing localized flooding.

Ice Storms

Ice storms occur when rain falling on tree branches and the ground freezes on contact, leading to ice buildups. These events are somewhat less common, but also have the ability to cripple access to utilities on elevated poles such as electric and telecommunications, and limit transportation as a result of downed trees and icy roadways. According to the National Climatic Data Center (NCDC), Bristol County has experienced 8 ice storms from 1971 through 2009[26], occurring most frequently in late December and early January.

[24] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010.
[25] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010.
[26] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010.

Ice Jams

Ice jams can also cause hazards, either by a downstream portion of the river freezing and backing up flowing water to the north, or by the breaking up of an ice jam, causing large pieces of ice to flow downriver and possibly damage property and infrastructure. Although ice jams are possible, the United States Army Corps of Engineers Ice Jam Database does not indicate a single occurrence in Dartmouth over the past 100 years. Due to the relatively small rivers flowing through the Town and its close proximity to the relatively warm Atlantic Ocean, ice jams are not expected to occur.

Summary

Hazard Location:

- Snowstorms and Blizzards:
  - Heavy snowfall across inland areas of town and surrounding region, with typically less near the coast
  - High winds, particularly along the coast
  - Localized coastal flooding and storm surge
- Ice Storm:
  - Widespread, capable of affecting the entire town and surrounding region
- Ice Jam:
  - Ice buildup in inland rivers

Potential Damage (All Hazards):

- Damage to infrastructure and trees associated with heavy snow and ice loads
- Power outages, limited access to communications and utilities
- Limited travel or impassible roads due to snowfall, ice, downed power lines and trees
- Prolonged cold weather, possibly causing frozen pipes and other damage
- Health hazards associated with exertion (snow shoveling) and exposure to cold

Scale / Extent:

- Snowstorms and Blizzards:
  - Snowfall anywhere from a few inches to a few feet depending on the storm
  - Typically storms drop less than a foot of snow
  - Severe storms and blizzards may drop up to and in excess of three feet of snow
- Ice Storm:
  - Can be up to 1 inch of ice covering the entire town, including electrical and telephone wires, tree branches, structures, roadways, etc.
  - Typical ice buildup of less than ¼ inch are generally not problematic
- Ice Jam:
  - Large pieces of ice potentially the width of the affected stream. As streams in Dartmouth are typically small, ice jams are not likely to occur

Previous Occurrences:

- Snowstorms and Blizzards:
  - Regular snowfall events occur regularly, typically around 10 times per year
  - Minor winter storms expected to occur once or twice a year

    - Major blizzards expected to occur less frequently, likely every two to three years as per **Table** 4.5
- Ice Storm:
    - Minor occurrences happen every several years
    - Major events happen every several decades
- Ice Jam:
    - No occurrences in Dartmouth during the previous 100 years

Likelihood of Future Occurrences:

- Snowstorms and Blizzards:
    - Likely to experience slightly fewer than 10 snowstorms each year of varying size
    - 20% chance each year of having at least 1 snow event larger than 12 inches
- Ice Storm:
    - Expected minor occurrences every several years
    - Expected major event every several decades
- Ice Jam:
    - Not likely to occur, perhaps once every 50 to 100 years

4.3 Hurricanes and Nor'Easters

Hurricanes

Hurricanes are typically fast-moving storms (typically lasting 6 to 12 hours[27]) with high winds in excess of 74 miles per hour and torrential rains averaging 6 to 8 inches, but possibly dropping as much as 15 to 20 inches of rainfall. Hazards also include localized flooding and coastal storm surges. Storms typically form in warm, southern waters and typically follow the US coast up to the New England area, accelerating rapidly with forward speeds as high as 47 mph. Hurricanes typically occur between June and November, though are most common in August and September when waters are warmest.

High winds, heavy rains and coastal storm surge can be expected to cause widespread power outages, limited access to other utilities such as drinking water and telecommunications, and limited transportation. High coastal winds and storm surge could cause substantial damage to homes and businesses, and devastate coastal infrastructure such as marinas.

Due to New England's location as a protrusion into the Atlantic Ocean, hurricanes may pose a significant threat, both from coastal flooding and high winds. Dartmouth's location abutting the Atlantic Ocean makes it possible that a hurricane could make landfall directly in Dartmouth, thereby subjecting the Town to the highest possible winds, largest storm surge and heaviest rainfall. Damage would be particularly severe should the hurricane make landfall during high tide, further aggravated by the presence of Buzzards Bay.

Statistically, New England can expect one major hurricanes (defined as a Category 3, 4, or 5 on the Saffir-Simpson scale as shown in **Table** 4.6) to make landfall each decade[28]. **Table** 4.7 shows damaging hurricanes making landfall in New England over the past 100 years[29].

[27] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010.
[28] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[29] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.

Table 4.6 – Saffir-Simpson Hurricane Scale

Category	Wind Speeds	Expected Storm Surge
Category 1	74-95 mph	4-5 feet
Category 2	96-110 mph	6-8 feet
Category 3	111-129 mph	9-12 feet
Category 4	130-156 mph	13-18 feet
Category 5	>157 mph	>18 feet

Table 4.7 – Major New England Hurricanes

Date	Name	Intensity
August 19, 1991	Hurricane Bob	Category 2/3
September 27, 1985	Hurricane Gloria	Category 2
September 12, 1969	Hurricane Donna	Category 2/3
September 11, 1954	Hurricane Edna	Category 3
August 31, 1954	Hurricane Carol	Category 3
September 15, 1944	Unnamed (Great Atlantic Hurricane)	Category 3
September 21, 1938	Unnamed (Great New England Hurricane of 1938)	Category 3

Note that no hurricane has hit the New England area for over 20 years, with a major hurricane not occurring for almost 60 years. Smaller tropical storms and depressions have affected the area, generally inflicting minor damage such as some downed tree limbs, power outages, and limited damage to boating-related infrastructure. NOAA estimates that 80 to 90% of the population now living in United States coastal areas has never experienced a major hurricane[30], potentially exacerbating disruption due to limited preparation and preparedness on behalf of residents. Coupled with a significant population increase since 1954 in coastal areas, landfall of a major hurricane near Dartmouth could have catastrophic consequences in both dollar amounts and human tolls.

Coastal Storms or Nor'Easters

A northeast coastal storm, typically known as a nor'easter for its generally northeast trajectory and strong winds blowing from the northeast, typically occurs during late fall and early winter. Nor'easters are fairly common, with Massachusetts typically encountering a nor'easter once or twice per year in varying states of intensity. The storm typically forms either in the Gulf of Mexico or off the coast before moving up the east coast to New England.

Storms are typically large, and bring strong winds possibly exceeding hurricane-force gusts in strength, heavy rain or snow, and damaging coastal waves and surges. Storms may also remain stationary or nearly stationary for several days, potentially dropping substantial amounts of rain or snow. Although hurricanes can produce more damage, Massachusetts has historically suffered more damage from nor'easters due to the greater frequency of occurrence[31].

[30] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[31] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.

As with hurricanes, high winds, localized flooding, heavy rains or snow and potentially severe coastal erosion can be expected to cause widespread power outages, limited access to other utilities, and possibly temporarily limit transportation due to downed trees or heavy snow. Hazards are typically the same as those associated with hurricanes or blizzards depending on the time of year.

Summary

Typical Hazards and Location (All Hazards):

- High winds across the entire town and surrounding region, particularly along coastal areas
- Inland flooding and erosion occurring along rivers and streams
- Coastal flooding, erosion and storm surge along the coast

Potential Damage (All Hazards):

- Wind damage to infrastructure and trees
- Power outages, limited access to communications and utilities
- Impassible roads due to flooding, downed power lines and trees
- Flooded basements, buildings, parking lots, roadways, and other infrastructure

Scale / Extent (All Hazards):

- High winds depending on the magnitude of the storm, from <75 mph to >150 mph
- Inland flooding – flooding caused by rainfall up to 7 inches (100 year storm) but potentially up to and in excess of 12 inches
- Coastal flooding and storm surge – small, localized areas to moderate area depending on the magnitude of the storm, anywhere from <4 foot storm surge to >18 feet

Previous Occurrences:

- Hurricanes:
    - Major hurricanes previously occurred approximately once every 10 to 20 years
    - Smaller hurricanes and tropical storms have previously made landfall approximately every few years
- Coastal Storms or Nor'Easters
    - See previous occurrences of Hurricanes and Blizzards

Likelihood of Future Occurrences (All Hazards):

- Hurricanes:
    - Statistically one major hurricane (category 3, 4, or 5) every decade with smaller hurricanes more frequently
    - However no hurricane has made landfall in Dartmouth in over 20 years
- Coastal Storms or Nor'Easters
    - See previous occurrences of Hurricanes and Blizzards

4.4 Tornadoes and Thunderstorms

Tornadoes

Tornadoes are a vortex of rapidly rotating air moving along the ground. Tornadoes typically occur during the spring, summer and fall months, usually during the afternoon. Tornadoes may

occur in unusually severe thunderstorms, bringing hazards such as very high wind speeds (typically anywhere from 100 to 300 miles per hour) along a localized area, localized heavy rainfall and flooding, frequent lightning and damaging hail.

Tornadoes may be anywhere from less than 250 feet to over two miles in diameter. Typically, tornadoes dissipate after no more than a couple miles on the ground; however have been known to stay on the ground for dozens of miles, causing substantial damage along the way. Although not commonly occurring, tornadoes have occurred in every state. In Massachusetts, tornadoes occur most frequently in and around Worcester County, however may occur wherever conditions are right. According to NOAA, Bristol County is located in an area of very low probability of occurrence, with less than one tornado expected to occur every five years[32]. **Table** 4.8 shows tornadoes occurring in Bristol County since 1950[33].

Table 4.8 – Tornadoes in Bristol County

Date	Strength	Fatalities	Injuries
July 23, 2008	F0	0	0
August 6, 1997	F0	0	0
September 14, 1972	F0	0	0
August 28, 1970	F2	0	0
August 2, 1970	F1	0	0
August 9, 1968	F1	0	4
September 7, 1958	F0	0	0
June 9, 1953	F3	0	17

Table 4.9 defines the Fujita scale, used for rating tornado intensity based on the damage tornadoes inflict.

Table 4.9 – Fujita Scale

Scale	Wind Speed	Damage Path	Typical Damage
F0	40-72 mph	50-165 ft	Light damage. Some damage to chimneys, branches broken off trees, shallow-rooted trees pushed over, sign boards damaged
F1	73-112 mph	100-500 ft	Moderate damage. Peels surface off roofs, mobile homes pushed off foundations, attached garages may be destroyed
F2	113-157 mph	360-820 ft	Significant damage. Roofs torn off houses, mobile homes demolished, large trees snapped or uprooted
F3	158-206 mph	0.1-0.3 mi	Severe damage. Roofs and some walls torn off well-constructed houses, most trees in forest uprooted
F4	207-260 mph	0.3-0.6 mi	Devastating damage. Well-constructed houses leveled, structures with weak foundations blown away
F5	261-318 mph	0.7+ mi	Incredible damage. Strong frame houses lifted off foundations, steel reinforced structures badly damaged.

[32] NOAA. http://www.nssl.noaa.gov/primer/tornado/tor_hazardgraph.html
[33] TornadoHistoryProject.com. www.tornadohistoryproject.com

Unlike large scale disasters such as winter storms, hurricanes and earthquakes, tornadoes typically produce damage on a very limited, albeit intense scale. Although tornadoes have the capability to develop to over a mile wide and decimate an entire town, damage paths are typically limited to several hundred feet wide, causing somewhat limited destruction. However, it is not uncommon for structures suffering a direct hit to be completely destroyed.

A tornado capable of significant damage has not occurred in Dartmouth, based upon available records since 1950. Over time, residents may have grown complacent, believing that a tornado cannot occur in Dartmouth. This feeling could potentially exacerbate problems, should a tornado occur.

Thunderstorms

A thunderstorm is a storm which produces lightning, typically accompanied by heavy, localized rainfall, strong winds, and occasionally hail (hailstorms). They typically occur during the spring, summer and fall months, usually during the afternoon. Thunderstorms typically form in a line or front, typically moving west-to-east ahead of a cold front. Unusually severe thunderstorms may rotate, known as supercells, and have the potential to spawn tornadoes.

Thunderstorms have both an updraft of rising air and a downdraft of sinking air. Extremely strong downdrafts, known as downbursts, have the potential to cause extreme straight-line wind damage, similar to that of a tornado. A small (<2.5 mile path) downburst is known as a "microburst" while a larger downburst is known as a "macro-burst." Winds exceeding 100 mph have been measured in Massachusetts from downbursts[34].

An average thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Severe thunderstorms can be much larger and last much longer. Southern New England typically experiences about 10 to 15 days per year in which there are severe thunderstorms[35]. Thunderstorms occur quite often and typically do not pose a serious threat to the Town, however unusually severe storms may bring limited damage.

Summary

Hazard Location:

- Tornadoes:
  - Very high winds across a generally narrow section of town, typically less than ½ mile wide. Exact locations are unpredictable and may occur anywhere
  - Lightning strikes across a broader portion of town. Exact locations are unpredictable and may occur anywhere
- Thunderstorms:
  - Potentially high winds across a wide swath of town and the surrounding region
  - Inland flooding occurring along rivers and streams
  - Lightning strikes across a wide swath of town and the surrounding region

Potential Damage (All Hazards):

- Wind damage to infrastructure and trees

[34] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010.
[35] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010.

- Power outages, limited access to communications and utilities
- Impassible roads due to flooding, downed power lines and trees
- Flooded basements, buildings, parking lots, roadways, and other infrastructure
- Lightning strikes, potentially igniting a fire

Scale / Extent:

- Tornadoes:
  - Very high winds depending on the magnitude of the storm, from <40 mph to >300 mph
- Thunderstorms:
  - Inland flooding – flooding caused by rainfall up to 7 inches (100 year storm) but potentially up to and in excess of 12 inches
  - High winds depending on the magnitude of the storm, from <40 mph to >100 mph

Previous Occurrences:

- Tornadoes:
  - Bristol County typically experiences one tornado approximately once per decade, typically magnitude F0 or F1 on the Fujita Scale, with the potential for this event to occur within the Town of Dartmouth
  - A tornado causing significant damage has not occurred for many years (F3 on June 9, 1953)
- Thunderstorms:
  - Thunderstorms occur on a monthly, if not weekly basis during summer months
  - There have been no recorded thunderstorms that have caused widespread severe or significant damage within Dartmouth

Likelihood of Future Occurrences:

- Tornadoes:
  - Dartmouth is located in an area of very low probability of occurrence, with less than one tornado expected to occur every five years
  - Small tornadoes may occur causing localized damage
  - A damaging tornado is unlikely to occur
- Thunderstorms:
  - Southern New England typically experiences about 10 to 15 days per year in which there are severe thunderstorms
  - Thunderstorms may be expected to occur several times a month during the late spring, summer, and early fall months

4.5 Geologic Hazards

Earthquake

An earthquake is a sudden, intense shaking of the ground caused by the sudden movement of large portions of the Earth's crust, potentially causing massive damage to buildings and infrastructure. Earthquakes can occur suddenly at any time, with virtually no warning.

The Northeast States Emergency Consortium indicates that New England experienced 1,507 earthquakes from 1638 through 2007, of which 355 were located in Massachusetts. The vast

majority of these earthquakes were minor in nature. Minor earthquakes, such as those less than 3.0 in magnitude, occur frequently in the region, however are virtually undetectable by all but the most sensitive scientific equipment. Minor earthquakes of this magnitude cause no damage and do not warrant concern.

Although the risk of a damaging earthquake is low, the potential hazard is high because of potentially devastating damage to the entire region. Nearly all critical infrastructure is vulnerable, including roads, bridges, utilities, communications, etc. State and federal emergency response could also be hindered by damage present throughout the region.

Dartmouth is located in a region with a peak ground acceleration (PGA) of approximately 0.07g with a 2% chance of occurrence every 50 years[36]. According to the United States Geological Survey (USGS), earthquake damage begins to occur at a ground movement level of approximately 0.10g. At this level, damage would be minor in nature. However, the probability of an event is extremely low, and according to the USGS can be expected to occur once every 2,476 years[37].

While major earthquakes are unlikely, they have occurred within the region in the past. On November 18, 1755, an earthquake estimated between 6.0 and 6.3 on the Richter scale struck just off the coast of Cape Ann, Massachusetts, reportedly damaging chimneys and homes as far away as New Haven, Connecticut. A 1990 MEMA study estimated that if a similar quake shook Boston today, it could result in as much as $5 billion in damage and hundreds of deaths[38]. **Table** 4.10 outlines the Richter Magnitude Scale, a logarithmic scale used for documenting energy released during an earthquake.

Table 4.10 – Richter Magnitude Scale

Magnitude	Description	Typical Damage
<2.0	Micro	Micro earthquake, not felt
2.0-2.9	Minor	Generally not felt, but recorded
3.0-3.9		Often felt, but rarely causes damage
4.0-4.9	Light	Noticeable shaking of indoor items. Significant damage unlikely.
5.0-5.9	Moderate	Can cause major damage to poorly constructed buildings over small regions. At most slight damage to well-designed buildings
6.0-6.9	Strong	Can be destructive in areas up to approximately 160 kilometers across populated areas
7.0-7.9	Major	Can cause serious damage over larger areas
8.0-8.9	Great	Can cause serious damage several hundred kilometers across
9.0-9.9		Devastating in areas several thousand kilometers across
10.0+	Massive	Never recorded, widespread devastation across very large areas.

A major earthquake has not occurred in Dartmouth in recent recorded history. Although a magnitude 6+ earthquake occurred off of Cape Ann, it happened over 250 years ago and thus

[36] United States Geological Survey. http://earthquake.usgs.gov/hazards/products/conterminous/2008/maps/
[37] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010.
[38] Newman, William A. and Holton, Wilfred E. *Boston's Back Bay: the story of America's greatest nineteenth-century landfill project*. University Press of New England. 2006.

residents are likely not prepared to deal with the effects of an earthquake. Similar to problems associated with hurricanes and tornadoes, this feeling could exacerbate problems, should an earthquake occur.

Landslide
A landslide typically occurs on a section of steeply sloping ground. Landslides can involve movement of mud, soil, rocks, and other debris such as trees. Due to the relatively flat topography of Dartmouth, landslides are not expected to pose a hazard to the Town. Any landslides that occur will likely be minor in nature, impacting only very localized areas.

Sinkhole
A sinkhole is a depression or hole opening up in the ground surface. It can be either as a result of natural causes, or most likely in this area of the country, a result of a broken water main, sewer main or stormwater pipe. Sinkholes vary in size, however those caused by utility failure are typically not much deeper than the utility itself, typically less than twelve feet deep and up to several dozen feet wide. Any sinkholes that occur will be minor in nature, typically impacting only localized utility and transportation access.

Summary
Hazard Location:

- Earthquake:
  - Damaging ground movement affecting the entire town and surrounding region
- Landslide:
  - Steep hillsides, generally not present within Dartmouth
- Sinkhole:
  - Could occur nearly anywhere, but typically associated with leaking water, sewer, or stormwater utilities

Potential Damage

- Earthquake:
  - Extensive damage to buildings and infrastructure
  - Extended power outages
  - Limited access to transportation, communications and utilities
  - Fires ignited by ruptured gas lines
  - Flooding from dam failures
- Landslide:
  - Localized damage to buildings, roadways, and utilities
- Sinkhole:
  - Localized damage to roadways and utilities

Scale / Extent:

- Earthquake:
  - Varies from undetectable (<2.0 Richter Magnitude Scale) to strong (6.0 to 6.9 Richter Magnitude Scale).
- Landslide:
  - Likely minor in nature, if occurring at all

- Sinkhole:
    - Damage will be minor and localized

Previous Occurrences:

- Earthquake:
    - Small, undetectable earthquakes occur several times a year causing no damage
    - A major earthquake has never been recorded in Dartmouth
- Landslide:
    - Never occurred or documented within Dartmouth
- Sinkhole:
    - Never occurred or documented within Dartmouth

Likelihood of Future Occurrences:

- Earthquake:
    - Small, undetectable earthquakes typically occur several times a year
    - Large, damaging earthquakes are extremely rare, occurring far less than once per century and can be expected to occur once every 2,476 years
- Landslide:
    - Unlikely to occur
- Sinkhole:
    - Could potentially occur, however unlikely to be associated with natural causes

4.6 Forest Fires / Wildfires

Wildfires and forest fires are naturally occurring events, and part of a normal, healthy ecosystem. Naturally occurring fires help keep forest floors free of excessive debris buildup, thin crowded trees, encourage growth of new vegetation, and recycle nutrients into the soil. Forest fires may occur at any time of year, however typically occur during hot, dry summer months, or during windy conditions during the spring and fall. Natural ignition most frequently occurs as the result of a lightning strike. Though other natural sources are possible such as volcanic eruption or coal fires, these sources are not expected to occur in Dartmouth. There are four types of forest fires, and are typically fed by organic materials as shown in **Table** 4.11:

Table 4.11 – Forest Fire Types

Fire Type	Location	Typical Fuel
Ground	At or below ground surface	Underground roots, buried leaves or other subsurface organic matter
Surface	Ground surface	Surface leaves, grass, low-lying vegetation and underbrush
Ladder	Between the surface and canopy	Underbrush, downed logs, vines and small trees
Canopy	In the tree canopy	Tall trees, vines and branches

Though fires can be started by natural occurrences, they are most frequently ignited by humans as a result of discarded cigarettes, downed power lines, or are intentionally set. The Bureau of Fire Control estimates that nearly 98% of fires in Massachusetts are started by human

carelessness[39]. Each year, an average of 6,000 fires burn up to 9,000 acres in Massachusetts[40]. No information is available specific to Dartmouth.

Forest fires vary in size, however thanks to modern detection and firefighting equipment methods, fires are typically kept to a reasonably small area. The Bureau of Fire Control estimates that the average fire 100 years ago consumed approximately 34 acres, while today the average fire burns only 1.2 acres. However, large fires have occurred nearby in the past, such as the 1957 fire in Myles Standish State Forest which burned over 18,000 acres, stopping only when it reached the ocean[41]. The 2010 Massachusetts Hazard Mitigation Plan identifies the southeastern part of Massachusetts, including the southern coast of Bristol County and Dartmouth, to be the most susceptible area in the state to wildfires due to the availability of fuel, impacts from offshore winds, and increasing development within wooded areas[42].

While modern fire detection, prevention and extinguishing techniques have minimized damage from fires, it has also led to excessive vegetation growth in forests, meaning that there is excess fuel available, should a fire occur. Vegetated material that once would have been periodically consumed during natural fire events now stands crowded into the same area, potentially increasing the severity of a fire should one occur. Global warming has also increased the damage potential of a wildfire by raising average temperatures and increasing drought-like conditions.

Summary

Hazard Location:

- Fires typically occurring in wooded areas, though could spread to developed areas
- Most likely to occur in less developed portions of town to the north and southwest

Potential Damage:

- Damage to trees and other vegetated areas
- Limited damage to homes and other infrastructure
- Health concerns due to noxious smoke

Scale / Extent:

- Varies from minor (<1 acre consumed) to substantial (>1,000 acres consumed)

Previous Occurrences

- No information is available specific to Dartmouth, however no major fires have been documented within the Town
- Minor fires can occur throughout the course of the year, however are quickly extinguished before burning more than one acre

[39] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[40] Town of Dartmouth, MA Comprehensive Emergency Management Plan. 2011.
[41] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[42] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010.

Likelihood of Future Occurrences:

- Minor wildfires causing little damage may occur somewhat frequently due to human carelessness or lightning strikes, however large, damaging fires are rare

4.7 Drought

Drought is an extended period of time where a region experiences a notable reduction in available water supply typically caused by a lack of precipitation, and can be related to either surface water or groundwater sources. Though most droughts in Massachusetts last only a matter of months, it is possible for drought conditions to extend over a period of years due to reduced rainfall and snowfall accumulations contributing to lower groundwater and surface water levels.

According to the 2002 Massachusetts Drought Management Plan, Massachusetts communities generally receive enough precipitation to support typical residential and business water demand[43]. However, during period of reduced rainfall or drought, communities frequently implement water use regulations to restrict non-critical water use, such as outdoor watering, in order to maintain adequate water supplies for drinking, washing and firefighting activities.

Drought can cause significant environmental and financial impacts, such as failed agricultural crops, limited availability of drinking water, heavy erosion once rainfall returns, and ecosystem damage to plants and animals. Drought can also be a major factor in the propagation of forest fires. Less water in the ground and vegetation translates to more easily combustible fuel for a fire. Drought can also reduce water available to fight a forest fire, making it that much more difficult to extinguish.

Most droughts affecting Dartmouth have typically started with dry winters, leading to reduced spring snowmelt. The most severe drought on record in the northeastern United States was during the summer from 1961 through 1969[44]. Additional droughts occurred from 1980 through 1981, and 1987 through 1989, with damages from the latter estimated at $39 billion to crops, wildlife, livestock, land values, water quality and the economy[45]. No information is available specific to Dartmouth.

Summary

Hazard Location:

- Droughts would affect the entire town and surrounding region

Potential Damage:

- Limited access to drinking water and water for firefighting

Scale / Extent:

- Varies from somewhat minor to major, depending on how much and when precipitation is received

[43] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[44] Massachusetts Department of Conservation and Recreation. http://www.mass.gov/dcr/watersupply/rainfall/reports/2012/0612%20Comp%20estimate%20web.pdf
[45] Town of Dartmouth, MA Comprehensive Emergency Management Plan. 2011.

- Can last from a matter of weeks to years
- Minor droughts may only require enforcement of outdoor watering restrictions,
- Major events could cause loss of agricultural crops, drinking water shortages, widespread ecological damage to plants and animals, and increased fire risk

Previous Occurrences

- No information is available specific to Dartmouth, however droughts severe enough to cause significant environmental and financial impacts have not been recorded in town
- Minor droughts, severe enough to enforce outdoor watering restrictions, occur nearly every year

Likelihood of Future Occurrences:

- Minor droughts are expected to occur often, though major droughts are rare

4.8 Dam Failures / Breaches

According to FEMA, a dam is an artificial barrier constructed for the purpose of storage or control of water. Dam failure can occur either catastrophically by sudden, rapid, and uncontrolled release of impounded water, or slowly via a partial breach or overtopping of limited water quantities. Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam;
- Deliberate acts of sabotage;
- Lack of maintenance;
- Structural failure of the dam or foundation; and
- Erosion of soil in embankment dams.

The Bureau of Dam Safety (BDS), a division of the Massachusetts Department of Conservation and Recreation (DCR), has jurisdictional authority over dams that meet the following criteria: dam structure six feet or higher, or impoundment of 15 acre feet or more, or a significant downstream hazard as determined by staff review (e.g. campground, densely developed area, major thoroughfare, etc.). This includes government and privately owned dams[46]. Regulations went into effect in 2003 that require owners to register the dams and have them professionally inspected. Dam hazards are classified into three categories: high hazard; significant hazard; or low hazard[47], and must be inspected every 2, 5, and 10 years, respectively. Descriptions are as follows:

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

[46] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[47] Massachusetts Department of Conservation and Recreation. http://www.mass.gov/dcr/pe/damSafety/index.htm

According to the 2004 SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan, Dartmouth has 12 dams. The DCR has provided a list of the following dams located within Dartmouth as shown in **Table** 4.12.

