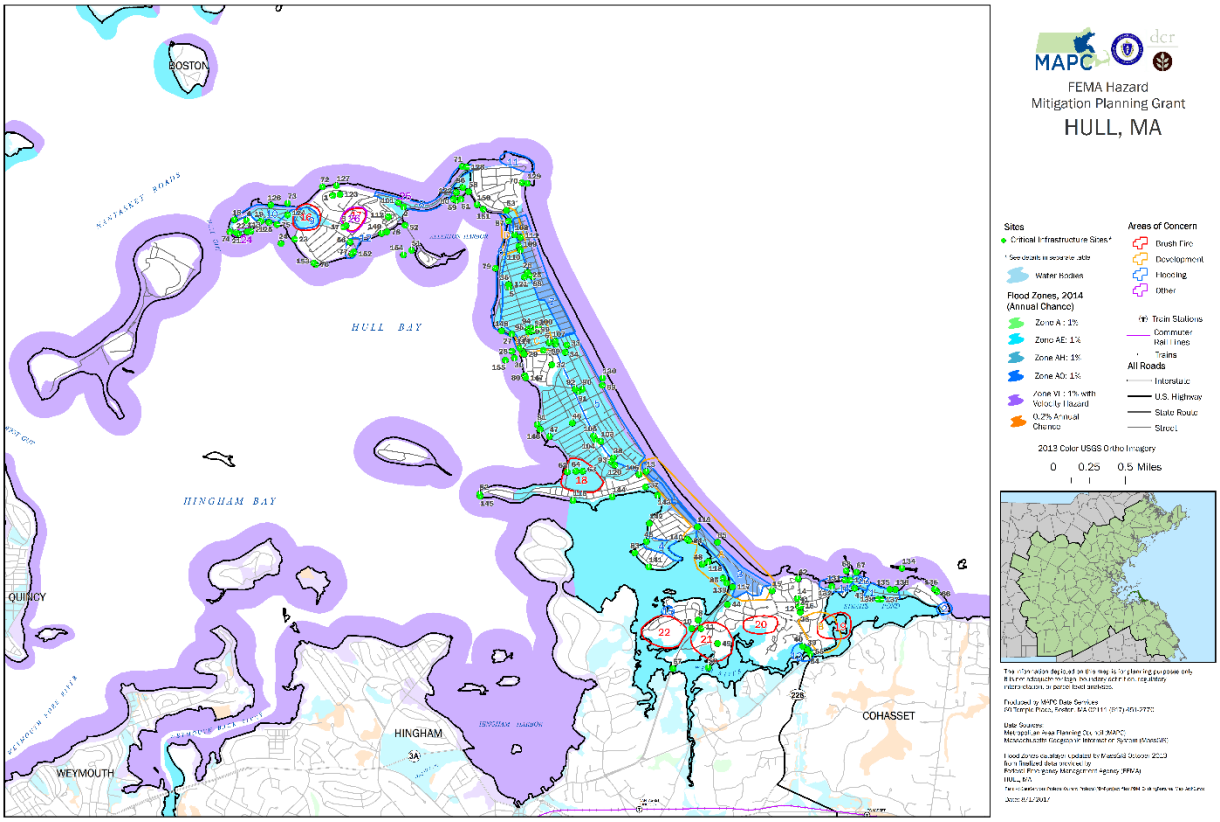
TOWN OF HULL
HAZARD MITIGATION PLAN
2018 UPDATE



MAPC 50 YEARS
METROPOLITAN AREA PLANNING COUNCIL
SMART GROWTH AND REGIONAL COLLABORATION

Final Plan
Adopted by the Town
April 26, 2018

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ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the Town of Hull by the Metropolitan Area Planning Council (MAPC) under the direction of the Massachusetts Emergency Management Agency (MEMA) and the Massachusetts Department of Conservation and Recreation (DCR).

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2018 UPDATE

I. EXECUTIVE SUMMARY

Hazard Mitigation planning is a proactive effort to identify actions that can be taken to reduce the dangers to life and property from natural hazard events. In the communities of the Boston region of Massachusetts, hazard mitigation planning tends to focus most on flooding, the most likely natural hazard to impact these communities. The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to be eligible to receive FEMA funding for hazard mitigation grants, to adopt a local multi-hazard mitigation plan and update this plan in five year intervals.

Planning Process

Planning for the Hazard Mitigation Plan update was led by the Hull Local Hazard Mitigation Planning Team, composed of staff from a number of different Town Departments. This team met on August 9, 2017, October 18, 2017, and November 15, 2017, and discussed where the impacts of natural hazards most affect the Town, goals for addressing these impacts, updates to the Town's existing mitigation measures and new or revised hazard mitigation measures that would benefit the Town.

Public participation in this planning process is important for improving awareness of the potential impacts of natural hazards and to build support for the actions the Town takes to mitigate them. The Town's Hazard Mitigation Planning Team hosted two public meetings, the first on September 19, 2017 and the second on February 8, 2018, and the draft plan update was posted on the Town's website for public review. Key town stakeholders and neighboring communities were notified and invited to review the draft plan and submit comments. No public comments were received.

Risk Assessment

The Hull Hazard Mitigation Plan assesses the potential impacts to the Town from flooding, high winds, winter storms, brush fire, geologic hazards, extreme temperatures, and drought. These are shown on the map series (Appendix B).

The Hull Local Hazard Mitigation Planning Team identified 149 Critical Facilities. These are also shown on the map series and listed in Table 22, identifying which facilities are located within the mapped hazard zones.

A HAZUS-MH analysis provided estimates of damages from Hurricanes of category 2 and 4 ($19 million to $115 million), earthquakes of magnitudes 5 and 7 ($184 million to $1.4 billion), and flood damage estimates for the 100 and 500 year storms ($299,540,000 million to $448,670,000 million).

Hazard Mitigation Goals

The Hull Local Hazard Mitigation Planning Team identified the following hazard mitigation goals for the Town:

Goal 1: Ensure that critical infrastructure sites are protected from natural hazards.

Goal 2: Protect existing residential and business areas from flooding.

Goal 3: Maintain existing mitigation infrastructure in good condition.

Goal 4: Continue to enforce current zoning and building regulations.

Goal 5: Educate the public about zoning and building regulations, particularly with regard to changes in regulations that may affect tear-downs and new construction.

Goal 6: Work with surrounding communities to ensure regional cooperation and solutions for hazards affecting multiple communities such as coastal erosion.

Goal 7: Encourage future development that addresses hazard mitigation including measures that reflect mitigation and adaptation to climate change and the risk of sea level rise.

Goal 8: Educate the public about natural hazards and mitigation measures including the potential impacts of climate change.

Goal 9: Make efficient use of public funds for hazard mitigation.

Hazard Mitigation Strategy

The Hull Local Hazard Mitigation Planning Team identified a number of mitigation measures that would serve to reduce the Town's vulnerability to natural hazard events. Historically, flooding from coastal storms has been the most significant natural hazard facing Hull. In 2016, Hull commissioned a "Coastal Climate Change Vulnerability Assessment and Adaptation Study" which considered additional threats posed by future climate change, and in particular sea level rise. The team added a Climate Resilience/Adaptation section that includes such mitigation measures as relocating the light plant to a higher elevation and increasing flood protection for the Memorial Middle School and elevating utilities at the sewer plant. Other recommendation include integrating climate considerations into capital plans, as well as open space and master plans, updating evacuation plans and educating residents on protection strategies.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Hull will be an ongoing process as our understanding of natural hazards and the steps that can be taken to mitigate their damages changes over time. Global climate change and a variety of other factors impact the Town's vulnerability now and in the future, and local officials will need to work together across municipal lines and with state and federal agencies in order to understand and address these changes. The Hazard Mitigation Strategy will be incorporated into the Town's other related plans and policies.

Plan Review and Update Process

The process for developing Hull's Hazard Mitigation Plan 2018 Update is summarized in Table 1 below.

Table 1 Plan Review and Update Process

Chapter	Reviews and Updates
III – Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan, discussing strategies to enhance participation opportunities at the first local committee meeting. During plan development, the plan was discussed at two public meetings hosted by the Capital Outlay Committee and the Board of Selectmen. The plan was also available on the Town's website for public comment. No public comments were received.
IV – Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. Town staff reviewed critical infrastructure with MAPC staff in order to create an up-to-date list. MAPC also used the most recently available version of HAZUS to assess potential impacts of flooding, earthquakes, and hurricanes.
V - Goals	The Hazard Mitigation Goals were reviewed and endorsed by the Hull Local Hazard Mitigation Planning Team.
VI – Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the Town.
VII & VIII – Hazard Mitigation Strategy	Mitigation measures from the 2012 plan were reviewed and assessed as to whether they were completed, in-progress, or deferred. The Local Hazard Mitigation Planning Team determined whether to carry forward measures into the 2018 Plan Update or modify or delete them. The Plan Update's hazard mitigation strategy reflects both new measures and measures carried forward from the 2012 plan. The Local Hazard Mitigation Team prioritized all of these measures based on current and future conditions.
IX – Plan Adoption & Maintenance	This section of the plan was updated with a new on-going plan for implementation review and a five year update process that will assist the Town in incorporating hazard mitigation issues into other Town planning and regulatory review processes and better prepare the Town for the next comprehensive plan update.

As indicated on Table 27, Hull made good progress on implementing mitigation measures identified in the 2012 Hazard Mitigation Plan. Many flood protection projects have been completed, including major improvements to revetments and seawalls at Stony and Crescent Beaches, upgrades and repairs to pump stations, flapper valve installation in nine locations, FEMA flood elevation grants, annual beach grass planting, and the on-going freeboard incentive program. In addition the electric light plant hardened wiring and infrastructure, many upgrades

to communications and emergency operations were instituted, public education was expanded considerably, and the town completed a study of risks from future sea level rise.

Several projects that were not completed will be continued into this plan update. These include the Bay Avenue East drainage project, for which funding has been secured, relocation of Aquarion water pipes, and installation of hurricane doors at the A Street fire station.

Moving forward into the next five year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town's decision making processes. The Hazard Mitigation Implementation Team, consisting of the Town Manager and Department Heads from Planning and Community Development, Conservation, Building, Public Works, Light Plant, Police, Fire, Harbormaster, Wastewater Treatment, and Health, met annually to review and revise the mitigation measures from the 2012 plan. The Hazard Mitigation Implementation Team will continue its annual review as described in Section IX, Plan Adoption and Maintenance.

II. INTRODUCTION

Planning Requirements under the Federal Disaster Mitigation Act

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

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

Massachusetts has taken a regional approach and has encouraged the regional planning agencies to apply for grants to prepare plans for groups of their member communities. The Town of Hull contracted with the Metropolitan Area Planning Council (MAPC), to assist the Town in updating its local Hazard Mitigation Plan, which was first adopted in 2007 as a multijurisdictional plan. The local Hazard Mitigation Plan update produced under this contract is designed to individually meet the requirements of the Disaster Mitigation Act for each community while listing regional concerns and hazards that impact the Town or City creating the plan.

What is a Hazard Mitigation Plan?

Natural hazard mitigation planning is the process of determining how to systematically reduce or eliminate the loss of life and property damage resulting from natural hazards such as floods, earthquakes, and hurricanes. Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, projects, and other activities.

Previous Federal/State Disasters

The Town of Hull has experienced 22 natural hazards that triggered federal or state disaster declarations since 1991. These are listed in Table 2 below. The majority of these events involved flooding, while eight were due to hurricanes or nor'easters, and seven were due to severe winter weather.

Table 2 Previous Federal/State Disaster Declarations

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
Hurricane Bob (August 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)
No-Name Storm (October 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	FEMA Individual Household Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
December Blizzard (December 1992)	FEMA Public Assistance Project Grants	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk (7 projects)
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	All 14 Counties
May Windstorm (May 1996)	State Public Assistance Project Grants	Counties of Plymouth, Norfolk, Bristol (27 communities)
October Flood (October 1996)	FEMA Public Assistance Project Grants	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	FEMA Individual Household Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk (36 projects)
1997	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
June Flood (June 1998)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (19 projects)
(1998)	Community Development Block Grant-HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
March Flood (March 2001)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)
February Snowstorm (Feb 17-18, 2003)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 22-23, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
Hurricane Katrina (August 29, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
May Rainstorm/Flood (May 12-23, 2006)	Hazard Mitigation Grant Program	Statewide
April Nor'easter (April 15-27, 2007)	Hazard Mitigation Grant Program	Statewide
Flooding (March, 2010)	FEMA Public Assistance FEMA Individuals and Households Program SBA Loan	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Statewide
Hurricane Earl (September 2010)	FEMA Public Assistance Project Grants	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester
Tropical Storm Irene (August 27-28, 2011)	FEMA Public Assistance	Statewide
Hurricane Sandy (October 27-30, 2012)	FEMA Public Assistance	Statewide
Severe snowstorm and Flooding (February 8-09, 2013	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide
Blizzard of 2015 (January 26-28, 2015)	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide

Source: database provided by MEMA

FEMA Funded Mitigation Projects

FEMA Funded Mitigation Projects

Over the last 27 years the Town of Hull has received funding from FEMA for seven mitigation projects under the Hazard Mitigation Grant Program (HMGP) and the Flood Mitigation Assistance Program (FMA). In addition, the Massachusetts DEM received HMGP funding to support work at Allerton Point. These projects totaled more than $2,044,858, with $1,533,644 covered by FEMA grants and $511,214 by local funding. The projects are summarized in Table 3 below.

Table 3 FEMA-Funded Mitigation Projects

Year	Project Title	Scope of Work	Total Cost	Federal Funding	Local Funding
2010	HMGP	Elevate one home, retrofit utilities for one home	$41,481	$31,111	$10,370
2009	FMA – Elevations & Retrofits	Elevate three (3) properties, retrofit utilities at one (1) home	$310,460	$240,889	$69,560
2007 (April Nor'easter)	HMGP - Elevations and Retrofits	Elevate five (5) homes, retrofit utilities at one (1) home.	$315,539	$236,519	$78,840
1996 (October Flood)	HMGP - Allerton Point Seawall Upgrade	Placement of an embedded toe and reconstruction of existing revetment.	$1,294,262	$940,360	$323,566 (DEM)
1992 (December Blizzard)	HMGP - Ocean Meadows – Retrofitting / Elevation	Retrofitting: relocating heating systems; elevation	$52,312	$36,982	$12,327
1991 (Hurricane Bob)	HMGP - Ocean Meadows – Retrofitting / Elevation	Retrofitting: relocating heating systems; elevation	$17,155	$12,128	$4,042
1991 (No-Name Storm)	HMGP - Treatment Plant	Purchase emergency generator for Pumping Station A	$13,649	$8,942	$2,980

(Source: database provided by MEMA)

Community Profile

Hull is located 18 miles southeast of Boston on a long narrow peninsula projecting into Boston harbor. In 1825 a new industry was launched in Hull when Paul Warrick built the Sportsman Hotel on Nantasket Avenue, the very first hotel in the town. The magnificent beaches of the town, easy

access to Boston, and sea air brought hordes of visitors. By 1840 steamers were making three trips a day between Boston and Hull. Boardinghouses and elaborate hotels catered to visitors while Hull fishermen and farmers still pulled nets and farmed in its rural acreage. When Paragon Park closed in 1985, an era ended for the town and the millions of visitors. But another era began as Hull acquired a suburban character with a growing number of year-round residents moving into town, and today there are over 11,050 residents.

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

- While Hull's year-round population has grown, Hull still has a significant seasonal population. Nantasket Beach draws thousands of daily visitors during the summer season.
- Hull's status as a seaside community; economic activity includes lobstering, fishing, and several marinas.
- Hull has a relatively small commercial base, the town is reliant on residential property taxes to support municipal services.
- Hull is highly vulnerable to coastal storms and has only three evacuation routes from town.
- Hull's natural resources and beauty are highly valued by residents.

The town maintains a website at www.town.hull.ma.us

Table 4 - Hull Characteristics

Population = 10,293
• 4.1% are under age 5 • 17.3% are under age 18
• 15.5% are over age 65
• 2.7% speak English less than "very well" (over age 5)
• 8.1% of households have no vehicle
• 14.6% have a disability
Number of Housing Units = 5,762
• 29.5% are renter-occupied housing units
• 40.9% of housing units were built before 1940

Source: U.S. Census, 2010 and American Community Survey 2015

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III. PLANNING PROCESS AND PUBLIC PARTICIPATION

MAPC employs a six step planning process based on FEMA's hazard mitigation planning guidance focusing on local needs and priorities, but maintaining a regional perspective matched to the scale and nature of natural hazard events. Public participation is a central component of this process, providing critical information about the local occurrence of hazards while also serving as a means to build a base of support for hazard mitigation activities. MAPC supports participation by the general public and other plan stakeholders through Local Hazard Mitigation Planning Teams, two public meetings hosted by the local Hazard Mitigation Team, posting of the plan to the Town's website, and invitations sent to neighboring communities, Town boards and commissions, the local chamber of commerce, and other local or regional entities to review the plan and provide comment.

Planning Process Summary

The seven-step planning process outlined below is based on the guidance provided by FEMA in the Local Multi-Hazard Mitigation Planning Guidance. Public participation is a central element of this process, which attempts to focus on local problem areas and identify needed mitigation measures based on where gaps occur in the existing mitigation efforts of the municipality. By working on municipal hazard mitigation plans in groups of neighboring cities and towns, MAPC is able to identify regional opportunities for collaboration and facilitate communication between communities. In plan updates, the process described below allows staff to bring the most recent hazard information into the plan, including new hazard occurrence data, changes to a municipality's existing mitigation measures, and progress made on actions identified in previous plans.

- Map the Hazards – MAPC relies on data from a number of different federal, state, and local sources in order to map the areas with the potential to experience natural hazards. This mapping represents a multi-hazard assessment of the municipality and is used as a set of base maps for the remainder of the planning process. A particularly important source of information is the knowledge drawn from local municipal staff on where natural hazard impacts have occurred. These maps can be found in Appendix B.

- Assess the Risks & Potential Damages – Working with local staff, critical facilities, infrastructure, vulnerable populations, and other features are mapped and contrasted with the hazard data from the first step to identify those that might represent particular vulnerabilities to these hazards. Land use data and development trends are also incorporated into this analysis. In addition, MAPC develops estimates of the potential impacts of certain hazard events on the community. MAPC drew on the following resources to complete the plan:

    - Town of Hull, Annual Report 2016
    - Town of Hull Zoning By-Laws
    - Town of Hull Community Development Strategy
    - Town of Hull Open Space and Recreation Plan, 2000
    - Kleinfelder Inc., Coastal Climate Change Vulnerability Assessment and Adaptation Study, 2016
    - Environment America Research and Policy Center, *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation,* July 2012
    - FEMA, Local Mitigation Plan Review Guide; October 1, 2011
    - FEMA, Flood Insurance Study, Plymouth County, 11/4/2016
    - FEMA Flood Insurance Rate Maps for Plymouth County, MA, 2012
    - FEMA LOMR, Effective 12/13/17
    - MA Office of Coastal Zone Management, Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning, December 2013.
    - MA Office of Dam Safety, Inventory of Massachusetts Dams
    - Massachusetts State Hazard Mitigation Plan, 2013
    - Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data.
    - New England Seismic Network, Boston College Weston Observatory, http://aki.bc.edu/index.htm
    - NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/
    - Northeast States Emergency Consortium, http://www.nesec.org/
    - US Census, 2010

- Review Existing Mitigation – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as most have adopted flood plain zoning districts, wetlands protection programs, and other measures as well as enforcing the State building code, which has strong provisions related to hazard resistant building requirements. All current municipal mitigation measures must be documented.