Table 4.12 – Dams within Dartmouth

Dam Name	River	Owner	Ownership Type	Hazard Code
Noquochoke Lake Dam	Shingle Island River/East Branch Westport River	City of Fall River, Department of Water Treatment & Resources	Municipality	High Hazard
High Hill Reservoir Dam	Tributary of Paskamanset River	City of New Bedford, Department of Public Infrastructure	Municipality	Significant Hazard
Russells Mill Pond Dam	Paskamanset River	Town of Dartmouth, Board of Selectmen	Municipality	Significant Hazard
Cornell Lower Pond Dam	Copicut River	Rod and Gun Club of New Bedford, Inc.	Municipality	Significant Hazard
Lake Noquochoke Upper Dam	Westport River	City of Fall River, Department of Water Treatment & Resources	Municipality	Low Hazard
Hawes Pond Dam	Paskamanset River	UD - Various Equities Corp.	Private	Significant Hazard
Grimshaw #1 Pond Dam	Destruction Brook	Not Regulated	Private	Not Regulated
Grimshaw #2 Pond Dam	Destruction Brook	Not Regulated	Private	Not Regulated
Grimshaw #3 Pond Dam	Destruction Brook	Not Regulated	Private	Not Regulated
Grimshaw #4 Pond Dam	Destruction Brook	Not Regulated	Private	Not Regulated
Copicut River Dam	Copicut River	Not Regulated	Private	Not Regulated
Georges Pond Dam	not listed	Not Regulated	State	Not Regulated

Summary

Hazard Location:

- At each dam situated along rivers or streams, 12 locations within town
- Impact depends on the size of the dam, however generally small, localized areas

Potential Damage:

- Erosion, flooded buildings, parking lots, roadways, and other infrastructure
- Impassible or washed out roads

Scale / Extent:

- Minor dam failure could release a wall of water up to 1 foot high, typical of privately owned dams in Dartmouth
- Major dam failure could release a wall of water greater than 6 feet high, typical of larger high hazard and significant hazard dams in town.

Previous Occurrences:

- A dam failure within Dartmouth has never occurred

Likelihood of Future Occurrences:

- Possible, however a damaging failure is unlikely

4.9 Future Climate Change and Global Warming

Climate change is a shift in long-term weather patterns, and includes alterations in typical temperature, precipitation, wind, and more. According to the National Academy of Sciences, the Earth's surface temperature has risen by about 1° Fahrenheit in the past century, with accelerated warming during the past two decades[48]. As average temperatures increase, sea level is expected to rise as freshwater inputs from glacier and ice sheet melting occurs. As stated in the Commonwealth of Massachusetts State Hazard Mitigation Plan:

> "Records of tide gauges around Boston, Woods Hole, and Nantucket indicate that our relative sea level has risen approximately 10 inches over the past 100 years. The Intergovernmental Panel on Climate Change (IPCC) predicts that sea-level rise and its risk to coastal resources will accelerate over the next 100 years (IPCC, 2007). Conservative projections of sea-level rise by the end of the century range from 4 to 21 inches, while projections given a higher emissions scenario range from 8 to 33 inches. Also, important to note, there is a strong consensus among coastal experts that the IPCC projections for sea level rise are even too conservative. As new research emerges projects of 20 to 55 inches of sea level rise are estimated by 2100."

As sea level rises, low-lying coastal areas will be particularly vulnerable to coastal storm hazards such as erosion and flooding. While some low-lying areas may be permanently inundated, other inland areas not currently subject to coastal storm impacts may be impacted by storm surge and other flooding events[49].

4.10 Natural Hazard Indexing Methodology

As discussed previously, Dartmouth faces a number of potential natural disasters and hazards. A Hazard Identification matrix was developed that rates natural hazards based on the following three items:

- Likelihood of Occurrence – the probability that a hazard will occur;
- Geographic Scale – location and/or size of the area affected; and
- Impacts – expected damage and disruptions to be expected.

[48] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010
[49] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2010

Specific hazards were then assigned a point value for each of these items based on the expected severity of the hazard. Point values and descriptions for each category are shown in **Table** 4.13. This information was then used to establish a Hazard Index for each type of natural hazard and associated risk level based on the total score as shown in **Table** 4.14. Hazards associated with the highest index value were determined to have the greatest potential impact to Dartmouth. The entire scoring matrix is provided as **Table** 4.15.

Table 4.13 – Hazard Identification Criteria

Score	Category	Description
Likelihood of Occurrence		
3	Highly Likely	50% to 100% probability in the next year
2	Likely	Between 10% and 50% probability in the next year
1	Possible	Between 1% and 10% probability in the next year
0	Unlikely	Less than 1% probability in the next year
Geographic Scale		
3	Large	More than 50% of the town affected
2	Medium	10% to 50% of the town affected
1	Small	Less than 10% of the town affected
Impacts		
3	Catastrophic	Multiple deaths & injuries possible, >50% property severely damaged Complete shutdown of facilities for 30 days or more
2	Critical	Multiple injuries possible, <50% to >25% property severely damaged Complete shutdown of critical facilities for at least 1 week
1	Limited	Minor injuries only, <25% to >10% property severely damaged Complete shutdown of critical facilities for more than one day
0	Minor	Very few injuries, if any, only minor property damage Shutdown of critical facilities and services for 24 hours or less

Table 4.14 – Risk Level

Hazard Index Score	Risk Level
8-9	Extremely High
6-7	Very High
5	High
4	Moderate
3	Low
1-2	Very Low

Table 4.15 – Natural Hazard Index

Natural Hazard	Likelihood of Occurrence	Geographic Scale	Impacts	Hazard Index Score[1]	Risk Level
Floods					
Coastal Flooding	2 Likely	2 Medium	2 Critical	6	**Very High**
Riverine Flooding	2 Likely	1 Small	1 Limited	4	Moderate
Flooding from Storm Runoff	2 Likely	1 Small	0 Minor	3	Low
Erosion	2 Likely	1 Small	0 Minor	3	Low
Winter Storm Events					
Snowstorms and Blizzards	2 Likely	3 Large	0 Minor	5	High
Ice Storm	1 Possible	3 Large	1 Limited	5	High
Ice Jam	0 Unlikely	1 Small	1 Limited	2	Very Low
Hurricanes and Nor'Easters					
Hurricanes	1 Possible	3 Large	2 Critical	6	**Very High**
Coastal Storms or Nor'easters	2 Likely	2 Medium	1 Limited	5	High
Tornadoes and Thunderstorms					
Tornadoes	0 Unlikely	2 Medium	2 Critical	4	Moderate
Thunderstorms	3 Highly Likely	1 Small	1 Limited	5	High
Geologic Hazards					
Earthquakes	0 Unlikely	3 Large	3 Catastrophic	6	**Very High**
Landslides	0 Unlikely	1 Small	1 Limited	2	Very Low
Sinkholes	0 Unlikely	1 Small	0 Minor	1	Very Low
Other Hazards					
Drought	2 Likely	3 Large	0 Minor	5	High
Forest Fires / Wildfires	1 Possible	2 Medium	1 Limited	4	Moderate
Dam Failures	0 Unlikely	1 Small	1 Limited	2	Very Low

[1]Possible 9 points, 9 being high, 1 being low.

5.0 VULNERABILITY ASSESSMENT

The following sections provide an overview of Dartmouth's vulnerability to the various natural hazards outlined previously. Based on these hazards, the following sections outline the most likely source of damage and provide an estimate of damage in dollars that may result from each natural hazard. Where possible, guidance published by FEMA, such as FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[50], was used to estimate dollar amounts.

To determine potential damages, the Local Planning Team obtained property value information from the Tax Assessor's database. For those hazards affecting a limited area of Dartmouth such as flooding, only those structures located within hazard-prone areas were evaluated. For hazards capable of affecting the entire town, such as earthquakes and thunderstorms, an assessment was made based on an assumed percentage of buildings damaged within the entire Town. **Table** 5.1 provides a summary of property values in Dartmouth, based on the Tax Assessor's office data.

Table 5.1 – Property Values within Dartmouth

Zone	Number of Properties	Total Building Value	Average Building Replacement Cost	Total Value (Building, Land, Other)
Single Residence A	3,568	$527,200,000	$148,000	$972,300,000
Single Residence B	6,457	$1,215,700,000	$188,000	$2,575,000,000
General Residential	3,377	$522,200,000	$155,000	$1,081,500,000
General Business	763	$304,900,000	$400,000	$566,400,000
General Industrial	44	$26,400,000	$601,000	$49,800,000
Limited Business	35	$7,800,000	$222,000	$20,500,000
Limited Industrial	283	$119,500,000	$422,000	$231,900,000
Office Professional	83	$10,000,000	$120,000	$13,000,000
Neighborhood Business	22	$3,000,000	$142,000	$7,700,000
TOTAL	**14,632**	**$2,737 Million**		**$5,518 Million**

Note: dollar amounts based on property values obtained from the Tax Assessor's database for fiscal year 2013.

Note that the above values do not account for the value of personal property (cars, boats etc.) or infrastructure (roads, bridges, electrical lines, etc.) that can be damaged during a disaster event. As such, values and percentages assumed in the following sections are adjusted higher to account for this additional damage potential. The majority of disasters affect either the entire town (earthquakes, snowstorms, thunderstorms, etc.), or a small yet difficult to determine section (tornadoes, fires, landslides, sinkholes, etc.) Due to the unpredictability of some hazards, inability to protect the location and/or severity of the hazard, or inability to quantify impacts in a reliable manner, vulnerability dollar amounts may range substantially.

The vulnerability assessments represent a worst-case scenario, as it is likely that a portion(s) of the building would remain usable, most notable being the foundation. Additionally costs do not

[50] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

include the replacement cost of land, as it is assumed that all structures may be rebuilt at the same location. This assumption may not apply for storm events that cause severe erosion along coastal properties.

5.1 Floods

Coastal and Riverine Flooding

Flooding is associated with high water levels and may impact inland streams and/or coastal waters. Flooding may be caused by a number of factors, including heavy rainfall, excessive snowmelt, storms such as hurricanes or nor'easters, or any number of other factors.

To quantify the number and type of each structure vulnerable to flood damage, areas potentially subject to flooding (i.e. FEMA maps, SLOSH maps, etc.) were overlain with zoning and parcel maps obtained from Dartmouth's Planning Board and the Assessor's Office. The Assessor's Database also provided building and property values for each potentially affected location. **Table** 5.2 outlines a list of potentially vulnerable structures based on zoning types, totaling approximately 1,650 residential buildings and 50 other buildings located within vulnerable areas.

Table 5.2 – Property Values within Flood-Prone Areas

Zone	Number of Affected Properties	Total Building Value	Average Building Replacement Cost
Single Residence A	171	$32,000,000	$187,000
Single Residence B	924	$290,000,000	$314,000
General Residential	558	$122,400,000	$219,000
General Business	23	$24,800,000	$1,077,000
Limited Business	24	$7,000,000	$292,000
Limited Industrial	1	$300,000	$254,000
Neighborhood Business	5	$600,000	$128,000
TOTAL	1,706	$477,000,000	

Note: dollar amounts based on property values obtained from the Tax Assessor's database for fiscal year 2013.

The total building values of $477 million within flood-prone areas represent approximately 17% of the total building value of the town. Coastal or riverine flooding may cause damage to the above structures in varying amounts depending on flooding severity. Minor floods will likely cause minimal to no damage, while severe floods could damage or destroy a large number of these structures, particularly those located near the coast. **Table** 5.3 provides a vulnerability assessment of flooding based on severity of the hazard.

Table 5.3 – Flooding Vulnerability Assessment

Flooding Depth	Typical Expected Damage	% of Property Damaged	Total Damage
<1'	Minimal. No property damage	0%	<$100,000
1' to 4'	Moderate. Some flooding of structures and roads	10%	$47,700,000
4' to 8'	Major. Heavy damage to flood-prone areas	25%	$119,300,000
>8'	Severe. Extensive inundation likely	50%	$238,500,000

Note: dollar amounts based on property values obtained from the Tax Assessor's database for fiscal year 2013.

Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[51], two story buildings with basements as typical to Dartmouth have an approximate 50% damage rate for any flood event over 8 feet. Infrastructure damage could also be extensive, and include damage to roads, utilities, bridges, culverts, etc. Total damages could exceed $230 million in the event of an extreme flood event, particularly when adding in damages to structure contents and downtime during repairs. Smaller events have a correspondingly smaller damage percentage, however even a relatively moderate flood can inflict substantial financial damages to affected properties.

Flooding from Stormwater Runoff

Flooding due to stormwater runoff will likely occur in conjunction with riverine flooding as a result of heavy precipitation. Typically, stormwater flooding affects a localized area associated with a single outfall or culvert, and as such damages are generally minimal in comparison to other major disasters. A worst-case scenario may involve flooding of several major businesses, typically causing less than $1 million in damages, but potentially up to $5 million depending on the extent of damage and which business(es) are affected.

Erosion

Erosion is also typically associated with other flood events, including coastal, riverine, or stormwater. Impacts are often limited to localized areas and typically do not affect structures. An exception is severe coastal erosion; however this would be quantified under a more severe disaster such as a hurricane. Erosion damage is typically minimal in comparison to other hazards, generally less than $0.1 million, however may exceed $1 million should a major roadway, bridge or culvert be washed out.

5.2 Winter Storm Events

Snowstorms and Blizzards

Damage from snowstorms is typically caused by heavy snowfall loads on roofs, utility lines, and trees, causing damage from resultant collapse. Most "damage" will be from economic impacts as a result of residents being unable to get to work and town expenditures for snow removal. Blizzards, however, have the added impacts of high winds and wave action along the coast. Corresponding damages can be much more severe, and closer to the monetary damages associated with nor'easters. As with many other hazards, damage from snowstorms varies with intensity. Minor snow storms occur quite regularly, with little damage apart from the occasional vehicle accident. **Table** 5.4 outlines the potential damage expected during snow storms of varying intensity.

Table 5.4 – Snowstorm Vulnerability Assessment

Snowstorm Severity	Typical Expected Damage	Total Damage
Notable	Light snow, travel unaffected, virtually no damage	$100,000
Significant	Moderate snow, travel lightly affected, little damage	$500,000
Major	Heavy snow, travel impacted, light damage	$1,000,000
Crippling	Very heavy snow, travel difficult, light damage	$2,000,000
Extreme	Substantial snow, travel impossible, moderate damage	$4,000,000

Note: dollar amounts based on property values obtained from the Tax Assessor's database for fiscal year 2013.

[51] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

The table above refers to damages caused by snow alone, as well as costs of snow removal. The vast majority of snow storms cause less than $2 million in damages. Note that damage from very intense blizzards may be closer in dollars to that assumed for nor'easters, as evidenced by damage caused from high winds and wave action along the coast (as much as $50 million). In general, high winds and wave action cause far more damage than snow alone.

Ice Storms

Damage inflicted by ice storms can vary greatly, depending on the intensity and timing. Minor ice storms with ice buildup of less than a quarter inch will likely result in little damage. Alternatively, ice storms with buildup greater than one-half inch can result in substantial damage from tree limbs falling onto structures, vehicles, power lines, and other infrastructure. FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[52] does not include any standard loss estimation models for estimated ice storm damage, however **Table** 5.5 outlines the potential damage expected during ice storms of varying intensity.

Table 5.5 – Ice Storm Vulnerability Assessment

Ice Buildup	Typical Expected Damage	Total Damage
<¼"	Minimal damage expected, travel dangerous	<$100,000
¼" to 1"	Some tree branches downed, power outages likely, some roadways blocked	$10,000,000
>1"	Substantial trees and tree limbs downed, major extended power outages, blocked roadways	$20,000,000

Note: dollar amounts based on property values obtained from the Tax Assessor's database for fiscal year 2013.

Dartmouth has not experienced a damaging ice storm in recent history, however a worst-case scenario could exceed $20 million in damages.

Ice Jams

Damage from ice storms will result from large pieces of ice damaging structures or infrastructure such as roadways and culverts. Alternatively, ice jams could force water to backup and cause flooding, however this would be covered under flooding damages. To date, no ice jams have occurred within Dartmouth and expected damages are essentially $0, however a worst-case scenario could involve damages of up to $1 million, should a roadway culvert be destroyed.

5.3 Hurricanes and Coastal Storms or Nor'Easters

Hurricanes

Damage inflicted by hurricane strength winds and storm surge will depend on the category of hurricane and corresponding hazards. The majority of buildings in Dartmouth are single family homes, most of which are of wood frame construction typical of this area of the country. A much smaller percentage of homes are mobile or pre-constructed houses, typically less tolerant of wind loads. The remaining structures are constructed from brick, concrete, steel, or other material typical of municipal, commercial and industrial building construction.

[52] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[53], there are no standard loss estimation models for estimated wind damage, however **Table** 5.6 outlines the potential damage expected during hurricanes of varying intensity.

Table 5.6 – Hurricane Vulnerability Assessment

Hurricane Category	Typical Expected Damage	% of Property Damaged	Total Damage
Category 1	Minimal damage to residential roofs, virtually no damage to stronger structures	1%	$27,400,000
Category 2	Broken windows and roof damage to many structures, signs and canopies toppled	2%	$54,700,000
Category 3	Roof and exterior wall damage common, major damage to poorly built structures	5%	$136,900,000
Category 4	Heavy damage to residential structures, roofs removed on many structures	8%	$219,000,000
Category 5	Severe damage to all but the strongest structures	12%	$328,400,000

Note: dollar amounts based on property values obtained from the Tax Assessor's database for fiscal year 2013.

As shown above, hurricanes are perhaps the most destructive hazard with a reasonable chance of occurrence within Dartmouth. Damage values relate heavily to the flooding damage assessed previously based on FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[54]. Although a category 5 storm impact would be devastating with potentially over $325 million in damages, a more realistic scenario is a category 3 storm, with potential damages in excess of $125 million.

Coastal Storms or Nor'Easters

Damage due to coastal storms is comparable to that inflicted by a weak hurricane, typically a category 1 or category 2 equivalent. Potential monetary damages may range from less than $25 million to over $50 million depending on severity of the storm. Damages will vary depending on storm intensity and timing.

5.4 Tornadoes and Thunderstorms

Tornadoes

Damage from tornadoes is due almost exclusively to high winds in a localized area, although minor damage may also result from hail, heavy rains and lightning. As with other disasters, damage ranges depending on the severity of the occurrence. However, unlike other hazards that typically affect a large area of town (blizzard, hurricane, etc.) a tornado is limited to a relatively narrow swath. As such, the location of occurrence is also important, as a potentially minor tornado occurring in a heavily developed area can cause far more damage than a major tornado occurring in a sparsely developed location.

[53] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.
[54] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[55], tornado losses should be estimated based on past occurrences as there are no standard loss estimation models. As outlined earlier, Dartmouth has not experienced a damage-causing tornado, with most storms in Bristol County consisting of F0 or F1 tornadoes. Therefore, damage estimates from larger tornadoes are difficult to determine, however **Table** 5.7 provides a worst-case dollar estimate for each potential storm.

Table 5.7 – Tornado Vulnerability Assessment

Tornado Category	Typical Expected Damage	% of Property Damaged	Total Damage
F0-F1	Light damage. Some roof and garage damage, mobile homes moved	1%	$27,400,000
F2-F3	Significant damage. Roofs torn off, mobile homes demolished, large trees snapped or uprooted	5%	$137,000,000
F4-F5	Devastating damage. Houses leveled, damage to well-constructed buildings, cars thrown	15%	$411,000,000

Note: dollar amounts based on property values obtained from the Tax Assessor's database for fiscal year 2013.

As shown above, even a minor tornado can cause substantial financial damage should it occur in a heavily developed area. However, tornadoes rarely occur within Dartmouth and the vast majority that occur in the area do very little damage. Due to rarity of occurrence and inability to determine where a tornado will occur, vulnerability to a "typical" tornado is impossible. Percentages and dollar values are based on a worst-case scenario, with a tornado affecting the most densely developed areas of town.

Thunderstorms

Similar to tornadoes, thunderstorm damage is typically caused by high winds, with lesser damage caused by heavy precipitation and hail. Damage is typically less than that inflicted by a tornado; however thunderstorms generally affect a much larger area than a tornado. Thunderstorm damage is typically similar to the damages inflicted by a very weak tornado, with damages estimated at less than $1 million. Additional damages may also result from flooding as outlined earlier in this section.

5.5 Geologic Hazards

Earthquake

Damage from earthquakes is caused by moderate to severe shaking of the ground. As with other disasters, damage ranges depending on the severity of the occurrence. Due to the rarity of a major earthquake occurrence, most structures within town are not constructed to a high seismic design level. Therefore, an earthquake occurrence of a damaging level has the potential to inflict substantial damage across the community.

As outlined earlier, Dartmouth has never experienced a damage-causing earthquake, with virtually all earthquakes occurring in the area of barely detectable magnitude. Even an earthquake of less than 4.0 is rare, and will typically cause $0 in damage. For planning purposes,

[55] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

an earthquake of 0.10g with a reoccurrence interval of once every 2,476 years may be considered a "typical" worst-case scenario. Damage for this earthquake is estimated to affect 2% of buildings, assumed to be a worst-case scenario for unreinforced masonry construction as outlined in FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[56] totaling up to $54.7 million. Larger earthquakes will affect more structures and have a correspondingly higher damage total, however are considered extremely rare, occurring less than once every several thousand years.

Landslide

Dartmouth has never experienced a landslide, and the likelihood of occurrence is minimal. Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[57], there are no standard loss estimation models. Landslide damages will depend on the location of occurrence, and will typically be minimal. Should one occur, damages will likely be less than $1 million.

Sinkhole

As with landslides, Dartmouth has never had a damaging sinkhole. Should one occur, it will likely be associated with a utility line failure and not due to natural causes. Sinkhole damages will likely be less than $1 million.

5.6 Forest Fires / Wildfires

Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[58], there are no standard loss estimation models for wildfires. As wildfires typically occur in localized, sparsely developed areas, damages are typically light compared with those that take place in either highly developed areas or over a large area. Most fires will cause damages less than $1 million, however may potentially exceed $5 million depending on size and location.

5.7 Drought

Damages due to drought are difficult to determine, and actual damage to structures and infrastructure is typically minimal. However, damage to crops and other water-sensitive features can be extensive depending on drought timing and duration. Unlike most other disasters that are over in days at most, droughts can last years. Should an extended drought occur, droughts lasting years can have substantial financial consequences. Although extended droughts are possible, most droughts are fairly brief with little to no damaging impacts.

5.8 Dam Failures / Breaches

Damages from dam failures will be caused by a sudden release of water along an inland waterway, likely to roadway infrastructure or buildings in close proximity to the affected stream. Damages will directly relate to the size and location of the dam that failed. Many dams in Dartmouth are small and located in remote areas. Damages from the failure of one of these will be minimal, potentially $0 other than the cost of replacing the dam if desired. However, failure of a major dam, such as those listed as High Hazard or Significant Hazard can cause substantial damages comparable to localized inland flooding. Damages from a dam failure are difficult to quantify, however could exceed $25 million, or similar to a minor to moderate flood event.

[56] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.
[57] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.
[58] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

5.9 Vulnerability Summary

The following table provides a summary of the above vulnerability assessment for Dartmouth. Note that the following dollar amounts are for planning purposes only and should not be used as a comprehensive assessment in the event of a natural disaster.

Table 5.8 – Vulnerability Summary

Natural Hazard	Potential Hazard Damage		
	Low	Moderate	High
Floods			
Flooding	$0 to $25 Million	$25 to $100 Million	>$100 Million
Flooding from Storm Runoff	Up to $5 Million		
Erosion	Up to $1 Million		
Winter Storm Events			
Snowstorms and Blizzards	$0 to $1 Million	$1 to $3 Million	>$3 Million
Ice Storm	$0 to $5 Million	$5 to $20 Million	>$20 Million
Ice Jam	Up to $1 Million		
Hurricanes and Nor'Easters			
Hurricanes	$0 to $40 Million	$40 to $200 Million	>$200 Million
Coastal Storms or Nor'easters	$0 to $10 Million	$10 to $50 Million	>$50 Million
Tornadoes and Thunderstorms			
Tornadoes	$0 to $30 Million	$30 to $300 Million	>$300 Million
Thunderstorms	Up to $1 Million		
Geologic Hazards			
Earthquakes	$0 to $50 Million	$50 to $500 Million	>$500 Million
Landslides	Up to $1 Million		
Sinkholes	Up to $1 Million		
Other Hazards			
Forest Fires / Wildfires	Up to $5 Million		
Drought	Unknown		
Dam Failures	Up to $25 Million		

6.0 HIGH HAZARD AREAS

The Local Planning Team has evaluated areas of the Town that are particularly vulnerable to the hazards associated with a natural disaster as discussed in Section 4.0. The following sections outline areas at the highest risk of adverse impacts from hazards, as well as the potential impacts at each location. As many hazards such as earthquakes and winter storm events can affect the entire town, this section has been tailored to localized events, particularly those associated with flooding and/or coastal storm surge.

6.1 Critical Infrastructure

Critical infrastructure is essential to the health and welfare of the Town and is especially important following hazard events. Critical infrastructure includes buildings and infrastructure such as emergency operations centers and shelters, critical municipal buildings, transportation features, utilities and communications infrastructure, water and wastewater facilities, etc. The Local Planning Team developed a list of critical infrastructure and facilities as provided in **Appendix B**. Only a portion of critical infrastructure facilities are located within high hazard areas such as floodplains, however due to the importance of these facilities, special care must be taken to ensure continued operation even during disaster events.

During the planning process, it became apparent that the list of critical infrastructure was extensive, making it impractical to respond to the needs of all facilities during or immediately after an emergency. Therefore, the LPT prioritized critical infrastructure into the following "tiers" based on priority of importance, and shown on the respective figure:

- Tier 1 – Emergency Response and Utilities (**Figure 2**);
- Tier 2 – Municipal and Community Centers (**Figure 3**); and
- Tier 3 – Other (**Figure 4**).

Tier 1 facilities are the most critical and include facilities such as police, fire and medical services, water and sewer infrastructure, department of public works facilities, and other important utilities. This infrastructure is necessary to maintain a minimal level of service to provide necessary utilities and emergency services to residents. Every feasible opportunity should be taken to ensure that these facilities remain functional and accessible at all times.

Tier 2 facilities are also important and include large municipal, public, semi-public and other gathering places servicing a proportionally large group of people. Infrastructure includes town offices and other municipal buildings, schools, nursing homes, and other miscellaneous buildings such as the post office and Bristol County House of Corrections.

Tier 3 facilities are generally less critical, however still important to the community as a whole. Infrastructure includes smaller preschool and kindergarten facilities, daycare facilities, animal shelters, historic properties, parks and cemeteries.

6.2 Hazardous Material Sources

Facilities storing large quantities of hazardous or other regulated materials such as oil deserve special consideration due to the potential environmental contamination possible in the event of a natural disaster. The Massachusetts Board of Fire Prevention Regulations requires facilities to

register the storage of flammable materials with the local fire department. **Appendix C** provides a list of facilities storing more than 500 gallons of flammable materials as registered with Dartmouth Fire Districts. Products stored are typically oil and fuel that could cause a fire or environmental hazard in the event of a disaster.

6.3 Repetitive Loss Properties

Nationally, approximately one-fourth of all National Flood Insurance Program (NFIP) claims (almost $9 billion) since 1978 have been paid to "repetitive loss properties," which, in turn, represent only 1.3% of all policies[59]. Repetitive loss scenarios are as follows:

- Repetitive loss – Properties experiencing two or more losses of at least $1,000 each within any 10 year period since 1978; and
- Severe repetitive loss – Single or multifamily residential properties experiencing 4 or more claims each exceeding $5,000, or properties with 2 separate claims with the cumulative dollar amount exceeding the market value of the property. Either scenario must have at least 2 claims occurring within 10 years of each other.

Repetitive loss properties are those for which two or more losses of at least $1,000 each have been paid under the NFIP within any 10 year period since 1978. FEMA reports that a total of 4 residential properties in south Dartmouth have experienced repetitive losses, all in the vicinity of Apponagansett Bay. Losses occurred in 1991, 1992, 1997, 2001 and 2005, with each property experiencing two to three events.

6.4 High Hazard Areas

The Local Planning Team has established a number of areas in the Town as being prone to hazards associated with natural disasters. Areas were selected based on the local knowledge offered by Town personnel, as well as mapping efforts conducted through the use of GIS and Flood Insurance Rate Maps (FIRMs).

Although these areas are subject to hazards such as wind, fire, earthquakes and snow, these types of hazards have the potential to affect the entire town. High hazard areas were selected because they experience localized damage associated with flooding problems. In general, dense areas located in the eastern and central portions of the Town built up prior to the introduction of wetlands protection regulations experience the greatest problems. Flooding typically occurs because development was allowed in areas that would now be considered wetlands[60].

A description of each high hazard area is provided in the following sections, as well as expected causes and potential mitigation issues.