- Develop Mitigation Strategies – MAPC works with the local municipal staff to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessments, and the community's existing mitigation efforts to determine where additional

work is necessary to reduce the potential damages from hazard events. Additional information on the development of hazard mitigation strategies can be found in Chapter VII.

- Plan Approval & Adoption – Once a final draft of the plan is complete it is sent to MEMA for the state level review and, following that, to FEMA for approval. Typically, once FEMA has approved the plan, the agency issues a conditional approval (Approval Pending Adoption), with the condition being adoption of the plan by the municipality. More information on plan adoption can be found in Chapter IX and documentation of plan adoption can be found in Appendix D.

- Implement & Update the Plan – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a five year basis making preparation for the next plan update an important on-going activity. Chapter IX includes more detailed information on plan implementation.

2012 Plan Implementation and Maintenance

The 2012 Town of Hull Hazard Mitigation Plan contained a risk assessment of identified hazards for the Town and mitigation measures to address the risk and vulnerability from these hazards. Since approval of the plan by FEMA and local adoption, progress has been made on implementation of the measures. The Town has advanced many projects for implementation, including a significant investment in both structural and natural resource improvement projects to protect against flooding.

The Local Multiple Hazard Community Planning Team

MAPC worked with the local community representatives to organize a Local Hazard Mitigation Planning Team for Hull. MAPC briefed the local representatives as to the desired composition of that team as well as the need for public participation in the local planning process.

The Local Hazard Mitigation Planning Team is central to the planning process as it is the primary body tasked with developing a mitigation strategy for the community. The local team was tasked with working with MAPC to set plan goals, provide information on the hazards that impact the town, existing mitigation measures, and helping to develop new mitigation measures for this plan update. The Local Hazard Mitigation Planning Team membership can be found in Table 5 below.

The Hull Planning Board, the Hull Conservation Commission, are the primary entities responsible for regulating development in town. Feedback from the Planning Board and the Conservation Commission was assured through the participation of the Director of Community Development and Planning, Conservation Administrator and the Town Manager. In addition, MAPC, the State-designated regional planning authority for Hull, works with all agencies that that regulate development in the region, including the listed municipal entities and state agencies, such as the MassDOT and the Department of Conservation and Recreation.

The Local Hazard Mitigation Planning Team met on: August 9, October 18, and November 15, 2017. The purpose of the first meeting included review and updates to the hazard mitigation goals, and gathering information on local hazard mitigation issues, and sites or areas related to these. The second meeting focused on verifying information gathered by MAPC staff and

discussion of existing mitigation practices, the status of mitigation measures identified in the 2012 hazard mitigation plan, and potential new or revised mitigation measures. The third meeting finalized new mitigation measures and focusing primarily on evaluating measures to address future sea level rise.

The agendas for these meetings are included in Appendix A.

Table 5
Membership of the Hull Hazard Mitigation Planning Team

Name	Representing
Chris Krahforst	Conservation
Chris Dilorio	Planning and Community Development
Phillip Lemnios	Town Manager
Joyce Sullivan	Health Department
Chris Russo	Fire Department
Bartley Kelly	Building Department
Kurt Bornheim	Harbormaster
Jim Dow	Public Works
John Struzziery	Wastewater Treatment Plant
John Dunn	Police Department
Panos Takadjian	Light Plant

Public Meetings

Public participation in the hazard mitigation planning process is important, both for plan development and for later implementation of the plan. Residents, business owners, and other community members are an excellent source for information on the historic and potential impacts of natural hazard events and particular vulnerabilities the community may face from these hazards. Their participation in this planning process also builds understanding of the concept of hazard mitigation, potentially creating support for mitigation actions taken in the future to implement the plan. To gather this information and educate residents on hazard mitigation, the Town hosted two public meetings, one during the planning process and one after a complete draft plan was available for review.

Natural hazard mitigation plans unfortunately rarely attract much public involvement in the Boston region, unless there has been a recent hazard event. One of the best strategies for overcoming this challenge is to include discussion of the hazard mitigation plan on the agenda of an existing board or commission. With this strategy, the meeting receives widespread advertising and a guaranteed audience of the board or commission members plus those members of the public who attend the meeting. These board and commission members represent an engaged audience that is informed and up to date on many of the issues that relate to hazard mitigation planning in the locality and will likely be involved in plan implementation, making them an important audience with which to build support for hazard mitigation measures. In addition, these meetings frequently receive press coverage, expanding the audience that has the opportunity to hear the presentation and provide comment.

The public had an opportunity to provide input to the Hull hazard mitigation planning process during a meeting of the Capital Outlay Committee on September 19, 2017 held in the Hull High

School Media Room. It was broadcast live on local cable television. The draft plan update was presented at a Board of Selectmen meeting on February 8, 2018 at Hull Town Hall. Both meetings were publicized in accordance with the Massachusetts Public Meeting Law. The attendance list for each meeting can be found in Table 6. See public meeting notices in Appendix C. No public comments were received.

Table 6 Hull Public Meetings	
Meeting #1 September 19, 2017	
Total Attendance: 24	
Name	**Representing**
Chris Krahforst	Conservation Department
Chris Dilorio	Planning and Community Development
Philip Lemnios	Town Manager
Bart Kelly	Building Department
Participants included: the Capital Outlay Committee, Selectmen (4), Town Counsel, and representatives from the: Planning Board, Conservation Commission, Community Preservation Act Committee, Advisory Committee, School Committee, Chamber of Commerce, and general public.	
Meeting #2 February 8, 2018	
Chris Krahforst	Conservation Department
Kevin Richardson	Board of Selectmen
Chris Mitchell	Board of Selectmen
John Reilly	Board of Selectmen
Philip Lemnios	Town Manager
Rhoda Kanet	Beach Management Committee

Local Stakeholder Involvement

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

Town of Hingham
Town of Cohasset
Hull Nantasket Chamber of Commerce
Wellspring
U.S. Coastguard
Lifesaving Museum
Hull Redevelopment Authority
Weir River Watershed Association
Straits Pond Watershed Association

No public comments were received. See Appendix C for public meeting notices.

Town Web Site

The draft Hull Hazard Mitigation Plan 2018 Update was posted on the Town's website for the second public meeting. Members of the public could access the draft document and submit comments or questions to the Town. No public comments were received.

Continuing Public Participation

Following the adoption of the plan update, the planning team will continue to provide residents, businesses, and other stakeholders the opportunity to learn about the hazard mitigation planning process and to contribute information that will update the town's understanding of local hazards. As the annual update and review of the plan are conducted by the Hazard Mitigation Implementation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Implementation Team will be publicly noticed in accordance with town and state open meeting laws.

Planning Timeline

August 9, 2017	Meeting of the Hull Hazard Mitigation Team
September 19, 2017	First Public Meeting with Hull Hazard Mitigation Team
October 18, 2017	Meeting of the Hull Hazard Mitigation Planning Team
November 15, 2017	Meeting of the Hull Hazard Mitigation Team
February 8, 2018	Second Public Meeting before the Board of Selectmen
February 28, 2018	Draft Plan Update submitted to MEMA
April 2, 2018	Notice of Approval Pending Adoption issued by FEMA

IV. RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town of Hull as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. This section also includes a vulnerability assessment that estimates the potential damages that could result from certain large scale natural hazard events.

Update Process

In order to update Hull's risk assessment, MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. MAPC also used FEMA's damage estimation software, HAZUS (described below).

Overview of Hazards and Impacts

The Massachusetts Hazard Mitigation Plan provides an in-depth overview of natural hazards in Massachusetts. Previous state and federal disaster declarations since 1991 are summarized in Table 2. Table 7 below summarizes the hazard risks for Hull. This evaluation takes into account the frequency of the hazard, historical records, and variations in land use. This analysis is based on the vulnerability assessment in the Massachusetts State Hazard Mitigation Plan. The statewide assessment was modified to reflect local conditions in Hull using the definitions for hazard frequency and severity listed below. Based on this, the Town developed locally-specific rankings for the frequency and severity of each category of natural hazard in Hull.

Table 7 - Hazard Risks Summary

Hazard	Frequency		Severity	
	Massachusetts	Hull	Massachusetts	Hull
Flooding	High	High	Serious	Serious
Dam failures	Very Low	Very Low	Extensive	Extensive
Coastal Hazards	High	High	Serious	Serious
Tsunami	Very Low	Very Low	Extensive	Extensive
Hurricane/Trop Storm	Medium	Medium	Serious	Serious
Tornadoes	Medium	Low	Serious	Serious
Thunderstorms	High	High	Minor	Minor
Nor'easter	High	High	Extensive	Extensive
Winter-Blizzard/Snow	High	High	Minor	Minor
Winter-Ice Storms	Medium	Medium	Minor	Minor
Earthquakes	Very Low	Medium	Serious	Serious
Landslides	Low	Low	Minor	Minor
Brush fires	Medium	Medium	Minor	Minor
Extreme Temperatures	Medium	Medium	Minor	Minor
Drought	Low	Low	Minor	Minor

Source, Massachusetts State Hazard Mitigation Plan, 2013, modified for Hull.

Definitions used in the Commonwealth of Massachusetts State Hazard Mitigation Plan

Frequency
Very low frequency: events that occur less frequently than once in 100 years (less than 1% per year)
Low frequency: events that occur from once in 50 years to once in 100 years (1% to 2% per year);
Medium frequency: events that occur from once in 5 years to once in 50 years (2% to 20% per year);
High frequency: events that occur more frequently than once in 5 years (Greater than 20% per year).

Severity
Minor: Limited and scattered property damage; limited damage to public infrastructure and essential services not interrupted; limited injuries or fatalities.
Serious: Scattered major property damage; some minor infrastructure damage; essential services are briefly interrupted; some injuries and/or fatalities.
Extensive: Widespread major property damage; major public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and/or fatalities.
Catastrophic: Property and public infrastructure destroyed; essential services stopped; numerous injuries and fatalities.

It should be noted that one of the hazards listed in the 2013 Massachusetts State Hazard Mitigation plan is not applicable to the Town of Hull. Due to its size and the development patterns in Hull, Major Urban Fires are not applicable.

Flood Related Hazards

Flooding was the most prevalent natural hazard identified by local officials in Hull. Flooding is generally caused by hurricanes, nor'easters, severe rainstorms and thunderstorms. Global climate change has the potential to exacerbate these issues over time with the potential for changing rainfall patterns and heavier storms and higher sea levels leading to more coastal flooding.

Regionally Significant Floods

There have been a number of major floods that have affected the Metro Boston region over the last fifty years. Significant historic flood events in Hull have included:

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991 ("The Perfect Storm") Considered to be a 100-year storm.
- December 1992
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- December 2010
- March 2013

On January 4, 2018 Hull experienced significant flooding due to a nor'easter. The storm coincided with astronomical high tides and resulted in a surge, recorded at the Boston tide station, of 15.16 – higher than the highest surge from the Blizzard of 78. As a result the Town additional flooding areas that hadn't previously been identified (see Flood Hazard Areas below).

Town-specific data for previous flooding occurrences are not collected by the Town of Hull. The best available local data is from the National Climatic Data Center (see Table 8). Plymouth County, which includes the Town of Hull, experienced 37 flood events from 1996 –2014. No deaths or injuries were reported and the total reported property damage in the county was $25.8 million dollars.

Table 8 Plymouth County Flood Events, 1996-2017

Location	Date	Type	Deaths	Injuries	Property Damage
PLYMOUTH CO.	9/18/1996	Flood	0	0	0
PLYMOUTH CO.	3/5/2001	Flood	0	0	0
EASTERN PLYMOUTH	3/28/2005	Flood	0	0	0
EASTERN PLYMOUTH / PART OF NORFOLK	10/15/2005	Flood	0	0	350,000
WESTERN PLYMOUTH	10/15/2005	Flood	0	0	200,000
EASTERN PLYMOUTH / PART OF NORFOLK	10/15/2005	Flood	0	0	50,000
WESTERN PLYMOUTH	10/15/2005	Flood	0	0	100,000
WESTERN PLYMOUTH	10/15/2005	Flood	0	0	140,000
EASTERN PLYMOUTH / PART OF NORFOLK	10/25/2005	Flood	0	0	35,000
EASTERN PLYMOUTH / PART OF NORFOLK	12/9/2005	Flood	0	0	40,000
SOUTHERN PLYMOUTH	5/13/2006	Flood	0	0	500,000
PLYMOUTH CO.	5/13/2006	Flood	0	0	0
PLYMOUTH CO.	6/7/2006	Flood	0	0	30,000
PLYMOUTH CO.	6/23/2006	Flood	0	0	2,000
PLYMOUTH CO.	8/20/2006	Flood	0	0	5,000
PLYMOUTH CO.	10/28/2006	Flood	0	0	10,000
PLYMOUTH CO.	3/2/2007	Flood	0	0	10,000
PLYMOUTH CO.	3/17/2007	Flood	0	0	8,000
PLYMOUTH CO.	4/15/2007	Flood	0	0	25,000
PLYMOUTH CO.	2/13/2008	Flood	0	0	0
PLYMOUTH CO.	3/8/2008	Flood	0	0	5,000
PLYMOUTH CO.	3/8/2008	Flood	0	0	0
PLYMOUTH CO.	9/27/2008	Flood	0	0	50,000
PLYMOUTH CO.	5/24/2009	Flood	0	0	0
PLYMOUTH CO.	8/29/2009	Flood	0	0	0

PLYMOUTH CO.	3/14/2010	Flood	0	0	16,150,000
PLYMOUTH CO.	3/29/2010	Flood	0	0	8,070,000
PLYMOUTH CO.	4/1/2010	Flood	0	0	0
PLYMOUTH CO.	7/13/2011	Flood	0	0	5,000
PLYMOUTH CO.	8/10/2012	Flood	0	0	30,000
PLYMOUTH CO.	5/11/2013	Flood	0	0	0
PLYMOUTH CO.	5/11/2013	Flood	0	0	0
PLYMOUTH CO.	6/7/2013	Flood	0	0	0
PLYMOUTH CO.	9/3/2013	Flood	0	0	0
PLYMOUTH CO.	3/30/2014	Flood	0	0	0
PLYMOUTH CO.	10/22/2014	Flood	0	0	0
PLYMOUTH CO.	11/17/2014	Flood	0	0	0
PLYMOUTH CO.	05/31/2015	Flood	0	0	0
PLYMOUTH CO.	07/28/2015	Flood	0	0	15,000
PLYMOUTH CO.	09/10/2015	Flood	0	0	0
PLYMOUTH CO.	10/29/2015	Flood	0	0	0
PLYMOUTH CO.	05/30/2016	Flood	0	0	0
PLYMOUTH CO.	04/01/2017	Flood	0	0	5,000
PLYMOUTH CO.	04/06/2017	Flood	0	0	5,000
TOTAL			**0**	**0**	**25,840,000**

Source: NOAA, National Climatic Data Center

Overview of Town-Wide Flooding

The Town of Hull is subject to two kinds of flooding; coastal flooding where wind and tide leads to flooding along the shore and tidal waterways and inland flooding where the rate of precipitation or amount of water overwhelms the capacity of natural and structured drainage systems to convey water causing it to overflow the system. These two types of flooding are often combined as inland flooding is prevented from draining by the push of wind and tide driven water. Both types of flooding can be caused by major storms, known as northeasters and hurricanes. Northeasters can occur at any time of the year but they are most common in winter.

The frequency and locations of flood hazard events in Hull can be estimated based on the reported loss occurrences for repetitive loss properties and from local knowledge captured through discussion with local staff and the public during identification of local flood hazard areas. Based on these factors flooding occurs most often along the ocean shoreline, where even a relatively small storm can lead to very high tides and overwash of seawalls and dunes, and in a number of low-lying neighborhoods throughout the town. Reported losses on repetitive loss properties indicate that a flood event resulting in property damage occurs on average a little more frequently than once a year, though there have been stretches of time over the last 30 years of up to a couple years during which flooding of this extent did not occur. In particular, winter storms in 1978, 1979, 1982, 1991, 1992, 2001, 2003 (twice), 2005, 2006, and 2007, 2010, and 2013 all led to extensive flood insurance claims in Hull's low lying, flood prone areas.

Inland/Riverine Flooding

Given Hull's largely peninsular geography, riverine flooding is less of a prominent issue compared to the hazards presented by coastal flood events. The Weir River and its tributaries, located at the southern end of the Town, is the only real river system. Flooding is relatively limited in this area and active land conservation and wetland protection measures in this area have limited the exposure of homes and businesses to this type of flooding.

Another type of inland flooding that is a greater issue for the Town is flooding driven by inadequate storm water drainage. Particularly an issue in those parts of the Town with greater levels of imperviousness, this flooding occurs in areas where the storm drain pipes are inadequately sized compared to the level of storm water run-off. Exceptionally high tides can also effectively block these storm drain systems, given Hull's generally low-lying geography.

Coastal Flooding

Coastal flooding is associated with severe coastal storms that, through the combination of winds and tides, drive tidal waters to higher levels than normally experienced, leading to the inundation of low lying land areas and the overtopping of sea walls. Hull has extensive exposure to coastal flooding and flooding along large stretches of its coastline can be a relatively frequent occurrence. The greatest amount of coastal storm related flooding is along the eastern coastline, which faces the greatest exposure to wind driven waves.

Sea Wall Failure and Coastal Erosion

Sea wall failure and coastal erosion are related issues increasingly impacting towns along the Massachusetts coast. Rising sea levels have led to increased rates of erosion along beaches and coastlines and the undermining of sea walls, some of which in the Boston region are many decades old. Sea walls protect the buildings behind them from storm damage and their failure can lead to increased property damage. Similarly, intact beaches with dunes dissipate wave energy, protecting buildings behind them. As the beaches erode away, this protection is lost. In some cases, sea walls can accelerate beach erosion. In April of 2010, 500 feet of sea wall in Marshfield collapsed due to undermining of its foundation from erosion.

FEMA has indicated in their latest rules that post hazard event reconstruction or repair funding for coastal protection structures will only be made available where the damage can be directly attributed to the storm event. Therefore, in order to receive this funding, the Town must maintain records of maintenance and repair activities that demonstrate the status of each structure.

Dams and Dam Failure

The Department of Conservation and Recreation (DCR) Office of Dam Safety lists one dam in Hull, which is ranked as a significant hazard.

Dam failure can arise from two types of situations. Dams can fail because of structural problems independent of any storm event. Dam failure can follow an earthquake by causing structural

damage. Dams can fail structurally because of flooding arising from a storm or they can overspill due to flooding.

In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters. An issue for dams in Massachusetts is that many were built in the 19th century without the benefits of modern engineering or construction oversight.

The Massachusetts DCR has three hazard classifications for dams:

High Hazard:	Dams located where failure or mis-operation will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).
Significant Hazard:	Dams located where failure or mis-operation may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities.
Low Hazard:	Dams located where failure or mis-operation may cause minimal property damage to others. Loss of life is not expected.

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

Straits Pond Dam – The Straits Pond Dam in fact refers to the tide gate of the same name, which was recently replaced and is alarmed and monitored frequently. This structure is listed by DCR as a Significant Hazard.

Ice Jam

Ice jams occur in cold weather when normally flowing water begins to freeze effectively damming the waterway and causing localized flooding in the area. There is no recent history of ice jams leading to flooding in Hull and Town staff did not identify this hazard as an issue for the Town. As coastal Massachusetts experiences somewhat warmer winters than the western part of the State and tidal waters are less subject to freezing, this hazard is unlikely to be an issue in the Town.

Potential Flood Hazard Areas

Information on potential flood hazard areas was taken from several sources. The first was the National Flood Insurance Rate Maps. The FIRM flood zones are shown on Map 3 in Appendix B and their definitions are listed below. The second was from a 2017 analysis of Hull's repetitive loss properties developed by the Town as part of its compliance with FEMA's Community Rating System program (see Appendix D). Finally, information on areas subject to flooding was provided by local officials.

Flood Insurance Rate Map Zone Definitions

Zone AO (1% chance zone) Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.

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

Zones X500 (.2% annual chance) **-** Zone X500 is the flood insurance rate zone that correspond to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone.

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

The Locally Identified Areas of Flooding described below were identified by town staff as areas where flooding is known to occur. All of these areas do not necessarily coincide with the flood zones from the FIRM maps. Some may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone. The numbers correspond to the numbers on Map 8, "Local Hazard Areas."

1) Atlantic Avenue – Overwash of the sea wall leads to flooding, especially during Nor'easters.
2) Atlantic Avenue @ Cohasset Border – Overwash leads to flooding.
3) Nantasket Beach (DCR) – Waves during storm events top the sea wall in this area.
4) Hampton Circle – Floods in the low area between Hampton and Sagamore Hills.
5) Beach Avenue to Nantasket Avenue, (Phipps to A Streets) – Coastal flooding overtops or erodes the sand dunes. Flooding is compounded by lack of adequate drainage.
6) Sunset/Cadish Avenue, Bayside – Coastal flooding overtops seawalls and revetments.
7) Alphabet Streets, Oceanside – Coastal flooding overtops the sand dunes.
8) Stoney Beach– Coastal flooding overtops seawalls and revetments. Flooding is compounded by lack of adequate drainage.
9) Ocean Avenue Marsh– Coastal flooding overtops seawalls and revetments. Flooding is compounded by lack of adequate drainage.
10) Channel Street – Sea wall– Coastal flooding overtops seawalls and revetments. Flooding is compounded by lack of adequate drainage.
11) Point Allerton - Coastal flooding overtops the revetment.
12) James Avenue– Coastal flooding overtops seawalls and revetments.
13) DPW Building – adjacent to Weir River storm surge overtops the bank
14) Gun Rock Beach - Coastal flooding overtops seawalls and revetments.
15) Dighton Street adjacent to Hull Bay
23) Gun Rock Coastal flooding overtops seawalls and revetments
28) Central Avenue – flooding from rain events is exacerbated by poor drainage
29) Edgewater Road – flooded between 6th and 11th Streets in the January 2018 storm
30) Bay Street – flooded along the southern section in the January 2018 storm

31) Nantasket Road – flooded between 11th Street and Clifton Avenue in the January 2018 storm

Repetitive Loss Structures

As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property for which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. There are 229 repetitive loss properties in Hull: almost all are residential properties impacted by coastal flooding. These properties are shown on the maps in Appendix A. These repetitive loss properties had a total of 749 losses between 1978 and 2015, totaling $7,618,446 in damages. For more information on repetitive losses see https://www.fema.gov/txt/rebuild/repetitive_loss_faqs.txt and https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet.

Table 9 summarizes the number and type of repetitive loss structures located within Hull and the number of losses and total claims associated with them.

Table 9 Summary of Repetitive Losses and Claims

	Single Family Residential	Multi Family Residential	Commercial	Total
Number of Properties	204	20	5	229
Number of Losses	660	71	18	749
Total Claims	$6,448,017	$627,105	$543,324	$7,618,446

Source: Department of Conservation and Recreation, FEMA Repetitive Loss data

Since 1978, 18 repetitive loss properties have been mitigated. The properties had 79 damage claims and over $1.6 million in damages.

Based on the record of previous occurrences flooding events in Hull are a High frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in five years, or a greater than 20% chance per year.

Coastal Hazards and Tsunamis

Tsunamis are caused by seismic activity or other displacement of the ocean floor. While all of the coast of Massachusetts could be subject to a tsunami, according to the Massachusetts Hazard Mitigation Plan the probability of a damaging tsunami is unknown. Other coastal hazards are addressed in the section on flood hazards.

Wind Related Hazards

Wind-related hazards include hurricanes, tropical storms, and tornadoes as well as high winds during Nor'easters and thunderstorms. As with many communities, falling trees that result in downed power lines and power outages are an issue in Hull. Information on wind related hazards can be found on Map 5 in Appendix B

Hurricanes and Tropical Storms

A hurricane is a violent wind and rainstorm with wind speeds of 74-200 miles per hour. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits the land. The Town's entire area is vulnerable to hurricanes. Hurricanes occur between June and November. A tropical storm has similar characteristics, but wind speeds are below 74 miles per hour.

Since 1900, 39 tropical storms have impacted New England (NESEC). Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane. A hurricane or storm track is the line that delineates the path of the eye of a hurricane or tropical storm.

As shown in Map 5 in Appendix A, a tropical storm tracked through Hull near Pemberton Point in 1923. In addition, Hull experiences the impacts of hurricanes and tropical storms regardless of whether the storm track passes directly through the Town, and numerous hurricanes have affected the communities of eastern Massachusetts (see Table 10) The hazard mapping indicates that the 100 year wind speed in Hull is 110 miles per hour (see Appendix B).

Table 10 Hurricane Records for Massachusetts, 1938 - 2017

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

*Category 3. Source: National Oceanic and Atmospheric Administration

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

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

Source: NOAA

Hurricanes typically have regional impacts beyond their immediate tracks. Falling trees and branches are a significant problem because they can result in power outages when they fall on power lines or block traffic and emergency routes. Hurricanes are a town-wide hazard in Hull. Potential hurricane damages to Hull have been estimated using HAZUS-MH. Total damages are estimated at $19 million for a Category 2 hurricane and $115 Million for a Category 4 hurricane. Other potential impacts are detailed in Table 23.

Based on records of previous occurrences, hurricanes in Hull are a Medium frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard occurs from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Tornados

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. These events are spawned by thunderstorms and occasionally by hurricanes, and may occur singularly or in multiples. They develop when cool air overrides a layer of warm air, causing the warm air to rise rapidly. Most vortices remain suspended in the atmosphere. Should they touch down, they become a force of destruction. Some ingredients for tornado formation include:

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

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

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

Source: Massachusetts State Hazard Mitigation Plan, 2013

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

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

There has been one recorded tornado within the limits of the Town of Hull on October 30, 1970. Since 1958 there have been 10 additional tornadoes in surrounding Plymouth County recorded by the Tornado History Project. One of these was a F2 tornado, and four were F1 tornados. The 10 tornadoes resulted in a total of one fatality and two injuries and $119 thousand to $1.15 million in damages, as summarized in Table11.

Table 11 - Tornado Records for Plymouth County

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

Source: The Tornado History Project

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

Although tornadoes are a potential town-wide hazard in Hull, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Hull would greatly depend on the track of the tornado. Generally, the more densely developed areas would likely be subject to more damage in the event of a tornado.

Based on the record of previous occurrences since 1950, Tornado events in Hull are a Low frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur from once in 50 years to once in 100 years.

Nor'easters

A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center. Featuring strong northeasterly winds blowing in from the

ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 10 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rains or snows, depending on temperatures. Previous occurrences of Nor'easters include the following which are listed in the Massachusetts State Hazard Mitigation Plan 2013:

February 1978	Blizzard of 1978
October 1991	Severe Coastal Storm ("Perfect Storm")
December 1992	Great Nor'easter of 1992
January 2005	Blizzard/Noreaster
October 2005	Coastal Storm/Nor'easter
April 2007	Severe Storms, Inland & Coastal Flooding/Nor'easter
January 2011	Winter Storm/Nor'easter
October 2011	Severe Storm/Nor'easter

Many of the historic flood events identified in the previous section were precipitated by nor'easters, including the "Perfect Storm" event in 1991. More recently, blizzards in December 2010, October 2011, February 2013, and January 2015 were large nor'easters that caused significant snowfall amounts.

Hull is vulnerable to both the wind and precipitation that accompanies nor'easters. High winds can cause damage to structures, fallen trees, and downed power lines leading to power outages. Intense rainfall can overwhelm drainage systems causing localized flooding of rivers and streams as well as urban stormwater ponding and localized flooding. Fallen tree limbs as well as heavy snow accumulation and intense rainfall can impede local transportation corridors, and block access for emergency vehicles.

The entire Town of Hull could be at risk from the wind, rain or snow impacts from a nor'easter, depending on the track and radius of the storm, but due to its inland location the town is not subject to coastal hazards.

Based on the record of previous occurrences, nor'easters in Hull are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Severe Thunderstorms

While less severe than the other types of storms discussed, thunderstorms can lead to localized damage and represent a hazard risk for communities. A thunderstorm typically features lightning, strong winds, and rain and/or hail. Thunderstorms sometime give rise to tornados. On average, these storms are only around 15 miles in diameter and last for about 30 minutes. A severe thunderstorm can include winds of close to 60 mph and rain sufficient to produce flooding. The town's entire area is potentially subject to severe thunderstorms.

The best available data on previous occurrences of thunderstorms in Hull is for Plymouth County through the National Climatic Data Center (NCDC). Between the years 1995 and 2017 NCDC records show 4 thunderstorm events in Plymouth County that identify Hull (Table 12). These storms resulted in a total of $5,000 in property damages. There were no injuries or deaths reported.

Table 12 Plymouth County Thunderstorm Events, 1995-2017

LOCATION	BEGIN_DATE	EVENT_TYPE	MAGNITUDE	DEATHS	INJURIES	DAMAGE
Hingham/Hull	4/4/1995	Thunderstorm	0	0	0	0
Hull	6/22/1997	Thunderstorm	90	1	0	0
Hull	6/27/2000	Thunderstorm	50	0	0	0
Hull	7/21/2006	Thunderstorm	50	0	0	5,000
TOTAL				**1**	**0**	**5,000**

Source: NOAA, National Climatic Data Center Magnitude refers to maximum wind speed (kts).

Severe thunderstorms are a town-wide hazard for Hull. The town's vulnerability to severe thunderstorms is similar to that of Nor'easters. High winds can cause falling trees and power outages, as well as obstruction of key routes and emergency access. Heavy precipitation may also cause localized flooding, both riverine and urban drainage related.

Based on the record of previous occurrences, severe thunderstorms in Hull are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Winter Storms

Winter storms, including heavy snow, blizzards, and ice storms, are the most common and most familiar of the region's hazards that affect large geographic areas. The majority of blizzards and ice storms in the region cause more inconvenience than they do serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response.

Heavy Snow and Blizzards

A blizzard is a winter snow storm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow reducing visibility to or below ¼ mile. These conditions must be the predominant condition over a 3 hour period. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of the definition. The hazard created by the combination of snow, wind and low visibility significantly increases, however, with temperatures below 20 degrees.

Winter storms are a combination hazard because they often involve wind, ice and heavy snow fall. The National Weather Service defines "heavy snow fall" as an event generating at least 4 inches of snowfall within a 12 hour period. Winter Storms are often associated with a Nor'easter event, a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain.

The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004) characterizes and ranks high impact northeast snowstorms. These storms have large areas of 10 inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The largest NESIS values result from

storms producing heavy snowfall over large areas that include major metropolitan centers. The NESIS categories are summarized below:

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	10.0+	Extreme

Source: Massachusetts State Hazard Mitigation Plan, 2013

The most significant winter storm in recent history was the "Blizzard of 1978," which resulted in over 3 feet of snowfall and multiple day closures of roadways, businesses, and schools. In Hull blizzards and severe winter storms have occurred in the following years:

Table 13. Severe Winter Storm Records for Massachusetts	
Blizzard of 1978	February 1978
Blizzard	March 1993
Blizzard	January 1996
Severe Snow Storm	March 2001
Severe Snow Storm	December 2003
Severe Snow Storm	January 2004
Severe Snow Storm	January 2005
Severe Snow Storm	April, 2007
Severe Snow Storm	December 2010
Severe Snow Storm	January 2011
Blizzard of 2013	February 2013
Blizzard of 2015	January 2015

Source: National Oceanic and Atmospheric Administration

The Town of Hull does not keep local records of winter storms. Data for Plymouth County, which includes Hull, is the best available data to help understand previous occurrences and impacts of heavy snow events. According to National Climate Data Center (NCDC) records, from 1997 to 2016 Eastern Plymouth County experienced 40 heavy snowfall events, resulting in no deaths, no injuries, and $108 thousand dollars in property damage. See Table 14 for and heavy snow events and impacts in Plymouth County.

Table 14 - Heavy Snow events and Impacts in Eastern Plymouth County 1997 –2016

DATE	TYPE	DEATHS	INJURIES	PROPERTY DAMAGE
1/11/1997	Heavy Snow	0	0	0
2/16/1997	Heavy Snow	0	0	0
3/31/1997	Heavy Snow	0	0	0
4/1/1997	Heavy Snow	0	0	0
12/24/1998	Heavy Snow	0	0	0

1/14/1999	Heavy Snow	0	0	0
2/25/1999	Heavy Snow	0	0	0
3/15/1999	Heavy Snow	0	0	0
1/13/2000	Heavy Snow	0	0	0
2/18/2000	Heavy Snow	0	0	0
1/20/2001	Heavy Snow	0	0	0
3/5/2001	Heavy Snow	0	0	0
3/26/2001	Heavy Snow	0	0	0
12/5/2002	Heavy Snow	0	0	0
3/16/2004	Heavy Snow	0	0	0
2/24/2005	Heavy Snow	0	0	0
12/13/2007	Heavy Snow	0	0	0
12/16/2007	Heavy Snow	0	0	0
1/27/2008	Heavy Snow	0	0	0
12/19/2008	Heavy Snow	0	0	3000
12/31/2008	Heavy Snow	0	0	0
1/18/2009	Heavy Snow	0	0	0
1/19/2009	Heavy Snow	0	0	0
2/3/2009	Heavy Snow	0	0	0
3/2/2009	Heavy Snow	0	0	0
12/19/2009	Heavy Snow	0	0	0
12/20/2010	Heavy Snow	0	0	0
1/26/2011	Heavy Snow	0	0	0
1/21/2012	Heavy Snow	0	0	0
2/8/2013	Heavy Snow	0	0	0
3/7/2013	Heavy Snow	0	0	0
1/2/2014	Heavy Snow	0	0	0
1/21/2014	Heavy Snow	0	0	0
2/5/2014	Heavy Snow	0	0	0
2/15/2014	Heavy Snow	0	0	5000
2/2/2015	Heavy Snow	0	0	0
2/8/2015	Heavy Snow	0	0	0
3/5/2015	Heavy Snow	0	0	0
2/5/2016	Heavy Snow	0	0	100000
4/4/2016	Heavy Snow	0	0	0

Source: NOAA, National Climatic Data Center

Blizzards are considered to be high frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs more than once in five years, with a greater than 20 percent chance of occurring each year.

Ice Storms

The ice storm category covers a range of different weather phenomena that collectively involve rain or snow being converted to ice in the lower atmosphere leading to potentially hazardous conditions on the ground. Hail size typically refers to the diameter of the hailstones. Warnings and reports may report hail size through comparisons with real-world objects that correspond to certain diameters:

Description	Diameter (inches)
Pea	0.25
Marble or Mothball	0.50
Penny or Dime	0.75
Nickel	0.88
Quarter	1.00
Half Dollar	1.25
Walnut or Ping Pong Ball	1.50
Golf ball	1.75
Hen's Egg	2.00
Tennis Ball	2.50
Baseball	2.75
Tea Cup	3.00
Grapefruit	4.00
Softball	4.50

While ice pellets and sleet are examples of these, the greatest hazard is created by freezing rain conditions, which is rain that freezes on contact with hard surfaces leading to a layer of ice on roads, walkways, trees, and other surfaces. The conditions created by freezing rain can make driving particularly dangerous and emergency response more difficult. The weight of ice on tree branches can also lead to falling branches damaging electric lines.

Town-specific data for previous ice storm occurrences are not collected by the Town of Hull. The best available local data is for Plymouth County through the National Climatic Data. Plymouth County, which includes the Town of Hull, since 1950 experienced no ice storm events and one hail event on 6/27/2000. Ice storms and hail are considered to be low frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs once in 50 years to once in 100 years, with 1% to 2% chance of occurring each year.

Geologic Hazards

Geologic hazards include earthquakes and landslides. Although new construction under the most recent building codes generally will be built to seismic standards, there are still many structures which pre-date the most recent building code. Information on geologic hazards in Hull can be found on Map 4 in Appendix B.

Earthquakes

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

Seismologists use a Magnitude scale (Richter Scale) to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized below.

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

Source: Nevada Seismological Library (NSL), 2005

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2007, 355 earthquakes were recorded in Massachusetts (NESEC). Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault located off the coast of Rockport. The region has experienced larger earthquakes, including a magnitude 5.0 earthquake in 1727 and a 6.0 earthquake that struck in 1755 off the coast of Cape Anne. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940, and a 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historical records of some of the more significant earthquakes in the region are shown in Table 15.

Table 15
Historical Earthquakes in Massachusetts or Surrounding Area

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA – Cape Ann	2/10/1728	NA
MA – Cape Ann	3/30/1729	NA
MA – Cape Ann	12/9/1729	NA
MA – Cape Ann	2/20/1730	NA
MA – Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA – Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6

MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA – Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA – Cape Ann	1/7/1925	4
MA – Nantucket	10/25/1965	NA
MA – Boston	12/27/74	2.3
VA –Mineral	8/23/11	5.8
MA - Nantucket	4/12/12	4.5
ME - Hollis	10/17/12	4.0

Source: Boston HIRA

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

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

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

Earthquakes are a potential town-wide hazard in Hull, The Town has many older buildings that pre-date current building code which could be vulnerable in the event of a severe earthquake. Potential earthquake damages to Hull have been estimated using HAZUS-MH. Total building damages are estimated at $184 million for a 5.0 magnitude earthquake and $1.4 billion for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 24.

According to the Boston College Weston Observatory, in most parts of New England, there is a one in ten chance that a potentially damaging earthquake will occur in a 50 year time period. The Massachusetts State Hazard Mitigation Plan classifies earthquakes as Very Low frequency events that occur less frequently than once in 100 years, or a less than 1% per year.

Landslides

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

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

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

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

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

All of Hull is classified as having a low risk for landslides (see Map 4, Appendix B). The Town does not have records of any damages caused by landslides in Hull. Should a landslide occur in the future, the type and degree of impacts would be highly localized, and the town's vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures. Potential damages would depend on the extent of impact, based on how many properties were affected. However, there are no data available on landslide damages in Hull, as there are no records of any damages caused by landslides in the town. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Hull. Based on past occurrences and the Massachusetts Hazard Mitigation Plan, landslides are Low frequency events that can occur once in 50 to100 years (a 1% to 2% chance of occurring each year).

Fire Related Hazards

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

- Surface fires are the most common type and burn along the floor of a forest, moving slowly and killing or damaging trees;
- Ground fires are usually started by lightning and burn on or below the forest floor;
- Crown fires spread rapidly by wind, jumping along the tops of trees.

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

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

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

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

The Fire Department has rarely had to respond to brush fires. There was one brushfire on Straits Pond Island in recent history. It was not extensive and no restoration was required.

<u>Potential Brushfire Hazard Areas</u>

The following areas of town were identified as having the highest potential for brush fires based either on higher concentration of brush or forest, or large stands of phragmites. The numbers correspond to the numbers on Map 8, “Hazard Areas”.