Buttonwoods Brook Crossings

Most inland flooding locations coincide where Buttonwoods Brook crosses under roadways. Several existing culverts are undersized and cannot handle elevated stream flows during storm

[59] National Flood Insurance Program Community Rating System (NFIP/CRS). "Strategic Plan Evaluation Repetitive Loss Strategy. June 2011. http://crs2012.org/uploads/docs/other/repetitive_losses_final.pdf
[60] SRPEDD. "2007 Dartmouth Master Plan". 2007. http://www.town.dartmouth.ma.us/Pages/DartmouthMA_BComm/Planning/DartmouthMasterPlan.pdf

events. Buttonwoods Brook crosses under Hawthorn Street and Allen Street from upstream to downstream where flooding has recently occurred.

The Hawthorn Street culvert is the most upstream problem area along Buttonwoods Brook. The roadway also serves as a major route into and out of New Bedford, as well as providing access to the Southcoast Brain and Spine Center. Nearby critical infrastructure also includes the James M Quinn Elementary School. The small culvert size and low roadway elevation causes the river to backup, inundating Hawthorn Street with as much as two feet of water and preventing roadway use. This area receives stormwater runoff from approximately 224 acres, including runoff from a portion extending north of Route 6.

Located just downstream of Hawthorn Street, the Allen Street culvert also periodically backs up, causing flooding in the Southcoast Brain and Spine Center parking lot. During heavy flooding, as much as half of the parking lot may be submerged underwater. Due to the closely interconnected hydrology between Hawthorn and Allen Streets, backup at the Allen Street culvert is typically observed when flood flows overtop Hawthorn Street. Combined with the runoff area for the Hawthorn Street culvert, this area receives stormwater runoff from approximately 960 acres, including runoff from a portion of New Bedford roadways and extending north to I-195. Therefore, it is possible that upgrading the Allen Street culvert may help alleviate flooding at Hawthorn Street. However, upgrading the Allen Street culvert may shift the flooding problem to other culverts located further downstream. An alternative approach is to mitigate the runoff flows upstream of the Hawthorn Street culvert, by creating additional stormwater detention volume.

Russells Mills Dam

The Russells Mills Dam, classified as a Significant Hazard dam, serves as an impoundment for the Paskamanset River and outlets under Rock O'Dundee Road via three culverts, each approximately six feet in diameter. Culverts appear to be constructed of corrugated metal and show signs of aging as evidenced by corroded inverts and sidewalls. During heavy rainfall events, the impoundment upstream of the dam will release water capable of overwhelming the hydraulic carrying capacity of the outfall pipes, causing the roadway to flood up to 18 inches deep. To date, no upstream or downstream flood losses have occurred, however two houses located downstream along Horseneck Road may be at risk should a substantial storm occur. One problem with the dam is the inability to easily lower water levels (ahead of a storm event) within the impoundment due to inadequate access to the existing drawdown structure. Currently, DPW personnel must use a backhoe or similar equipment to deploy a worker onto the drawdown structure to remove one or more flashboards.

Russells Mills Road and Padanaram Causeway

Russells Mills Road and the Padanaram Bridge on Gulf Road are subject to coastal flooding during major events such as a hurricane or nor'easter. Dartmouth routinely closes the bridge in advance of hazardous flooding conditions. High winds and heavy surf drive seawater from Buzzard's Bay into Apponagansett Bay, raising water levels and limiting the ability of waters within Apponagansett Bay to drain back into the ocean. Sea, Lake, and Overland Surge from Hurricanes (SLOSH) maps indicate that this area is subject to inundation from a Category 1 hurricane as shown in **Figure 5**.

Should the Padanaram Causeway become impassable, emergency access routes are extended by as much as 8 miles, as Russells Mills Roadway will also be underwater. This is especially problematic, as the Dartmouth Fire District 1 station is located on Bridge Street, just to the east of Apponagansett Bay. Should an emergency situation occur just to the west of Padanaram Causeway during a flood event, emergency personnel will have to make a substantial detour, likely taking an additional 20 or 30 minutes to respond to the call. Flooding can also impact operation of a wastewater pump station and cause damage to buildings and infrastructure along Apponagansett Bay.

Knowles Beach
Another area of concern is a small isolated area in the vicinity of Knowles Beach in the vicinity of the Smith Neck Road and Gulf Road intersection. Although a small channel connects this area with the rest of Apponagansett Bay, storm surge events will typically inundate the area with seawater and fill in the channel. Because of the Padanaram Causeway and nearby beach, this area will not properly drain into Apponagansett Bay, instead remaining stagnant. The Town must then re-dredge the channel to allow this area to drain. The Town is currently exploring options to install a culvert to allow proper drainage as outlined in Section 8.3.

Tucker Road
The Tucker Road culvert in the vicinity of Eddy Street allows passage of a tributary to the Paskamanset River. This culvert periodically floods and has caused damage to the North Dartmouth Library in the recent past. The Town is currently planning to realign Tucker Road and perform drainage upgrades as outlined in Section 8.3. These upgrades are expected to alleviate flooding concerns and issues at this location.

Old Fall River Road
The Old Fall River Road culvert allows the Shingle Island River to flow below the roadway. Flooding appears primarily associated with the river, however there are several swamps in the area including the Colebrook Swamp, Shingle Island Swamp, and Flag Swamp indicating high groundwater is likely present. Flooding also appears to be caused by stormwater runoff from the road itself. Old Fall River Road is a major roadway, allowing access to a large portion of North Dartmouth, including a gas turbine and solar power facility. It appears that flooding may be alleviated by enlarging the culvert to allow additional flow and raising the roadway elevation to create additional upstream storage if needed.

Chase Road
Chase Road is yet another main road in Dartmouth. The Chase Road culvert near Lucy Little Road periodically floods due to uncontrolled floods from a tributary to the Paskamanset River. Flooding appears primarily associated with stormwater runoff, as this tributary receives runoff from large portions of the University of Massachusetts. The Dartmouth Water Treatment Facility and public wells are in close proximity to this area. UMass has conceptual plans for drainage and detention improvements on their campus, upstream of this area, which should help to lessen impacts in this area.

Minor Flooding Areas
In addition to the above areas, the Local Planning Team identified the following areas subject to occasional minor inland, coastal, or stormwater flooding conditions:

- Old Westport Road and Route 6, inland flooding;
- Maine Avenue and Ohio Avenue near Route 6, inland flooding;
- Greystone Avenue, inland flooding;
- End of Marianna Street and Rapoza Street, coastal flooding;
- End of Buttonwood Road near Walsh Street, coastal flooding;
- End of Sol E Mar Street, coastal flooding; and
- Railroad crossing at Faunce Corner Road.

In general, each area does not impact more than one or two houses and does not greatly impact transportation and access during an emergency. Emergency access limitations affect only a few houses or a detour is readily available.

6.5 Recent Development in High Hazard Areas

Development in hazard prone areas since completion of the 2004 Plan has included single family residential development in the areas of Round Hill, Captains Lane, adjacent to Jones Park, and Little River Road. All development in these high hazard areas have either (1) built structures outside the boundaries of the hazard zones or (2) have built structures in accordance with the Massachusetts Building Code, which is more strict that the federal regulations for building in these hazard areas. Both practices help minimize risk and damage from natural hazards.

7.0 EXISTING DISASTER MITIGATION MEASURES

Recent natural disaster response has been adequate, with generally good communication and cooperation between various Town departments. Communication efforts have been improved over the years to better prioritize problem areas and expedite responses.

Dartmouth has implemented a number of existing hazard mitigation measures in response to previous disaster situations. Existing measures primarily include regulations and bylaws to protect existing structures and future development, however other measures are also in place. Existing mitigation measures are discussed in the following sections.

7.1 Emergency Management Agency

Dartmouth has established a local Emergency Management Agency at a Town-owned facility at 247 Russells Mills Road. The agency acts in the event of a natural or other disaster, and provides emergency services such as providing auxiliary communications, lighting, and electrical power as needed. The agency operates under the general direction of the Massachusetts Civil Defense Department.

7.2 Emergency Management Plans

Dartmouth has developed a Comprehensive Emergency Management Plan (CEMP) to document mitigation, preparedness, response and recovery actions to be taken by the Town in the event of an emergency. The plan evaluates both natural and manmade hazards, and addresses coordination between multiple departments and agencies within the area to provide for the safety and welfare of Dartmouth citizens. The plan is periodically updated to reflect the most up-to-date information available.

As part of the CEMP, Dartmouth has also developed a Hazardous Materials Emergency Plan (HMEP) to outline planning and response actions in the event of an incident involving hazardous chemicals. The plan describes actions to be taken to minimize hazards to life and the environment, establishes coordination procedures for multiple agencies, and identifies emergency response actions.

7.3 Federal and State Regulations

Development in Dartmouth must adhere to all applicable Federal and State regulations, as set forth by the appropriate agency. Agencies include, but not limited to:

- United States Environmental Protection Agency (EPA);
- United States Army Corps of Engineers (ACoE);
- Federal Emergency Management Agency (FEMA);
- Massachusetts Department of Environmental Protection (MassDEP);
- Massachusetts Department of Fire Services (DFS); and
- Massachusetts Department of Public Safety (DPS).

All development in town is subject to the minimum requirements set forth by federal and state regulatory agencies. Local regulations and bylaws may be developed that outline more stringent requirements. Applicable local regulations and bylaws are discussed in the following section.

7.4 Local Regulations and Bylaws

Dartmouth currently has a number of bylaws and regulations in place. Bylaws and regulations provide for water quality and resource area protection in an effort to maintain the health and stability of wetlands, marshes, and other environmentally sensitive areas. These areas provide critical water storage during flood events that help alleviate potential property damage and loss of life. Applicable local bylaws and regulations include:

- General Bylaws (2011);
- Zoning Bylaws (2011);
- Subdivision Regulations (2007);
- Department of Public Works (DPW) Construction Specifications (2009); and
- Wetland Protection Bylaw Regulations (2009).

The General Bylaws contain a number of relevant sections, including articles on Wetlands, Earth and Soil Removal, Water Use Restrictions, and Waterways management. Zoning Bylaws also contain several relevant sections on overlay districts, including a Waterfront Overlay District, Floodplain District, and Aquifer Protection District. Regulatory documents such as the Subdivision Regulations and Wetland Protection Bylaw Regulations generally contain design standards to ensure proper design and construction of sites to minimize flooding and other damage.

Town agencies, including the Building Department, Conservation Commission, and Planning Board enforce existing local regulations, as well as state and federal regulations set forth by the Massachusetts Department of Fire Services, Massachusetts Department of Public Safety, Environmental Protection Agency, Army Corps of Engineers, Federal Emergency Management Agency, and Massachusetts Department of Environmental Protection. If existing bylaws and regulations prove ineffective, or additional measures are developed that better protect infrastructure and the environment, changes should be adopted to maintain adequate protection.

Note that the Massachusetts State Building Code, enforced locally by the Building Department, contains many standards governing proper construction methods and techniques. Many of the standards are in place to help ensure buildings and other structures can withstand natural hazards such as high winds, heavy rains, snow loads, and high waters. The Building Department requires that permits be obtained for many construction-related projects, and permits must be obtained before occupying the building.

General Bylaws

Article 66 - Wetlands

The purpose of the bylaw is to protect the wetlands, related water resources, and adjoining land areas by controlling activities deemed likely to have a significant or cumulative effect upon wetland values. Unless permitted by the Conservation Commission, no person shall remove, fill, dredge, build upon, or alter land in or within a 100 foot buffer zone of an environmental resource area, or be subject to fines and other legal action.

Article 67 – Earth and Soil Removal

No earth shall be removed from land within the Town without obtaining a permit either from the Board of Appeals or a finding from the Building Commissioner that removal will not violate the

Zoning Bylaws. A cover of soil suitable for seeding shall remain or be replaced for all operations involving the removal of hills, all stripping operations, and an area of any pit which lies above the water table. The project also may not increase or redirect drainage water onto an abutters property or onto a roadway. No permit shall be issued for the removal of soil within 4 feet of the average maximum groundwater elevation unless specifically authorized, and any permit issued within the Aquifer Protection District shall be in accordance with Zoning Bylaws.

Article 91 – Water Use Restrictions

The purpose of the bylaw is to protect, preserve and maintain the public health, safety and welfare whenever there is in force a state of water supply conservation or state of water supply emergency. People violating restrictions may be subject to fines. The Board of Public Works may declare a State of Water Conservation upon a determination that a shortage of water exists, and that conservation of water is necessary to insure adequate supply to all consumers under all conditions. A State of Water Conservation may include any of the following restrictions, conditions, or requirements restricting water use for essential purposes to protect the water supply:

- Odd/Even Lawn Watering – Lawn watering at odd numbered addresses permitted only on odd days, lawn watering at even numbered addresses permitted only on even days.
- Outdoor Watering Ban – Lawn watering and non-essential outdoor water use prohibited.
- Outdoor Watering Hours – Outdoor watering is permitted only during off-peak hours.
- Filling Swimming Pools – Filling of swimming pools prohibited.
- Automatic Sprinkler Use – Using automatic sprinkler systems for watering prohibited.

The Board may also declare a State of Water Emergency and implement provisions, restrictions, and/or requirements of conditions as necessary to end the emergency.

Article 104 – Waterways Management

All owners of moorings in Dartmouth waters shall register with the Harbor Master by July 1st of each year. Moorings shall not be placed until the location, tackle, and maximum vessel capacity are approved by the Harbor Master. Moorings shall be inspected prior to placement, and every three years thereafter. No vessel shall discharge any sewage into the Apponagansett River, known as Padanaram Harbor or be subject to fines per each discharge.

Zoning Bylaws

Section 18 – Waterfront Overlay District

The purpose of the Waterfront Overlay District is to provide adequate areas for harbor dependent uses, to prevent encroachment by uses detrimental to harbor dependent uses, and to promote access to the waterfront. This overlay district is designed to manage Town growth while preserving the Town's maritime heritage. Maritime-related uses are generally allowed, such as construction and use of boatyards, marinas, yacht clubs, ferries, offices, and related boat construction, repair, maintenance and storage. Construction of residential, most commercial, and parking areas require a special permit.

Section 19 – Floodplain District

The "Flood Prone Land Overlay District" is a district designed to protect structures located in areas subject to flooding during hurricanes or located in wave velocity zones as provided in

Figure 6. The district is based on a compilation of FIRMs and Flood Boundary and Floodway maps issued by FEMA. Note that although the hurricane flood zone for the ocean is generally 13 feet above sea level, exposed land in wave velocity zones can have waves cresting as much as 20 or 30 feet above sea level[61]. The purposes of the Floodplain District are to ensure public safety, reduce flood damage to property, eliminate costs associated with the response and cleanup, avoid the loss of utility services, and prevent the occurrence of public emergencies due to flooding-related water quality contamination and pollution.

All uses shall comply with Massachusetts General Law, Chapter 131, Section 40, addressing the removal, fill, dredging or altering of land bordering waters, Massachusetts State Building Code, addressing floodplain and coastal high hazard areas, Massachusetts Department of Environmental Protection (MassDEP) Wetlands Protection Regulations, and the Dartmouth Conservation Commission Wetlands Protection Bylaw. Additionally, the following design standards apply:

- No area of human habitation may be built below the mapped flood level.
- A Special Permit from the Board of Appeals is required to fill or excavate land in a flood zone other than that related to building a house.
- All development shall be designed so surrounding properties are not damaged by floodwaters as the result of proposed development.
- All habitable structures shall be located landward of the reach of the mean high tide and be elevated 1 foot above established base flood elevations.
- Within Zones AH and AO on the FIRM, drainage paths are required around structures on slopes to guide floodwaters around and away from proposed structures
- In Zone AE and along watercourses with a regulatory floodway, encroachments resulting in increased flood levels during the occurrence of base flood discharge are prohibited.
- Man-made alteration of sand dunes is prohibited within Zones VE, and V which would increase potential flood damage or impair the dunes ability to function as a storm barrier.
- The Planning Board and/or Building Commissioner will review applications to ensure minimization of flood damage and adequate drainage is provided to reduce flood hazards.

Section 20 – Aquifer Protection District

The purpose of the Aquifer Protection District is to protect groundwater supplies and recharge areas, particularly those contributing to the public water supply. There are 3 Aquifer Protection Districts as shown on **Figure 7** and as follows:

- Area 1 – MassDEP Approved Zone I. A 400 foot radius extending in all directions from each public water supply well, and include all the land within the radius;
- Area 2 – MassDEP Approved Zone II. The recharge area associated with a public water supply well after 180 days of continuous pumping, at approved yield with no recharge from precipitation. Area 2 is equivalent to Zone II as defined in 310 CMR 22.02; and
- Area 3 – Recharge and Potential Groundwater Development Areas. The potential groundwater development areas and areas providing recharge to Area 2.

[61] SRPEDD. "2007 Dartmouth Master Plan". 2007. http://www.town.dartmouth.ma.us/Pages/DartmouthMA_BComm/Planning/DartmouthMasterPlan.pdf

Many uses that could involve storage or handling of hazardous wastes, petroleum products, solid waste, human or animal waste products or chemicals are prohibited in aquifer protection district areas that could potentially be damaging to the environment, the Town's drinking water sources and public health, should a release occur. Some uses storing more than 990 gallons of liquid petroleum and certain existing prohibited uses may be expanded or modified if a Special Permit is obtained. In Area 1, all uses are prohibited except structures and uses necessary to extract groundwater for public water supply.

In general, new construction requires recharge of roof runoff from primary buildings directly into the ground. A change of use, alteration or reconstruction of more than 50% of a buildings value, increasing a building footprint by 10%, or increasing lot coverage by 5% also requires infiltration of roof runoff. New commercial, industrial, institutional, multifamily, roadways or parking areas with more than 10 spaces must prepare a stormwater management plan addressing recharge of roof runoff. Site design must also incorporate natural drainage patterns and the use of stormwater BMPs to remove pollutants from stormwater.

Subdivision Regulations

The design of the subdivision shall be such that it preserves the scenic and environmental character of the Town. Due regard shall be made to preserve wetlands, as well as preserve community assets. Stormwater management shall be designed and constructed to:

- Remove storm water from roadways to permit safe and convenient travel during storms of moderate severity;
- Control the direction of flow of storm runoff in a manner that is not detrimental to abutting lots, properties or ways; and
- Mitigate the discharge of stormwater in order to avoid increasing the occurrence of downstream flooding or degradation of water quality.

Direct discharge from the drainage system into any waterbody such as a stream, pond, or estuary is prohibited. All drainage from paved surfaces shall first be mitigated for rate and quality by directing flow through a stormwater BMP. Design must follow guidance set forth in applicable Town bylaws, covering aspects such as design methodology, design storm frequency, slopes, sizing, layout, and other typical design criteria associated with stormwater system design. All plans, details, narratives, calculations, etc. must be submitted to the Town for approval.

Pervious areas disturbed by construction activities must be loamed and revegetated to prevent erosion upon completion of subdivision improvements. All newly created slopes or disturbed areas shall be permanently stabilized or vegetated to prevent erosion and shall have a maximum slope of 2:1.

Subdivision regulations also require that all utility services be located in public right-of-ways and buried underground to reduce the likelihood of disruptions during natural disasters.

Wetland Protection Bylaw Regulations – Effective January 20, 2009

Because stormwater discharges can cause damage to the functioning of wetlands and the quality of receiving water and are a significant source of pollution, the following requirements shall apply to roadways, parking plans, and industrial and commercial projects:

1. The recommended methods for developing stormwater hydrographs and estimating peak discharges are included in the Soil Conservation Service (SCS) publication, "Urban Hydrology for Small Watersheds", Technical Release 55 (TR-55). All calculations, hydrographs, plans, details and supporting data should be submitted for review.
    a. As TR-55 conservatively estimates runoff rates, it is recommended that existing flow rates be deliberately underestimated or that attenuation facilities accomplish at least a moderate flow rates reduction in order to achieve a real "zero increase".
    b. A hydrologic analysis must include all areas modified by construction activities and up-gradient areas. The analysis should include plans indicating sub-catchment boundaries, soils classifications, and cover types for pre- and post-development.
    c. Although subcatchment boundaries may be realigned, the total area and perimeter of the analysis must be the same for pre- and post-development conditions.
    d. The determination of catchment time of concentration must include an accurate estimate and evaluation of sheet, shallow concentrated, and open channel flow.
    e. As peak flow rates and lag time can be substantially impacted by ponding areas, detailed storage routing procedures should be used where necessary.
2. Storage basin infiltration during the storm normally cannot be substantiated. If such infiltration losses are to be assumed in design, they must be supported by data such as groundwater elevation, soil profiles and permeability evaluations.
3. Stormwater system design must account for all runoff in excess of system capacity. Storage facilities proposed for the attenuation of peak flow rates should incorporate adequate freeboard and/or overflow capacity to minimize risk of failure.
4. In order to prevent the pollution of groundwater resources, the bottom elevation of any attenuation facility must be located above the recorded ground water level.

7.5 Backup Power Supplies

Much of Dartmouth's critical drinking water and wastewater collection, pumping, and treatment infrastructure is equipped with onsite backup power sources. Dartmouth's wastewater treatment plant has three backup generators for emergency use, while all sewer pump stations are equipped with emergency generators. Water treatment facilities and many drinking water supply wells also have backup generators, with the exception of water storage tanks. The water storage tanks function automatically by gravity to maintain flows and pressures throughout the water system, with backup power only required for instrumentation purposes (i.e. communicate tank water levels). Generators are powered by onsite fuel sources such as aboveground diesel tanks or propane tanks, and may be refueled as needed by conventional methods.

Emergency generators are also available for other municipal facilities, including Town Hall, Police Station, Council on Aging, three schools (Dartmouth High School, Dartmouth Middle School, and James M. Quinn Elementary School), all DPW facilities, and centers of operations. These facilities could also be used for emergency shelters if necessary.

The Town routinely tests backup generators, either utilizing automatic test methods such as on DPW's water and sewer pump station generators or manual weekly tests such as on those located at schools and the police station. Backup power supplies are listed in **Appendix D**.

Current Town bylaws require proposed assisted living facilities to be equipped with an emergency backup power supply. Dartmouth is currently working on amending these regulations to require all assisted living facilities to be equipped with an adequate emergency power supply.

7.6 Emergency Shelters and Mutual Aid

Dartmouth has established the following emergency shelters for use in the event of a natural disaster:

1. Primary – Council on Aging, 628 Dartmouth Street
2. Alternate – Dartmouth High School, 555 Bakerville Road

Typically, the Council on Aging (CoA) building is opened first, with the high school opened as needed should the capacity of the CoA be exceeded. Both shelters are equipped with emergency generators in the event of a power outage. Additionally, personnel from UMass-Dartmouth have indicated that the college could function as an emergency shelter. See Section 7.11 for further information.

Dartmouth and neighboring towns currently have an informal mutual aid agreement, however nothing formal is in place.

7.7 Preventative Maintenance

The Department of Public Works typically performs several preventative maintenance items directly preceding an expected storm event:

- Pre-clean known problem catch basins and other drainage structures to ensure adequate flow of stormwater and prevent flooding;
- Remove stop logs at the Russells Mills Dam to draw down the Paskamanset River impoundment located north of Rock O'Dundee Road and provide additional water storage; and
- Deploy orange barrels and DPW saw horses in advance of the emergency at known flooding areas to allow easier closing of roadways if necessary.

During the event, access to the Padanaram Causeway and Bridge may be restricted by closing gates across the roadway. Smaller roadways may be closed in part or completely by deploying barrels and other barriers as necessary.

Inmates at the Bristol County House of Corrections are available to perform certain operations, such as filling sand bags for use around critical infrastructure. The more advanced notice is provide, the more sand bags may be filled for use around the Town.

In addition, NSTAR is currently performing tree trimming throughout Dartmouth in an effort to minimize damage to power lines and poles from falling tree limbs.

7.8 Structural Upgrades

Buttonwood Brook culverts have been recently upgraded at Milton Street and Sharp Street to help alleviate flooding during large storm events at these locations. Culverts at both locations allow additional water to flow below the roadways, thereby reducing the frequency and severity

of flooding events. However, other culverts along Buttonwood Brook such as Hawthorn Street and Allen Street continue to flood and impact other roadways. The Town will continue to watch the culverts at Milton and Sharp streets to evaluate any worsening conditions. It is possible that upgrading culverts at upstream locations will allow more water downstream, causing new flooding at Milton Street and Sharp Street.

7.9 Public Outreach

Dartmouth has implemented several programs as a means of reaching out to the public prior to and during an emergency. The Town routinely distributes information via the local cable channel broadcast by Dartmouth Community Television (DCTV). DCTV operates two channels, 17 and 18, which have been used to convey information to the general public during and after natural disasters. Information typically includes closed roadways, power company response estimates, etc. DCTV also runs a message board to provide residents with up to date information on current events and other pertinent information. The television studio is typically run via a portable generator during disaster times in order to keep public cable channels available to residents.

Dartmouth uses the town website as a means of conveying information to the public. The website includes links to all Town departments, as well as applicable contact information. The website also provides links to applicable emergency agencies, such as Dartmouth Police, Fire, and Emergency Management Agency. The website also provides emergency management maps such as flood insurance maps, floodplains, and hurricane maps. Residents can also utilize the new E-News feature of the website, allowing the public to automatically receive an email of any Town news or other important information. If necessary, Dartmouth Police have also hand-delivered informational items to residents in affected areas.

The Town has also recently begun the use of web-based social media platforms, including Facebook, as a means of communicating with residents during an emergency. Thanks to the rise of mobile smart phones, this has proved to be a valuable commodity, especially during times of power outages, as residents may still have access to the internet via the mobile phone network.

7.10 National Flood Insurance Program

Dartmouth currently participates in FEMA's NFIP. Per FEMA's Local Multi-Hazard Mitigation Planning Guidance document, the NFIP has three basic aspects:

1. Floodplain identification and mapping – adopt flood maps depicting hazards;
2. Floodplain management – adopt and enforce floodplain management regulations; and
3. Flood insurance – require property owners to purchase insurance in exchange for floodplain management regulations that reduce future flood damages.

Floodplain Identification and Mapping

Flood Hazard Boundary Maps (FHBMs) were established on February 28, 1975, with flood insurance rate maps following on August 15, 1977. The FIRMs were amended several years ago with an effective date of July 7, 2009[62]. Dartmouth will work towards updating FIRMs as appropriate as outlined in Section 7.3, action item 1.

[62] Federal Emergency Management Agency. http://coop.fema.gov/cis/MA.pdf

Floodplain Management
Dartmouth has implemented a Floodplain District as regulated under the zoning bylaws to protect existing and future infrastructure located in flood-prone areas. The Town will update its bylaws as necessary to reflect any changes to flood-prone areas. Updates may be required after FHBMs and/or FIRMs are updated.

Flood Insurance
Dartmouth currently has 596 insurance policies in force, with a total insurance value of $144,082,900[63] as of March 31, 2013. Loss statistics for January 1, 1978 through March 31, 2013 are shown below[64] in **Table** 7.1.

Table 7.1 – Dartmouth Loss Statistics

Total Losses	Closed Losses	Open Losses	Closed Without Payment Losses	Total Payments
140	88	0	52	$865,001.95

Ongoing Compliance
As part of ongoing NFIP requirements, Dartmouth tracks development within flood hazard areas as identified on community FIRMs to ensure new buildings and substantial improvements are properly elevated above applicable floodplains. For properties located within FIRM Zone A, the elevation of the lowest floor, including a basement, must be documented, as well as any floodproofing performed on the structure. Similarly, for properties located within FIRM Zones V1-30, VE, and V, the elevation of the lowest structural member of the lowest floor must be recorded.

Dartmouth will also work with nearby communities to establish mutual aid agreements to address administering the NFIP following a major storm event as outlined further in Section 7.3, action item 17.

7.11 UMass-Dartmouth

UMass-Dartmouth provides an Emergency Guide to students, staff and faculty as a guide on what to do in an emergency. The guide contains information on emergency contacts, shelters, and evacuations, as well what to do regarding specific emergencies.

During the most recent class cancellation event, the campus required approximately 2.5 hours to completely empty of commuter students via the main entrance at Old Westport Road prior to a snow storm.

Should a true emergency evacuation be required the campus has emergency access via Lucy Little Road and Chase Road which may be used for emergency evacuations out of the campus to help expedite traffic flow. However, Town personnel indicated that these roads are not always accessible during natural hazard events, due to their condition (unpaved). Also, the additional traffic on emergency access roadways will also impact traffic flow at other locations in Town rather than concentrating traffic on Old Westport Road. Traffic at the intersection of Old

[63] FEMA National Flood Insurance Program. http://bsa.nfipstat.fema.gov/reports/1011.htm#MAT
[64] FEMA National Flood Insurance Program. http://bsa.nfipstat.fema.gov/reports/1040.htm#25

Westport Road and Chase Road, as well as the intersection of Old Westport Road, Faunce Corner Road and Route 6 will likely be heavily impacted as commuter students proceed towards Route 6 and Interstate 195.

The university is in the process of hiring an Emergency Management Coordinator to "develop and maintain the University's Business Continuity and Disaster Recovery initiatives", as well as implementing the "Automated Critical Asset Management System (ACAMS) program by collecting campus critical infrastructure information for input into ACAMS and to develop specialized campus and building evacuation maps, continuity of operations plans (Coop) and other emergency preparedness plans for University".

University personnel have also indicated that UMass typically has approximately two weeks of food reserves onsite. Food reserves may be a valuable resource in the event of an emergency. The university is also comprised of thirteen primary buildings constructed of reinforced concrete. Buildings should be capable of withstanding all but the most severe natural disasters, and could be used to house community members if necessary. No formal agreement exists presently for this type of mutual aid.

7.12 Existing Disaster Mitigation Measures Matrix

The matrix below outlines the following information for each existing disaster mitigation measure:

- Existing Protection Measure;
- Description;
- Implementing Department or Agency;
- Staffing;
- Existing Funding;
- Effective Area covered;
- Applicable Hazards;
- Effectiveness; and
- Improvements or Changes Needed.

"Staffing" and "Existing Funding" columns also indicate whether or not existing levels are adequate or not, depicted under the "(Adequate?)" description in parentheses by "(Yes)" or "(No)" for Town items, or "(Unknown)" for agencies outside Town regulation such as State and Federal agencies. Town-controlled items not identified as adequately staffed and/or funded by a "(Yes)" have additional information provided under the "Improvement or Changes Needed" column.

Finally, the "Improvement or Changes Needed" column also indicates whether any additional funding sources are needed, depicted under the "(Funding Sources)" description in parentheses. Items not in need of additional funding sources are shown as "(N/A)", or Not Applicable, generally because no changes are needed at this time and existing funding sources are adequate. Should additional funding be required, potential sources are outlined in parentheses under the "Improvement or Changed Needed" column, such as "(Town general fund and operating budgets)".

Table 7.2 – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Implementing Department or Agency	Staffing (Adequate?)	Existing Funding (Adequate?)	Effective Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed (Funding Source)
Emergency Management Agency	Agency in charge of coordinating response efforts between agencies during an emergency	Emergency Management Agency	Director of Emergency Management Agency, Staff (Yes)	Town general fund and operating budgets (Yes)	Entire town	All hazards	Effective to date	No changes needed at this time (N/A)
Emergency Management Plans	Comprehensive Emergency Management Plan to document preparing for, and procedures to be taken during, an emergency	Emergency Management Agency	Director of Emergency Management Agency, Staff (Yes)	Town general fund and operating budgets (Yes)	Entire town	All hazards	Effective to date	No changes needed at this time (N/A)
	Hazardous Materials Emergency Plan outlining actions to be taken in the event of an incident involving hazardous materials	Emergency Management Agency			Entire town, primarily the transportation network	Geologic hazards		
Federal and State Regulations	Regulations and agencies designed to protect infrastructure, the environment, and public safety.	EPA, ACoE, FEMA, MassDEP, DFS, DPS, etc.	Agency Staff (Unknown)	State and Federal taxes (Yes)	Entire town	All hazards	Effective	No changes needed at this time
Local Regulations and Bylaws – General	Bylaws / Regulations designed to…							
Article 66 – Wetlands	Protect wetlands and other sensitive water resource areas by controlling or prohibiting alterations that could affect the environment	Dartmouth Conservation Commission	Conservation Commission Members (Yes)	Town general fund and operating budgets (Yes)	Resource areas and areas within regulated buffer zones	Riverine flooding, erosion, thunderstorms, flooding from storm runoff	Effective	No changes needed at this time (N/A)
Article 67 – Earth and Soil Removal	Require permits for removing earth, particularly for areas subject to erosion and close to groundwater. Also prohibits redirecting runoff onto abutters property	Dartmouth Conservation Commission, Planning Board, and Soil Conservation Board	Conservation Commission Members, Planning Board Members Soil Conservation Board Members (Yes)	Town general fund and operating budgets (Yes)	Entire town	Erosion, thunderstorms, hurricanes, flooding from storm runoff, landslides	Effective	No changes needed at this time (N/A)
Article 91 – Water Use Restrictions	Enforce water conservation by regulating outdoor watering to ensure adequate supply during water supply emergencies	Dept. of Public Works, Fire Dept.	DPW Personnel, Fire Department Personnel (Yes)	Town general fund and operating budgets (Yes)	Households connected to the Town water supply	Drought, wildfires, urban fires	Effective	No changes needed at this time (N/A)
Article 104 – Waterways Management	Require mooring registrations and prohibiting sewerage discharge into the harbor	Dartmouth Harbormaster	Harbormaster and Personnel (Yes)	Town general fund and operating budgets (Yes)	Padanaram Harbor	Coastal flooding, coastal storms or nor'easters, hurricanes	Effective	No changes needed at this time (N/A)

Table 7.3 (continued) – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Implementing Department or Agency	Staffing (Adequate?)	Existing Funding (Adequate?)	Effective Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed (Funding Source)
Local Regulations and Bylaws – Zoning	Bylaws / Regulations designed to…							
Section 18 – Waterfront Overlay District	Regulate development along the waterfront, promote access, and protect the harbor	Dartmouth Planning Board	Planning Board Members (Yes)	Town general fund and operating budgets (Yes)	Waterfront overlay district (areas along the waterfront)	Coastal flooding, coastal storms or nor'easters, hurricanes	Effective	No changes needed at this time (N/A)
Section 19 – Floodplain District	Protect public safety, reduce damage, and lower cleanup costs in areas subject to flooding during hurricanes by regulating development and requiring permits	Dartmouth Planning Board, Dept. of Public Works	Planning Board Members and DPW Staff (Yes)	Town general fund and operating budgets (Yes)	Flood prone land overlay district (SLOSH zones)	Flood-related hazards	Effective	No changes needed at this time (N/A)
Section 20 – Aquifer Protection District	Protect groundwater supplies from contamination by limiting uses involving hazardous materials near public wells. Also promotes rooftop runoff infiltration.	Dartmouth Planning Board,	Planning Board Members (Yes)	Town general fund and operating budgets (Yes)	400' radius around public wells, recharge areas to public wells	Drought, flooding from storm runoff	Effective	No changes needed at this time (N/A)
Subdivision Regulations	Bylaw to preserve environmental areas by regulating stormwater discharges. Stormwater systems must be designed to permit safe travel, minimize flooding, and not cause adverse impacts to property.	Dartmouth Conservation Commission	Conservation Commission Members (Yes)	Town general fund and operating budgets (Yes)	Subdivisions	Erosion, flooding from storm runoff	Effective	No changes needed at this time (N/A)
	Utilities must be buried within public right-of-ways.	Dartmouth Planning Board	Planning Board Members (Yes)			All hazards		
Wetland Protection Bylaw Regulations	Regulations governing new construction to ensure proper drainage system sizing, stormwater treatment, peak flow accommodation, groundwater protection, and wetland protection.	Dartmouth Conservation Commission	Conservation Commission Members (Yes)	Town general fund and operating budgets (Yes)	Resource areas and areas within regulated buffer zones	Riverine flooding, erosion, thunderstorms, flooding from storm runoff	Effective	No changes needed at this time (N/A)
Backup Power Supplies	Emergency generators to maintain water and sewer service in the event of a power outage. Emergency generators also available for other critical facilities and centers of operations. These facilities can be used for emergency shelters if necessary.	Dartmouth Dept. Of Public Works	DPW Director and Personnel (Yes)	Town general fund and operating budgets (Yes)	Select water and most sewer infrastructure	All hazards	Effective	Continue use and testing of backup power supplies. Amend bylaws to require installation at assisted living facilities (Town general fund and operating budgets)

Table 7.4 (continued) – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Implementing Department or Agency	Staffing (Adequate?)	Existing Funding (Adequate?)	Effective Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed (Funding Source)
Emergency Shelters and Mutual Aid	Emergency shelters provided for use during a natural disaster. Primary shelter: Council on Aging. Alternate: Dartmouth High School.	Dartmouth Emergency Management Agency	Director of Emergency Management Agency, Staff (Yes)	Town general fund and operating budgets (Yes)	Entire town	All hazards	Effective to date	See Section 7.0, Planned Disaster Mitigation Measures (Town general fund and operating budgets)
	Informal mutual aid agreements with neighboring towns.	Dartmouth Emergency Management Agency					Not used to date	Implement formal mutual aid agreements with neighboring towns (Town general fund and operating budgets)
Preventative Measures	Maintenance on drainage structures and other measures to prevent flooding.	Dartmouth Dept. of Public Works	DPW Director and Personnel (Yes)	Town general fund and operating budgets (Yes)	Entire town	Flood and wind-related hazards	Effective to date	No changes needed at this time (N/A)
	Pre-closing roadways, Padanaram Causeway or other areas subject to flooding when imminent.	Dartmouth Police Department, Dept. of Public Works	Police Chief and Personnel, DPW Director and Personnel (Yes)				Effective to date	No changes needed at this time (N/A)
	Tree trimming to reduce power outages.	Dartmouth Dept. of Parks and Recreation, NSTAR	Parks and Recreation Personnel, NSTAR (Yes for Dartmouth, unknown for NSTAR)				Somewhat effective	Continue to trim trees in problem areas to reduce power outages (Town general fund and operating budgets)
Structural Upgrades	Structural culvert upgrades at Milton and Sharp streets to alleviate flooding of Buttonwood Brook.	Dartmouth Dept. of Public Works	DPW Director and Personnel (Yes)	Town general fund and operating budgets, FEMA funding (No)	Culverts below roadways and town infrastructure	Riverine flooding, dam failures, thunderstorms, hurricanes, flooding from storm runoff	Effective to date	Monitor locations for flooding, particularly after further upgrades along Buttonwood Brook (Town general fund and operating budgets)
	Other culverts along the brook, such as Hawthorn and Allen streets continue to flood.						Unknown	See Section 7.0, Planned Disaster Mitigation Measures (Town general fund and operating budgets)
Public Outreach	Measures to provide information to the public during an emergency. Methods include two cable television (DCTV) channels, and message board.	DCTV, Dartmouth Police Dept., Fire Dept., Dept. of Public Works Dartmouth Computer Services, DCTV	Department Staff (Yes)	Town general fund and operating budgets (Yes)	Entire town	All hazards	Effective to date	See Section 7.0, Planned Disaster Mitigation Measures (Town general fund and operating budgets)
	Electronic methods include town website, E-News updates, and social media.						Effective to date	See Section 7.0, Planned Disaster Mitigation Measures (Town general fund and operating budgets)

Table 7.5 (continued) – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Implementing Department or Agency	Staffing (Adequate?)	Existing Funding (Adequate?)	Effective Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed (Funding Source)
National Flood Insurance Program	Dartmouth is enrolled in FEMA's NFIP, which in part identifies floodplain areas, manages floodplains, and requires flood insurance by affected residents.	Dartmouth Planning Department	Planning Board Members (Yes)	Town general fund and operating budgets, FEMA funding assistance (Yes)	Areas identified in FEMA FIRMs	Flood-related hazards	Effective	Update FEMA maps, record applicable structural elevations within flood-prone areas, establish mutual aid agreements (Town general fund and operating budgets, FEMA funding assistance)
UMass-Dartmouth	UMass provides an Emergency Guide to students and staff outlining procedures during an emergency. UMass also provides two emergency evacuation exits from campus.	UMass-Dartmouth	University Personnel (Unknown)	Funding by UMass-Dartmouth (Unknown)	UMass-Dartmouth	All hazards	Effective May not be effective if impassable	Hire an Emergency Management Coordinator Measures (funding by UMass-Dartmouth) See Section 7.0, Planned Disaster Mitigation Measures (funding by UMass-Dartmouth)

8.0 PLANNED DISASTER MITIGATION MEASURES

Although the Town has implemented a number of existing hazard mitigation measures as discussed in Section 7.0, additional measures should be considered to protect Town infrastructure in the event of a disaster.

8.1 Goal Statements

During Local Planning Team meetings, responsible personnel discussed existing areas of hazard protection as discussed in Section 7.0 that require expansion and/or improvement to better protect the Town of Dartmouth. The team then developed goals and objectives to reduce impacts and losses due to hazards associated with natural disasters. The team agreed that the primary goal is as follows, consistent with the 2004 SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan:

- Reduce the loss of life, property, infrastructure, and cultural resources from natural disasters.

In addition, the following objectives were established by the Local Planning Team to minimize the impacts of natural disasters on residents, businesses and infrastructure:

- Reduce or eliminate preventable damage to buildings and infrastructure;
- Identify and prioritize structural mitigation projects based in part on feasibility and cost effectiveness;
- Maintain adequate access to public utilities such as electricity, drinking water, and communications during and after a natural disaster;
- Maintain an adequate Level of Service (LOS) on all roadways during and after natural disasters, particularly on major roadways;
- Maintain communication between private citizens, businesses, utility companies, and town, regional, state, and federal agencies before, during and after a natural disaster;
- Provide residents adequate protection during natural disaster events;
- Improve public education to inform residents in advance of a disaster on what may happen, particularly regarding rare natural disasters such as hurricanes;
- Incorporate disaster mitigation actions into local plans, regulations and structural improvement projects;
- Identify funding sources to implement mitigation items; and
- Make improvements to existing practices based on experience gained during disaster response and recovery.

8.2 Planning Process

In order to identify, evaluate and prioritize specific mitigation actions and projects to reduce the effects of a natural disaster, the LPT used the STAPLEE method as developed by FEMA as follows and as provided in **Appendix E**:

- **S**ocial – Determine if measures are acceptable to the public and nearby community;
- **T**echnical – Evaluate whether measures are technically feasible;
- **A**dministrative – Review staffing, funding and maintenance needs for implementation;
- **P**olitical – Evaluate local and state political support for the measure;
- **L**egal – Determine if local, state or federal laws allow for implementation;

- **E**conomic – Ensure the local community budget can support project implementation; and
- **E**nvironmental – Ensure the local environment is protected at all times.

8.3 SRPEDD Proposed Mitigation Actions

The 2004 SRPEDD Plan outlined a number of proposed mitigation actions identified during the planning process conducted prior to the release of the 2004 plan. It is important to note that this was a regional plan prepared over 10 years ago targeting the entire area, and few mitigation actions are specific to Dartmouth. As the plan is over 10 years old and no updates have occurred, many of the mitigation measures have either been enacted or are out of date. The schedule also no longer applies. However, the following table outlines items that were identified in the plan as the responsibility of "Local Communities" and progress made since plan release.

Table 8.1 – 2004 SRPEDD Plan Mitigation Actions

Action	2004 Timeline	2004 Needed Resources	2015 Plan Update Progress
Objective 3: Identify implementing body and pursue funding that builds local capacity and supports grant-writing for the mitigation actions identified in the regional and local PDM plans.			
Consider use of SRPEDD municipal assistance hours for technical assistance	Ongoing	Part of annual budget – 40 hours total per community per year.	Dartmouth has not utilized municipal assistance hours to date, however, this is a potential resource for implementing mitigation planning measures to date.
Objective 4: Increase communication/coordination between federal, state, regional, county, municipal, private, and non-profit agencies in the area of pre-disaster mitigation. In particular, coordinate planning around prisons, colleges, and large employers.			
Develop or use existing town websites.	Ongoing	May need funding or use student labor.	Dartmouth utilizes its website for this purpose as outlined in Section 7.9. Additional proposed coordination with UMass and the Bristol County Sheriff's Office is outlined under Proposed Mitigation Action #18.
Objective 5: Maintain and enhance working relationships with the utilities including the annual meetings with emergency personnel, and satellite spaces within each community for temporary emergency headquarters.			
This exists – local communities need to maintain this relationship.	Ongoing	No funds needed, space exists.	Dartmouth currently has working relationships with all utilities in the community as outlined throughout this Plan. No further updates required.

Table 8.1 (continued) – 2004 SRPEDD Plan Mitigation Actions

Action	2004 Timeline	2004 Needed Resources	2015 Plan Update Progress
Objective 6: Improve hazard warning systems and notification to vulnerable populations.			
Coordinate this action with Homeland Security planning and implementation actions. Review Cable capabilities.	2005	Homeland Security funding may be available to address this concern.	Dartmouth has implemented improved hazard warning systems since preparation of the 2004 Plan as outlined in Section 7.9. Through the Dartmouth Emergency Management Agency, activities have been coordinated through the Massachusetts Civil Defense Department and Department of Homeland Security.
Share ideas on successful ways of tracking vulnerable populations through SRPEDD/DCR/MEMA newsletters such as Visiting nurses, self-identify card with tax bill, or COA coordination.	Ongoing	Plugs into existing program	Improvements to inter-departmental communication are ongoing, consistent with the timeline/timeframe provided by the 2004 Plan. No further updates required.
Objective 7: Combat complacency and foster appropriate individual responsibility for mitigating disaster impacts by educating all parts of the community including: school children, elderly, employers, school administrators, and municipal employees.			
Use all existing websites – town and SRPEDD.	Ongoing	Uses existing channels.	Dartmouth utilizes its website for this purpose as outlined in Section 7.9. No further updates required.
Display pre-disaster mitigation plan mapping series at local libraries and at major regional events.	2005	May need small stipend to complete, possible PDM project.	Upon completion of this 2015 updated plan, updated maps will be made available at various public venues, as well as on the website for download as outlined in Section 10.4.
Objective 8: Promote use of full range of federal and state resources related to disaster mitigation such as educational materials, training, and National Weather Service forecasts.			
Set a goal of 5 communities certified as "Storm Ready" by 2010. (Right now Taunton is only community certified.)	2004-2010	Interest and commitment	Carver and Mansfield are currently certified as "Storm Ready". Dartmouth could pursue certification as a "Storm Ready" community if Town personnel desire at a later date.

Table 8.1 (continued) – 2004 SRPEDD Plan Mitigation Actions

Action	2004 Timeline	2004 Needed Resources	2015 Plan Update Progress
Objective 10: Find funding to review and update the regional and local disaster mitigation plans on a five year cycle.			
Fund staff time to convene process and review and update plan.	Future	Funding will be needed to complete this work.	Once adopted, this Hazard Mitigation Plan will be updated every five years as outlined under Section 10.0. Funding will come from general departmental operating budgets.
Objective 11: Incorporate disaster mitigation actions into appropriate local and regional plans – Master Plan, Open Space Plan, Transportation Plan, and Capital Programming.			
SRPEDD educate communities as they update all of these plans; local representatives also indicate a need for this. Annexes should identify connections.	Ongoing	Done within other planning process funded with local or state funds as available.	Section 10.2 outlines measures to incorporate future disaster mitigation actions. Additionally, several disaster mitigation actions have already been included in existing planning mechanisms as outlined in Section 10.3.
Objective 12: Integrate disaster mitigation concerns into transportation projects (e.g. drainage improvements, underground utilities, etc.).			
SRPEDD and local representatives need to speak about these concerns during project development.	Ongoing	Coordination with project planning processes.	A number of proposed transportation and drainage structural improvements are proposed as detailed under Proposed Mitigation Action #'s 9 through 15.
Objective 14: Identify PDM actions that are consistent with the objectives of other interest groups, and reach out to collaborate on achieving these initiatives. (For example conservation or environmental groups that support wetlands protection, river corridor acquisition, or reducing runoff.)			
Local representatives must identify these common goals especially through the Open Space or Master Plan planning process	Ongoing	Staff time and interest.	All planning documents solicit input from the public and public interest groups. Groups include the Dartmouth Natural Resources Trust, Buzzards Bay Coalition, Westport River Watershed Alliance, etc. Common goals and projects are identified during the planning process and incorporated into the final product.
Objective 20: Ensure that each community has a Unified Incident Command program in place, with special attention to communities that have federal, state, or county facilities within their borders.			
Support efforts to get training funds and to integrate this training in other programs	Ongoing	Funding for training is needed.	Dartmouth's Unified Incident Command program is through its Emergency Management Agency. No further updates required.

8.4 Dartmouth Proposed Mitigation Actions

Proposed mitigation actions developed during the LPT planning process have been divided into the following categories:

- Planning and Prevention – Regulatory modifications to bylaws and regulations to prevent damage and preserve or restore natural resources;
- Public Safety – Improvements to protect residents and property during a disaster;
- Property Protection – Modifications or removal of infrastructure to protect from a hazard;
- Structural Projects – Construction projects to reduce hazard impacts; and
- Communications and Awareness – Actions to better communicate information before and during a disaster.

Planning and Prevention

The following proposed disaster mitigation measures should be explored in an effort to preserve natural resources for added environmental protection.

- Action Item 1 – Petition FEMA to Update FIRMs

  Existing FEMA FIRMs have some inaccuracies concerning certain areas of the town. In particular, there are areas of town not shown as subject to flooding when in actuality, areas could be subject to periodic inundation during major storms. As these properties are not shown on FIRMs, they are not regulated by the NFIP regulations and flood insurance requirements.

  Furthermore, affected residents may not be aware that their property is located in areas where flooding is possible. Conversely, some properties are shown on flood maps and thus required to purchase flood insurance when these locations have never experienced any flooding, even during the largest storms. Dartmouth should inventory areas based on the severity of the problem and work with FEMA to complete letter of map revisions (LOMRs) to ensure all affected properties have flood insurance. Updated FIRMs should be incorporated into the Town's Floodplain District.

Public Safety

The following proposed disaster mitigation measures should be explored in an effort to preserve public safety in the event of a natural hazard event.

- Action Item 2 – Establish an additional Emergency Shelter in North Dartmouth

  The Council on Aging (Senior Center), located at 628 Dartmouth Street is unofficially located in South Dartmouth. Due to its reasonably far distance from areas in North Dartmouth (about 10 minutes if driving) and reluctance of the elderly population to cross busy roadways such as Route 6, many elderly residents of North Dartmouth will not travel to the Senior Center.

  The Council on Aging may wish to consider providing an alternative location within North Dartmouth to house the elderly population on a temporary basis. Options include opening a secondary full-time senior center, or utilizing an alternative shelter location during emergencies, such as the Autumn Glen (Heritage at Dartmouth) assisted living

community or the North Dartmouth Library, once the campus relocation is complete. Note that relocation would be short duration, likely less than 2 days, until affected residents could be relocated to the main emergency shelter at the Council on Aging building. All Emergency Shelter locations should be incorporated into the Town's Emergency Response Plan.

- Action Item 3 – Establish an additional Emergency Shelter near Smith Neck Road
  In the event of a hurricane, SLOSH maps indicate that the area along Smith Neck Road has the potential to become isolated from the rest of Dartmouth. Access is limited to three roads (Gulf Road, Rock O'Dundee Road, and Little River Road), all of which are subject to flooding. Should roads become impassible, residents will be unable to access both the primary or alternate emergency shelter.

  Dartmouth should look into establishing a second emergency shelter in this area. It is recommended that the Town coordinate this potential use with the Smith Neck Church or Nonquitt Casino, as both facilities are located within the affected area but outside flood-prone areas. As with Action Item 2, relocation would be short duration until affected residents could be relocated to the main emergency shelter. All Emergency Shelter locations should be incorporated into the Town's Emergency Response Plan.

- Action Item 4 – Establish Evacuation Routes and Procedures
  Fortunately, Dartmouth has never needed to perform a large-scale evacuation of the town. However, should one ever be required, Town officials should document procedures and routes to provide the most efficient routes possible. Considerations should be given to:
  - Procedures for voluntary and mandatory evacuations for different areas of town;
  - Potential duration of an evacuation;
  - How best to disseminate public information concerning evacuations;
  - Role of emergency personnel, particularly police, to facilitate a smooth process;
  - Areas most likely in need of evacuation, such as those located in coastal areas or areas prone to isolation;
  - Staggering different areas of town for evacuation to cut down on peak flows;
  - Control of traffic at critical roadways and intersections;
  - Providing alternate transportation such as busses for those otherwise unable to leave affected areas; and
  - Periodic updates.

  Special considerations should also be given to elderly populations, those with special medical needs, people with disabilities, etc. to ensure all people can evacuate safely. Evacuation procedures should be incorporated into the Emergency Response Plan.

- Action Item 5 – Ensure Evacuation Routes provide Adequate Traffic Flow
  Town personnel have indicated that Route 6 and the intersection of Old Fall River Road and Faunce Corner Road are bottlenecks during evacuation efforts. Route 6 is a main east-west road, serving as a collection point for many local roadways. Extensive traffic lights and commercial development exacerbate traffic flow problems along this roadway.

The intersection of Old Fall River Road and Faunce Corner Road is currently a four-way intersection with no signaling devices, potentially restricting traffic flow during high capacity events. The Dartmouth DPW, Police Department, and Fire Department should look into improving traffic flow in these areas during emergencies, particularly during evacuations. Potential solutions may involve upgrading to a signalized intersection, or using a police detail during emergency situations to improve traffic flow.

It is assumed that a major evacuation would most likely be triggered by a hurricane, and thus most affected people will be traveling from the southern coastal areas to the northern major roadways. People will likely be funneling towards Route 6, Route 140 and Interstate 195 to travel north, west or east. It is possible that major roads with multiple lanes such as Routes 6 and 140 could be temporarily reconfigured with traffic cones or barrels to provide contraflow, so as to favor traffic flow away from Dartmouth.

Property Protection

The following proposed disaster mitigation measures should be explored to preserve and protect existing property and infrastructure in the event of a natural hazard event.

- Action Item 6 – Address Recommendations on the Russells Mills Dam
  A report addressing the Russells Mills Dam, a Significant Hazard dam located on Rock O'Dundee Road was recently completed to outline recommendations observed during a September 30, 2012 inspection. Proposed structural improvements include the installation of guardrail along the culvert headwall, repair of corroded areas within the roadway culvert, limited roadway repairs, maintenance on the auxiliary stone masonry walls, and general maintenance such as brush cutting, sediment removal, and slope stabilization. Design and permitting for the above items has been completed, and construction is currently scheduled for late spring with work taking place this summer.

- Action Item 7 – Provide Flood Protection at Critical Wastewater Pump Stations
  The DPW is in the process of evaluating the Clarence, Faunce Corner, North and South wastewater pump stations for potential improvement due to their locations in low-lying areas. During the planning process, members of CEI and the DPW visited the above sites to look for potential retrofit opportunities. Both North Station and Faunce Corner Station are located in low-lying areas close to the river, and appear to be located within the 100 year flood plain. Stations are fed by a number of smaller pump stations, and thus it is imperative that each remain functional at all times.

  To reduce the possibility of inundation, it is possible that a berm could be constructed around each facility capable of creating an "island" to keep the facility dry during flood events. All pump stations could benefit from increased waterproofing, such as watertight doors, barriers to reduce water intrusion around ventilation louvers, and sump pumps capable of handling water intrusion. Options to prevent flooding and inundation of these stations during a hazard event should be explored further to maintain full-time operation.

  Action Item 8 – Address Police Station Property
  The Police Station is currently located just outside areas subject to flooding (100-year

storm event), including areas subject to inundation during a hurricane as indicated on the SLOSH maps. Although shown just outside these areas, a rare storm could potentially inundate this area, compromising this facility's operations during a disaster. Additionally, police department operations are currently relocated to temporary trailers located in the rear parking lot, just outside the walk-out basement at a lower elevation due to mold issues in the main building. Due to the lower elevation, these current police operations could be adversely impacted during a disaster. A special committee is currently reviewing this property and whether to rehabilitate the facility or move to a different location. Facility operation during a natural disaster will be one component impacting the decision to move or keep the police at this facility.

Structural Projects

The following structural projects are proposed as a way to alleviate potential flooding damage to buildings and infrastructure within Dartmouth.