16. Ocean Avenue Marsh
17. Fort Revere
18. WBZ Marsh Area
19. Straights Pond Island
20. Shore Garden Road Area
21. Landfill
22. Weir River Woods

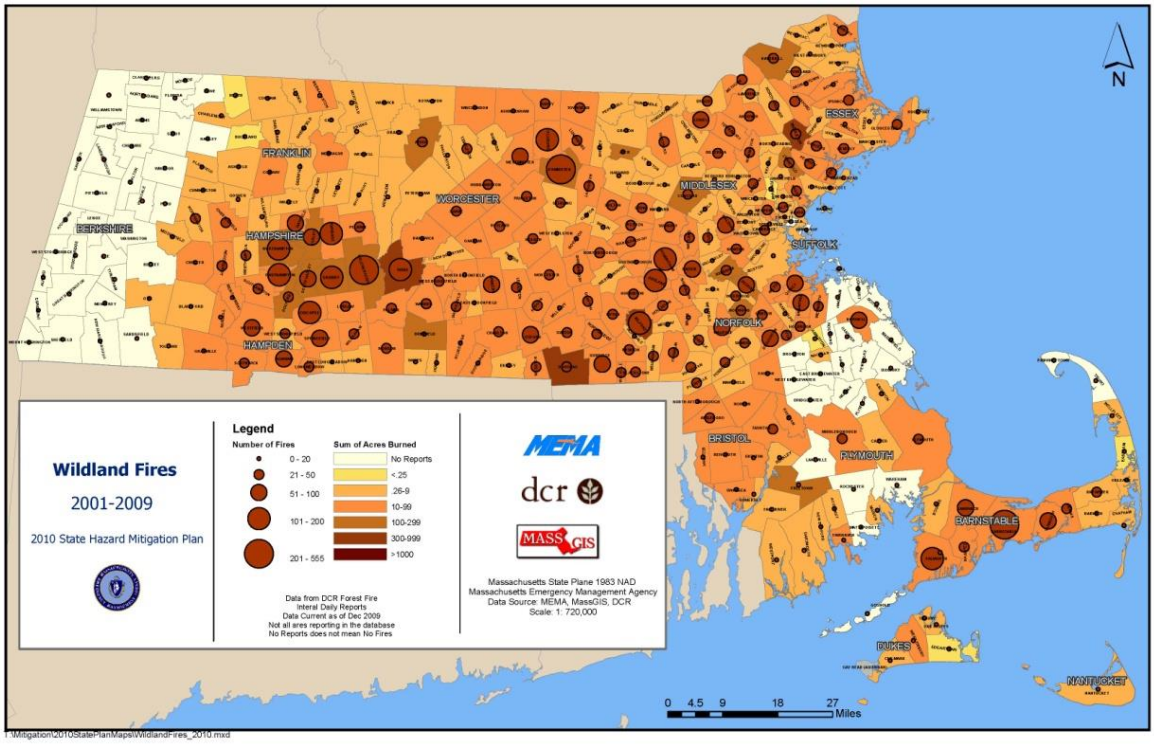
Wildfires in Massachusetts are measured by the number of fires and the sum of acres burned. The most recent data available for wildfires in Massachusetts, shown in Figure 1 below, indicates that there were no wildfire reports for Hull from 2001-2009.

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

Potential damages from wildfires in Hull would depend on the extent and type of land affected. There could be the need for post-fire revegetation to restore a burned property, which could cost from a few thousand dollars to tens of thousands for an extensive area. However, there are no data on actual wildfire damages.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan 2013, brushfires are of Medium frequency, events that occur from once in 5 years to once in 50 years (2% to 20% probability per year).

Figure 1 Massachusetts Wildfires 2001-2009



Source: Massachusetts State Hazard Mitigation Plan

Extreme Temperatures

Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time when there is a prolonged period of excessively hot or cold weather.

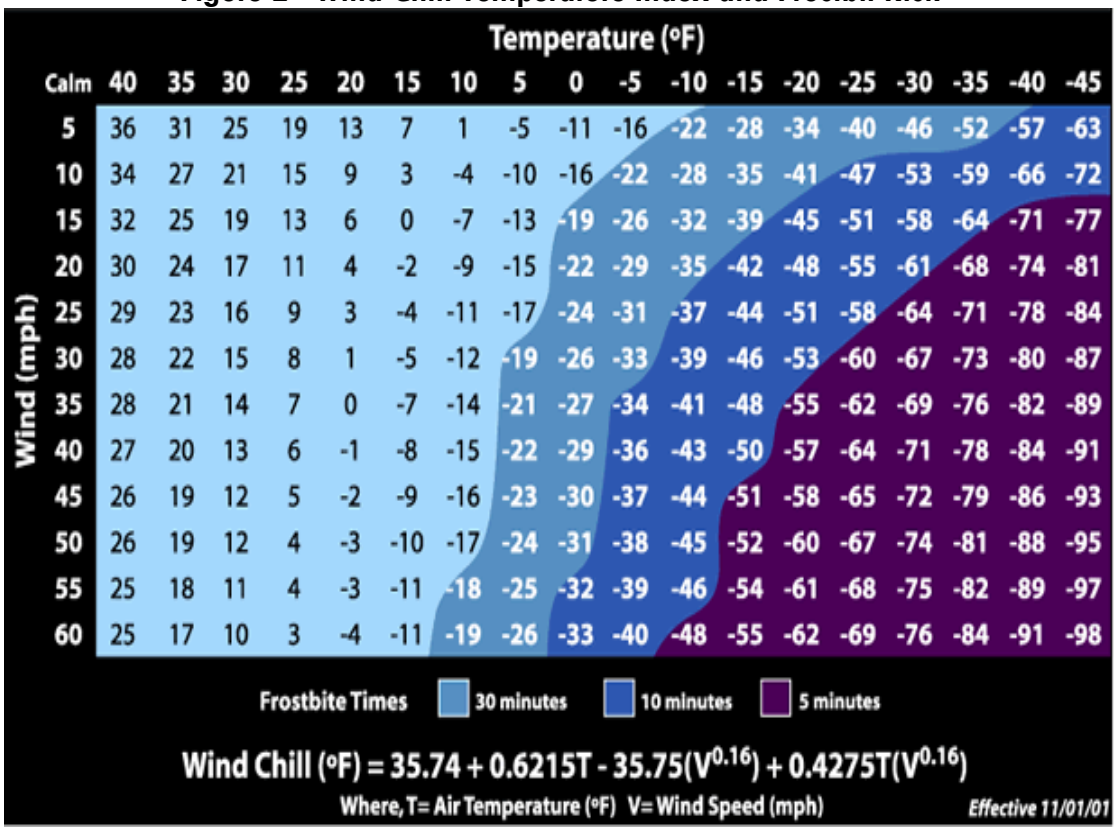
Hull has four well-defined seasons. The seasons have several defining factors, with temperature one of the most significant. Extreme temperatures can be defined as those, which are far outside of the normal seasonal ranges for Massachusetts. The average temperatures for Massachusetts are: winter (Dec-Feb) Average = 31.8°F and summer (Jun-Aug) Average = 71°F. Extreme temperatures are a town-wide hazard.

Extreme Cold

For extreme cold, temperature is typically measured using Wind Chill Temperature Index, which is provided by the National Weather Service (NWS). The latest version of the index was implemented in 2001 and it meant to show how cold conditions feel on unexposed skin. The index is provided in Figure 2 below.

Extreme cold is relative to the normal climatic lows in a region. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.

Figure 2 - Wind Chill Temperature Index and Frostbit Risk



Extreme cold is relative to the normal climatic lows in a region. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.

Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat.

The Town of Hull does not collect data for previous occurrences of extreme cold. The best available local data are for Plymouth County, through the National Climatic Data Center (NCDC). There are two extreme cold events on record which caused no deaths, injuries, or property damage. (see Table 16).

Table 16 – Plymouth County Extreme Cold and Wind Chill Occurrences

Date	Deaths	Injuries	Damage
2/16/2015	0	0	0
2/14/2016	0	0	0

Source: NOAA, National Climatic Data Center

Extreme Heat

While a heat wave for Massachusetts is defined as three or more consecutive days above 90°F, another measure used for identifying extreme heat events is through a Heat Advisory from the NWS. These advisories are issued when the heat index (Figure 3) is forecast to exceed 100

Figure 3 Heat Index Chart

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

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke or Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Degrees, Fahrenheit (F) for 2 or more hours; an excessive heat advisory is issued if forecast predicts the temperature to rise above105 degree F.

Extreme heat poses a potentially greater risk to the elderly, children, and people with certain medical conditions, such as heart disease. However, even young and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. Hot summer days can also worsen air pollution. With increased extreme heat, urban areas of the Northeast are likely to experience more days that fail to meet air quality standards.

The Town of Hull does not collect data on excessive heat occurrences. The best available local data are for Plymouth County through the National Climatic Data Center. From 1950 - 2017, there is one recorded excessive heat event, with no deaths or injuries, and no property damage resulting from excessive heat (see Table 17).

Extreme temperature events are projected to be medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. Both extreme cold and hot weather events occur between once in five years to once in 50 years, or a 2 percent to 20 percent chance of occurring each year.

Table 17 – Plymouth County Extreme Heat Occurrences

Date	Deaths	Injuries	Damage
7/6/2010	0	0	0

Source: NOAA, National Climatic Data Center

Drought

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

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

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

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

Five levels of drought have been developed to characterize drought severity: Normal, Advisory, Watch, Warning, and Emergency. These drought levels are based on the conditions of natural resources and are intended to provide information on the current status of water resources. The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions. They begin with a normal situation where data are routinely collected and distributed, move to heightened vigilance with increased data collection during an advisory, to increased assessment and proactive education during a watch. Water restrictions might be appropriate at the watch or warning stage, depending on the capacity of each individual water supply system. A warning level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which mandatory water restrictions or use of emergency supplies is necessary. Drought levels are used to coordinate both state agency and local response to drought situations.

As dry conditions can have a range of different impacts, a number of drought indices are available to assess these various impacts. Massachusetts uses a multi-index system that takes advantage of several of these indices to determine the severity of a given drought or extended period of dry conditions. Drought level is determined monthly based on the number of indices which have reached a given drought level. Drought levels are declared on a regional basis for each of six regions in Massachusetts. County by county or watershed-specific determinations may also be made.

A determination of drought level is based on seven indices:

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

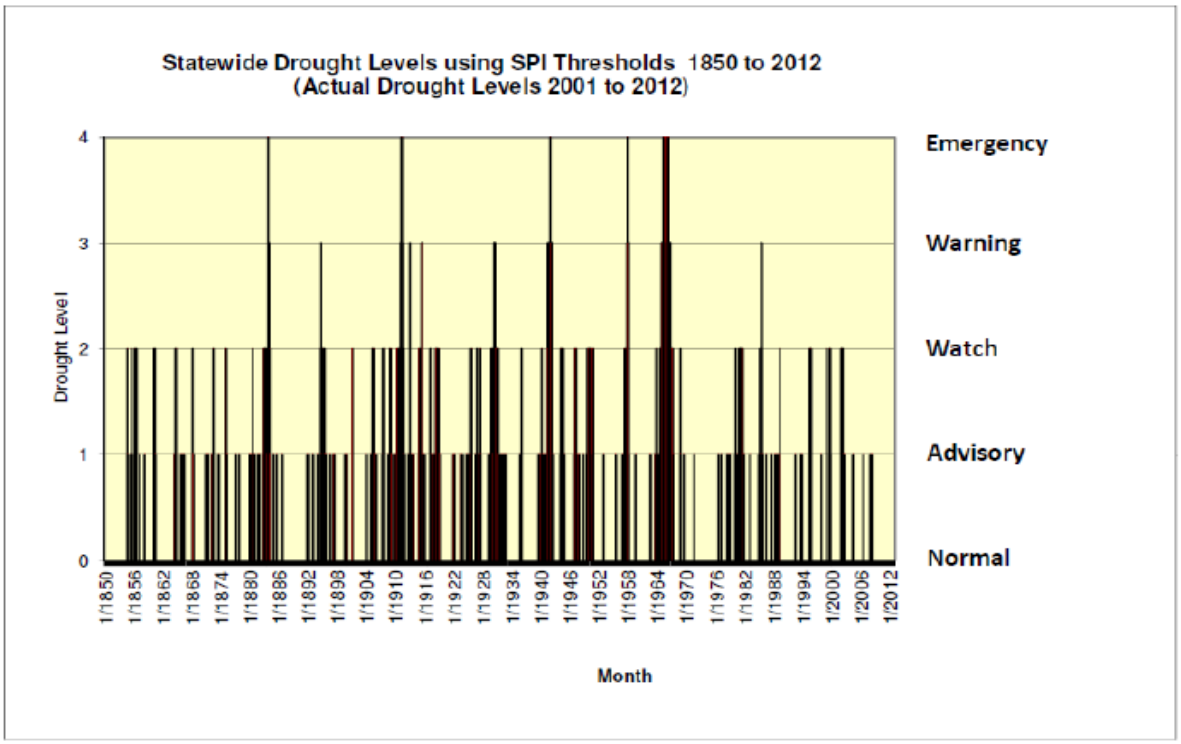
Determinations regarding the end of a drought or reduction of the drought level focus on two key drought indicators: precipitation and groundwater levels. These two factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture and potential for forest fires.

Previous Occurrences

Hull does not collect data relative to drought events. Because drought tends to be a regional natural hazard, this plan references state data as the best available data for drought. The statewide scale is a composite of six regions of the state. Regional composite precipitation values are based on monthly values from six stations, and three stations in the smaller regions (Cape Cod/Islands and West).

Figure 4 depicts the incidents of drought levels' occurrence in Massachusetts from 1850 to 2012 using the Standardized Precipitation Index (SPI) parameter alone. On a monthly basis, the state would have been in a Drought Watch to Emergency condition 11 percent of the time between 1850 and 2012. Table 18 summarizes the chronology of major droughts since the 1920's.

Figure 4 - Statewide Drought Levels using SPI Thresholds 1850 – 2012



(Source: Mass. State Drought Management Plan 2013)

Drought Emergency

Drought emergencies have been reached infrequently, with 5 events occurring in the period between 1850 and 2016: in 1883, 1911, 1941, 1957, and 1965-1966. The 1965-1966 drought period is viewed as the most severe drought to have occurred in modern times in Massachusetts because of its long duration. On a monthly basis over the 162-year period of record, there is a one percent chance of being in a drought Emergency.

Drought Warning

Drought Warning levels not associated with drought Emergencies have occurred five times, in 1894, 1915, 1930, 1985, and 2016. On a monthly basis over the 162-year period of record, there is a two percent chance of being in a drought Warning level. Hull was under a Drought Warning from July to December 2016 (see Figure 5). In response to the drought, Aquarion Water Company instituted restrictions on outdoor watering.

Drought Watch

Drought Watches not associated with higher levels of drought generally have occurred in three to four years per decade between 1850 and 1950. In the 1980s, there was a lengthy drought Watch level of precipitation between 1980 and 1981, followed by a drought Warning in 1985

(see Table 18). A frequency of drought Watches at a rate of three years per decade resumed in the 1990s (1995, 1998, 1999). In the 2000s, Drought Watches occurred in 2001, 2002, and 2016. The overall frequency of being in a drought Watch is 8 percent on a monthly basis over the 162-year period of record.

Figure 5 Massachusetts Drought Status as of October 2016

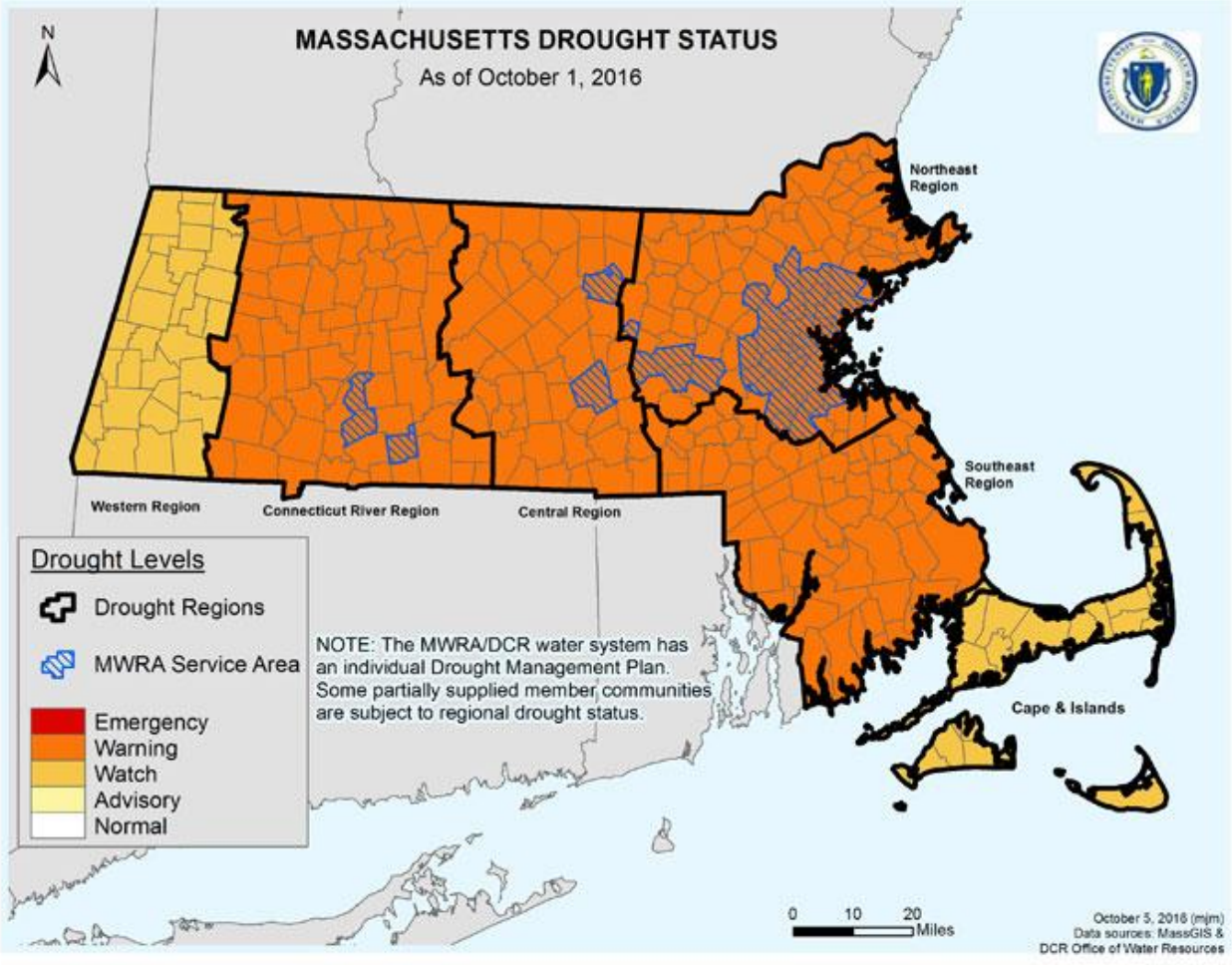


Table 18 - Chronology of major droughts in Massachusetts

Date	Area affected	Recurrence interval (years)	Remarks
1929-32	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.
	Statewide	15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.
1957-59	Statewide	5 to 25	Record low water levels in observation wells, northeastern Massachusetts.
1961-69	Statewide	35 to >50	Water-supply shortages common. Record drought.

			Multistate.
1980-83	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.
1985-88	Housatonic River basin	25	Duration and severity unknown. Streamflow showed mixed trends elsewhere.
2016-2017	Statewide	N/A	Drought declaration began in July 2016 with a Drought Watch which was upgraded to a Drought Warning in August 2016. The Central and Northeast regions were the most severely affected.

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

Probability of Future Occurrences

The state has experienced Emergency Droughts five times between 1850 and 2016. Even given that regional drought conditions may occur at a different interval than state data indicates, droughts remain primarily regional and state phenomena in Massachusetts. Emergency Drought conditions over the 162 period of record in Massachusetts are a Low Frequency natural hazard event that can occur from once in 50 years to once in 100 years (1% to 2% chance per year), as defined by the Massachusetts State Hazard Mitigation Plan, 2013.