- Action Item 9 – Make Infrastructure Improvements along Buttonwoods Brook
  Dartmouth is currently exploring ways to improve the flow of Buttonwoods Brook, particularly at Hawthorn Street and Allen Street as these two locations are particularly prone to flooding. Potential improvements involve raising portions of the roadway and/or enlarging culverts to facilitate better stream passage.

  It is possible that downstream infrastructure improvements may be required before upstream locations (for instance, improve Allen Street before Hawthorn Street) to alleviate possible downstream choke points. Additional study must be done in these locations to examine feasible ways of improving river flow and reducing the flooding potential

- Action Item 10 – Alleviate Flooding at Eddy Street
  The Town is currently proposing to realign Tucker Road in the vicinity of Eddy Street to alleviate periodic flooding at the North Dartmouth Library. During the realignment process, culverts handling flow of a tributary to the Paskamanset River will be enlarged to allow additional flow and reduce flooding occurrences.

- Action Item 11 – Enlarge Culvert or Raise Old Fall River Road
  Flooding along Old Fall River Road may potentially be alleviated by raising the roadway and enlarging the culvert to provide additional flow capacity below the road. Elevating the roadway will also increase storage and impoundment capabilities upstream of the roadway, reducing the likelihood of flooding. Additional study must be done to examine feasible ways of improving river flow and reducing the flooding potential

- Action Item 11 – Improve Drainage under Padanaram Causeway
  The Town is currently pursuing funding via the Transportation Improvement Program (TIP) to install a culvert below Gulf Road in the vicinity of Padanaram Causeway. The culvert would be designed to allow the isolated area in the vicinity of Knowles Beach to drain into Apponagansett Bay rather than remaining stagnant and isolated. This area currently requires periodic excavation to maintain proper drainage.

- Action Item 12 – Improve Padanaram Bridge and Causeway Flow Capacity
  The creation of the Padanaram Bridge and causeway over and through Apponagansett Bay has restricted the upper bay's ability to effectively drain after a hurricane or storm surge event. The current design allows flow only under the Padanaram Bridge, or approximately one-third of the original harbor outlet while the rest is blocked by the causeway. During previous natural disasters, the inability to properly drain has delayed the reopening of Russells Mills Road due to flooding at the northern end of the harbor, a major road within the Town. Dartmouth should evaluate alternatives to improving flow from the upper bay area such as by adding one or more culverts or bridges to the existing causeway.

- Action Item 14 – Address UMass Drainage and Flooding Issues
  The University of Massachusetts is currently developing plans to improve drainage from impervious areas of the campus. Much of the runoff is discharged to a tributary to the Paskamanset River, occasionally causing flooding at Chase Road. Drainage improvements will likely focus on detaining runoff to reduce peak flows to downstream receptors and infiltrating runoff where possible. Dartmouth should cooperate with UMass to implement drainage improvements to maintain access to all roads.

- Action Item 15 – Address Additional Areas Prone to Periodic Flooding
  Additional retrofits may be necessary along State Road in the vicinity of the Target, BJ's Wholesale Club, and T.G.I. Friday's restaurant. This heavily developed and highly impervious area occasionally floods at a Paskamanset River tributary stream crossing.

Communications and Awareness

- Action Item 16 – Expand use of Social Media and Other Public Outreach Channels
  As mentioned previously, Dartmouth recently began the use of social media platforms as a means of communicating with residents during an emergency. The Town is looking to expand its social media services for use during an emergency as a way of reaching out to new and additional residents. DCTV is currently looking to expand to Twitter and other services easily accessible on mobile devices such as smart phones which are typically still usable during a power outage or other natural disaster. The Town will also look to continue expansion to its website, cable channel outreach, DCTV message board, and implement other means to reach out to the public. Outreach items will be tailored towards reducing risks and impacts to public safety infrastructure. Mitigation measures may focus on directing traffic away from impacted areas to maintain passage of emergency vehicles and/or repair equipment.

- Action Item 17 – Prepare and Formalize Mutual Aid Agreements
  Dartmouth and the surrounding communities should document and formalize mutual aid agreements to provide disaster mitigation support in the event of a disaster. Documentation should include, but not limited to:
  - Intercommunity and interagency communications procedures;
  - Emergency agency support (fire, police, medical, etc.), personnel and equipment;
  - Backup water supply interconnections;

- Heavy equipment available for debris clearing;
- Available portable emergency backup power sources and deployment;
- Preparation and training for personnel responsible for plan implementation; and
- Periodic plan updates.

➢ Action Item 18 – Improve Interdepartmental and Interagency Communications
Although recent disaster communication between town departments, outside agencies, and with the public has been acceptable, coordination and communication can always be improved. Town departments including the DPW, Police, Fire, and Emergency Response Agency should continually evaluate ways to improve communication and reduce impacts on critical infrastructure and utilities.

Particular consideration should be given to organizations outside the Town's direct control, such as:

- NSTAR – Expedite restoration of electricity to critical infrastructure as soon as possible, with the remainder of Dartmouth following;
- Bristol County Sheriff's Office – Inmates at the Bristol County House of Corrections may be used to fill sand bags for use in mitigating flooding impacts and/or help clear roadways before, during, or after an emergency; and
- UMass Dartmouth – Coordinate on the preparation of the campus evacuation plan, and other emergency preparedness plans, and ensure students are dismissed from the university early enough to prevent excessive roadway congestion to allow adequate transportation level of service during a disaster.

8.5 Proposed Disaster Mitigation Measures Matrix

The matrix below outlines the following information for proposed disaster mitigation measures:

Table 8.2 – Proposed Disaster Mitigation Measures Matrix

Proposed Protection Measure	Area Covered	Applicable Hazards
Action Item #1 – Petition FEMA to update FIRMs	Unmarked flood-prone areas	Flood-related hazards
Action Item #2 – Establish an additional Emergency Shelter in North Dartmouth	North Dartmouth	All hazards
Action Item #3 – Establish an additional Emergency Shelter near Smith Neck Road	Area around Smith Neck Road	All hazards, primarily coastal flooding
Action Item #4 – Establish Evacuation Procedures	Entire town, particularly coastal areas	Coastal flooding
Action Item #5 – Ensure Evacuation Routes provide Adequate Traffic Flow	Entire town, particularly coastal areas	Coastal flooding
Action Item #6 – Address Recommendations on the Russells Mills Dam	Area around the Russells Mills Dam	Riverine flooding
Action Item #7 – Provide Flood Protection at Critical Wastewater Pump Stations	Sewer pump stations	Flood-related hazards

Table 8.2 (continued) – Proposed Disaster Mitigation Measures Matrix

Proposed Protection Measure	Area Covered	Applicable Hazards
Action Item #8 – Address Police Station Property	Police Station Property, 249 Russells Mills Road	Coastal flooding, hurricanes
Action Item #9 – Make Infrastructure Improvements along Buttonwoods Brook	Stream cross-streets, mainly Hawthorn and Allen streets	Riverine flooding
Action Item #10 – Alleviate Flooding at Eddy Street	Area around Tucker Road and Eddy Street	Riverine flooding
Action Item #11 – Enlarge Culvert or Raise Old Fall River Road	Area around Old Fall River Road	Riverine flooding
Action Item #12 – Improve Drainage under Padanaram Causeway	Area around Padanaram Causeway and Gulf Road	Coastal flooding, hurricanes
Action Item #13 – Improve Padanaram Bridge and Causeway Flow Capacity	Area around Padanaram Bridge and causeway	Coastal flooding, hurricanes
Action Item #14 – Address UMass Drainage and Flooding Issues	UMass-Dartmouth and Lucy Little Road	Flooding from storm runoff
Action Item #15 – Address Additional Areas Prone to Periodic Flooding	Localized areas subject to flooding	Flood-related hazards
Action Item #16 – Expand use of Social Media and Other Public Outreach Channels	Entire town	All hazards
Action Item #17 – Prepare and Formalize Mutual Aid Agreements	Entire town	All hazards
Action Item #18 – Improve Interdepartmental and Interagency Communications	Entire town	All hazards

8.6 National Flood Insurance Program

As outlined earlier, Dartmouth participates in FEMA's NFIP. In order to maintain compliance with the NFIP requirements, FIRMs will be periodically updated as necessary to reflect the most up-to-date information possible concerning floodplain locations and flooding hazards. The Floodplain District as regulated under the zoning bylaws will also be updated as needed to reflect any changes in the floodplain and other vulnerable areas as a result of altered stormwater drainage, natural stream channel deviations, global warming, etc.

The Town will continue to evaluate and track flood damage to buildings and infrastructure in town, particularly for repetitive loss structures, to determine if any additional measures are required to reduce or prevent damage. Bylaws and/or regulations will also be updated as needed to improve flood protection.

8.7 Community Preservation Fund

As mentioned previously, Dartmouth has passed the Community Preservation Act, allowing the community to create a local Community Preservation Fund to preserve open space and historic

sites, create affordable housing, and develop outdoor recreational facilities. Therefore, local funding may be available for improvements under the historical provision of the locally controlled CPA fund.

8.8 Prioritization and Implementation of Mitigation Actions

Effective implementation of the proposed mitigation actions outlined in Section 8.3 is critical to minimizing damage from future natural hazards. Measures should be prioritized to make the best use out of limited resources as outlined in sections below. Implementation of mitigation actions will be directed and enforced by the appropriate agency and will take place over several years depending on a number of factors such as urgency, need, funding sources, etc.

To facilitate prioritization, proposed mitigation measures were first separated into those to be performed in-house by assorted Dartmouth agencies, and those requiring additional outside funding and planning. The LPT then reviewed each of the identified mitigation measures and prioritized improvements based in part on the STAPLEE criteria outlined in Section 8.2 and Appendix E.

In-House Mitigation Actions

Most of the following action items can be accomplished by the Town for little or no cost as part of ongoing improvements and updates to its existing measures, plans and procedures. Several structural projects already in progress are also listed below. Proposed protection measures have been loosely prioritized as high, moderate and low priority and include the following information:

- Priority grouping / ranking;
- Town department / board responsibility;
- Potential funding sources; and
- Estimated timeline to completion.

Many of these items may be mixed and matched, particularly if performed by different agencies. Prioritization is provided as a guideline only and timelines do not represent a definitive schedule.

Table 8.3 – Prioritization of In-House Mitigation Actions

Proposed Protection Measure	Responsibility	Implementation Timeframe
High Priority		
Action Item #1 – Petition FEMA to Update FIRMs	Department of Public Works, & Conservation Commission	By 2020
Action Item #8 – Address Police Station Property	Special Committee	By 2018
Action Item #10 – Alleviate Flooding at Eddy Street	Department of Public Works	By 2020
Action Item #12 – Improve Drainage under Padanaram Causeway	Department of Public Works	By 2020

Table 8.3 (continued) – Prioritization of In-House Mitigation Actions

Proposed Protection Measure	Responsibility	Implementation Timeframe
Moderate Priority		
Action Item #2 – Establish an additional Emergency Shelter in North Dartmouth	Emergency Management Agency	2016-2017
Action Item #3 – Establish an additional Emergency Shelter near Smith Neck Road	Emergency Management Agency, Council on Aging	2016-2017
Action Item #16 – Expand use of Social Media and Other Public Outreach Channels	Emergency Management Agency, DCTV	Continuous yearly updates, by 2020
Action Item #18 – Improve Interdepartmental and Interagency Communications	All departments and boards	Continuous improvements, by 2020
Low Priority		
Action Item #4 – Establish Evacuation Procedures	Emergency Management Agency	2016-2017
Action Item #5 – Ensure Evacuation Routes provide Adequate Traffic Flow	Department of Public Works, Emergency Mgmt. Agency	2017-2019
Action Item #6 – Address Recommendations on the Russells Mills Dam	Department of Public Works, Conservation Commission	By 2020
Action Item #17 – Prepare and Formalize Mutual Aid Agreements	Emergency Management Agency	2018-2020

Property and Structural Mitigation Actions

Many measures classified as Property Protection or Structural Projects require will require additional consideration and design. These items have been classified separately, as projects will likely be implemented one at a time following a more specific order. The following matrix provides the following information for proposed property and structural action items:

- Priority ranking;
- Proposed protection measure
- Town department / board responsibility;
- Estimated project cost;
- Potential funding sources; and
- Estimated timeline to completion

Project costs are approximate and assumed to represent a general range for a project of this type based on LPT and in-house knowledge. Timelines are provided as an estimate of project duration, including obtaining funding sources, design, permitting and construction.

Table 8.4 – Prioritization of Property and Structural Mitigation Actions

Priority Rank	Proposed Protection Measure	Responsibility	Project Cost[1]	Potential Funding	Timeframe
#1	**Action Item #9 –** Make Infrastructure Improvements along Buttonwoods Brook	Department of Public Works	$500,000	Local Funding & FEMA Grant	By 2019
#2	**Action Item #7 –** Provide Flood Protection at Critical Wastewater Pump Stations	Department of Public Works	$200,000	Local Funding & FEMA Grant	By 2017
#3	**Action Item #13 –** Improve Padanaram Bridge and Causeway Flow Capacity	Department of Public Works	$500,000	Local Funding & FEMA Grant	By 2020
#4	**Action Item #11 –** Enlarge Culvert or Raise Old Fall River Road	Department of Public Works	$250,000	Local Funding & FEMA Grant	By 2020
#5	**Action Item #14 –** Address UMass Drainage and Flooding Issues	UMass-Dartmouth, Department of Public Works	To be determined by UMass-Dartmouth	UMass; 319 Grant, Local Funding & FEMA Grant	By 2018
#6	**Action Item #15 –** Address Additional Areas Prone to Periodic Flooding	Department of Public Works	To be determined by Town of Dartmouth	Local Funding & FEMA Grant	Ongoing, high priority projects constructed by 2020

[1]Project cost is approximate, and is only intended to provide a scale of magnitude for estimating purposes.

9.0 PLAN ADOPTION

At the conclusion of planning efforts conducted by the Local Planning Team, the final Local Multi-Hazard Mitigation Plan was reviewed and informally approved by all applicable Town departments, boards, and other agencies identified as members of the LPT. The plan was endorsed by the Dartmouth Select Board, who intends on formally adopting the completed Plan after it has been reviewed and approved by the various regulatory agencies. The Plan was then sent to the State Hazard Mitigation Officer (SHMO) of the Massachusetts Department of Resource Conservation, the Massachusetts Emergency Management Agency (MEMA) and the FEMA for review and approval.

Upon receiving final approval from MEMA and FEMA, the Plan will undergo final review and local approval by the Dartmouth Select Board. Proof of final approval will be included in **Appendix F**. Following final adoption, the Plan will be implemented as outlined in Section 10.0.

10.0 PLAN MAINTENANCE PROCESS

As required by FEMA, this Plan must include a plan and maintenance process to ensure the plan remains active and relevant to the current conditions of the Town. The process must identify the following items:

- Plan Monitoring, Evaluation and Updates – Method and schedule for monitoring, evaluating and updating the plan at least once every five years;
- Incorporation of Mitigation Strategies – Explanation of how local governments will incorporate mitigation strategies into existing mechanisms; and
- Continued Public Involvement – Requirements that public participation continue throughout the plan maintenance process.

10.1 Plan Monitoring, Evaluation and Updates

As required by FEMA, the written plan will be evaluated and updated at least once every five years by the departments, boards, agencies and other organizations listed under the Local Planning Team. In the interim, select members of the LPT will conduct annual reviews to track implementation progress and update areas as necessary. Should a major disaster occur in the interim, the plan may be evaluated or updated if Town personnel feel that the plan failed in some way, or imminent changes are required to better respond to a disaster situation. As necessary, LPT member departments and/or organizations may be added or deleted to obtain the most accurate and applicable information possible.

Evaluations and updates will take place in much the same way as development of this original plan. The process will include meetings of the LPT, review of goals and objectives, updating community profile information, review and modification of potential hazards to the Town, review of existing hazard-prone areas and the addition of any new areas, updating existing and planned hazard mitigation measures, and an evaluation as to the effectiveness of the plan to date.

10.2 Incorporation of Future Mitigation Strategies

Mitigation strategies outlined in this Plan will be incorporated into existing mechanisms such as plans, bylaws and regulations as feasible. Existing planning mechanisms include:

- Plans:
  - Master Plan;
  - Capital Improvement Plan;
  - Open Space Plan; and
  - Emergency Management Plan.
- Bylaws and Regulations:
  - General (earth and soil removal, water use, waterways, etc.);
  - Zoning (waterfront district, floodplain district, etc.);
  - Subdivision Regulations;
  - DPW) Construction Specifications; and
  - Wetland Protection Bylaw Regulations.

Updates to the above planning mechanisms will occur as these documents themselves are periodically updated, unless a major change is required in the meantime as identified by applicable personnel. This Plan update will be distributed to all applicable Town departments

and boards to solicit potential input into planning mechanisms. Plan updates, including applicable mitigation measures, goals and objectives will be the responsibility of Town departments, boards, agencies and/or personnel in charge of implementation and enforcement.

10.3 Previous Incorporation of Future Mitigation Strategies

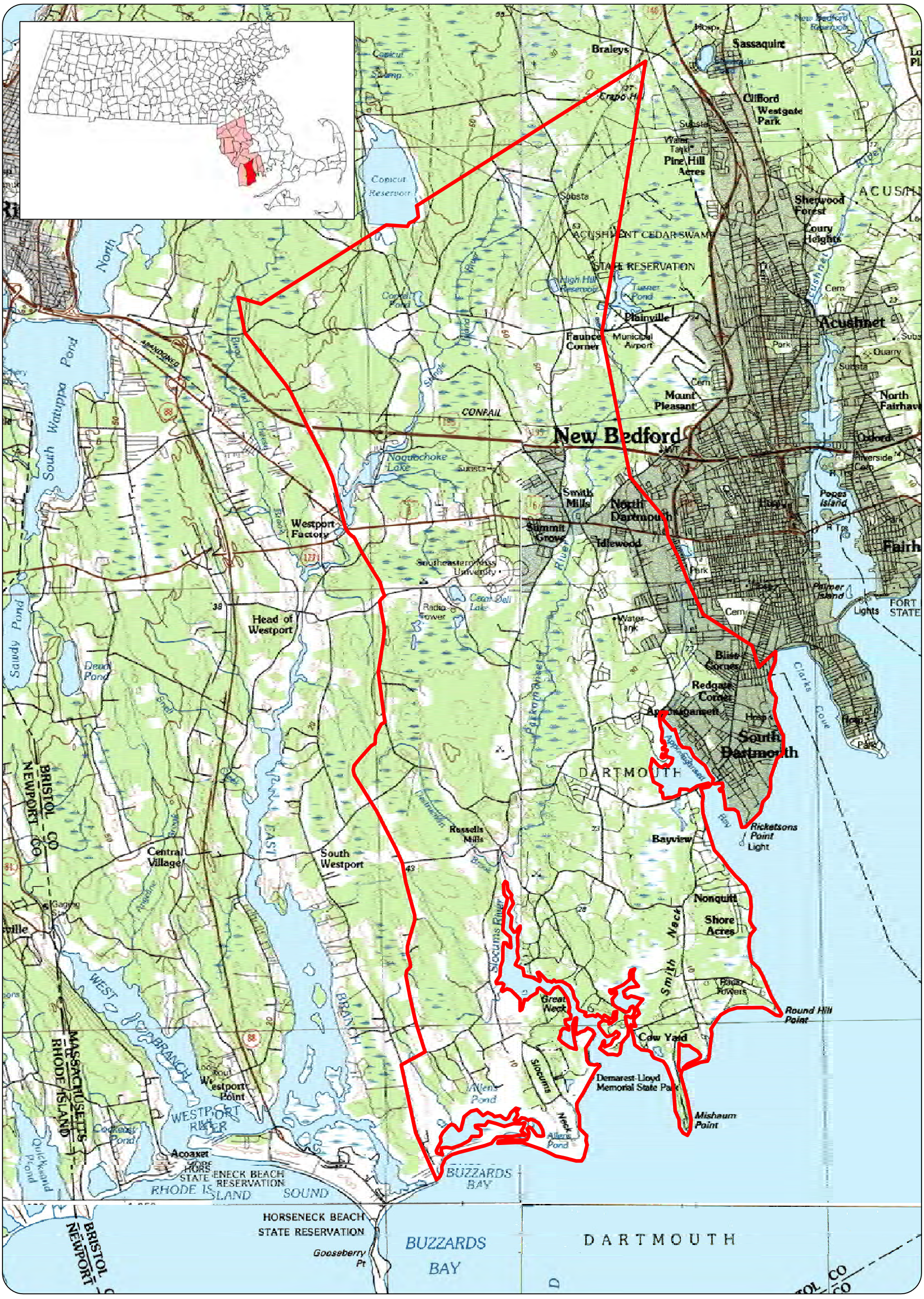
Since the preparation of the 2004 SRPEDD Plan, several items have been incorporated into local bylaws and regulations. These items were identified by Town personnel during routine updates and incorporated as needed:

- Floodplain District: mapping updated October 20, 2009
- Aquifer Protection: updated November 6, 2006.
- Waterfront Overlay District: updated November 6, 2006 and November 13, 2010.

Additionally, Dartmouth has implemented improved hazard warning systems since preparation of the 2004 Plan as outlined in Section 7.9. As further updates are made, this section will be updated.

10.4 Continued Public Involvement

During the periodic five year update process, the Local Planning Team will hold at least one public workshop or similar meeting to solicit feedback from the general public on the progress made to date. Concerned citizens will also be invited to make any additional recommendations for improving the Plan. All events will be publicly advertised in the local newspaper and/or similar method. Copies of the Plan will be provided in public places such as the Town Hall and/or Dartmouth Public Libraries. The Plan will also be made available to the general public via the Town's website for download.



SCALE

7,500 0 7,500 15,000

SCALE 1" = 7,500'

N W E S

FIGURE 1 - LOCUS MAP
TOWN OF DARTMOUTH

Town of Dartmouth
400 Slocum Road
Dartmouth, MA 02747

Figure 2 - Tier 1 Critical Infrastructure

Legend

Critical Infrastructure

- Emergency Response (Police, Fire, Ambulance)
- Water Supply Infrastructure
- Sewer Infrastructure
- Miscellaneous Emergency Response
- Hurricane Category Surge Inundation
- FEMA National Flood Hazard Layer

0 2,500 5,000 7,500 Feet

0 0.25 0.5 0.75 1 1.25 1.5 Miles

N W E S

FREETOWN
FALL RIVER
NEW BEDFORD
ACUSHNET
FAIRHAVEN
WESTPORT
Buzzards Bay
Clarks Cove
Apponagansett Bay
Copicut Reservoir
Noquochoke Lake
Cornell Pond
Cedar Dell Lake
Allens Pond
Slocumus River
Little River
Paskamanset River
Shingle Island River
Copicut River
Tucker Pond
Castaldi
Old Fall River Road Tank
Fire Station, District 3 Station 2
Hawthorn Medical Associates
Stat Ambulance Services
State Police Barracks
Grove Street Station
Deerfield Road Station
Lake Noquochoke Station
Reed Road Station
Lakewood Road Station
Woodcart Drive Station
Cross Road Tank
Elswick Street Station
Route 6 Station
Lincoln Park Pump Station
Response Ambulance Services
Fire Station, District 3 Headquarters
Dartmouth Medical Center
Eisenhower
Kingston
Faunce Corner Station
Fire Station, District 3 Station 3
Hawthorn Medical Associates (Urgent Care)
Sharon Avenue
Penelli 1 and 2 Wells
Water Treatment Facility
Junior Street Pump Station
Violetta 1, 2 and 3 Wells
North Station
Southcoast Brain and Spine Center
DPW Water & Sewer Division
Water Department Garage
Allen Street Elevated Tank and Standpipe
A, B, C, F-1, and F-2 Wells
Water Treatment Facility
Emergency Management Agency
Police Station
South Station
Clarence Station
Mosher Street Station
Fire Station, District 1
D, E-1 and E-2 Wells
Water Treatment Facility
Wastewater Treatment Facility
Lakeside Pump Station
DPW Transfer Station and Highway Yard
Fire Station, District 2
Gulf Road Pump Station
West Smith Neck
Smith Neck Road Tank

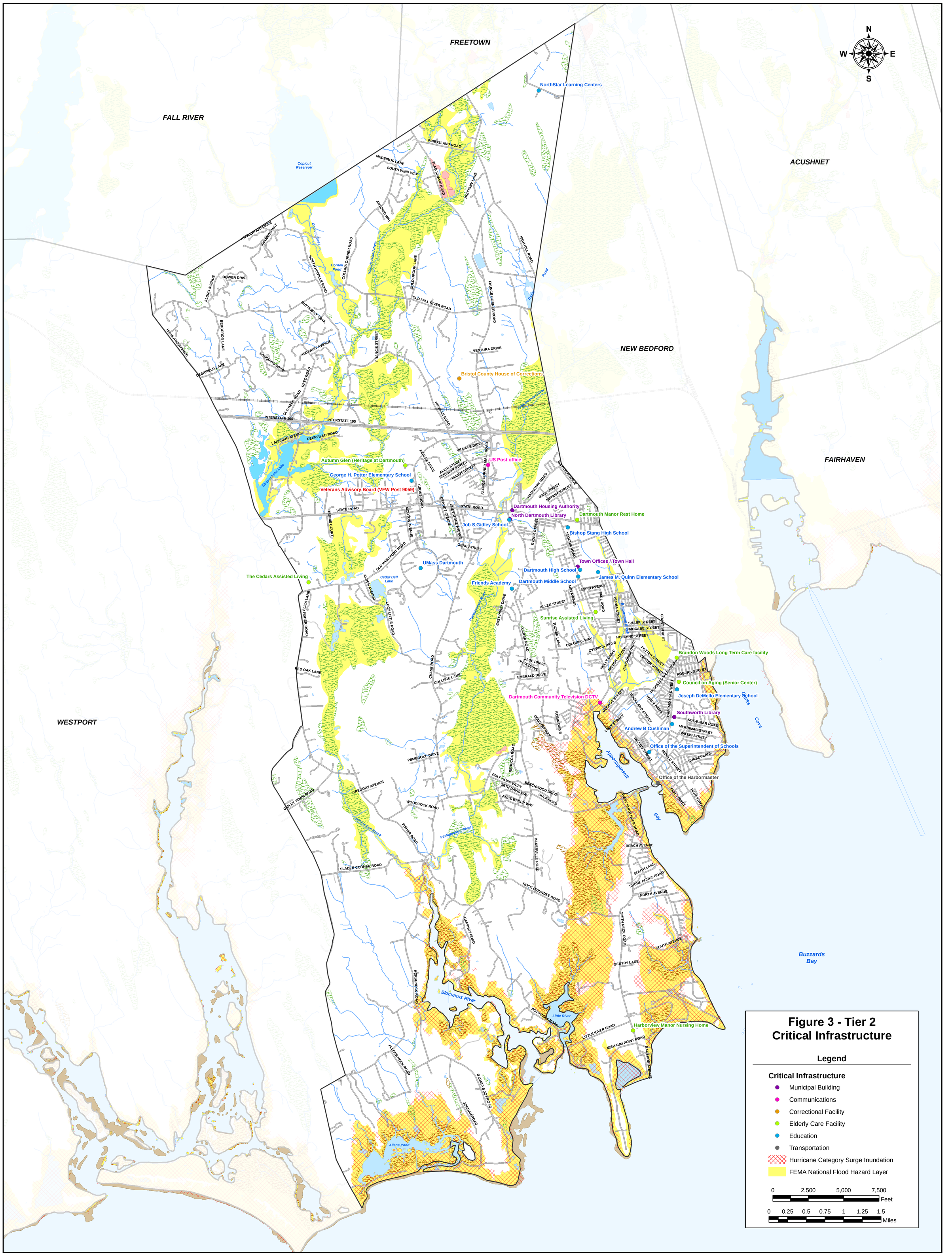


Figure 3 - Tier 2 Critical Infrastructure

Legend

Critical Infrastructure

- Municipal Building
- Communications
- Correctional Facility
- Elderly Care Facility
- Education
- Transportation
- Hurricane Category Surge Inundation
- FEMA National Flood Hazard Layer

0 2,500 5,000 7,500 Feet

0 0.25 0.5 0.75 1 1.25 1.5 Miles

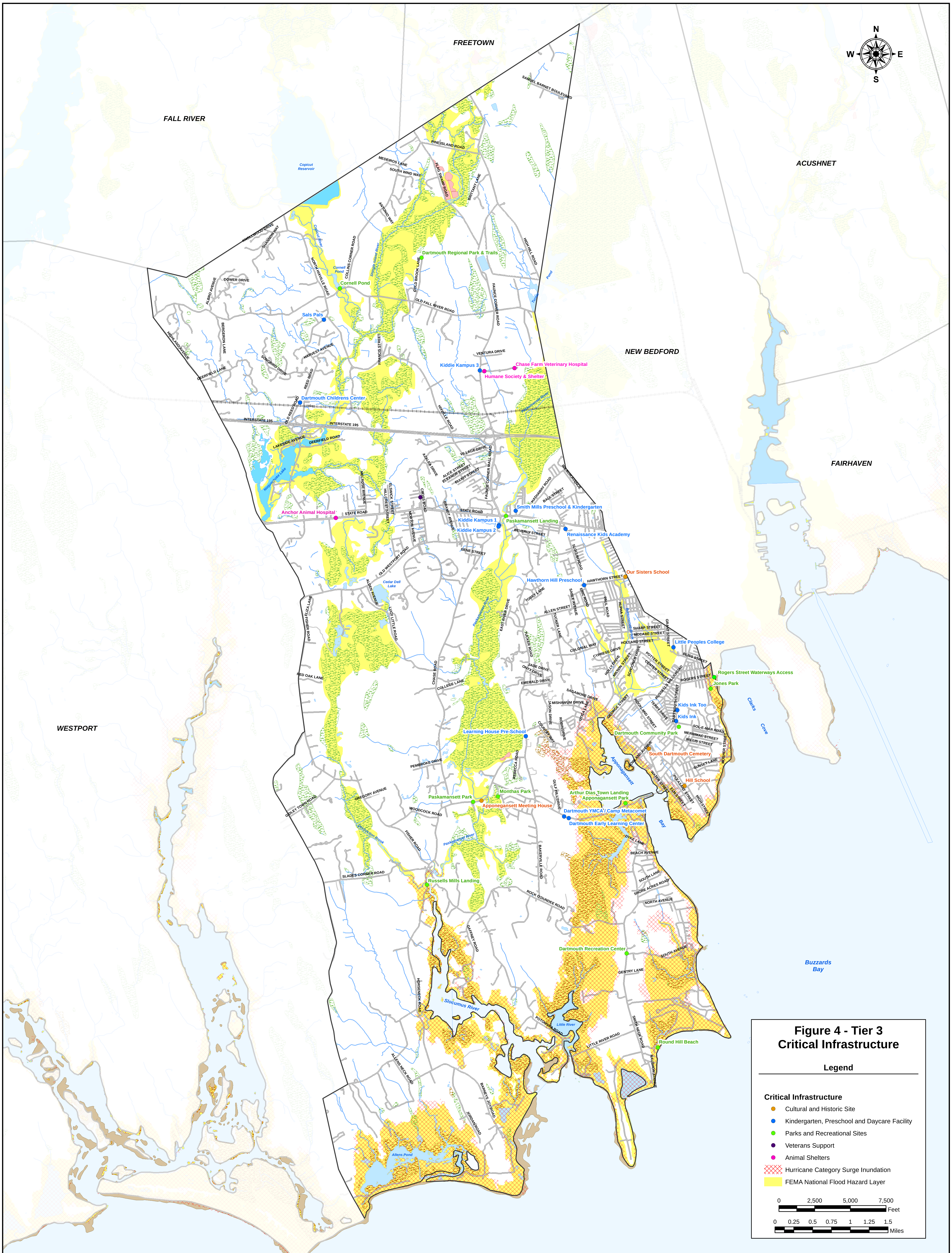
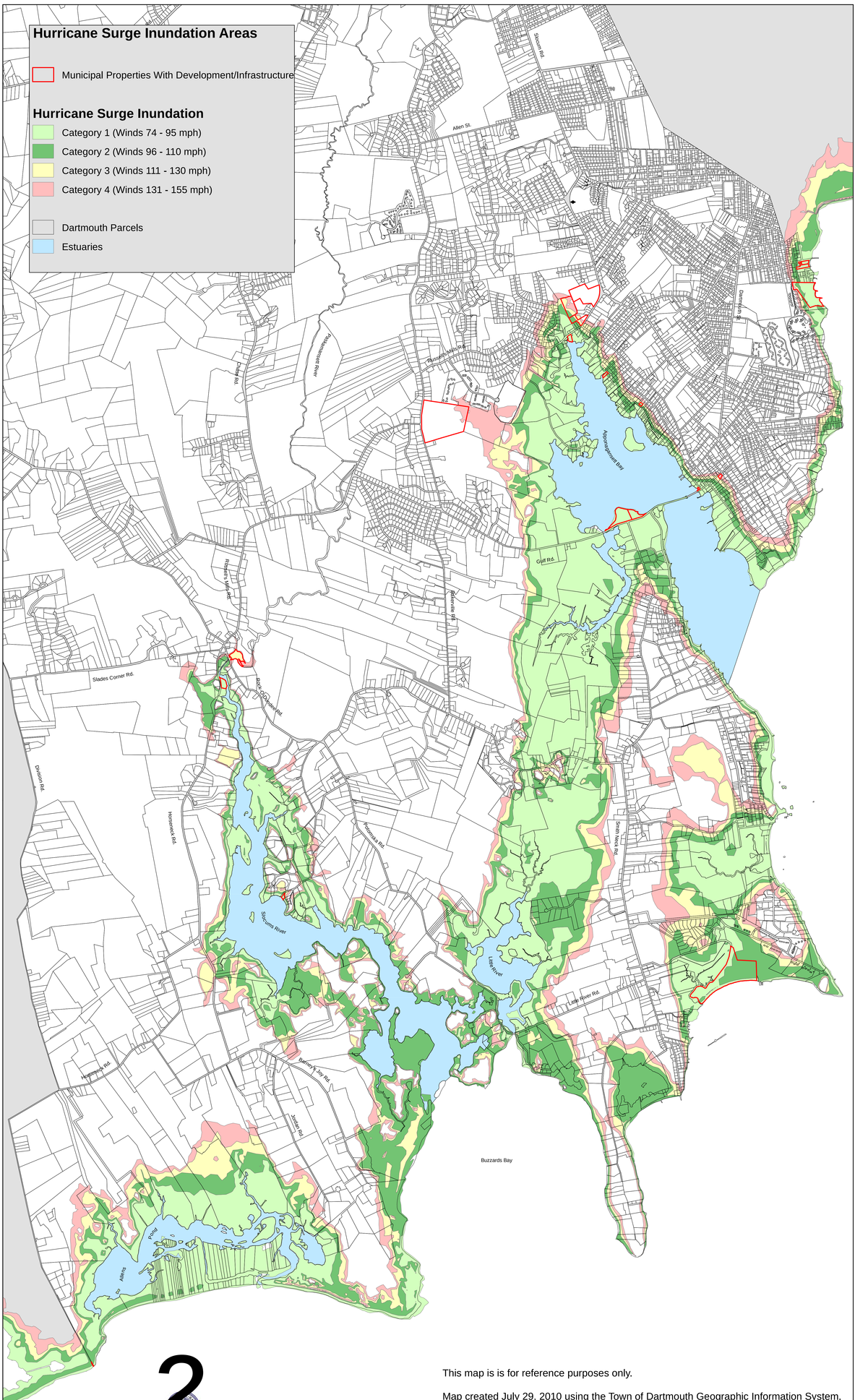


Figure 4 - Tier 3
Critical Infrastructure
Legend
Critical Infrastructure
Cultural and Historic Site
Kindergarten, Preschool and Daycare Facility
Parks and Recreational Sites
Veterans Support
Animal Shelters
Hurricane Category Surge Inundation
FEMA National Flood Hazard Layer
0 2,500 5,000 7,500 Feet
0 0.25 0.5 0.75 1 1.25 1.5 Miles
N
W
E
S
FREETOWN
FALL RIVER
ACUSHNET
NEW BEDFORD
FAIRHAVEN
WESTPORT
Buzzards Bay
Clarks Cove
Apponagansett Bay
Copicut Reservoir
Cornell Pond
Noquochoke Lake
Cedar Dell Lake
Slocumus River
Little River
Allens Pond
Paskamanset River
Destruction Brook
Shingle Island River
Copicut River
Buttonwood Brook
Dartmouth Regional Park & Trails
Cornell Pond
Sals Pals
Kiddie Kampus 3
Chase Farm Veterinary Hospital
Humane Society & Shelter
Dartmouth Childrens Center
Anchor Animal Hospital
Smith Mills Preschool & Kindergarten
Paskamansett Landing
Kiddie Kampus 1
Kiddie Kampus 2
Renaissance Kids Academy
Our Sisters School
Hawthorn Hill Preschool
Little Peoples College
Rogers Street Waterways Access
Jones Park
Kids Ink Too
Kids Ink
Dartmouth Community Park
South Dartmouth Cemetery
Hill School
Learning House Pre-School
Monthas Park
Paskamansett Park
Apponegansett Meeting House
Arthur Dias Town Landing
Apponagansett Park
Dartmouth YMCA / Camp Metacomet
Dartmouth Early Learning Center
Russells Mills Landing
Dartmouth Recreation Center
Round Hill Beach

FIGURE 5
Hurricane Inundation Areas, Maximum Extent of Storm Surge



2

Town of Dartmouth
Geographic Information System

This map is is for reference purposes only.

Map created July 29, 2010 using the Town of Dartmouth Geographic Information System.

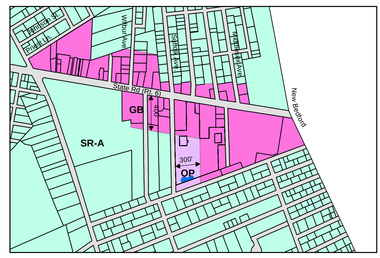
Sources:

Town of Dartmouth
US Army Corps of Engineers
Buzzards Bay National Estuary Program
MassGIS

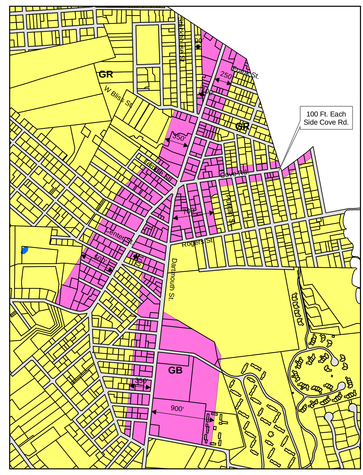
To obtain information directly from the source please go to:
http://www.nae.usace.army.mil/projects/ma/hurricanemaps/hurricanestudies.htm

Miles 0 0.25 0.5 1 1.5 2

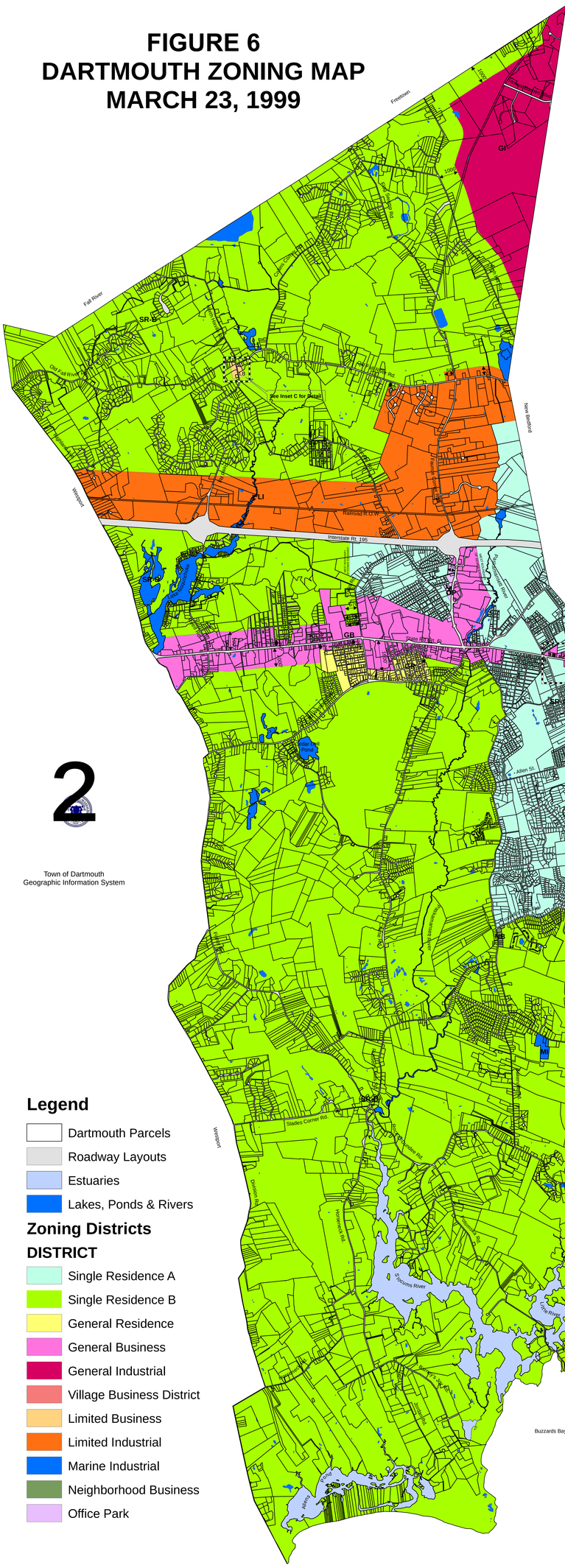
FIGURE 6
DARTMOUTH ZONING MAP
MARCH 23, 1999



Inset A



Inset B



Inset C

2

Town of Dartmouth
Geographic Information System

Legend

- Dartmouth Parcels
- Roadway Layouts
- Estuaries
- Lakes, Ponds & Rivers

Zoning Districts

DISTRICT

- Single Residence A
- Single Residence B
- General Residence
- General Business
- General Industrial
- Village Business District
- Limited Business
- Limited Industrial
- Marine Industrial
- Neighborhood Business
- Office Park

This map is incorporated into the Dartmouth Zoning Bylaw by Reference in sections 2.301.

For a full description of the Zoning Districts, please review the Zoning Bylaw.

The regulatory lines on this map are shown in a heavy black line. Light grey lines are theTown of Dartmouth Parcel boundaries and are for reference and orientation purposes only andhold no regulatory authority.

Map amended by Town Meeting vote January 26, 2010 creating the Village Business District.

Map created February 1, 2010 with the Town of Dartmouth Geographic Information System.

For more information on Zoning Districts or for questions regarding zoning please call the Director of Inspectional Services.

0 2,250 4,500 9,000 13,500 18,000 22,500 Feet

1:24000

FIGURE 7
DARTMOUTH ZONING MAP
AQUIFER PROTECTION DISTRICTS

Town of Dartmouth
Geographic Information System

Legend

- • Town Wells
- Zone I
- Zone II
- Zone III
- Lakes, Ponds & Rivers
- Estuaries
- Roadway Layouts
- Dartmouth Parcels

0 2,000 4,000 8,000 12,000 16,000 20,000 Feet

1:24000

APPENDIX A – PLANNING PROCESS AGENDA AND WORKSHEETS

Local Multihazard Mitigation Plan
Town of Dartmouth, MA

Meeting 1 – July 18, 2012, 10:30 AM

1. **Introductions**

2. **Review Scope of Work**

3. **Identify Local Planning Team** (worksheet)

4. **Identify Critical Infrastructure** (worksheet)

5. **Discuss High Hazard Areas** (worksheet and GIS)

6. **Discuss Recent Disasters** (worksheet)

7. **Identify existing emergency procedures in place**
   - Emergency plans
   - Evacuation routes
   - Emergency shelter access
   - Public information dissemination
   - Mutual aid agreements
   - Bylaws and regulations
   - Problem area studies or evaluations
   - Training or drills

8. **Identify recent and proposed hazard protection measures**
   - Any of the above listed under existing procedures
   - Drainage improvements,
   - Culvert upgrades
   - Equipment purchases
   - Funding increases

9. **Discuss Info Needed** (worksheet)

10. **Next Steps**

Notes:

- Step 1: Map the Hazards - Where Are they?
- Step 2: Determine Potential Damage - What Are the Risks?
- Step 3: Identify What's Already in Place - What Are We Already Doing?
- Step 4: Identify What's Not Being Done - Where Are the Gaps in Our Protection?
- Step 5: Brainstorm Alternatives - What Actions Can Be Taken?
- Step 6: Evaluate Actions - What is Feasible?
- Step 7: Coordinate with Others - Who Else is Doing This?
- Step 8: Select Actions - What Are Our Priorities?
- Step 9: Develop a Strategy - How Do We Implement Actions?
- Step 10: Adopt and Monitor the Plan - Putting It All Together

Week 2:
Existing and proposed measures
Nick review bylaws

Week 3:
Review hazard prioritization
GIS map with FEMA 100-year floodplain, vulnerable buildings, plus critical infrastructure
Vulnerability pricing, use some sort of median home pricing for town/county

Curt to get Nick an index of stuff mapped with GIS

LOCAL PLANNING TEAM MEMBERS

Local Planning Team members typically consist of various public officials, business leaders and residents in order to gain a broad understating of the hazard risks, local community problem areas, existing and proposed prevention measures, etc.

Name	Position	Affiliation
1.		Board of Selectmen/Executive Admin.
2.		Department of Public Works
3.		Dartmouth Emergency Mgmt. Agency
4.		Police Department
5.		Fire Districts 1,2, and 3
6.		Dartmouth Community Television
7.		Harbormaster
8.		Department of Public Health
9.		School Department
10.		Council on Aging
11.		N.B. Area Chamber of Commerce
12.		Dartmouth Mall
13.		UMass Dartmouth
14.		Mass. DCR
15.		
16.		
17.		

INFORMATION REQUESTED FROM DARTMOUTH

The following information is required by CEI to complete the Plan:

Utilities within Town:

- Gas: NSTAR
- Electric: NSTAR
- Cable: Comcast
- Phone:
- Water: Town
- Wastewater: Town
- _____
- _____

Applicable Bylaws:

- General
- Zoning
- Wetland protection
- _____
- _____
- _____

Dams Present in Town:

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Town GIS layers

AST records (fire department)

Existing FEMA-Approved plan

Local Multihazard Mitigation Plan
Town of Dartmouth, MA

Meeting 2 – August 22, 2012, 1:00 PM

Meeting 2 Agenda*

1. **Local Planning Team Introductions**

2. **Review Scope of Project/Grant**

   - **Identify Critical Infrastructure** (worksheet)

   - **Discuss High Hazard Areas** (worksheet and GIS)

   - **Discuss Recent Disasters** (worksheet)

3. **Next Steps**

   - **Identify existing emergency procedures in place**
     - Emergency plans
     - Evacuation routes
     - Emergency shelter access
     - Public information dissemination
     - Mutual aid agreements
     - Bylaws and regulations
     - Problem area studies or evaluations
     - Training or drills

   - **Identify recent and proposed hazard protection measures**
     - Any of the above listed under existing procedures
     - Drainage improvements,
     - Culvert upgrades
     - Equipment purchases
     - Funding increases

*Please note that agenda items may be covered over multiple meetings.

CRITICAL INFRASTRUCTURE

Critical infrastructure is public or private buildings or systems that provide important or valuable services to the community and generally require additional consideration when determining hazard mitigation strategies. Likely responsible names and departments are listed below as *Primary Information Sources*.

1. Emergency response (fire, police, hospitals, emergency centers, shelters)

Primary Information Sources

Emergency Response – Ed Pimental

Police Department

Fire District 1 – Chief John Judson

Fire District 2 – Chief Timothy Andre

Fire District 3 – Chief Richard Arruda

Stat Ambulance

Structures/Infrastructure

Police Department, 249 Russells Mills Road

Fire HQ District 1, 140 Cross Road

Fire District 2, 1100 Hixville Road

Fire District 3, 254 State Road

2. Municipal Buildings (town hall, public works facilities)

Primary Information Sources

Town Offices: Board of Selectmen

Department of Public Works – Dave Hickox

Municipal facilities / municipal survey: Greg

3. Transportation (critical roads, bridges, tunnels, railroads, airports)

Primary Information Sources

Department of Public Works – Dave Hickox

4. Communications (cell towers, antennas, cable and phone companies)

Primary Information Sources

Executive Administrator – Dave Cressman

5. Child care (daycare facilities, YMCA, boys and girls club)

Primary Information Sources

Building Department – Paul Murphy

Public Health

6. Elderly care (senior centers, nursing homes, elderly housing)

Primary Information Sources

Council on Aging

Building Department – Paul Murphy

Dartmouth Housing Authority

7. Animal shelters

Primary Information Sources

Public Health

Animal Control

8. Education (schools, colleges and universities)

Primary Information Sources

School Department

Friends Academy

UMass Dartmouth

various

Structures/Infrastructure

Dartmouth High School, 555 Bakerville Road

Dartmouth Middle School, 366 Slocum Road

Joseph DeMello Elementary School, 654 Dartmouth Street.

George H. Potter Elementary School, 185 Cross Road

James M. Quinn Elementary School, 529 Hawthorn Street

Friends Academy, 1088 Tucker Road

Bishop Stang High School, 500 Slocum Road

UMass Dartmouth, 285 Old Westport Road

9. Drinking water supply (water treatment plant, wells, pipelines)

Primary Information Sources

Department of Public Works, Water & Sewer – Steve Sullivan

10. Wastewater treatment plant and pump stations

Primary Information Sources

Department of Public Works – Dave Hickox

11. Power plants and/or substations

Primary Information Sources

NSTAR

UMass Dartmouth / natural gas fired turbine

Morris Energy / Dartmouth Power Associates **(2)** natural gas fired turbines

Private solar

12. Correctional facilities

Primary Information Sources

Bristol County House of Corrections

13. Hazardous materials facilities

Primary Information Sources

Fire Department

UMass Dartmouth

Building Department – Paul Murphy

14. Cultural and historic sites (churches, cemeteries, museums, libraries, historic buildings)

Primary Information Sources

State Historic Preservation Officer

Historic Commission

Parks and Recreation – Tim Lancaster

HIGH HAZARD AREAS

High hazard areas are geographic areas identified as having a high risk from natural disasters. They typically include areas prone to river and stream flooding, coastal flooding, stormwater flooding, high winds, etc. High hazard areas may be chosen by the Local Planning Team or developed from FEMA flood reports and maps.

Each section should outline information such as:

- Location (culvert, street address, etc.)
- Size of impacted area (parking lot, 2 residential lots, etc.)
- Frequency (during heavy rains, spring snowmelt events, every 2 years, etc.)
- Impacts (flooded parking lots, basements or yards, impassible streets, etc.)
- Expected causes if known (undersized pipe, culvert or bridge, etc.)
- Potential solutions (enlarged culvert, upgraded drainage system, etc.)

1. Hawthorn Street Culvert

2. Sharp Street Culvert

3. Elm Street Culvert

4. Tucker Road

5. Padanaram Bridge and Culvert

6. Horseneck Road

7. Chase Road

8. Flag Swamp

9. Hixville Road / Shingle Island

Impassable during flooding events

10. Old Fall River Road / Shingle Island

Impassable during flooding events

11. _____

12. _____

13. _____

14. _____

RECENT DISASTERS

Hazards associated with natural disasters typically encountered (e.g. flood events, hurricanes, winter storms) include high winds, heavy rains and localized flooding. The following sections should be used to describe recent, unusual, and problematic natural disasters. Sections should include information such as:

- Approximate date
- Location
- Scope and extent of impact
- Response taken

1. Winter Storms (snow storms/blizzards/nor'easters)

2. Flood events (hurricanes, stormwater impacts)

Southworth Library experienced flooding in the lot, garage, and lower level on July 8, August 8, and September 8 of 2011 due to torrential rain. The Children's Room and most of the lower level had to be closed to the public. No permanent damage was done, and staff were able to clean up once the rain stopped.

3. Forest Fires

4. Other Wind Events

5. Dam Breaches (if applicable)

6. Other

Meeting 2 – August 22, 2012

Name	Department
1. TIMOTHY LEE	DARTMOUTH POLICE DEPT.
2. DAVID HICKOX	DARTMOUTH DPW
3. Paul Pacheco	Dartmouth D.P.W
4. Lynne Antunes	Dartmouth Public Libraries
5. Dave Gavigan	Bristol County Sheriff's Office
6. PAUL MURPHY	BUILDING DEPT.
7. RICHARD ARRUDA	DARTMOUTH FIRE DISTRICT 3
8. JOHN JUDSON	" " " 1
9. EDWARD V. PIMENTAL JR	DARTMOUTH EMA
10. Dave Cressman	Town Administrator
11. GARY SOARES	DARTMOUTH P.D.
12. RICHARD FERREIRA	DARTMOUTH School Dept.
13. STEVE MELO	Dartmouth Harbormaster
14. Mike O'Reilly	Environmental/Conservation/GIS
15. DEBORAH MELINO-WIENER	~~dmelino-w~~ dwender@town.dartmouth.ma.us Development
16. Cynthia Marland	DCTV
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	
25.	

Local Multihazard Mitigation Plan
Town of Dartmouth, MA

Meeting 3 – September 20, 2012, 10 AM

Meeting 3 Agenda*

1. **Review Mapping Efforts to Date**
   - Inland flooding hazards
   - SLOSH maps
   - Critical Infrastructure within Hazard Areas

2. **Prioritization of Critical Infrastructure**
   - Coordination with NSTAR

3. **Identify Existing Hazard Mitigation Measures in Place** (worksheet)
   - Structural Improvement Projects
   - Regulations and Bylaws
   - Preventative Maintenance and Inspection Operations
   - Emergency Operations
   - Existing Plans

4. **Identify Proposed Hazard Protection Measures** (worksheet)

5. **Next Steps**
   - Vulnerability Assessment
   - Implementation of Mitigation Actions
   - Public Participation and Input

*Please note that agenda items may be covered over multiple meetings.

CRITICAL INFRASTRUCTURE

Critical infrastructure is public or private buildings or systems that provide important or valuable services to the community and generally require additional consideration when determining hazard mitigation strategies. Likely responsible names and departments are listed below as *Primary Information Sources*.

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Primary Information Sources

Emergency Response – Ed Pimental

Police Department

Fire District 1 – Chief John Judson

Fire District 2 – Chief Timothy Andre

Fire District 3 – Chief Richard Arruda

Stat Ambulance

Structures/Infrastructure

Police Department, 249 Russells Mills Road

Fire HQ District 1, 10 Bridge Street

Fire District 2, 1100 Russells Mills Road

Fire District 3 Headquarters, 140 Cross Street

Fire District 3 Station 2, 1140 Hixville Road

Fire District 3 Station 3, 254 State Road

2. Municipal Buildings (town hall, public works facilities)

Primary Information Sources

Town Offices: Board of Selectmen

Department of Public Works – Dave Hickox

Municipal facilities / municipal survey: Greg

3. Transportation (critical roads, bridges, tunnels, railroads, airports)

Primary Information Sources

Department of Public Works – Dave Hickox

4. Communications (cell towers, antennas, cable and phone companies)

Primary Information Sources

Executive Administrator – Dave Cressman

5. Child care (daycare facilities, YMCA, boys and girls club)

Primary Information Sources

Building Department – Paul Murphy

Public Health

6. Elderly care (senior centers, nursing homes, elderly housing)

Primary Information Sources

Council on Aging

Building Department – Paul Murphy

Dartmouth Housing Authority

7. Animal shelters

Primary Information Sources

Public Health

Animal Control

8. Education (schools, colleges and universities)

Primary Information Sources

School Department

Friends Academy

UMass Dartmouth

various

Structures/Infrastructure

Dartmouth High School, 555 Bakerville Road

Dartmouth Middle School, 366 Slocum Road

Joseph DeMello Elementary School, 654 Dartmouth Street.