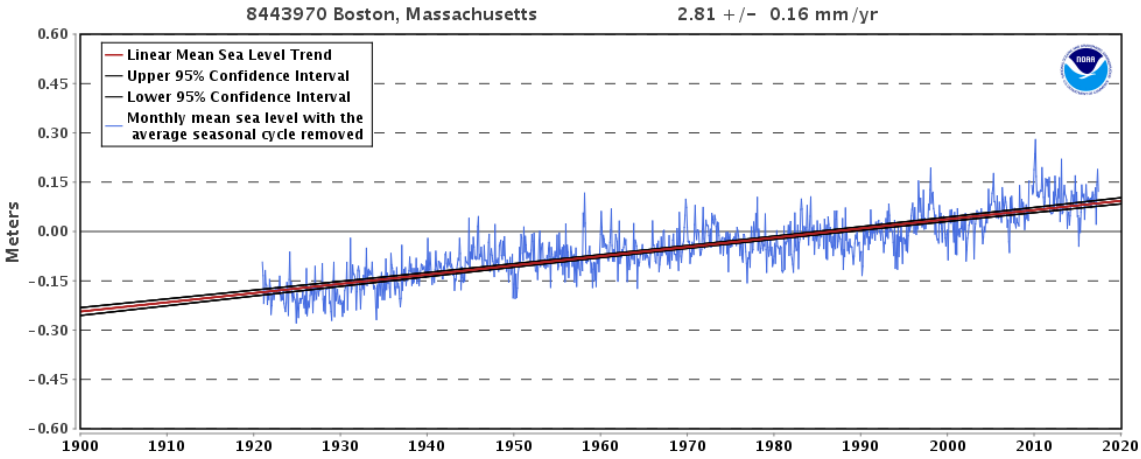
Impacts of Climate Change

Many of the natural hazards that Hull has historically experienced are likely to be exacerbated by climate change in future years. This is particularly true for flooding caused by sea level rise, extreme precipitation, and extreme heat. These are described in more detail below.

Climate Change Impacts: Sea Level Rise

Hull is most susceptible to the impacts of sea level rise, as it will magnify the flooding associated with coastal storms. As shown by records from the Boston Tide Station (see Figure 6) seas have risen the equivalent of 11 inches over 100 year, based on data from 1921 to 2016.

Figure 6 Boston Sea Level Rise from 1921 to 2016

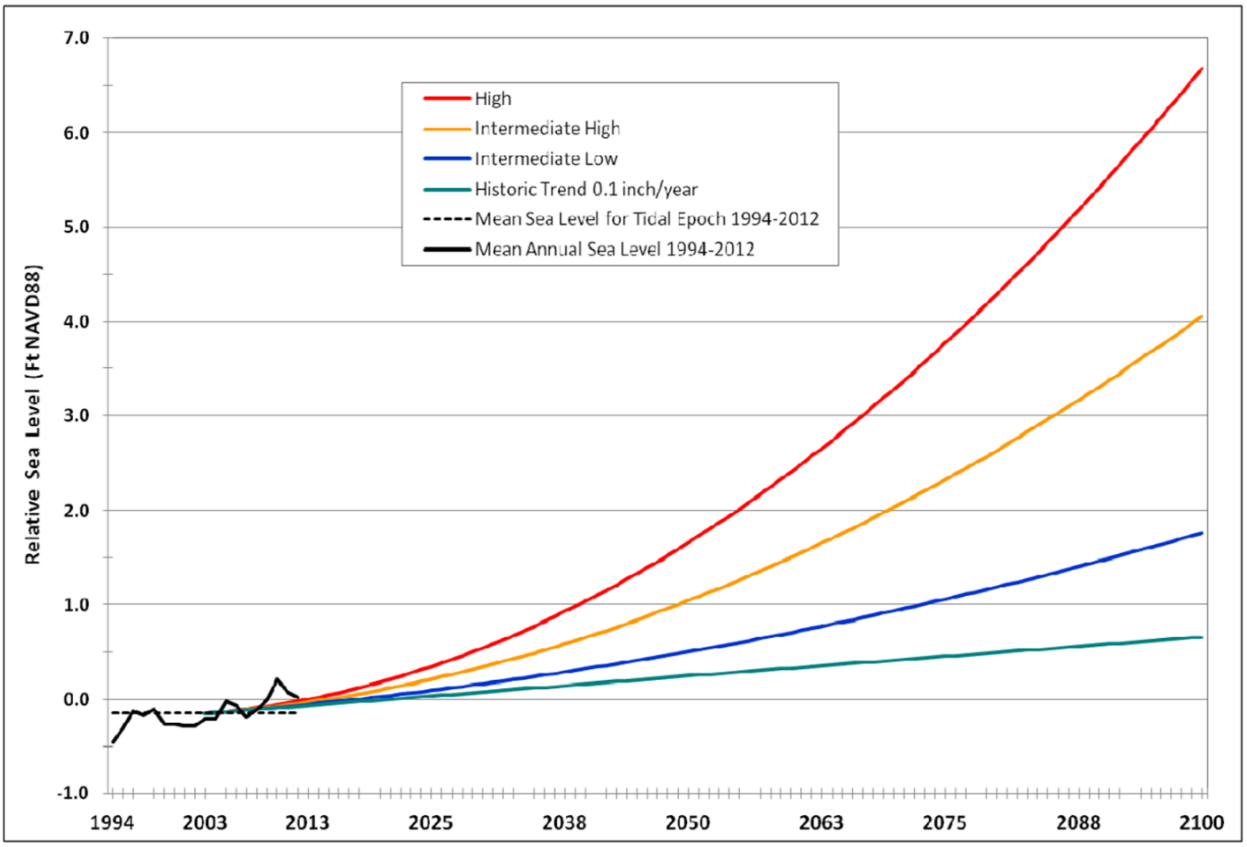


Source: NOAA

The Massachusetts Office of Coastal Zone Management (CZM) adjusted global predictions for future sea level rise, taking into account local subsidence (see Figure 7). The range of projections for the future is quite wide, particularly approaching the end of this century. The High scenario includes ocean warming and a calculation of maximum glacier and ice sheet melt. The Intermediate High scenario averages higher predictions but includes lesser ice sheet melting. The Intermediate Low considers lower sea level rise scenarios and limited ice melt. The Historic Trend reflects a continuation of the current rate of sea level rise. The CZM estimate for the Boston Harbor does not take into account more recent research that suggests the Boston Harbor is included in a region that may experience greater than average sea level rise. CZM cautions that the Historic and Intermediate Low scenarios may "considerably underestimate actual sea level rise", particularly for time horizons beyond 25 years.

The Town of Hull has devoted considerable resources to assessing and preparing for the impacts of future sea level rise. With grant support from the Massachusetts Office of Coastal Zone Management, working with Kleinfelder, Inc., Hull completed a "Coastal Climate Change Vulnerability Assessment and Adaptation Study" in 2016. Many of its recommendations have been incorporated into this Hazard Mitigation plan.

Figure 7 Projected Sea Level Rise for Greater Boston Harbor

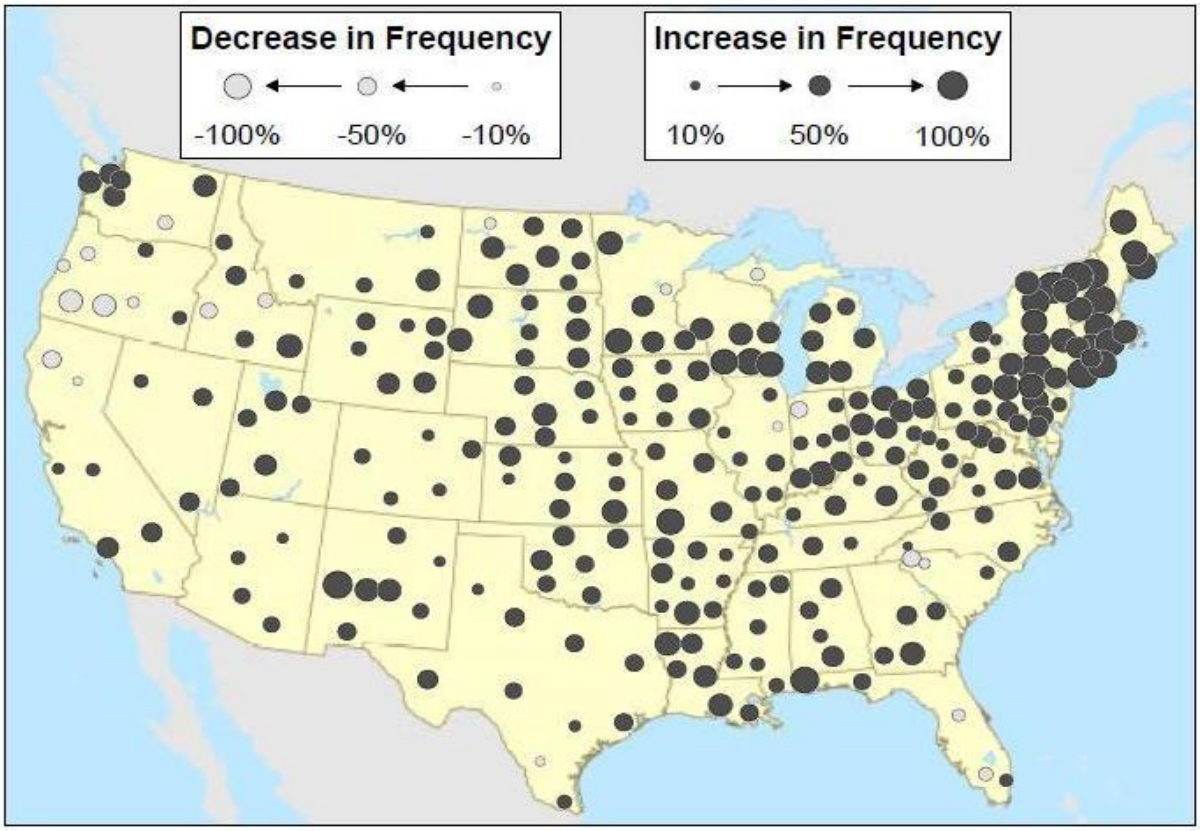


Source: Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning, Massachusetts Office of Coastal Zone Management, December 2013.

Climate Change Impacts: Extreme Precipitation

Hull's average annual precipitation is 42 inches. While total annual precipitation has not changed significantly, according to the 2012 report *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation from 1948 to 2011,* intense rainstorms and snowstorms have become more frequent and more severe over the last half century in the northeastern United States. Extreme downpours are now happening 30 percent more often nationwide than in 1948 (see Figure 8). In other words, large rain or snow storms that happened once every 12 months, on average, in the middle of the 20th century, now happen every nine months.

Figure 8 Changes in Frequency of Extreme Downpours, 1948 – 2011



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

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

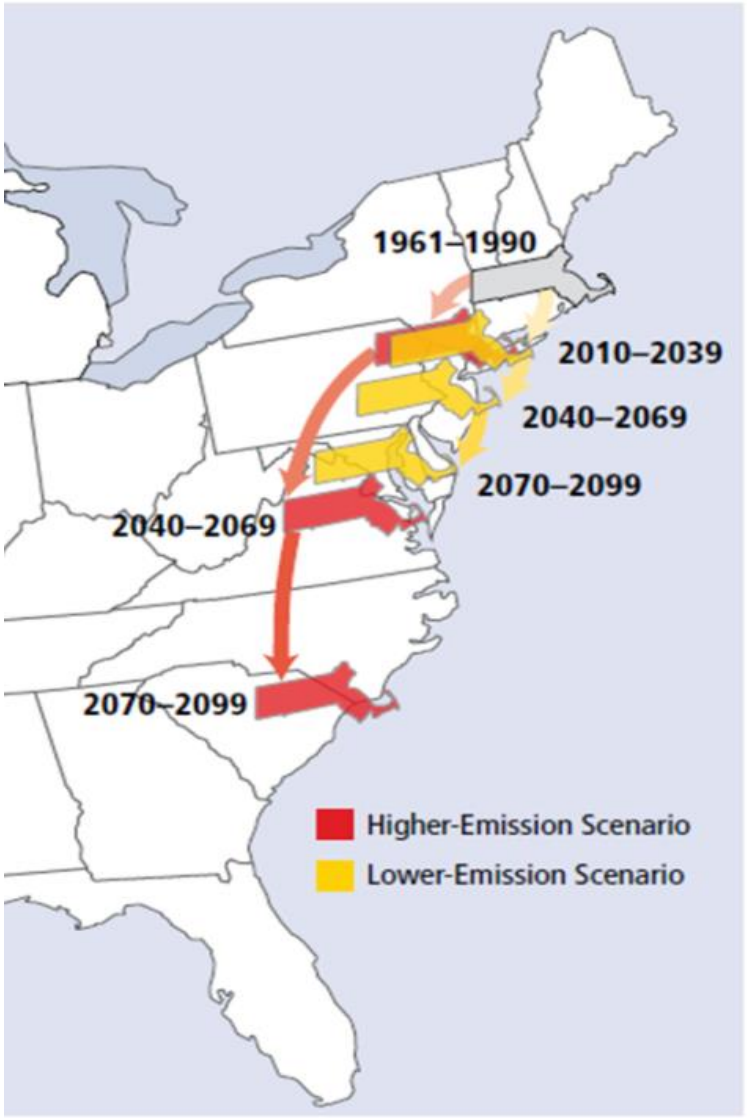
At the other extreme, changes in precipitation patterns and the projected future rising temperatures due to climate change will likely increase the frequency of short-term (one- to three-month) droughts and decrease stream flow during the summer.

Climate Change Impacts: Extreme Heat

Recent temperature trends suggest greater potential impacts to come due to climate change. In the report "Confronting Climate Change in the U.S. Northeast," (2007), the Union of Concerned Scientists presented temperature projections to 2099 based on two scenarios, one with lower carbon dioxide emissions, and the other with high emissions.

Between 1961 and 1990, Boston experienced an average of 11 days per year over 90°F. That could triple to 30 days per year by 2095 under the low emissions scenario, and increase to 60 days per year under the high emissions scenario. Days over 100°F could increase from the current average of one day per year to 6 days with low emissions or 24 days with high emissions.

Figure 9 – Mass. Extreme Heat Scenarios



Source: Union of Concerned Scientists

By 2099, Massachusetts could have a climate similar to Maryland's under the low emissions scenario, and similar to the Carolinas' with high emissions (Figure 9). Furthermore, the number of days with poor air quality could quadruple in Boston by the end of the 21st century under the higher emissions scenario, or increase by half under the lower emissions scenario. These extreme temperature trends could have significant impacts on public health, particularly for those individuals with asthma and other respiratory system conditions, which typically affect the young and the old more severely.

Land Use and Development Trends

Existing Land Use

The most recent land use statistics available from the state are from aerial photography done in 2005. Table 19 shows the acreage and percentage of land in 23 categories. Because Hull has extensive shoreline, Saltwater Beach is calculated as 45.4% of total land use. If the five residential categories are aggregated, residential uses make up 31% of the area of the town (567 acres). Commercial and industrial combined make up 1.4% of the town, or 33 acres. Recreation, and urban public, and comprise a total of 2.4%, or 46.2 acres. This does not include Hull's significant beaches which comprise the largest land use category as noted above.

Table 19 - 2005 Land Use

Land Use Type	Acres	Percent
Forest	217.0	11.4%
Saltwater Wetlands	100.8	5.3%
Non-Forested Wetlands	8.3	.44%
Forested Wetland	.8	.04%
Mining	4.4	.23%
Open & Urban Open Land	29.2	1.53%
Participation and Spectator Recreation	13.1	0.69%
Water-based Recreation	10.4	0.54%
Saltwater Beach	865.4	45.4%
Marina	3.9	.2%
Multi-family Residential	80.8	4.23%
High Density Residential	201.6	10.6%
Medium Density Residential	272.8	14.3%
Low Density Residential	7.8	.4%
Very Low Density Residential	3.8	.19%
Commercial	22.9	1.2%
Industrial	3.2	.18%
Transportation	.5	.03%
Waste Disposal	5.2	0.3%
Water	2.5	0.1%
Brushland/Successional	5.8	0.3%
Urban Public	33.1	1.7%
Cemetery	13.4	0.7%
Total Acres	**1,906.7**	**100.0%**

For more information on how the land use statistics were developed and the definitions of the categories, please go to http://www.mass.gov/mgis/lus.htm.

Economic Elements

Hull has two primary commercial areas. The first is centered around the Department of Conservation and Recreation (DCR) Nantasket Beach Reservation. It includes a number of businesses related to the recreation and tourism at Nantasket Beach, historic buildings owned by DCR, docks for a portion of Hulls commercial fishing fleet, and open land targeted for development. The second is the Kenberma Business Block in the vicinity of Kenberma Street and Nantasket Avenue. This area includes the local supermarket, hardware store, pharmacy, and numerous other local businesses. Both areas are susceptible to damage from coastal storms; the Nantasket Beach area is flooded more often than the Kenberma district.

Historic, Cultural, and Natural Resource Areas

The Local Committee identified four sites of cultural importance to the Town, the Boathouse, the Lifesaving Museum, Paragon Carousel, and Fort Revere. Several Town buildings were also noted to be of historic value including the library and Town Hall.

Development Trends

The entire peninsula occupied by the Town of Hull is built out with a relatively high density of homes. Historically, much of Hull's development has been driven by beach oriented development along the coast. Anticipated new development is primarily limited to the occasional single residential lot redevelopment, with the exception of potential redevelopment in the Nantasket Beach area, Waveland area and Nantasket Avenue from R Street to Fitzpatrick Way. Extensive wetlands and floodplains limit the land available for development.

Development trends throughout the metropolitan region are tracked by MAPC's Development Database, which provides an inventory of new development over the last decade. The database tracks both completed developments and those currently under construction. The database includes just one completed development in the Town of Hull since 2012. It also include two potential new developments including Nantasket Beachfront Condominiums, and redevelopment of Coast Guard housing.

The database also includes housing units and commercial space. See Table 20 below.

Table 20 Summary of Hull Developments 2012-2017

DEVELOPMENTS COMPLETED 2007-2015	HOUSING UNITS	COMMERCIAL (SQ FEET)	PROJECT TYPE
The Estuary	11	0	Residential condominiums
SUBTOTAL	11	0	
PLANNED			
Coastguard Housing	8		Residential – existing units were auctioned
Nantasket Beachfront Condominiums	66	?	Residential and retail new development
Total	74	?	

Potential Future Development

MAPC consulted with town planning staff to determine areas that may be developed in the future, based on the Town's comprehensive planning efforts and current trends and projects. These areas are described below. In order to characterize any change in the town's vulnerability associated with new developments, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map. The analysis shows that all four sites are located in flood zones. Three of those parcels have more than 90% of land in the flood zone, the fourth parcel has 35% of land located in a flood zone. All of the developments are in the areas defined as "Low Landslide Incidence." Other hazards are categorized at the same level throughout town. For snowfall, all of Hull is in the zone of 36 to 48 inches average annual snowfall. With respect to wind, there is no variation across the four sites; the hazard map depicts the entire town of Hull with a 100-year wind speed of 110 miles per hour. (See hazard maps in Appendix C).

Nantasket Focus Area (A)
Future residential and retail development
Worrick Estates (B)

Possible future redevelopment location
Waveland Area (C)
Targeted for redevelopment.
R St. to Fitzpatrick Way (Nantasket Avenue) (D)
Targeted for redevelopment

Table 21 shows the relationship of these parcels to three of the mapped hazards. This information is provided so that planners can ensure that development proposals comply with flood plain zoning and that careful attention is paid to drainage issues.