George H. Potter Elementary School, 185 Cross Road

James M. Quinn Elementary School, 529 Hawthorn Street

Friends Academy, 1088 Tucker Road

Bishop Stang High School, 500 Slocum Road

UMass Dartmouth, 285 Old Westport Road

9. Drinking water supply (water treatment plant, wells, pipelines)

Primary Information Sources

Department of Public Works, Water & Sewer – Steve Sullivan

10. Wastewater treatment plant and pump stations

Primary Information Sources

Department of Public Works – Dave Hickox

11. Power plants and/or substations

Primary Information Sources

NSTAR

UMass Dartmouth / natural gas fired turbine

Morris Energy / Dartmouth Power Associates **(2)** natural gas fired turbines

Private solar

12. Correctional facilities

Primary Information Sources

Bristol County House of Corrections

13. Hazardous materials facilities

Primary Information Sources

Fire Department

UMass Dartmouth

Building Department – Paul Murphy

14. Cultural and historic sites (churches, cemeteries, museums, libraries, historic buildings)

Primary Information Sources

State Historic Preservation Officer

Historic Commission

Parks and Recreation – Tim Lancaster

EXISTING HAZARD MITIGATION MEASURES

Existing hazard mitigation measures are those in place designed to minimize or prevent damage due to natural disasters and/or provide protection should one occur. The following sections should be used to identify measures currently in place.

1. Structural Measures

Drainage Improvements, Culverts, Outfalls, etc.

Roadway and Bridge Improvements

Flood Control Structures

Dredging, Dune or Beach Restoration

Dam Improvements

Other

2. Regulations and Bylaws

Existing Bylaws (add in any additional items)

Existing General Bylaws: Wetland Protection, Earth and Soil Removal, Water Use Restriction, Waterways Management. Existing Zoning Bylaws: Floodplain District, Aquifer Protection District. Existing Subdivision Regulations,

Additional Regulations and Permit Requirements (add in any additional items)

Existing Wetland Protection Regulations,

3. Preventative Maintenance and Inspection Operations

Existing Maintenance and Operations (drainage system inspection and cleaning, tree trimming near power lines, etc.)

Education and Training Programs

4. Emergency Operations

Interdepartmental Communications (procedures, particularly anything written)

Public Outreach during Disasters (procedures, methods, signs, etc.)

Local cable channel, social media such as Facebook

Evacuation Plans, Shelters and Routes (anything formalized and/or written?)

5. Existing Plans

Any existing plans in place to prevent damage during a natural disaster or alleviate impacts should one occur? (open space plan, drought management plan, mutual aid agreements, studies of problem areas, etc.)

National Flood Insurance Program,

PROPOSED HAZARD MITIGATION MEASURES

Proposed hazard mitigation measures are those in the process of being implemented to prevent or minimize damage due to natural disasters and/or provide protection should one occur. The following sections should be used to identify proposed measures .

1. **Structural Improvement Projects**

   Padanaram Causeway – Drainage Improvements (part of TIP project)

   Tucker Road Realignment – Drainage Improvements (Library Flooding)

   UMass Dartmouth - Stormwater Improvements (Chase Road Flooding)

2. **New Regulations or Revisions to any Existing Regulations or Bylaws**

3. **New or Modified Preventative Maintenance and Inspection Operations**

4. Revised Emergency Operations

5. Revisions to Existing Plans or the Creation of New Plans

Meeting 3 – September 20, 2012

Name	Department
1. DEBORAH MELINO-WENDER	DEVELOPMENT
2. Capt. TIM SHEEHAN	UMASS DARTMOUTH POLICE
3. Capt. Todd Castro	Bristol County sheriff's office
4. Colonel Dave Gavigan	BCSO AAG2@Comcast.net ~~AAG2@Comcast~~
5. Asst Chief Marcus Dumont	DISTRICT #1
6. Deputy Gary M. Soares	DART P.D.
7. Donald Perry	Planning Board
8. Mike O'Reilly	Conservation
9. DAVE HICKOX	DARTMOUTH DPW
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Local Multihazard Mitigation Plan
Town of Dartmouth, MA

Meeting 4 – October 23, 2012, 1 PM

Meeting 4 Agenda*

1. **Prioritization of Critical Infrastructure**
   - **Tier 1: Emergency Response and Utilities**
     - Police, fire, ambulance
     - Water, sewer
     - DPW
   - **Tier 2: Municipal and Community Centers**
     - Town offices, libraries, post office
     - Schools
     - Nursing homes
     - Prison
   - **Tier 3: Other**
     - Preschools, kindergartens, day cares
     - Animal shelters
     - Historic properties
     - Parks

   - Still need to coordinate with NSTAR

2. **Vulnerability Assessment**

3. **Document Emergency Shelters and Evacuation Routes (worksheet)**

4. **Critical Infrastructure Improvement**
   - Any suggestions?

5. **Next Steps**
   - Evaluate high hazard areas for improvement
   - Implementation of mitigation actions
   - Public participation and input

*Please note that agenda items may be covered over multiple meetings.

Tier 1 Critical Infrastructure in a Hazard Zone

	LOCATION	ADDRESS	Category	FEMA Inland Flooding	Hurricane Surge
1.	Police Station	249 Russells Mills Road	Emergency Response and Infrastructure	yes	yes
2.	Fire Station, District 1	10 Bridge Street	Emergency Response and Infrastructure		yes
3.	Emergency Management Agency	247 Russells Mills Road	Emergency Response and Infrastructure		yes
4.	Clarence Station	57 Captains Lane	Sewer Infrastructure	yes	yes
5.	Deerfield Road Station	15 Deerfield Road	Sewer Infrastructure	yes	
6.	Grove Street Station	10 Grove Street	Sewer Infrastructure	yes	
7.	Lake Noquochoke Station	736 Reed Road	Sewer Infrastructure	yes	
8.	Lakewood Road Station	65 Lakewood Road	Sewer Infrastructure	yes	
9.	Mosher Street Station	Mosher Street	Sewer Infrastructure	yes	yes
10.	North Station	1118 Tucker Road	Sewer Infrastructure	yes	
11.	Reed Road Station	643 Reed Road	Sewer Infrastructure	yes	
12.	South Station	260 Russells Mills Road	Sewer Infrastructure	yes	yes
13.	Gulf Road Pump Station	142 Gulf Road	Sewer Infrastructure	yes	yes
14.	West Smith Neck	35 West Smith Neck Road	Sewer Infrastructure	yes	yes
15.	Unnamed	Kingston Street	Sewer Infrastructure	yes	
16.	Violetta 1, 2 and 3 Wells	547 R Old Westport Road	Water Supply Infrastructure	yes	
17.	Violetta 1, 2 and 3 Wells	547 R Old Westport Road	Water Supply Infrastructure	yes	

Vulnerability Assessment

- Performed a vulnerability evaluation using GIS software, tax maps and zoning maps
- Areas subject to flooding (FEMA maps & SLOSH maps) overlain with zoning and parcel maps
- Obtained building and property values from Assessor's Office database
- Approximately 1,650 residential and 50 other buildings within vulnerable areas

Zone	Number of Affected Properties	Building Value	Land Value	Total Property Value
Single Residence A	171	$32.0 Million	$27.3 Million	$59.3 Million
Single Residence B	924	$290.0 Million	$424.8 Million	$714.7 Million
General Residential	558	$122.4 Million	$163.5 Million	$285.9 Million
General Business	23	$24.8 Million	$12.6 Million	$37.3 Million
Limited Business	24	$7.0 Million	$11.0 Million	$18 Million
Limited Industrial	1	$0.3 Million	$0.2 Million	$0.4 Million
Neighborhood Business	5	$0.6 Million	$0.8 Million	$1.4 Million
TOTAL	**1,706**	**$477 Million**	**$640 Million**	**$1,117 Million**

- Although infrastructure also vulnerable to non-flood disasters, unpredictability of some hazards (e.g. earthquakes and tornadoes), inability to protect the location and/or severity of the hazard (e.g. tornadoes and fires), or inability to quantify impacts in a reliable manner (e.g. high winds and heavy snow), only flood-related vulnerabilities were forecast

Vulnerability Assessment (continued)

- Replacement costs further reduced to building replacement values, as assumed that land will not be lost
- Note that these are "worst case" scenario, as likely that portion(s) of the building will remain usable after flooding recedes (e.g. foundation)

Zone	Number of Affected Properties	Building Value	Average Building Replacement Cost
Single Residence A	171	$32.0 Million	$187,000
Single Residence B	924	$290.0 Million	$314,000
General Residential	558	$122.4 Million	$219,000
General Business	23	$24.8 Million	$1,077,000
Limited Business	24	$7.0 Million	$292,000
Limited Industrial	1	$0.3 Million	$254,000
Neighborhood Business	5	$0.6 Million	$128,000
TOTAL	**1,706**	**$477 Million**	

EMERGENCY SHELTERS AND EVACUATION ROUTES

Access to well-staffed and provisioned emergency shelters are invaluable to a community. Shelters typically provide a warm, safe place for residents in need during and after natural disasters. Alternatively, well-functioning evacuation routes can allow capable residents to leave the area entirely, seeking refuge in a safer location until the threat has passed. The following sections should be used to identify emergency shelters and evacuation routes.

1. **Current Emergency Shelters**

2. **Any Formalized Evacuation Routes?**

3. **Known Evacuation Problem Areas?**

   Old Fall River Road, off Faunce Corner road

   UMass Dartmouth

Meeting 4 – October 23, 2012

	Name	Department
1.	JOHN H. JUDSON	DARTMOUTH FIRE DISTRICT NO. 1
2.	RICHARD K. ARRUDA	DARTMOUTH FIRE DISTRICT No. 3
3.	DEBORAH MELINO-WENDER	TOWN OF DARTMOUTH
4.	Todd Castro	BCSO
5.	DAVID W. GAVIGAN	BCSO
6.	Mike O'Reilly	Dartmouth Environmental / Coordinator
7.	PAUL MURPHY	DARTMOUTH BUILDING DEPT.
8.	EDWARD V. PIMENTAL, JR	DARTMOUTH EMA
9.	STEVEN MELO	DARTMOUTH HARBORMASTER
10.	Cynthia Marland	Dartmouth Community TV
11.	Dave Cressman	Town Administrator
12.	David Hickox	DPW -
13.	Mike Ohl	CEI
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Local Multihazard Mitigation Plan
Town of Dartmouth, MA

Meeting 5 – January 11, 10 AM

Background

The Town of Dartmouth and Comprehensive Environmental, Inc. (CEI) are in the process of preparing a Local Multi-Hazard Mitigation Plan through a FEMA grant obtained as part of the Hazard Mitigation Grant Program. The plan is being developed to meet three primary objectives:

- Examine natural hazards threatening the town;
- Assess vulnerabilities of buildings and infrastructure; and
- Recommend ways to mitigate the effects of a natural disaster.

Dartmouth would like to involve NSTAR to discuss ways in which the Town could help expedite power restoration after a disaster, prevent outages in the first place, and reduce downtime of critical infrastructure such as emergency response and water/sewer infrastructure.

Meeting 5 Agenda

1. **Review of the Town's critical infrastructure**
   - Location
   - Function
   - Priority

2. **Identification of NSTAR critical infrastructure / facilities in Dartmouth**

3. **Coordination of emergency response efforts**
   - Restoration of power to critical infrastructure
   - Restoration/maintenance of primary transportation routes (inactivation of downed power lines, debris removal, etc.)

CRITICAL INFRASTRUCTURE

GENERAL (TRANSPORTATION)		
Route I-195	Interstate Roadway	
Route 6	State Roadway	
Route 140	State Roadway	
Faunce Corner Road	Local Roadway	
Russells Mills Road	Local Roadway	
Gulf Road / Padanaram Bridge & Causeway	Local Roadway	
Old Westport Road	Local Roadway	
Hawthorn Street	Local Roadway	
Old Fall River Road	Local Roadway	
Tucker Road	Local Roadway	
Allen Street	Local Roadway	
Slocum Road	Local Roadway	
High Hill Road	Local Roadway	
New Plainville Road	Local Roadway	
Reed Road	Local Roadway	
Hathaway Road	Local Roadway	
Chase Road	Local Roadway	
Fisher Road	Local Roadway	
Dartmouth Street	Local Roadway	
Horseneck Road	Local Roadway	
Division Road	Local Roadway	
Middle Street	Local Roadway	
White Oak Run	Local Roadway	
TIER 1 – EMERGENCY RESPONSE AND UTILITIES		
Emergency Response and Infrastructure		
Fire Station, District 1	10 Bridge Street	2
Fire Station, District 2	1100 Russells Mills Road	3
Fire Station, District 3 Headquarters	140 Cross Street	4
Fire Station, District 3 Station 2	1140 Hixville Road	5
Fire Station, District 3 Station 3	254 State Road	6
Police Station	249 Russells Mills Road	1
State Police Barracks	265 Faunce Corner Road	
Medical Services		
Response Ambulance Services	654 State Road	7
Stat Ambulance Services	360 Faunce Corner Road	
Hawthorn Medical Associates Hawthorn Medical Associates (Urgent Care)	535/537 Faunce Corner Road 237A State Road	
Southcoast Brain and Spine Center	480 Hawthorn Street	
Dartmouth Medical Center	39 Faunce Corner Road	

Water Supply Infrastructure		
DPW Water & Sewer Division	751 Allen Street	9
Water Treatment Facility	299 Chase Road	53
Water Treatment Facility	687 Chase Road	54
Water Treatment Facility	579 Old Westport Road	55
Water Department Garage	1048 Allen Street	75
Allen Street Elevated Tank and Standpipe	1048 Allen Street	75
Old Fall River Road Tank	396 Old Fall River Road	77
Cross Road Tank	142 Cross Road	78
Smith Neck Road Tank	80 South Avenue	79
Faunce Corner Pumping Station	793 Faunce Corner Road	
Violetta 1, 2 and 3 Wells	547 R Old Westport Road	81
Penelli 1 and 2 Wells	408 Old Westport Road	82
A, B, C, F-1, and F-2 Wells	299 Chase Road	83
D, E-1 and E-2 Wells	687 Chase Road	84
Sewer Treatment Infrastructure		
DPW Water & Sewer Division	751 Allen Street	duplicate
Wastewater Treatment Facility	759 Russells Mills Road	56
Castaldi Station	Castaldi Drive	
Clarence Station	57 Captains Lane	85
Deerfield Road Station	15 Deerfield Road	86
Eisenhower Station	Eisenhower Street	104
Elswick Street Station	10 Elswick Street	87
Faunce Corner Station	43 Faunce Corner Road	88
Grove Street Station	10 Grove Street	89
Gulf Road Station	142 Gulf Road	102
Junior Street	1 Junior Street	
Kingston Station	Kingston Street	106
Lake Noquochoke Station	736 Reed Road	91
Lakeside Avenue Station	6 West Avenue	
Lakewood Road Station	65 Lakewood Road	93
Lincoln Park Station	6 Beeden Road	
Mosher Street Station	Mosher Street	95
North Station	1118 Tucker Road	96
Reed Road Station	643 Reed Road	97
Route 6 Station	688 State Road	98
Sharon Avenue	33 Sharon Avenue	101
South Station	260 Russells Mills Road	99
Woodcart Drive Station	17 Woodcart Drive	100
West Smith Neck Station	35 West Smith Neck Road	103
Utilities		
NSTAR facilities		
Cell towers		
Cable company, satellite dishes, antennas		

Algonquin Gas	Northern end of Dartmouth	
Other Critical Infrastructure		
DPW Highway Yard and Transfer Station	976 Russells Mills Road	
Emergency Management Agency	84 Rodgers Street	relocated
TIER 2 – MUNICIPAL AND COMMUNITY CENTERS		
Municipal and other Public Buildings		
Town Offices / Town Hall	400 Slocum Road	
Office of the Harbormaster	1 Bridge Street - rear	
Dartmouth Housing Authority	2 Anderson Way	
North Dartmouth Library	1383 Tucker Road	
Southworth Library	732 Dartmouth Street	
Dartmouth Community Television (DCTV)	247 Russells Mills Road	
US Post office	77 Faunce Corner Mall Road	
Bristol County House of Corrections	400 Faunce Corner Road	
Veterans Advisory Board (VFW Post 9059)	Cross Roads	
Education		
Office of the Superintendent of Schools	8 Bush Street	
Dartmouth High School	555 Bakerville Road	
Dartmouth Middle School	366 Slocum Road	
Joseph DeMello Elementary School	654 Dartmouth Street	
George H. Potter Elementary School	185 Cross Road	
James M. Quinn Elementary School	529 Hawthorn Street	
Friends Academy	1088 Tucker Road	
Bishop Stang High School	500 Slocum Road	
Our Sisters School	145 Brownell Ave	
NorthStar Learning Centers	267 Samuel Barnett Boulevard	
UMass Dartmouth	285 Old Westport Road	
Elderly Care Facilities		
Council on Aging (Senior Center)	628 Dartmouth Street	
Brandon Woods Nursing Home	567 Dartmouth Street	
Harborview Manor Nursing Home	173 Smith Neck Road	
Dartmouth Manor Rest Home	70 State Road	
Autumn Glen (Heritage at Dartmouth)	239 Cross Road	
Cedars Assisted Living	628 Old Westport Road	
Sunrise Assisted Living	274 Slocum Road	
TIER 3 – OTHER		
Kindergarten, Preschool, and Daycare Facilities		
Dartmouth Children's Center	968 Old Reed Road	
Dartmouth Early Learning Center	284 Gulf Road	
Dartmouth YMCA / Camp Metacomet	276 Gulf Road	
Hawthorn Hill Preschool	371 Slocum Road	
Kids Ink	728 Dartmouth Street	
Kids Ink Too	695 Dartmouth Street	

Kiddie Kampus 1	26 Old Westport Road	
Kiddie Kampus 2	31 Old Westport Road	
Kiddie Kampus 3	445 Faunce Corner Road	
Learning House Pre-School	550 Russells Mills Road	
Little People's College	52 Donald Street	
Renaissance Kids Academy	527 Slocum Road	
Sal's Pals	1305 Reed Road	
Smith Mills Preschool & Kindergarten	11 Anderson Way	
Home Daycare Facilities		
Ilda Amaral	Pembroke Drive	
Sally Belanger	Reed Road	
Kathleen DeFrias	Essex Street	
Tammy Desnoyers	Medeiros Lane	
Kristen Lee Gwozdz	Collins Corner Road	
Deborah Kaeterle	Champion Terrace	
Alison Letton	Southwind Way	
Barbara Rutledge	Wilbur Avenue	
Donna Ventura	Arthur Avenue	
Melissa Villanueva	Motta Drive	
Animal Shelters		
Anchor Animal Hospital	750 State Road	
Humane Society & Shelter	31 Ventura Drive	
Chase Farm Veterinary Hospital	35 Ventura Drive	
Cultural and Historic Sites		
South Dartmouth Cemetery	507 Elm Street	
Apponegansett Meeting House	850 Russells Mills Road	
Hill School	4 Middle Street	
Parks and Recreational Sites		
Dartmouth Recreation Center	487 Smith Neck Road	
Apponagansett Park	77 Gulf Road	
Cornell Pond	707 Old Fall River Road	
Dartmouth Community Park	Dartmouth Street	
Dartmouth Regional Park & Trails	443 Old Fall River Road	
Jones Park	66 Saint John Street	
Montha's Park	End of Mary Crapo Way	
Paskamansett Landing	287 State Road	
Paskamansett Park	879 Russells Mills Road	
Round Hill Beach	231 Smith Neck Road	
Russells Mills Landing	50 Horseneck Road	

Local Multihazard Mitigation Plan
Town of Dartmouth, MA

Meeting 6 – February 5, 2013, 1 PM

Meeting 6 Agenda

1. **Review of Existing Mitigation Measures (worksheet)**
   - Any additional items?

2. **Proposed Mitigation Measures Goal Statements**
   - Provide residents with adequate access to emergency shelters equipped with provisions, climate control and electricity;
   - Improve communications before, during and after a natural disaster;
   - Maintain adequate access to public utilities such as electricity, drinking water, and communications;
   - Maintain an adequate service on all roadways, particularly on major roadways;
   - Reduce or eliminate preventable flood damage to buildings and infrastructure;
   - Improve public education to inform residents on what may happen during a natural disasters

3. **Review of Proposed Mitigation Measures (worksheet)**
   - Any additional items?

4. **Prioritization of Proposed Mitigation Measures**

Next Steps

- Public participation and input
- Coordination with MEMA and FEMA

Table 6.1 – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed
Emergency Management Agency	Agency in charge of coordinating response efforts between agencies during an emergency	Entire town	All hazards	Effective to date	Continue to improve response and communications as needed
Emergency Management Plans	Comprehensive Emergency Management Plan to document preparing for, and procedures to be taken during, an emergency	Entire town	All hazards	Effective to date	Update as needed to reflect the most up-to-date information available
	Hazardous Materials Emergency Plan outlining actions to be taken in the event of an incident involving hazardous materials	Entire town, primarily the transportation network	Geologic hazards		
Federal and State Regulations	Regulations and agencies designed to protect infrastructure, the environment, and public safety. Agencies include EPA, ACoE, FEMA, MassDEP, DFS, and DPS	Entire town	All hazards	Effective	Continue to use and enforce federal and state regulations
Local Regulations and Bylaws – General Bylaws	Bylaws designed to…				
<u>Article 66 – Wetlands</u>	Bylaw to protect wetlands and other sensitive water resource areas by controlling or prohibiting alterations that could affect the environment	Resource areas and areas within regulated buffer zones	Riverine flooding, erosion, thunderstorms, flooding from storm runoff	Effective	Continue to enforce bylaw and make changes if ineffective

Table 6.2 (continued) – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed
Article 67 – Earth and Soil Removal	Bylaw requiring permits for removing earth, particularly for areas subject to erosion and close to groundwater. Also prohibits redirecting runoff onto abutters property	Entire town	Erosion, thunderstorms, hurricanes, flooding from storm runoff, landslides	Effective	Continue to enforce bylaw and make changes if ineffective
Article 91 – Water Use Restrictions	Bylaw to enforce water conservation by regulating outdoor watering to ensure adequate supply during water supply emergencies	Households connected to the Town water supply	Drought, wildfires, urban fires	Effective	Continue to enforce bylaw and make changes if ineffective
Article 104 – Waterways Management	Bylaw requiring mooring registrations and prohibiting sewerage discharge into the harbor	Padanaram Harbor	Coastal flooding, coastal storms or nor'easters, hurricanes	Effective	Continue to enforce bylaw and make changes if ineffective
Local Regulations and Bylaws – Zoning Bylaws	Bylaws designed to…				
Section 18 – Waterfront Overlay District	Regulate development along the waterfront, promote access, and protect the harbor	Waterfront overlay district (areas along the waterfront)	Coastal flooding, coastal storms or nor'easters, hurricanes	Effective	Continue to enforce bylaw and make changes if ineffective
Section 19 – Floodplain District	Protect public safety, reduce damage, and lower cleanup costs in areas subject to flooding during hurricanes by regulating development and requiring permits	Flood prone land overlay district (areas subject to flooding during hurricanes)	Flood-related hazards	Effective	Continue to enforce bylaw and make changes if ineffective

Table 6.2 (continued) – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed
Section 20 – Aquifer Protection District	Protect groundwater supplies from contamination by limiting uses involving hazardous materials near public wells. Also promotes rooftop runoff infiltration.	400' radius around public wells, recharge and potential recharge areas to public wells	Drought, flooding from storm runoff	Effective	Continue to enforce bylaw and make changes if ineffective
Subdivision Regulations	Bylaw to preserve environmental areas by regulating stormwater discharges. Stormwater systems must be designed to permit safe travel, minimize flooding, and not cause adverse impacts to property	Subdivisions	Erosion, flooding from storm runoff	Effective	Continue to use and enforce regulations and make changes if ineffective
	Utilities must be buried within public right-of-ways		All hazards		
Wetland Protection Bylaw Regulations	Regulations governing new construction to ensure proper drainage system sizing, stormwater treatment, peak flow accommodation, groundwater protection, and wetland protection.	Resource areas and areas within regulated buffer zones	Riverine flooding, erosion, thunderstorms, flooding from storm runoff	Effective	Continue to use and enforce regulations and make changes if ineffective
Backup Power Supplies	Emergency generators to maintain water and sewer service in the event of a power outage. Portable generators also available for other facilities	Select water and most sewer infrastructure	All hazards	Effective	Continue use of backup power supplies. Periodically test to ensure proper operation

Table 6.2 (continued) – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed
Emergency Shelters and Mutual Aid	Emergency shelters provided for use during a natural disaster. Primary shelter: Council on Aging. Alternate: Dartmouth High School.	Entire town	All hazards	Effective to date	See Section 7.0, Planned Disaster Mitigation Measures
	Informal mutual aid agreements with neighboring towns			Not used to date	Implement formal mutual aid agreements with neighboring towns
Preventative Measures	Maintenance on drainage structures and other measures to prevent flooding.	Entire town	Flood and wind-related hazards	Effective to date	Continue activities to reduce flood damage
	Pre-closing roadways, Padanaram Causeway or other areas subject to flooding when imminent			Effective to date	Continue to close areas subject to flooding as required
	Tree trimming to reduce power outages			Somewhat effective	Continue to trim trees in problem areas to reduce power outages
Structural Upgrades	Structural culvert upgrades at Milton and Sharp streets to alleviate flooding of Buttonwood Brook	Culverts below roadways and town infrastructure	Riverine flooding, dam failures, thunderstorms, hurricanes, flooding from storm runoff	Effective to date	Monitor locations for flooding, particularly after further upgrades along Buttonwood Brook
	Other culverts along the brook, such as Hawthorn and Allen streets continue to flood			Unknown	See Section 7.0, Planned Disaster Mitigation Measures

Table 6.2 (continued) – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed
Public Outreach	Measures to provide information to the public during an emergency. Methods include two cable tv (DCTV) channels, message board, and reverse 911 system	Entire town	All hazards	Effective to date	See Section 7.0, Planned Disaster Mitigation Measures
	Electronic methods include town website, E-News updates, and social media			Effective to date	See Section 7.0, Planned Disaster Mitigation Measures
National Flood Insurance Program	Dartmouth is enrolled in FEMA's NFIP, which in part identifies floodplain areas, manages floodplains, and requires flood insurance by affected residents	Areas identified in FEMA FIRMs	Flood-related hazards	Effective	Continue to update maps as provided by FEMA
UMass-Dartmouth	UMass provides an Emergency Guide to students and staff outlining procedures during an emergency.	UMass-Dartmouth	All hazards	Effective	Hire an Emergency Management Coordinator
	UMass also provides two emergency evacuation exits from campus			May not be effective if impassable	See Section 7.0, Planned Disaster Mitigation Measures

Prioritization and Implementation of Mitigation Actions

Proposed mitigation measures were separated into those to be performed in-house, and those requiring outside funding and planning.

In-House Mitigation Actions

These items can be accomplished by the Town as part of ongoing improvements and updates to its existing measures. Proposed measures have been loosely prioritized as high, moderate and low, and include the following information:

- Priority grouping / ranking;
- Town department / board responsibility;
- Potential funding sources; and
- Estimated timeline to completion.