Table 21 Relationship of Potential Development to Hazard Areas

Parcel	Flood Zone	Brush Fire Risk
Nantasket Focus Area (A)	23% AE, 30% AO, 41% VE	No
Worrick Estates (B)	35% AE	Yes
Waveland Area (C)	87% AE, 7% VE	No
R St. to Fitzpatrick Way (Nantasket Avenue) (D)	45% AE, 26% AO, 27%VE	No

Critical Infrastructure in Hazard Areas

Critical infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, etc.) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). There are 149 facilities identified in Hull. These are listed in Table 22 and are shown on the maps in Appendix B.

Explanation of Columns in Table 22

Column 1: ID #: The first column is an ID number which appears on the maps that are part of this plan. See Appendix B.
Column 2: Name: The second column is the name of the site.
Column 3: Type: The third column indicates what type of site it is.
Column 4: FEMA Flood Zone: The fifth column addresses the risk of flooding. A "No" entry in this column means that the site is not within any of the mapped risk zones on the Flood Insurance Rate Maps (FIRM maps). If there is an entry in this column, it indicates the type of flood zone as follows:
Zone AE (1% annual chance) **-** Zones AE is the flood insurance rate zone that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.
Zone AO (1% chance zone) Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.
Zone VE (1% annual chance) **-** Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.
Column 5: Locally-Identified Flood Area: The locally identified areas of flooding were identified by Town staff as areas where flooding occurs. These areas do not necessarily coincide with the flood zones from the FIRM maps. They may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone. The numbers correspond to the numbers on Map 8, "Hazard Areas".
Column 6: Brushfire Risk: The fourth column indicates whether the site falls within an area identified by municipal staff as posing a brushfire risk.
Column 7: Hurricane Surge Category: The seventh column indicates whether or not the site is located within a hurricane surge area and the category of hurricane estimated to be necessary to cause inundation of the area. The following explanation of hurricane surge areas was taken from the US Army Corps of Engineers web site:

> "Hurricane storm surge is an abnormal rise in sea level accompanying a hurricane or other intense storm. Along a coastline a hurricane will cause waves on top of the surge. Hurricane Surge is estimated with the use of a computer model called SLOSH. SLOSH stands for Sea Lake and Overland Surge from Hurricanes. The SLOSH models are created and run by the National Hurricane Center. The SLOSH model results are merged with ground elevation data to determine areas that will be subject to flooding from various categories of hurricanes. Hurricane categories are defined by the Saffir-Simpson Scale." See http://www.sam.usace.army.mil/hesdata/General/hestasks.htm

According to the Saffir-Simpson Scale, the least damaging storm is a Category 1 (winds of 74-95 miles per hour) and the most damaging storm is a Category 5 (winds greater than 155 miles per hour).

Table 22 Relationship of Critical Infrastructure to Hazard Area

ID	NAME	TYPE	FEMA Flood Zone	Locally-Identified Flood Area	Locally Identified Brushfire Risk	Hurricane Surge Areas
1	Lillian M Jacobs School	School	No	No	No	0
2	Hull Sewer Plant	Waste Water Treatment	AE	Stoney Beach	No	2
3	Gould Hall	Religious Facility	No	No	Fort Revere	0
4	Hull High School	School	No	Channel Street	No	2
5	Hull Memorial School	School	AE	Central Ave	No	2
6	Hull Fire – A St.	Fire Department	AE	No	No	2
7	Hull Police	Police Department	No	No	No	0
8	Hull Medical Facility	Medical Facility	AE	No	No	3
9	Hull Teen & Woman's Clinic	Medical Facility	No	No	Landfill	2
10	Hull Fire – Green Hill	Fire Department	No	No	No	0
11	McTighe Manor	Elderly/Disabled Housing	No	No	No	0
12	Hull Town Hall	Town Hall	No	No	No	0
13	Hull Fire - Village	Fire Department	No	No	No	4
14	Hull Wind Mill 1	Turbine	AE	Channel Street	No	2

Table 22 Relationship of Critical Infrastructure to Hazard Area						
ID	**NAME**	**TYPE**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Locally Identified Brushfire Risk**	**Hurricane Surge Areas**
15	Station 9	Waste Water Pump Station	VE	Channel Street	No	1
16	Pemberton Pier	Commuter Boat	VE	Channel Street	No	1
17	Life Saving Boat House	Educational Facility	AE	Channel Street	No	2
18	Pt. Allerton Coast Guard Station	Coast Guard Station	VE	No	No	2
19	Coast Guard Boat House	Beach Head	VE	No	No	0
20	Station 6	Waste Water Pump Station	AE	No	No	2
21	Stormwater Pump Station	Storm Water Pump Station	VE	Sunset/Cadish Avenue	No	1
22	Sunset Bay Marina	Marina	No	No	No	2
23	Tri Town Baptist Church	Religious Facility	No	No	No	4
24	Saint Ann's Church	Religious Facility	AE	Beach Avenue to Nantasket Avenue	No	2
25	Anne Scully's Senior Center	Elderly Center	AE	Beach Avenue to Nantasket Avenue	No	2
26	Memorial School Shelter	Warming Center	AE	No	No	1
27	Fuel Depot	Fuel Depot	No	No	No	0
28	Municipal Light Dept.	Electric Company Hdq.	No	No	No	2
29	Knights of Columbus	Meeting Place	No	Beach Avenue to Nantasket Avenue	No	2
30	DPW Barn	DPW Barn	AE	DPW Building	No	2
31	DPW Salt Shed	DPW Salt Shed	AE	DPW Building	No	3
32	Public Safety Dispatch Center	Dispatch Center (Secondary)	No	No	No	0
33	Waste Water Pump Station A	Waste Water Pump Station	VE	No	No	0
34	Waste Water Pump Station 1	Waste Water Pump Station	AE	No	No	2
35	Waste Water Pump Station 3	Waste Water Pump Station	AE	No	No	3
36	Waste Water Pump Station 4	Waste Water Pump Station	AE	Hampton Circle	No	2
37	Waste Water Pump Station 5	Waste Water Pump Station	AE	No	No	1
38	Storm Water Pump Station	Storm Water Pump Station	AE	No	No	1
39	Nantasket Pier	Pier	AE	No	No	1
40	Hull Landfill	Landfill	No	No	Landfill	0
41	Town Power Line	Power Line	AE	No	No	0
42	Spinnaker Island Bridge (private)	Bridge	VE	No	No	0

Table 22 Relationship of Critical Infrastructure to Hazard Area						
ID	**NAME**	**TYPE**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Locally Identified Brushfire Risk**	**Hurricane Surge Areas**
43	Drinking Water Booster Pump	Water Booster	No	No	No	3
44	West Corner Bridge	Bridge	AE	DPW Building	No	0
45	West Corner Culvert	Culvert	AE	DPW Building	No	3
46	Hull Public Library	Library	No	James Avenue	No	4
47	Borland Bridge	Bridge	AE	No	No	0
48	MLK Bridge	Bridge	AE	No	No	1
49	Windemeer Pier	Pier	VE	No	No	0
50	Hull Yacht Club	Marina	VE	No	No	0
51	Hull Salt Water Club	Marina	VE	No	No	0
52	Newport Road Dike	Dike	AE	No	WBZ	3
53	WBZ TV Towers	Communication Towers	AE	No	WBZ	1
54	Nantasket Beach Reservation Seawall	Seawall	VE	No	No	1
55	Summit Hill Seawall	Seawall	VE	No	No	1
56	Crescent/Gunrock Beach Seawall	Seawall	VE	No	No	1
57	Gunrock Beach Breakwater	Breakwater	VE	No	No	0
58	Beach Avenue Barrier Dunes	Dune	VE	Beach Avenue to Nantasket Avenue	No	2
59	Allerton Hill Bluff	Bluff	VE	No	No	4
60	Point Allerton Seawall	Seawall	VE	Stoney Beach	No	1
61	Stoney Beach/Fort Hill Riprap Seawall	Seawall	VE	No	No	0
62	Channel Street Seawall	Seawall	VE	No	No	0
63	Windmill Point Breakwater Riprap	Seawall	VE	Channel Street	No	0
64	Main Street Seawall	Seawall	VE	No	No	0
65	Hull Hill Seawall	Seawall	VE	No	No	1
66	James Avenue Landing Seawall Riprap	Seawall	VE	James Avenue	No	1
67	Spring Street Seawall	Seawall	VE	No	No	0
68	Cadish/Sunset Ave Seawall	Seawall	VE	No	No	0
69	Strawberry Hill Seawall	Seawall	VE	No	No	1
70	Newport Road Seawall	Seawall	VE	No	No	1
71	Sunset Point Seawall	Seawall	VE	No	No	1
72	Hampton Circle Seawall	Seawall	AE	No	No	1
73	Bay Street Seawall	Seawall	AE	Bay Street	No	0
74	Fitzpatrick Way Lagoon Seawall	Seawall	AE	No	No	0
75	Sunset Marina	Marina	VE	Sunset/Cadish Avenue	No	1

Table 22 Relationship of Critical Infrastructure to Hazard Area						
ID	**NAME**	**TYPE**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Locally Identified Brushfire Risk**	**Hurricane Surge Areas**
76	Nantasket Preschool	Preschool	AO	Alphabet Streets, Oceanside	No	2
77	North River Bus Company	Bus Garage	AE	Beach Avenue to Nantasket Avenue	No	2
78	Hadassah Way Temple Complex	RELIGIOUS FACILITY	AE	Beach Avenue to Nantasket Avenue	No	2
79	Hull Community Nursery School	Preschool	No	Beach Avenue to Nantasket Avenue	No	2
80	Boy Scout Building	Municipal Building	No	No	No	2
81	Hull Public Housing	Public Housing	AE	Central Ave	No	2
82	Hull Lifesaving Museum	Museum	AE	Stoney Beach	No	2
83	Nantasket Pharmacy	Pharmacy	No	Beach Avenue to Nantasket Avenue	No	2
84	Village Grocery Store	Food	No	No	No	2
85	US Post Office	Post Office	AE	No	No	2
86	Cumberland Farms	Food	No	No	No	3
87	Seven-Eleven	Food	AE	Beach Avenue to Nantasket Avenue	No	2
88	Daley and Wanzer Moving & Storage	Moving/storage	AO	No	No	2
89	Cumberland Farms	Food	AE	No	No	2
90	Allerton Post Office	Post Office	AE	No	No	2
91	Well Spring	Food Pantry	AO	Alphabet Streets, Oceanside	No	2
92	Hull Cemetery	Cemetery	No	No	No	0
93	Pemberton Boat Ramp	Boat Ramp	VE	Channel Street	No	1
94	A Street Boat Ramp	Boat Ramp	VE	Sunset/Cadish Avenue	No	1
95	8th Street Boat Ramp	Boat Ramp	AE	Edgewater Rd.	No	1
96	Gunrock Boat Ramp	Boat Ramp	VE	Gun Rock Beach	No	1
97	Roller Hockey Park Heliport	Heliport	AE	No	No	2
98	Burgin's Parking Lot Heliport	Heliport	AO	No	No	3
99	Kenberma Play Ground Heliport	Heliport	AE	No	No	2
100	L Street Playground Heliport	Heliport	AE	No	No	2
101	Mariners Park Heliport	Heliport	VE	No	No	2
102	Jacobs School Heliport	Heliport	No	No	No	0
103	Dust Bowl Heliport	Heliport	AE	No	No	1

Table 22 Relationship of Critical Infrastructure to Hazard Area						
ID	**NAME**	**TYPE**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Locally Identified Brushfire Risk**	**Hurricane Surge Areas**
104	Main Street Beach	Beach	VE	No	No	0
105	Channel Street Beach	Beach	VE	No	No	1
106	Stoney Beach	Beach	VE	No	No	1
107	Point Allerton Beach	Beach	VE	Stoney Beach	No	1
108	Allerton Hill Bluff Beach	Beach	VE	No	No	0
109	Nantasket Beach	Beach	VE	No	No	1
110	Gunrock Beach	Beach	VE	Gun Rock Beach	No	1
111	Stoney Beach	Beach	VE	Gun Rock Beach	No	1
112	Crescent Beach	Beach	VE	No	No	0
113	Crescent beach Breakwater	Breakwater	VE	No	No	2
114	Crescent beach Seawall	Seawall	VE	Atlantic Ave	No	1
115	Summit Ave Beach	Beach	VE	No	No	1
116	Bay Street Beach	Beach	AE	Bay Street	No	1
117	Hampton Circle Beach	Beach	AE	No	No	1
118	Bay Street Beach 2	Beach	AE	No	No	1
119	Topics Beach	Beach	AE	No	No	1
120	Edgewater Beach	Beach	AE	No	No	1
121	Sunset Point Beach	Beach	VE	No	No	1
122	New Port Road Beach	Beach	VE	No	No	1
123	Strawberry Hill Beach	Beach	VE	No	No	0
124	Cadish Ave Beach	Beach	VE	Sunset/Cadish Avenue	No	1
125	Spring Street Beach	Beach	VE	No	No	1
126	Fitzpatrick Way Beach	Beach	VE	No	No	1
127	Fitzpatrick Way Seawall	Seawall	VE	No	No	1
128	James Ave Beach	Beach	VE	James Avenue	No	1
110	Gunrock Beach	Beach	VE	Gun Rock Beach	No	1
129	Hull Hill Beach	Beach	VE	No	No	1
130	Water Pump	Water Pump	No	No	No	0
131	Hull Wind Mill 2	Turbine	AE	No	Landfill	2
132	Communications Shed	Communications Building	AE	No	No	2
133	Communications Tower	Communications Tower	No	No	No	0
134	Verizon Communications Tower	Communications Tower	AO	Nantasket Beach (DCR)	No	2
135	Water Pipe - 6" Main	Water Pipe	VE	No	No	0
136	Gas Line	Gas Line	No	DPW Building	No	3
137	3 Water Tanks in Bunker	Water Tank	No	No	No	0
138	St. Nicholas United Methodist	Church	No	No	Fort Revere	0
139	Harbormaster's Office	Town Facility	AE	No	No	1
140	Nantasket Beach Resort	Hotel	VE	No	No	1

Table 22 Relationship of Critical Infrastructure to Hazard Area						
ID	**NAME**	**TYPE**	**FEMA Flood Zone**	**Locally-Identified Flood Area**	**Locally Identified Brushfire Risk**	**Hurricane Surge Areas**
141	Nantasket Hotel	Hotel	No	No	No	0
142	Emergency Operations Center	Town Facility	AE	No	No	1
143	DCR Hdq., Fuel Station, Barracks	State Facility	AO	Nantasket Beach (DCR)	No	3
144	Bermaken	Rooming House	VE	Beach Avenue to Nantasket Avenue	No	3
145	Nantascot Lodging	Rooming House	No	No	No	2
146	Nantascot Beach Lodging	Rooming House	AO	Nantasket Beach (DCR)	No	3
147	Neighborhood Housing	Rooming House	AO	Nantasket Beach (DCR)	No	2
148	Sandpiper	Rooming House	AO	Nantasket Beach (DCR)	No	3
149	Spinnaker Island Beach	Beach	VE	No	No	1

Vulnerability Assessment

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

Introduction to HAZUS-MH

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

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

buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods and earthquakes on populations."

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

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

Estimated Damages from Hurricanes

The Hazus-MH software was used to model potential damages to the community from a 100 year and 500 year hurricane event; storms that are 1% and .0.2% likely to happen in a given year, and roughly equivalent to a Category 2 and Category 4 hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the Town, bringing the strongest winds and greatest damage potential.
Though there are no recorded instances of a hurricane equivalent to a 500 year storm passing through Massachusetts, this model was included in order to present a reasonable "worst case scenario" that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms.

Table 23 - Estimated Damages from Hurricanes

	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	4,553	
Estimated total building replacement value (2014 $)	$1,493,000,000	
Building Damages		
# of buildings sustaining minor damage	467	1,323
# of buildings sustaining moderate damage	56	478
# of buildings sustaining severe damage	2	79
# of buildings destroyed	3	50
Population Needs		
# of households displaced	2	80
# of people seeking public shelter	0	15
Debris		
Building debris generated (tons)	2,767	8,585
Tree debris generated (tons)	715	1,852

# of truckloads to clear building debris	72	345
Value of Damages		
Total property damage (buildings and content)	$17,424,070	$101,708,750
Total losses due to business interruption	$1,485,430	$13,151,340

Estimated Damages from Earthquakes

The Hazus-MH earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic center of the study area. For the purposes of this plan, two earthquakes were selected: magnitude 5.0 and a magnitude 7.0. Historically, major earthquakes are rare in New England, though a magnitude 5 event occurred in 1963.

Table 24 -Estimated Damages from Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	4,553	
Estimated total building replacement value (2014 $)	$1,493,000,000	
Building Damages		
# of buildings sustaining slight damage	1,313	216
# of buildings sustaining moderate damage	697	1,077
# of buildings sustaining extensive damage	191	1,276
# of buildings completely damaged	48	1,962
Population Needs		
# of households displaced	225	2,609
# of people seeking public shelter	101	1,206
Debris		
Building debris generated (tons)	30,000	290,000
# of truckloads to clear debris (@ 25 tons/truck)	1,360	11,580
Value of Damages		
Total property damage	$184,510,000	$1,397,020,000
Total losses due to business interruption	$28,300,000	$181,310,000

Estimated Damages from Flooding

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

Table 25 - Estimated Damages from Flooding		
	100 Year	**500 Year**
Building Characteristics		
Estimated total number of buildings	4,553	
Estimated total building replacement value (2014 $)	$1,493,000,000	
Building Damages		
# of buildings sustaining slight damage (<10%)	0	0
# of buildings sustaining moderate damage (10-50%)	544	852
# of buildings sustaining substantial damage (>50%)	119	193
Population Needs		
# of households displaced	1,154	1,609
# of people seeking public shelter	2,818	4,058
Value of Damages		
Total property damage (buildings and content)	$ 287,920,000	$447,660,000
Total losses due to business interruption	$ 610,000	$ 1,010,000

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V. HAZARD MITIGATION GOALS

The Hull Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2012 Hazard Mitigation Plan for the Town of Hull. All of the goals were found to continue to be reflective of the Town's priorities and concerns relative to natural hazard mitigation. All of the goals are considered critical for the Town and they are not listed in order of importance.

Goal 1: Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all major natural hazards.

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

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

Goal 4: Prevent and reduce the damage to public infrastructure resulting from all hazards.

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

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

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

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

Goal 9: Consider the potential impacts of future climate change. Incorporate climate sustainability and resiliency in hazard mitigation planning.

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VI. EXISTING MITIGATION MEASURES

The existing protections in the Town of Hull are a combination of zoning, land use, and environmental regulations, public education, infrastructure maintenance and infrastructure improvement projects. Infrastructure maintenance generally addresses localized drainage clogging problems, or seawall/revetment/dune repairs, while large scale capacity problems may require pipe replacement, invert elevation modifications, or large scale seawall/revetment improvements and replacements. These more expensive projects are subject to the capital budget process and lack of funding is one of the biggest obstacles to completion of some of these.

The Town's existing mitigation measures, which were in place prior to the original 2007 Plan, are listed by hazard type here and are summarized in Table 26 below. Many upgrades to existing measures are noted in the following sections.

Flooding – Existing Town-Wide Mitigation

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

National Flood Insurance Program (NFIP) – Hull participates in the NFIP with 2,094 policies in force as of the October 31, 2017. FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at https://bsa.nfipstat.fema.gov/reports/1011.htm

The following information is provided for the Town of Hull:

Flood insurance policies in force (as of October 31, 2017)	2,094
Coverage amount of flood insurance policies	$486,760,200
Premiums paid	$3,321,838
Total losses (all losses submitted regardless of the status)	2,263
Closed losses (Losses that have been paid)	1,888
Open losses (Losses that have not been paid in full)	0
CWOP losses (Losses that have been closed without payment)	375
Total payments (Total amount paid on losses)	$15, 214, 606

The Town complies with the NFIP by enforcing floodplain regulations, maintaining up-to-date floodplain maps, and providing information to property owners and builders regarding floodplain and building requirements.

CRS Program Participation – The Town of Hull participates in the Community Rating System (CRS) program, gaining a reduction in flood insurance rates for property owners in the Town in exchange for mitigation actions taken to reduce the Town's potential vulnerability to flooding. The program functions on a rating system, with an individual community's rating being based on the number of points they receive, with points allocated for each flood mitigation measure enacted. The Town of Hull currently has a rating of Class 8 with 1301 points, resulting in a 10% reduction in flood insurance rates in the Town.

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

- *Street sweeping* – Conducted annually, more frequently in environmentally sensitive areas and business districts.
- *Catch basin cleaning* – Conducted annually, more frequently in low lying areas.
- *Roadway treatments* – Mixture of sand and salt.
- *Other* – Continued repair and rehabilitation of check valves and back-flow preventers.

Stormwater Drainage System – Hull has an extensive stormwater drainage system that features a lagoon system with pumps as well as check valves and back-flow preventers.

Hull Community Development Plan, 2004 – The Community Development Plan includes an analysis of challenges and opportunities in the Town and proposes a vision for the Town's future and a general strategy for achieving it. The plan focuses on the potential for development in the Nantasket Beach area.

Conservation/Recreation Open Space Plan – The 2000 Open Space and Recreation Plan identifies current open space areas, as well as properties that could be acquired for open space, which serve a number of different purposes including mitigation of flooding and storm damage.

Weir River Estuary Land Protection Plan – The 2006 Weir River Estuary Land Protection Plan, covering an area that includes portions of Hull, Hingham, and Cohasset includes land protection goals for shoreline lands and wetlands that could also serve as flood and storm damage mitigation. The efforts to date have protected 368 acres of estuary land and there are approximately 150 acres of key parcels that have been identified as a priority for protection.

Harbor Management Plan - The Harbor Management Plan addresses the need for maintenance and repair of foreshore structures that prevent against flooding.

Floodplain Zoning District – Zoning is intended to protect the public health and safety through the regulation of land use. The Hull Zoning Bylaw includes a Floodplain District (Section 37and 42). The purposes of this district are to protect the public health, safety and general welfare, to protect human life and property from the hazards of periodic flooding, to preserve the natural flood control characteristics, and the flood storage capacity of the floodplains. The Floodplain District is an overlay district, defined by the 100-year floodplain as designated by FEMA. Within the District, all development must conform with the requirements of the State Building Code pertaining to the flood resistant construction and meet requirements related to anchorage, flood design considerations for enclosed spaces below base flood elevation, and water resistant construction. In High Hazard Zones (V Zones), buildings must be elevated two feet above base flood elevation, spaces below flood elevation levels should be free of obstruction or have "break-away walls", and be anchored to pilings.

Site Plan Review – The Hull Zoning Bylaw includes Site Plan Review Design Guidelines (Section 40) with provisions that relate to improving stormwater management.

1. Protection and enhancement of important existing site features
2. Protection of adjoining premises against detrimental uses by provision of surface water drainage, sound, sight and wind barriers and preservation of views, light and air quality.
3. Convenience and safety of vehicular and pedestrian movement within the site, the location of driveway openings in relation to traffic or to adjacent streets.
4. Adequacy of the arrangement of parking and loading spaces.
5. Adequacy of the methods of disposal of refuse and other wastes.
6. Relationship of buildings, structures and open space to the natural landscape and existing buildings and structures.
7. Prevention of pollution of surface and groundwater, soil erosion, increased runoff and flooding.
8.

Subdivision Control – "Town of Hull, Rules and Regulations Governing the Subdivision of Land" was adopted in 1988 to regulate land subdivision in the Town. These regulations include provisions that serve to address stormwater run-off associated flooding and land development within the floodplain.

Cluster Zoning - Section 43 Flexible Plan Development allows for cluster zoning. Properties of at least ten acres may receive a density bonus if a minimum of 25% of the property is preserved as open space, including passive or active recreation areas. Open space areas could be designated for the protection of natural drainage areas and streams.

Wetlands Protection Act – Hull enforces the State Wetlands Protection Act through the permitting authority of the Conservation Commission. Enforcement of the Act serves to protect the Town's shores, ponds, rivers, and wetlands for, among other reasons, flood control, erosion and sedimentation control, and storm damage prevention.

Resource Area Setbacks – Section 31-3.e and f of the Zoning Bylaw require building setbacks from sea walls and cliffs. Specifically, these sections require that no building be constructed within ten feet of a publicly owned seawall and that no structure be built closer than twenty five feet from the top edge of a cliff that is greater than twenty feet in height unless said cliff is certified as stable by a registered geologist or registered engineer.

DCR dam safety regulations – The state has enacted dam safety regulations mandating inspections and emergency action plans. All new dams are subject to state permitting.

Identification of Repetitive Loss Areas – The Town has identified and mapped areas where there are significant concentrations of repetitive loss properties.

Elevating Repetitive Loss Properties - The Town has received two FEMA Hazard Mitigation Grants for a total of more than $600,000 to elevate homes, or utilities within homes, for ten residential properties. The ten property owners are proceeding with their projects. The Town has applied for an additional FEMA Hazard Mitigation elevation grant for two homeowners.

Freeboard Incentive - For residential and commercial building elevation, or new construction projects, building department permit fees are reduced by $500 if an elevation certificate is provided to verify the building is elevated a minimum of two feet above the highest federal or state requirement for the flood zone.

Tide-Gates – The Town has three major tide-gates used to control incoming tide levels. The tide-gate at Strait Pond was recently repaired.

Seawalls, Jetties, and Dikes - There are 22.6 miles of coastal frontage in Hull, 5.9 miles of this coastal frontage is publicly owned. Hull has a significant number of seawalls and armoring treatments on this frontage. The town has a Seawall Maintenance and Monitoring plan to ensure Town seawalls are inspected on a regular basis, and corrective action taken when required. Recent work includes emergency repairs to the James Street seawall. In February 2006 the Town updated a comprehensive study of these facilities to determine which ones were in need of repair or replacement and what the likely impacts of a seawall failure would be. The Town completed an inventory, condition and ownership study for all in-town seawalls in the fall of 1996. A US Army Corp of Engineers (USACOE) feasibility study to mitigate flooding of north Nantasket Beach was completed in February 1996. The Town appropriates funding annually to support seawall maintenance and repair and actively inspects and monitors their condition.

Beach and Dune Protection - The Town plants beach grass each spring. In March 2010, as in the past several years, the Town planted 15,000 beach grass plants. The Town has continued to repair breaches in the dune and improve sand fencing to protect the dune from damage.

Existing Dam Failure Mitigation Measure

The tidegate at Straits Pond is classified as a dam. The town maintains the tidegate and has an alarm system to provide notice of any operational issues.

Existing Wind Hazard Mitigation Measures

Communication Tower Zoning Regulations – Regulations of communication towers were created to (a) protect the general public from hazards associated with wireless communication facilities; (b) minimize visual impacts from wireless communication facilities on districts in Hull and to preserve scenic views to and from roadways, open space, recreation areas, and waterways; (c) allow the provisions of necessary wireless communication services and (d) promote shared use of facilities to minimize the need for additional facilities. The zoning ordinance contains regulations that limit tower height and ensure that design and construction is done safely. A special permit from the Board of Appeals is required in order to construct a communications tower and it must meet the following conditions:

- Towers must be 500' from buildings
- Towers cannot be more than 50' above natural grade
- Allowed on public lands or commercial recreation by special permit
- Only mono-poles are allowed
- Not closer than 2 miles to nearest wireless facility
- No lighting allowed

Massachusetts State Building Code – The town enforces the Massachusetts State Building Code whose provisions are generally adequate to protect against most wind damage. The code's provisions are the most cost-effective mitigation measure against tornados given the extremely

low probability of occurrence. If a tornado were to occur, the potential for severe damages would be extremely high.

Tree-trimming program – The Town Light Department conducts tree trimming in coordination with the Department of Public Works.

Existing Winter Hazard Mitigation Measures

Snow disposal –The town conducts general snow removal operations with its own equipment.

Existing Brush Fire Hazard Mitigation Measures

Burn Permits – The Town fire department requires a written permit for outdoor burning, which includes explanation of the related regulations and precautions for the permit-holder to take. The permit-holder must call the fire department on the proposed burn day to confirm weather conditions are suitable for outdoor burning.

Subdivision/Development Review – The Fire Department participates in the review of new subdivisions and development projects.

Existing Geologic Hazard Mitigation Measures

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

Section 1612.2.5 sets up seismic hazard exposure groups and assigns all buildings to one of these groups according to a Table 1612.2.5. Group II includes buildings which have a substantial public hazard due to occupancy or use and Group III are those buildings having essential facilities which are required for post-earthquake recovery, including fire, rescue and police stations, emergency rooms, power-generating facilities, and communications facilities.

Existing Multihazard Mitigation Measures

Comprehensive Emergency Management Plan (CEMP) – Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain important information regarding flooding, hurricanes, tornadoes, dam failures, earthquakes, and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to all of the hazards discussed in this plan.

Communications Equipment – Hull has full coverage of the Town with emergency services radio. The Town is addressing compatibility issues that will allow for regional dispatch during emergency events. Incident command units are available through Plymouth County and MEMA.

Emergency Power Generators – The Town maintains emergency power generators in several important public facilities and emergency shelters.

Massachusetts State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads.

Regional and Local Emergency Management Planning Committees – Locally, the Town engages department heads in emergency management planning. On a regional level, the Town participates in regional emergency management groups, including emergency management cooperation across five neighboring communities and the Massachusetts Emergency Preparedness Region 4b, a health emergency preparation group operating across a large part of the metropolitan region and organized by Cambridge Health Alliance.

Public Information & Outreach – The Town provides information to residents and business owners relating to a range of potential natural hazards, most especially with regard to flooding, hurricanes, and northeasters. The Town maintains a section of its webpage devoted specifically to flooding issue awareness, located at http://www.town.hull.ma.us/Public_Documents/HullMA_conservation/flood. In addition, the Town has comprehensive flood information and mitigation materials in the town library and sends an annual mailing with flood information to all residents in a flood zone.

Existing mitigation measures from the 2007 plan are summarized in Table 26 below.

Table 26- Hull Existing Mitigation Measures

Type of Existing Mitigation Measures	Area Covered	Effectiveness/ Enforcement	Improvements/ Changes Needed
MULTIHAZARDS			
Comprehensive Emergency Management Plan (CEMP)	Town-wide	Emphasis is on emergency response.	None
Communications Equipment	Town-wide	Effective	None
Massachusetts State Building Code	Town-wide	Effective for new construction.	None
Emergency Power Generators	Town-wide	Effective.	None
Participation in the Regional and Local Emergency Planning Committees	Town-wide	Forums for cooperation on natural and manmade disasters.	None
Public Information & Outreach	Town-wide	Effective	Focus on flood protection education
FLOOD HAZARDS			
Participation in the National Flood Insurance Program (NFIP)	Areas identified on the FIRM maps.	There are 2,094 policies in force.	None

Table 26- Hull Existing Mitigation Measures			
Type of Existing Mitigation Measures	**Area Covered**	**Effectiveness/ Enforcement**	**Improvements/ Changes Needed**
CRS Program Participation	Town-wide	Class 8	Seek more CRS points.
Public Works Operations/Maintenance	Town-wide	Effective	More funding.
Stormwater Drainage System	Town-wide	Somewhat Effective	Upgrade and improve as funding allows.
Community Development Plan, 2004	Town-wide	Effective	Needs Updating.
Open Space Plan	Town-wide	Effective	Needs Updating
Weir River Estuary Land Protection Plan	Weir River	Effective	Needs Updating
Harbor Management Plan	Harbor Area	Effective	None
Zoning – Floodplain District	Town-wide	Effective	Update based on map changes
Site Plan Review	Town-wide	Effective	None
Subdivision Control Law	Town-wide	Effective	None
Cluster Zoning	Town-wide	Effective	None
Wetlands Protection Act	Resource Areas	Effective	None
Resource Area Setbacks	Town coastlines	Effective	None
DCR Dam Safety Regulations	Dams	Effective	None
Identification of Repetitive Loss Areas	Town-wide	Effective	Keep up to date.
Elevating Repetitive Loss Properties	Repetitive Loss Properties	Grants complete	None
Freeboard Incentive	Flood Zones	Effective	None
Flood Control Pump Stations	Town-wide	Effective	Upgrade/relocate D St. pump
Tide Gates	Town-wide	Effective	Inspect, maintain and repair as necessary.
Seawalls, Jetties, and Dikes	Coastline	Effective	Inspect, maintain and repair as necessary.
Beach Dune Protection	Coastline	Effective	Inspect, maintain and improve where possible.
WIND HAZARDS			
Communication Tower Zoning Regulations	Town-wide	Effective	None
The Massachusetts State Building Code	Town-wide	Effective for most situations except severe storms	None
Tree trimming program	Town-wide	Effective	None
WINTER HAZARDS			

Table 26- Hull Existing Mitigation Measures			
Type of Existing Mitigation Measures	**Area Covered**	**Effectiveness/ Enforcement**	**Improvements/ Changes Needed**
Snow Disposal Site	Town-wide	Effective	None
GEOLOGIC HAZARDS			
The Massachusetts State Building Code	Town-wide	Effective	None
BRUSHFIRE HAZARDS			
Burn Permit	Town-wide	Effective	None.
Development Review	Town-wide	Effective	None

Mitigation Capabilities and Local Capacity for Improvements

Under the Massachusetts system of "Home Rule," the Town of Hull is authorized to adopt and from time to time amend a number of local bylaws and regulations that support the town's capabilities to mitigate natural hazards. These include Zoning Bylaws, Subdivision and Site Plan Review Regulations, Wetlands Bylaws, Health Regulations, Public Works regulations, and local enforcement of the State Building Code. Local Bylaws may be amended each year at the annual Town Meeting to improve the town's capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission. The Town of Hull has recognized several existing mitigation measures that require implementation or improvements, and has the capacity based on these Home Rule powers within its local boards and departments to address these.

Several departments including Planning, Public Works, Light, and Sewer will address the many planned infrastructure projects. New strategies including paving reduction and drought resistant planting will be stewarded by the Conservation Commission. Many projects, including public education, encouragement of building elevation, open space planning, and incorporating climate issues into capital and other planning documents will be jointly pursued by departments and town leadership.

VII. MITIGATION MEASURES FROM THE 2012 PLAN

Implementation Progress on the Previous Plan

The Hazard Mitigation Planning Committee meets annually every September to review and update these mitigation measures. In 2013 and in 2015 the committee added new mitigation measures. They are listed at the end of Table 27. At a meeting of the Hull Hazard Mitigation Planning Committee, Town staff reviewed the mitigation measures identified in the 2012 Hull Hazard Mitigation Plan and determined whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into this Hazard Mitigation Plan 2018 Update. The decision on whether to delete or retain a particular measure was based on the committee's assessment of the continued relevance or effectiveness of the measure and whether the deferral of action on the measure was due to the inability of the Town to take action on the measure. Table 27 summarizes the status of mitigation measures. Completed mitigation projects are described in more detail below.

Table 27 Mitigation Measures from the 2012 Plan

Mitigation Measure	Measure Type	Implementation Lead	Priority	Current Status	Include in 2018 plan
FLOOD MITIGATION					
Alphabet Streets Drainage (Bay Avenue East)	Structural Projects	Community Development	High	Design and permitting complete. Funding secured, construction to begin in Spring 2018.	Yes
Relocate Aquarion Water Pipes	Natural Resource Protection	Conservation/ Public Works	High	Aquarion is working on final design. Funding not committed.	Yes
Encourage Building Elevation	Prevention /Property Protection	Building/ Conservation	High	Freeboard incentive is effective. By-laws to allow additional height and utilities in setbacks were passed by Town Meeting. Over 80% of projects include freeboard	Yes
Stormwater Drainage System Improvements	Structural Projects	Public Works	High	Multiple projects including Pond St. rain garden, drainage swale improvements, catch basin, drainage and outfall upgrades	Yes
Check Valves and Back-Flow Preventers	Structural Projects	Public Works	High	Flapper valves have been installed or repaired in nine locations.	Yes
Repair Flood Control Pump Stations	Structural Projects	Public Works	High	Major upgrades and repairs to the Draper Ave. and D St. pumps were completed. Additional work for D St. is planned.	Yes

Table 27 Mitigation Measures from the 2012 Plan					
Mitigation Measure	**Measure Type**	**Implementation Lead**	**Priority**	**Current Status**	**Include in 2018 plan**
Repair Nantasket Seawall	Structural Projects	DCR	High	Revetment was installed on 150' of seawall. The ACOE has permitted revetment for an additional 2,200'	Yes
Home Elevation Program	Property Protection	Conservation	High	Work was completed on 3 FEMA grants for home and utility elevations	No
Repair of Town Seawalls, Dikes, and Jetties	Structural Projects	Public Works	High	More than $5 million in grants and loans received. Repairs completed to walls/revetments at Allerton Lagoon, James Avenue, Newport and Nantasket Aves. and Stoney Beach. Stoney Beach 2 foot elevation and revetment replacement complete. Crescent Beach rebuild and 2 foot elevation underway.	Yes
Dune Repair and Protection	Natural Resource Protection	Conservation/ Public Works	High	Significant repairs of storm damage in 2013 and 2017. 20,000 beach grass planted annually, damage repaired as needed.	Yes
A Street Fire Station Flood Protection	Emergency Services Protection	Fire	High	The boiler was elevated. Grant for hurricane doors not received.	Yes
Paving Reduction Program	Prevention / Property Protection	Conservation/ Planning/ Building/ Sewer	Medium	No action, although plans for two-way road on Nantasket Avenue will reduce pavement.	Yes
Open Space Plan Update	Prevention	Planning	Medium	No action.	Yes
Harbor Management Plan Update	Prevention	Planning	Medium	Complete	No
Acquisition of Repetitive Loss Properties	Property Protection	Conservation	Medium	No repetitive loss properties were acquired. However, at least 8 repetitive loss properties have been elevated. This is difficult to fund due to coastal property values.	No
Floodplain Management	Prevention	Building/ Conservation	High	2012: Approved new flood maps and updated regulations and adopted Planning Board	Yes

Table 27 Mitigation Measures from the 2012 Plan					
Mitigation Measure	**Measure Type**	**Implementation Lead**	**Priority**	**Current Status**	**Include in 2018 plan**
				by-law requiring consideration of seal level rise in site plan review. 2013: Nantasket Beach Overlay district with freeboard incentive and floodplain safety language	
Acquisition of Vacant Flood Prone Lands	Natural Resource Protection	Conservation	High	No action.	No
Floodplain Mapping	Public Education	Conservation/ Building	Medium	The town maintains updated maps.	Yes
WIND MITIGATION					
Protect Electric Lines	Property Protection	Light Plant	Medium	The town has an on-going tree-trimming program. Projects to strengthen wiring and infrastructure to reduce the risk of failure have been completed.	Yes
MULTIHAZARD MITIGATION					
Emergency Power Generators	Emergency Services Protection	Emergency Management	High	Complete	No
Public Education	Public Education	Conservation	High	Town departments including Health, Fire, Emergency Planning and Conservation, conduct extensive public outreach. Social media outreach has been added with this plans. Craig Wolfe, a local volunteer, was honored by FEMA as a "Community Preparedness Hero".	Yes
Communications Equipment at Jacobs School	Emergency Services	Emergency Management	Medium	Many upgrades including walkie-talkies, additional radios, establishment of Code Red and School Messenger emergency notification services.	No
Community Development Plan Update	Prevention	Planning	Medium	No Action	No
Improve Emergency Operations *(added in 2013 annual*	Emergency Services	Emergency Management	High	Many improvements including establishment of the EOC at the Memorial School.	No

Table 27 Mitigation Measures from the 2012 Plan					
Mitigation Measure	**Measure Type**	**Implementation Lead**	**Priority**	**Current Status**	**Include in 2018 plan**
review)				Significant collaboration with regional partners.	
Study climate risk posed by sea level rise *(added in 2015 annual review)*	Prevention	Conservation	High	A study of sea level rise risk was completed. Recommendations from the study are integrated into this plan.	No

As indicated in Table 27, Hull made considerable progress implementing mitigation measures identified in the 2012 Hazard Mitigation Plan. Completed structural projects include the rebuilding and elevation of the Stoney Beach revetment, installation of a revetment at Nantasket Beach (DCR), installation of flapper valves, repairs to pump stations, as well as numerous stormwater drainage improvements. The dunes along Nantasket Beach were augmented significantly in 2013 and 2017. The Town made several regulatory changes including adopting by-laws to support the $500 Freeboard Incentive by allowing property owners to exceed zoning height and setback requirements. More than 80% of properties were eligible for the incentive by elevating two feet higher than required by the Building Code. The Town added language to Planning Board Site Plan Review that requires consideration of future sea level rise and impacts to neighboring properties. Finally the Town adopted a Zoning Overlay District to incentivize allowing floodwaters to pass through the first floor of development. The town significantly upgraded its emergency operations, adding communication equipment and fully outfitting an Emergency Operation Center at the Memorial Middle School. The town also significantly expanded its public education utilizing social media, written materials, and personal outreach. Other completed projects including FEMA grant funded elevation projects, annual beachgrass planting of the town dune, tree trimming and hardening of electric lines, and completion of a study of vulnerability to future sea level rise.