Table 7.1 – Prioritization of In-House Mitigation Actions

Action Item	Proposed Protection Measure	Responsibility	Timeline
High Priority			
#1	Continue to Enforce and Update current Bylaws and Regulations	Town departments & boards, primarily Building, Planning, & Conservation Commission	Ongoing
#9	Ensure Adequate Backup Power Supplies	Emergency Management Agency, Department of Public Works	1 year
#17	Prepare an Interdepartmental Emergency Response Plan	Emergency Management Agency	2 years
Moderate Priority			
#2	Establish an additional Emergency Shelter in North Dartmouth	Emergency Management Agency	2 years
#3	Establish an additional Emergency Shelter near Smith Neck Road	Emergency Management Agency, Council on Aging	2 years
#4	Establish Evacuation Procedures	Emergency Management Agency	2 years
#5	Ensure Evacuation Routes provide Adequate Traffic Flow	Emergency Management Agency, Department of Public Works	3 years
Low Priority			
#6	Address Recommendations on the Russells Mills Dam	Department of Public Works, Conservation Commission	Pending final report
#16	Expand use of Social Media and Other Public Outreach Channels	Emergency Management Agency, DCTV	Ongoing
#18	Prepare and Formalize Mutual Aid Agreements	Emergency Management Agency	3 years
#19	Improve Interdepartmental Communications	All departments and boards	Ongoing

Table 7.2 – Prioritization of Property and Structural Mitigation Actions

Priority Rank	Action Item	Proposed Protection Measure	Responsibility	Population or Region Affected	Project Cost	Potential Funding	Timeline
	#7	Provide Flood Protection at Critical Wastewater Pump Stations	Department of Public Works			FEMA Grant	2 years
	#8	Evaluate Flooding at the District 1 Fire Station	Department of Public Works, Fire District 1			In-house; 319 Grant	1 year
	#10	Make Infrastructure Improvements along Buttonwoods Brook	Department of Public Works			FEMA Grant	2 years
	#11	Realign Tucker Road to Alleviate Flooding Near Eddy Street	Department of Public Works			FEMA Grant	2 years
	#12	Enlarge Culvert or Raise Old Fall River Road	Department of Public Works			FEMA Grant	3 years
	#13	Improve Drainage under Padanaram Causeway	Department of Public Works			FEMA Grant	3 years
	#14	Address UMass Drainage and Flooding Issues	UMass-Dartmouth, Department of Public Works			UMass; FEMA Grant; 319 Grant	3 years
	#15	Address Additional Areas Prone to Periodic Flooding	Department of Public Works			FEMA Grant	5 years

Meeting 6 – February 5, 2013

	Name	Department
1.	Lynne Antunes	Library
2.	PAUL MURPHY	BUILDING
3.	Richard Ferreira	Schools
4.	BOB SZAFT	Police
5.	Mike O'Reilly	Conservation
6.	John Judson	Dartmouth Fire District No. 1
7.	David Cressman	Select Board
8.	Deborah Melim-Wende	Town
9.	June Eberhardt	U Mass - Dartmouth
10.	Wendy Henderson	Dartm. Health
11.	DAVID HICKOX	DPW
12.	STEVE MELO	HARBORMASTER
13.	DAVE GAVIGAN	Bristol County Sheriff's Office
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Local Multi-Hazard Mitigation Plan

Comprehensive Environmental, Inc.

April 29, 2013

Local Multi-Hazard Mitigation Plan
Introduction and Purpose

- HMGP administered through FEMA and locally through MEMA and DCR
- Funding of HMGP via periodic disaster declarations
- Local plan a pre-requisite for funding of future infrastructure improvements
- FEMA/MEMA support and fund cost-effective improvements to eliminate or reduce risks/damage to people or property from natural hazards.

Local Multi-Hazard Mitigation Plan
Introduction and Purpose

- Local plan funded through FEMA's HMGP (application Fall 2011, awarded Spring 2012)
- FEMA grant 75% of costs, with 25% local match (satisfied through tracking of LPT participation)
- Town eligible for future HMGP awards, to address improvements (new round now)

Local Multi-Hazard Mitigation Plan
Sample Eligible Improvements (HMGP)

- Property Acquisition
- Structure Elevation
- Structural Retrofitting
- Floodproofing (non-residential or historic)
- Localized Flood Reduction


Local Multi-Hazard Mitigation Plan
Objectives

- Primary Plan Objectives
  - Develop a local planning team
  - Identify natural hazard risks and vulnerable areas
  - Complete vulnerable infrastructure risk assessment
  - Identify existing and proposed mitigation measures
  - Plan adoption and periodic updates

Local Multi-Hazard Mitigation Plan
Local Planning Team

Department / Agency	Title / Position
Town Departments / Boards	
Building Department	Director of Inspectional Services
Community Television	Director of Media
Conservation Commission	Environmental Affairs Coordinator
Council on Aging	Director
Emergency Management Agency	Director of the Emergency Management Agency
Executive Administration	Town Administrator
	Director of Development
Fire District 1	Fire Chief
Fire District 2	Fire Chief
Fire District 3	Fire Chief
Harbormaster	Harbormaster
Parks and Recreation	Director of Parks & Recreation
Planning Board	Planning Director
Police Department	Chief of Police
	Deputy Chief
Public Health	Director of Public Health
Public Libraries	Director of Libraries
Public Works	Director of Public Works
	Superintendent Services & Infrastructure
School Department	Superintendent of Schools
	School Business Manager
	Director of Maintenance
Other Agencies and/or Organizations	
Bristol County Sheriff's Office	
NSTAR	
UMass Dartmouth	

Local Multi-Hazard Mitigation Plan
Plan Meetings

- Major Community Involvement
- Developed a Local Planning Team
  - Representatives of Town boards and departments
  - Meetings held about every 6 weeks, July 2012 through February 2013
- Also Must Allow Public Review and Comment
  - Purpose of tonight
  - Also have a meeting before final adoption

Local Multi-Hazard Mitigation Plan
Local Profile

- Plan Includes Background on the Town
  - Brief history
  - Geography
  - Climate
  - Waterbodies
  - Land use / zoning
  - Demographics
  - Government
  - Major institutions



Local Multi-Hazard Mitigation Plan
Natural Hazards

- Must Identify Historical Natural Hazards
  - Hurricanes, flooding events, winter storms
- And Even Those Not-So-Historical
  - Tornadoes, earthquakes, dam failures
- Then Develop a Risk Level for each Disaster
  - Likelihood of occurring
  - Geographic scale
  - Potential impacts

Local Multi-Hazard Mitigation Plan

Natural Hazards

Natural Hazard	Likelihood of Occurrence		Geographic Scale		Impacts		Hazard Index Score	Risk Level
Flood								
Riverine	2	Likely	1	Small	1	Limited	4	Moderate
Coastal	2	Likely	2	Medium	2	Critical	6	**Very High**
Erosion	3	Highly Likely	1	Small	0	Minor	4	Moderate
Dam Failures	1	Possible	1	Small	1	Limited	3	Low
Thunderstorms	3	Highly Likely	1	Small	1	Limited	5	High
Winter Storms	3	Highly Likely	3	Large	0	Minor	6	**Very High**
Coastal Storms or Nor'easters	3	Highly Likely	2	Medium	1	Limited	6	**Very High**
Hurricanes	1	Possible	3	Large	2	Critical	6	**Very High**
Flooding from Storm Runoff	3	Highly Likely	1	Small	1	Limited	5	High
Ice Jam	1	Possible	1	Small	1	Limited	3	Low
Wind								
Hurricanes	1	Possible	3	Large	2	Critical	6	**Very High**
Coastal Storms or Nor'easters	3	Highly Likely	2	Medium	1	Limited	6	**Very High**
Winter Storms	3	Highly Likely	3	Large	0	Minor	6	**Very High**
Downspouts	0	Unlikely	1	Small	1	Limited	2	Very Low
Tornadoes	0	Unlikely	2	Medium	2	Critical	4	Moderate
Fire								
Drought	2	Likely	3	Large	0	Minor	5	High
Wildfires	1	Possible	2	Medium	1	Limited	4	Moderate
Urban Fires	0	Unlikely	1	Small	2	Critical	3	Low
Flooding	1	Possible	1	Small	1	Limited	3	Low
Geologic								
Earthquakes	0	Unlikely	3	Large	3	Catastrophic	6	**Very High**
Landslides	0	Unlikely	1	Small	1	Limited	2	Very Low
Sink Holes	0	Unlikely	1	Small	0	Minor	1	Very Low

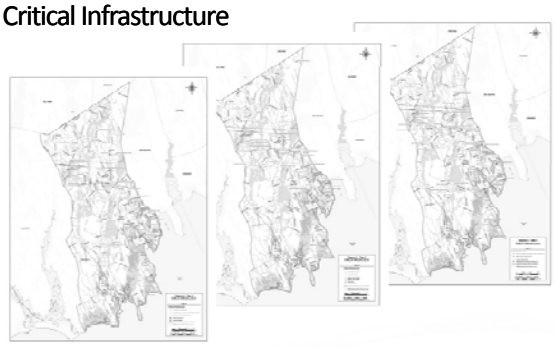
Local Multi-Hazard Mitigation Plan

High Hazard Areas

- LPT Identified Areas Impacted during Disasters
- Repetitive Loss Properties (from NFIP)
- Also Identified and Mapped Critical Infrastructure
  - Tier 1: Emergency Response & Utilities
  - Tier 2: Municipal & Community Centers
  - Tier 3: Other

Local Multi-Hazard Mitigation Plan

Critical Infrastructure



Local Multi-Hazard Mitigation Plan
Disaster Mitigation Measures

- Identified Existing and Recommended Measures
- Include Measures to:
  - Prevent damage and protect natural resources
  - Protect public safety
  - Local regulations and bylaws
  - Backup power supplies
  - Emergency shelters
  - Preventative maintenance
  - Public outreach

Local Multi-Hazard Mitigation Plan
Schedule

- Currently in the Draft Stage
  - First public comment period (starts tonight)
- Once Complete, MEMA and FEMA to Review
- When Approved, Town must Formally Adopt
  - Second public comment period (TBD)
- Final Adoption by the Town
- Plan must be Reviewed / Updated Every 5 Years

Questions?

Comprehensive Environmental, Inc.
225 Cedar Hill Street
Marlborough, MA 01752

TOWN OF DARTMOUTH

SECOND PUBLIC MEETING

HAZARD MITIGATION PLAN
DRAFT UPDATE

MONDAY, 24, 2014
3:30 PM
ROOM 304

THE TOWN OF DARTMOUTH IS IN THE PROCESS OF COMPLETING THE FINAL HAZARD MITIGATION PLAN. THIS IS THE SECOND PUBLIC MEETING AND IS BEING HELD PRIOR TO FINAL PLAN APPROVAL BY THE SELECT BOARD AND FINAL DISSEMINATION TO MEMA/FEMA FOR THEIR REVIEW AND APPROVAL.

THE TOWN IS SEEKING FINAL PUBLIC INPUT FOR THIS DOCUMENT.

3:30 PM	**INTRODUCTIONS AND OVERVIEW**
3:45 PM	**PUBLIC QUESTIONS, COMMENTS AND INPUT**
4:20 PM	**NEXT STEPS**
4:30 PM	**ADJOURNMENT**
(or later if required)	

The draft plan can be reviewed online at
http://www.town.dartmouth.ma.us/Pages/DartmouthMA_WebDocs/DartmouthHazardMitigationPlan3_14Draft.pdf

Meeting 8 – March 24, 2014

	Name	Department
1.	[illegible]	
2.	[illegible]	
3.	LT MARK Zielinski	
4.	DAVID T. HICKOX	
5.	Col. David W. GAUIGAN	
6.	RICHARD K. ARRUDA	
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APPENDIX B – CRITICAL INFRASTRUCTURE

GENERAL (TRANSPORTATION)	
Route I-195	Interstate Roadway
Route 6	State Roadway
Route 140	State Roadway
Faunce Corner Road	Local Roadway
Russells Mills Road	Local Roadway
Gulf Road / Padanaram Bridge & Causeway	Local Roadway
Old Westport Road	Local Roadway
Hawthorn Street	Local Roadway
Old Fall River Road	Local Roadway
Tucker Road	Local Roadway
Allen Street	Local Roadway
Slocum Road	Local Roadway
High Hill Road	Local Roadway
New Plainville Road	Local Roadway
Reed Road	Local Roadway
Hathaway Road	Local Roadway
Chase Road	Local Roadway
Fisher Road	Local Roadway
Dartmouth Street	Local Roadway
Horseneck Road	Local Roadway
Division Road	Local Roadway
Middle Street	Local Roadway
White Oak Run	Local Roadway

TIER 1 – EMERGENCY RESPONSE AND UTILITIES	
Emergency Response and Infrastructure	
Fire Station, District 1	10 Bridge Street
Fire Station, District 2	1100 Russells Mills Road
Fire Station, District 3 Headquarters	140 Cross Street
Fire Station, District 3 Station 2	1140 Hixville Road
Fire Station, District 3 Station 3	254 State Road
Police Station	249 Russells Mills Road
State Police Barracks	265 Faunce Corner Road
Medical Services	
Dartmouth Medical Center	39 Faunce Corner Road
Hawthorn Medical Associates Hawthorn Medical Associates (Urgent Care)	535/537 Faunce Corner Road 237A State Road
Response Ambulance Services	654 State Road
Southcoast Brain and Spine Center	480 Hawthorn Street
Stat Ambulance Services	360 Faunce Corner Road

Sewer Treatment Infrastructure	
DPW Water & Sewer Division	751 Allen Street
Wastewater Treatment Facility	759 Russells Mills Road
Castaldi Station	Castaldi Drive
Clarence Station	57 Captains Lane
Deerfield Road Station	15 Deerfield Road
Eisenhower Station	Eisenhower Street
Elswick Street Station	10 Elswick Street
Faunce Corner Station	43 Faunce Corner Road
Grove Street Station	10 Grove Street
Gulf Road Station	142 Gulf Road
Junior Street	1 Junior Street
Kingston Station	Kingston Street
Lake Noquochoke Station	736 Reed Road
Lakeside Avenue Station	6 West Avenue
Lakewood Road Station	65 Lakewood Road
Lincoln Park Station	6 Beeden Road
Mosher Street Station	Mosher Street
North Station	1118 Tucker Road
Reed Road Station	643 Reed Road
Route 6 Station	688 State Road
Sharon Avenue	33 Sharon Avenue
South Station	260 Russells Mills Road
Woodcart Drive Station	17 Woodcart Drive
West Smith Neck Station	35 West Smith Neck Road
Water Supply Infrastructure	
DPW Water & Sewer Division	751 Allen Street
Water Treatment Facility	299 Chase Road
Water Treatment Facility	687 Chase Road
Water Treatment Facility	579 Old Westport Road
Water Department Garage	1048 Allen Street
A, B, C, F-1, and F-2 Wells	299 Chase Road
Allen Street Elevated Tank and Standpipe	1048 Allen Street
Cross Road Tank	142 Cross Road
D, E-1 and E-2 Wells	687 Chase Road
Faunce Corner Pumping Station	793 Faunce Corner Road
Old Fall River Road Tank	396 Old Fall River Road
Penelli 1 and 2 Wells	408 Old Westport Road
Smith Neck Road Tank	80 South Avenue
Violetta 1, 2 and 3 Wells	547 R Old Westport Road
Other Critical Infrastructure	
DPW Highway Yard and Transfer Station	976 Russells Mills Road
Emergency Management Agency	84 Rodgers Street

TIER 2 – MUNICIPAL AND COMMUNITY CENTERS	
Municipal and other Public Buildings	
Bristol County House of Corrections	400 Faunce Corner Road
Dartmouth Community Television (DCTV)	247 Russells Mills Road
Dartmouth Housing Authority	2 Anderson Way
North Dartmouth Library	1383 Tucker Road
Office of the Harbormaster	1 Bridge Street - rear
Southworth Library	732 Dartmouth Street
Town Offices / Town Hall	400 Slocum Road
US Post office	77 Faunce Corner Mall Road
Veterans Advisory Board (VFW Post 9059)	Cross Roads
Education	
Bishop Stang High School	500 Slocum Road
Dartmouth High School	555 Bakerville Road
Dartmouth Middle School	366 Slocum Road
Friends Academy	1088 Tucker Road
George H. Potter Elementary School	185 Cross Road
James M. Quinn Elementary School	529 Hawthorn Street
Job S. Gidley School	1390 Tucker Road
Joseph DeMello Elementary School	654 Dartmouth Street
NorthStar Learning Centers	267 Samuel Barnett Boulevard
Office of the Superintendent of Schools	8 Bush Street
Our Sisters School	145 Brownell Ave
UMass Dartmouth	285 Old Westport Road
Elderly Care Facilities	
Autumn Glen (Heritage at Dartmouth)	239 Cross Road
Brandon Woods Nursing Home	567 Dartmouth Street
Cedars Assisted Living	628 Old Westport Road
Council on Aging (Senior Center)	628 Dartmouth Street
Dartmouth Manor Rest Home	70 State Road
Harborview Manor Nursing Home	173 Smith Neck Road
Sunrise Assisted Living	274 Slocum Road

TIER 3 – OTHER	
Kindergarten, Preschool, and Daycare Facilities	
Dartmouth Children's Center	968 Old Reed Road
Dartmouth Early Learning Center	284 Gulf Road
Dartmouth YMCA / Camp Metacomet	276 Gulf Road
Hawthorn Hill Preschool	371 Slocum Road
Kids Ink	728 Dartmouth Street
Kids Ink Too	695 Dartmouth Street
Kiddie Kampus 1	26 Old Westport Road
Kiddie Kampus 2	31 Old Westport Road
Kiddie Kampus 3	445 Faunce Corner Road
Learning House Pre-School	550 Russells Mills Road
Little People's College	52 Donald Street
Renaissance Kids Academy	527 Slocum Road
Sal's Pals	1305 Reed Road
Smith Mills Preschool & Kindergarten	11 Anderson Way
Animal Shelters	
Anchor Animal Hospital	750 State Road
Chase Farm Veterinary Hospital	35 Ventura Drive
Humane Society & Shelter	31 Ventura Drive
Cultural and Historic Sites	
Apponegansett Meeting House	850 Russells Mills Road
Hill School	4 Middle Street
South Dartmouth Cemetery	507 Elm Street
Parks and Recreational Sites	
Apponagansett Park	77 Gulf Road
Arthur F. Dias Town Landing	75 Gulf Road
Cornell Pond	707 Old Fall River Road
Dartmouth Community Park	Dartmouth Street
Dartmouth Regional Park & Trails	443 Old Fall River Road
Dartmouth Recreation Center	487 Smith Neck Road
Jones Park	66 Saint John Street
Montha's Park	End of Mary Crapo Way
Paskamansett Landing	287 State Road
Paskamansett Park	879 Russells Mills Road
Round Hill Beach	231 Smith Neck Road
Rogers Street Waterways Access Point	10-12 Rogers Street
Russells Mills Landing	50 Horseneck Road

APPENDIX C – BULK FLAMMABLE STORAGE

The following provides an inventory of facilities storing flammable liquids in excess of 500 gallons, as registered with the Dartmouth Fire Districts.

Flammable Liquid Storage Over 500 Gallons

Facility Name	Address	Qty.	Capacity	Contents
Ash Away (LP Fill Site)	703 State Road	1	1,000 gal.	LP
BJ's Gas	460 State Road	2	15,000 gal.	Gasoline
BJ's (LP Fill Site)		1	1,000 gal.	LP
BJ's Monroe Muffler		2	680 gal.	Waste Oil
Bliss Express	627 Dartmouth Street	1 1	23,000 gal 7,000 gal	Gasoline Diesel
Bristol County Sheriff's	400 Faunce Corner Road	1 1	3,000 gal. 3,000 gal.	Gasoline Diesel
Cumberland Farms	118-122 State Road	3	8,000 gal.	Gasoline
Cumberland Farms	142 Rockdale Avenue	1 1	32,000 gal. 8,000 gal.	Gasoline Diesel
Cumberland Farms	240 Russells Mills Road	3	8,000 gal.	Gasoline
Dartmouth Fire District 3	140 Cross Road	1 1	7,000 gal. 3,000 gal.	Gasoline Diesel
Dartmouth Gas & Service	582 Dartmouth Street	2 1 1	6,000 gal. 3,000 gal. 4,000 gal.	Gasoline Gasoline Diesel
Dartmouth High School	555 Bakerville Road	2	12,000 gal.	Fuel Oil
Dartmouth Power Associates	1 Energy Road	4 1	427,717 gal. 18,400 gal.	Fuel Oil Aqueous Ammonia
Dartmouth School Administration Building	8 Bush Street	1	3,000 gal.	Fuel Oil
DeMello Elementary School	654 Dartmouth Street	1	10,000 gal.	Fuel Oil
DPW Highway	188 Faunce Corner Road	1 1	6,000 gal. 6,000 gal.	Gasoline Diesel
DPW Water & Sewer	1048 Allen Street	1 1	1,500 gal. 1,500 gal.	Gasoline Diesel
Hess Facility	94 Faunce Corner Road	3	10,000 gal.	Gasoline
Martin's Service Station	77 Sharp Street	2	6,000 gal.	Gasoline
Mobil Gas Station	155 Faunce Corner Road	1 1 1 1	12,000 gal. 10,000 gal. 8,000 gal. 4,000 gal.	Gasoline Gasoline Gasoline Diesel
Mobil Gas Station	285 State Road	1 1 1	10,000 gal. 8,000 gal 6,000 gal.	Gasoline Gasoline Gasoline

Flammable Liquid Storage Over 500 Gallons (continued)

Facility Name	Address	Qty.	Capacity	Contents
New Bedford Country Club	585 Slocum Road	1 1	500 gal. 500 gal.	Gasoline Diesel
New Bedford Refuse	600 Quanapoag Road	1	1,000 gal.	Diesel
New Bedford Yacht Club	208 Elm Street	1 1	5,000 gal. 5,000 gal.	Gasoline Diesel
Prestige Dartmouth, Inc.	532 Russells Mills Road	2 1	12,000 gal. 10,000 gal.	Gasoline Diesel
Round Hill Community Corp.	307 Smith Neck Road	1	1,000 gal.	Gasoline
Shell of Colbea	831 State Road	2 1	8,000 gal. 6,000 gal.	Gasoline Gasoline
Sparks	425 State Road	2	660 gal.	Waste Oil
SpeeDee Oil Change	197 State Road	1	1,000 gal.	Waste Oil
State Road Cement Block	656 State Road	1	3,000 gal.	Diesel
Stop & Shop	25 Faunce Corner Road	1	20,000 gal.	Gasoline
Tom's Auto Sales	401 State Road	3	1,200 gal.	Waste Oil
Toyota of Dartmouth	100 Faunce Corner Road	2	2,000 gal.	Waste Oil
UPS	373 Cross Road	1	4,000 gal.	Diesel
Zuber and Sons (LP Fill Site)	40 Old Fall River Road	1	1,000 gal.	LP

APPENDIX D – BACKUP POWER SUPPLIES

The following provides an inventory of backup power sources capable of supplying emergency power to water and sewer infrastructure.

Facility	Address	Power Source	Fuel Type	Quantity	Expected Duration
Sewer Treatment Infrastructure					
Wastewater Treatment Facility	759 Russells Mills Road	3 generators	Diesel	Varies	Varies
Castaldi Station	Castaldi Drive	Generator	Natural gas	N/A	N/A
Clarence Station	57 Captains Lane	Generator	Diesel	300 gallons	2-3 days
Deerfield Road Station	15 Deerfield Road	Portable generator			
Eisenhower Station	Eisenhower Street	Generator	Diesel	221 gallons	4-5 days
Elswick Street Station	10 Elswick Street	Generator	Propane	500 gallons	8-10 days
Faunce Corner Station	43 Faunce Corner Road	Generator	Diesel	40 gallons	6-8 hours
Grove Street Station	10 Grove Street	Portable generator			
Gulf Road Station	142 Gulf Road	Generator	Propane	500 gallons	30 days
Junior Street Station	1 Junior Street	Generator	Propane	500 gallons	14 days
Kingston Station	Kingston Street	Portable generator			
Lake Noquochoke Station	736 Reed Road	Generator	Diesel	150 gallons	3 days
Lakeside Avenue Station	6 West Avenue	Portable generator			
Lakewood Road Station	65 Lakewood Road	Portable generator			
Lincoln Park Station	6 Beeden Road	Generator	Propane	500 gallons	8-10 days
Mosher Street Station	Mosher Street	Generator	Natural Gas	N/A	N/A
North Station	1118 Tucker Road	Generator	Diesel	300 gallons	2-3 days
Reed Road Station	643 Reed Road	Generator	Diesel	150 gallons	3 days
Route 6 Station	688 State Road	Generator	Propane	550 gallons	10-12 days
Sharon Avenue Station	33 Sharon Avenue	Generator	Propane	500 gallons	12-14 days
South Station	260 Russells Mills Road	Generator	Diesel	550 gallons	3 days
Woodcart Drive Station	17 Woodcart Drive	Portable generator			
West Smith Neck Station	35 West Smith Neck Road	Generator	Propane	500 gallons	15-17 days

Facility	Address	Power Source	Fuel Type	Expected Duration
Water Supply Infrastructure				
DPW Water & Sewer Division	751 Allen Street	Generator	Gas	
Water Treatment Facility	299 Chase Road	Generator	Propane	
Water Treatment Facility	687 Chase Road	Generator	Diesel	
Water Treatment Facility	579 Old Westport Road	Generator	Gas	
Water Department Garage	1048 Allen Street	none	N/A	
Allen Street Elevated Tank and Standpipe	1048 Allen Street	none	N/A	
Old Fall River Road Tank	396 Old Fall River Road	none	N/A	
Cross Road Tank	142 Cross Road	none	N/A	
Smith Neck Road Tank	80 South Avenue	none	N/A	
Faunce Corner Pumping Station	793 Faunce Corner Road	none	N/A	
Violetta 1, 2 and 3 Wells	547 R Old Westport Road	Generator	Propane	
Penelli 1 and 2 Wells	408 Old Westport Road	Generator	Propane	
A, B, C, F-1, and F-2 Wells	299 Chase Road	A, B, C: portable generators	A, B, C: propane	
D, E-1 and E-2 Wells	687 Chase Road	D, E1: power from treatment plant, E2: portable	Diesel	

APPENDIX E – STAPLEE PLANNING CRITERIA

The STAPLEE method was developed by the Federal Emergency Management Association as a technique for identifying, evaluating and prioritizing mitigation actions based on existing local conditions. Using the following criteria as provided in FEMA's 2008 Local Multi-Hazard Mitigation Planning Guidance document, local communities can weigh the pros and cons of implementing particular mitigation measures:

- **S**ocial — The public must support the overall implementation strategy and specific mitigation actions. Therefore, the projects will have to be evaluated in terms of community acceptance.

- **T**echnical — It is important to determine of the proposed action is technically feasible, will help reduce losses in the long term, and has minimal secondary impacts. Determine whether the alternative action is a whole or partial solution, or not a solution at all.

- **A**dministrative — Examine the anticipated staffing, funding, and maintenance requirements for the mitigation action to determine if the jurisdiction has the personnel and administrative capabilities necessary to implement the action or whether outside help will be needed.

- **P**olitical — Understand how your community and State political leadership feels about issues related to the environment, economic development, safety, and emergency management. Proposed mitigation objectives sometimes fail because of a lack of political acceptability.

- **L**egal — Determine whether your jurisdiction has the legal authority to implement the action, or whether the jurisdiction must pass new laws or regulations. Legal authority is likely to have a significant role later in the process when your community will have to determine how mitigation activities can best be carried out, and to what extent mitigation policies and programs can be enforced.

- **E**conomic — Cost-effective mitigation actions that can be funded in current or upcoming budget cycles are more likely to be implemented than mitigation actions that would incur long-term debt. Communities with tight budgets or budget shortfalls may be more willing to undertake a mitigation initiative if it can be funded, at least in part, by outside sources.

- **E**nvironmental — Evaluate whether, when implementing mitigation actions, there would be negative consequences to environmental asses such as threatened and endangered species, wetlands, and other protected natural resources.

APPENDIX F – DOCUMENTATION OF PLAN ADOPTION

Final certification to be completed and attached upon plan finalization.

TOWN OF DARTMOUTH, MASSACHUSETTS

CERTIFICATE OF ADOPTION

DARTMOUTH, MASSACHUSETTS

SELECT BOARD

A RESOLUTION ADOPTING THE

DARTMOUTH, MA LOCAL MULTI-HAZARD MITIGATION PLAN, 2015 UPDATE

WHEREAS, the Town of Dartmouth established a Committee to prepare the Hazard Mitigation plan; and

WHEREAS, the Town of Dartmouth, participated in the development of the **DARTMOUTH, MA LOCAL MULTI-HAZARD MITIGATION PLAN, 2015 UPDATE**;

and WHEREAS, the **DARTMOUTH, MA LOCAL MULTI-HAZARD MITIGATION PLAN, 2015 UPDATE** and contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Dartmouth, and

WHEREAS, a duly-noticed public meeting was held by the SELECT BOARD on July 27, 2015 for the public and municipality to review prior to consideration of this resolution; and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Dartmouth Select Board, formally approves and adopts the **DARTMOUTH, MA LOCAL MULTI-HAZARD MITIGATION PLAN, 2015 UPDATE** Hazard Mitigation Plan, in accordance with M.G.L. c. 40.

ADOPTED AND SIGNED this July 27, 2015

Shawn D. McDonald, Chairman

Stanley M. Mickelson, Vice Chairman

Frank S. Gracie III

Kelli A. Martin-Taglianetti

ATTEST