Several projects that were not completed will be continued into this plan update. These include construction of the Bay Avenue East drainage project (funded and planned for 2018), rebuild and elevation of the Crescent Beach seawall and revetment (completion in 2018), and relocation of Aquarion Water Company pipes under the dune.

Overall, sixteen mitigation measures from the 2012 plan will be continued in the plan update. They will retain the same priority in this 2018 update. A number of these are ongoing projects such as public education, floodplain management, and stormwater or drainage repairs. Six projects are not complete and will not be carried forward into current plan. Acquisition of repetitive loss properties and of vacant land are cost-prohibitive at this time. The town has instead focused on encouraging elevation of flood-prone properties.

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

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VIII. HAZARD MITIGATION STRATEGY

What is Hazard Mitigation?

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects and other activities. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Pre-Disaster Mitigation program (PDM), and the Flood Mitigation Assistance (FMA) program. The three links below provide additional information on these programs.
https://www.fema.gov/hazard-mitigation-grant-program
https://www.fema.gov/pre-disaster-mitigation-grant-program
https://www.fema.gov/flood-mitigation-assistance-grant-program

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

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

Regional and Inter-Community Considerations

Some hazard mitigation issues are strictly local. The problem originates primarily within the municipality and can be solved at the municipal level. Other issues are inter-community and

require cooperation between two or more municipalities. There is a third level of mitigation which is regional and may involve a state, regional or federal agency or three or more municipalities.

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

Overview of Regional Facilities within Hull
Major facilities owned, operated and maintained by federal, state, regional or private entities in Hull include: Routes 228 (Mass DOT); local bus service and commuter boat to Boston (MBTA); the Nantasket Beach Reservation (DCR); and the Coast Guard Station Pt. Allerton (U.S. Coast Guard).

Inter-Community Considerations
Shoreline Environment – The coastal shoreline of the South Shore area is a dynamic environment where forces of erosion and deposition of sand are constantly at work changing the beach profile. This process disregards municipal boundaries as sand and other materials are moved along the coast. Shoreline protection measures such as sea walls, jetties, and others have an impact on this process with the potential of building up sand in some areas while stripping it away from others. Municipalities along the South Shore should work to understand how these processes are at work locally and consider mutually beneficial means of protecting their shore side communities from the impacts of storm damage.

Weir River Estuary Land Protection – Amongst the numerous benefits that can be attributed to protecting land in the Weir River Estuary, covering an area that includes portions of Hull, Hingham, and Cohasset, protection of coastal land and wetland areas can serve to mitigate flooding and potential storm damage. These protected areas directly serve to absorb storm water and act as flood water retention areas. Indirectly, land along the water that is protected will not be developed with homes and buildings that would later be subject to storm and flood damage.

New Development and Infrastructure

As part of the process of developing recommendations for new mitigation measures for this plan update, the Town considered the issues related to new development, redevelopment, and infrastructure needs in order limit future risks. Taking into consideration the Zoning and By-law changes adopted in recent years, the Wetlands Act enforced by the Conservation Commission, and the recent adoption of the Community Preservation Act, the town determined that existing regulatory measures are taking good advantage of local Home Rule land use regulatory authority to minimize natural hazard impacts of development. Priorities for the future include

updating the open space plan, encouraging beach nourishment and dune development, and public education efforts toward ensuring that future development occurs in a sustainable manner.

Process for Setting Priorities for Mitigation Measures

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

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

Table 28 below demonstrates the prioritization of the Town's potential hazard mitigation measures. For each mitigation measure, the geographic extent of the potential benefiting area is identified as is an estimate of the overall benefit and cost of the measures. The benefits, costs, and overall priority were evaluated in terms of:

Estimated Benefits	
High	Action will result in a significant reduction of hazard risk to people and/or property from a hazard event
Medium	Action will likely result in a moderate reduction of hazard risk to people and/or property from a hazard event
Low	Action will result in a low reduction of hazard risk to people and/or property from a hazard event
Estimated Costs	
High	Estimated costs greater than $100,000
Medium	Estimated costs between $10,000 to $100,000
Low	Estimated costs less than $10,000 and/or staff time
Priority	
High	Action very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure
Medium	Action may have political and public support and necessary maintenance has potential to occur following the project

Low	Not clear if action has political and public support and not certain that necessary maintenance can occur following the project

Table 28 – Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Flood Mitigation				
Alphabet Streets Drainage (Bay Avenue East Project)	Bay Ave. East area	High	High	High
Relocate Aquarion Water Pipes	Alphabets, L to X St.	High	High	High
Encourage Building Elevation (Freeboard)	Town-wide	High	Low	High
Stormwater Drainage System Improvements (Beach Avenue drains, others as needed)	Town-wide	High	High	High
Install/Repair Check Valves and Back-Flow Preventers as needed	Town-wide	High	Medium	Medium
Upgrade D St. pump, consider relocation/elevation	Alphabets	High	High	High
Repair Nantasket Seawall – install revetment	Nantasket Beach - DCR	High	High	High
Repair of Town Seawalls, Dikes, and Jetties Complete Crescent Beach, Cadish Avenue, repairs as needed	Town-wide	High	High	High
Dune Repair and Protection	Nantasket Beach Phipps Street, north	High	Low	High
A Street Fire Station Flood Protection – install hurricane doors	Town-wide	Medium	Medium	Medium
Paving Reduction Program	Town-wide	Medium	Medium	Medium
Open Space Plan Update	Town-wide	Medium	Medium	Medium
GIS Floodplain Mapping – update as needed	Town-wide	High	Low	High
Pursue public ownership of beach lots to protect Nantasket Beach dune	Nantasket Beach Phipps St. north	High	High	High
Wind Mitigation				
Protect Electric Lines – continue project to Pemberton Point.	Hull Village to Pemberton Point	High	Medium	High
Brushfire Mitigation				
Arrange mutual aid with Plymouth County for brushfire truck	Brushfire areas	Medium	Low	Medium
Winter Storm Hazard Mitigation				
Evaluate public buildings for ability to withstand snow loads; retrofit to greatest degree feasible.	Public buildings	Medium	Low	Medium
Earthquake Mitigation				
Public building seismic assessments	Public Buildings	Medium	Medium	Medium
Dam Mitigation				
Maintain alarm system for Straits Pond tidegate	Atlantic	High	Low	High

Table 28 – Mitigation Measure Prioritization				
Mitigation Action	**Geographic Coverage**	**Estimated Benefit**	**Estimated Cost**	**Priority**
	Avenue			
Extreme Temperature Mitigation				
Consider establishment of a cooling center for extreme heat days	Town-wide	Medium	Low	Medium
Drought Mitigation				
Encourage drought resistant landscaping	Town-wide	Medium	Low	Medium
Multihazard Mitigation				
Public Education	Town-wide	High	Low	High
Rehabilitate Village Fire Station	Village	High	High	High
Climate Resilience/Adaptation				
Relocate light plant garages to higher elevation	Light Plant	High	High	High
Implement battery storage project	Town-wide	High	High	High
Develop evacuation plan considering sea level rise	Town-wide	High	Low	High
Elevate electricity and HVAC at sewer plant	Town-wide	High	High	High
Encourage beach nourishment on Nantasket Beach (DCR)	Nantasket DCR	High	High	High
Consider future climate impacts in all capital planning, as well as master plans, open space plans, etc.	Town-wide	High	Low	High
Consider plan to protect DPW barn from future flooding	Town-wide	High	High	Medium
Promote bicycle/pedestrian transportation to reduce auto use	Town-wide	Medium	High	High
Pursue opportunities to extend and expand Nantasket Beach dune	Nantasket Beach	High	High	High
Continue to incorporate recommendations from the Coastal Climate Change Vulnerability Assessment and Adaptation Study	Town-wide	High	Variable	High
Evaluate options to protect sewer plant from future flooding risk	Town-wide	High	Medium	High
Develop formalized property owner flood protection and flood insurance education plan	Town-wide	High	Low	High
Install flood protection for vulnerable segments of the Memorial School/EOC	Town-wide	High	Medium	High
Research ownership and status of WBZ dike tidegate to determine repair options	Bayside	High	Low	High
Purchase a drone to facilitate documentation of pre and post storm shoreline conditions	Town-wide	High	Low	High
Investigate options to protect against flooding along Cadish Avenue	Bayside	High	Low	High

Potential Mitigation Measures

The potential mitigation measures are provided in this section and summarized in Table 28.

Flooding, Drainage Infrastructure, and Dams
Infrastructure projects include Bay Avenue East drainage work, Beach Avenue storm drains, repair or relocate the D Street pump, relocation of Aquarion water pipes; seawall projects include Nantasket Beach (DCR), Cadish Avenue, and completion of the Crescent Beach seawall and revetment project. On-going work includes encouraging building elevation, dune repair and protection, and GIS floodplain mapping. Other work includes initiation of a paving reduction program, update to the Open Space plan, and pursuing public ownership of beach lots to protect the Nantasket Beach dune. The Straits Pond tidegate is classified by DCR as a dam. The town intends to monitor operations and maintain the alarm system.

Wind Hazards
Harden electric lines from Stoney Beach to Pemberton Point.

Fire Hazards
Arrange mutual aid with Plymouth County for brushfire truck.

Winter Hazards
Evaluate public buildings for ability to withstand snow loads; retrofit to greatest degree feasible.

Earthquakes
Earthquake building assessment—determine which public buildings may be most vulnerable to earthquake damage and conduct a structural assessment if needed.

Extreme Temperatures
Consider establishment of a cooling center for extreme heat days.

Drought
Encourage drought resistant landscaping.

Multihazard Mitigation
Continue public outreach with an emphasis on flooding, fire, and emergency preparedness. Rehabilitate the Village Fire Station.

Climate Change
The town identified flooding from sea level rise as the primary threat from climate change. The local team reviewed their Climate Change Vulnerability Assessment and Adaptation Study as part of the process of developing climate change mitigation goals. Infrastructure projects include relocating the light plant garages to higher ground, elevating electricity and HVAC at the sewer plant, and installing flood protection for the Memorial School/EOC. Planning projects include developing an evacuation plan for sea level rise, investing protection options along Cadish Avenue, including climate impacts in all capital planning and other town plans, evaluating options to protect the sewer plant and the highway barn from future flooding, and researching ownership of the WBZ dike to determine repair options. Other measures include implementing a battery storage project for energy resilience, encouraging beach nourishment for the DCR beach and pursuing opportunities to extend and expand the Nantasket Beach dune, purchasing a drone to facilitate documentation of pre and post storm shoreline conditions, and formalizing property owner flood protection and flood insurance education.

Introduction to Potential Mitigation Measures (Table 29)

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

Priority – As described above and summarized in Table 28, the designation of high, medium, or low priority was done considering potential benefits and estimated project costs, as well as other factors in the STAPLEE analysis.

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

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

Potential Funding Sources – This column attempts to identify the most likely sources of funding for a specific measure. The information on potential funding sources in this table is preliminary and varies depending on a number of factors. These factors include whether or not a mitigation measure has been studied, evaluated or designed, or if it is still in the conceptual stages. MEMA and DCR assisted MAPC in reviewing the potential eligibility for hazard mitigation funding. Each grant program and agency has specific eligibility requirements that would need to be taken into consideration. In most instances, the measure will require a number of different funding sources. Identification of a potential funding source in this table does not guarantee that a project will be eligible for, or selected for funding. Upon adoption of this plan, the local team responsible for its implementation should begin to explore the funding sources in more detail.

Additional information on funding sources – The best way to determine eligibility for a particular funding source is to review the project with a staff person at the funding agency. The following websites provide an overview of programs and funding sources.

> Army Corps of Engineers (ACOE) – The website for the North Atlantic district office is http://www.nae.usace.army.mil/. The ACOE provides assistance in a number of types of projects including shoreline/streambank protection, flood damage reduction, flood plain management services and planning services.
>
> Massachusetts Emergency Management Agency (MEMA) – MEMA coordinates FEMA hazard mitigation grants. https://www.mass.gov/orgs/massachusetts-emergency-management-agency.

Table 29 – Potential Mitigation Measures					
Mitigation Action	**Priority**	**Lead Implementation**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
Flood Hazard Mitigation					
Alphabet Streets Drainage (Bay Avenue East Project)	High	Planning	2018	High	Grant funds received
Relocate Aquarion Water Pipes	High	Conservation (Aquarion)	2022	High	Aquarion Water Co.
Encourage Building Elevation – Freeboard	High	Building/Conservation	On-going	Low	Town funds
Stormwater Drainage System Improvements (Beach Avenue drains, others as needed)	High	Public Works	On-going	Medium	Town funds
Install/Repair Check Valves and Back-Flow Preventers as needed	Medium	Public Works	On-going	Low	Town funds
Upgrade D St. pump, consider relocation/elevation	High	Public Works	2018-2022	High	Town funds, grants
Repair Nantasket Seawall – install revetment	High	DCR/ACOE	2018	High	DCR/ ACOE
Repair of Town Seawalls, Dikes, and Jetties – Complete Crescent Beach. Cadish Avenue and other work as needed	High	Public Works	On-going	High	State grants, town funds
Dune Repair and Protection	High	Conservation	On-going	Low	Town funds
A Street Fire Station Flood Protection – install hurricane doors	Medium	Fire	2022	Medium	Town funds/ grant
Paving Reduction Program	Medium	Conservation	On-going	Low	NA
Open Space Plan Update	Medium	Planning/Conservation	2020	Medium	Town funds
GIS Floodplain Mapping – update as needed	High	Conservation	On-going	Low	Town funds
Pursue public ownership of beach lots to protect Nantasket Beach dune	High	Town Manager	2021	High	Town funds
Wind Mitigation					
Protect Electric Lines – continue project to Pemberton Point.	High	Light Plant	2019	Medium	Town funds
Brushfire Mitigation					
Arrange mutual aid with Plymouth County for brushfire truck	Medium	Fire Department	2018	Low	NA
Winter Storm Hazard Mitigation					
Evaluate public buildings for ability to withstand snow loads; retrofit to greatest degree	Medium	Building	2022	Low	Town funds

Table 29 – Potential Mitigation Measures					
Mitigation Action	**Priority**	**Lead Implementation**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
feasible.					
Earthquake Mitigation					
Public building seismic assessments	Medium	Building	2022	Medium	Town funds
Dam Mitigation					
Maintain alarm system for Straits Pond tidegate	High	Public Works	On-going	Low	Town funds
Extreme Temperature Mitigation					
Consider establishment of a cooling center for extreme heat days	Low	Emergency Operations	2022	Low	Town funds
Drought Mitigation					
Encourage drought resistant landscaping	Medium	Conservation	On-going	Low	Town funds
Multihazard Mitigation					
Public Education	High	Multiple Departments	On-going	Low	Town funds
Rehabilitate Village Fire Station	High	Fire	2020	High	Town funds
Climate Resilience/Adaptation					
Relocate light plant garages to higher elevation	High	Light Plant	2020	High	Light Plant funds
Implement battery storage project	High	Light Plant	2020	High	Grant funds
Develop evacuation plan considering sea level rise	High	Emergency Management	2019	Medium	Grant Natl. Tsunami Center
Elevate electricity and HVAC at sewer plant	High	Sewer	2019	High	FEMA grant
Encourage beach nourishment on Nantasket Beach (DCR)	High	Conservation/ Town leadership	2018	High	ACOE
Consider future climate impacts in all capital planning, as well as master plans, open space plans, etc.	Medium	Town leadership and committees	On-going	Low	Town funds
Consider plan to protect DPW barn from future flooding	Medium	Public Works	2021	High	Town funds
Promote bicycle/pedestrian transportation to reduce auto use	High	Planning	On-going	Medium	Ch. 90 state funds, town funds
Pursue opportunities to extend and expand Nantasket Beach dune	High	Conservation	2018	High	CZM grant
Continue to incorporate recommendations from the Coastal Climate Change Vulnerability Assessment and Adaptation Study	High	Multiple departments	On-going	Variable	Town funds, grants
Evaluate options to protect sewer	High	Sewer	2019	High	Town funds,

Table 29 – Potential Mitigation Measures					
Mitigation Action	**Priority**	**Lead Implementation**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
plant from future flooding risk					grants
Develop formalized property owner flood protection and flood insurance education program	High	Building/ Conservation	2018	Low	Town funds
Install flood protection vulnerable segments of the Memorial School	Medium	Building /Emergency Management	2020	Medium	Town funds, grants
Research ownership and status of WBZ dike tidegate to determine repair options	High	Conservation	2018	Low	Town funds
Install cameras in shoreline areas to monitor storm conditions	High	Harbormaster	2018	Medium	Grant funds
Purchase a drone to facilitate documentation of pre and post storm shoreline conditions.	High	Hull Community Television	2018	Low	Town funds
Investigate options to protect against flooding along Cadish Avenue	High	Emergency Management	2020	Low	Town funds, grants

IX. PLAN ADOPTION AND MAINTENANCE

Plan Adoption

The Hull Hazard Mitigation Plan 2018 Update was adopted by the Board of Selectmen on April 26, 2018. See Appendix D for documentation. The plan was approved by FEMA on [ADD DATE] for a five-year period that will expire on [ADD DATE].

Plan Maintenance

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

Implementation and Evaluation Schedule

The coordinator of the Hazard Mitigation Implementation Team will coordinate annual meetings of the local implementation group members and other interested local stakeholders. S/he will document progress and any additions or changes to mitigation measures. The annual updates will be used to prepare a report or addendum to the local hazard mitigation plan in order to evaluate its effectiveness in meeting the plan's goals and identify areas that need to be updated in the next plan. The Hazard Mitigation Implementation Team, coordinated by the Conservation Administrator, will have primary responsibility for tracking progress, evaluating, and updating the plan.

Begin to Prepare for the next Plan Update -- FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the town's approved plan status and its eligibility for FEMA mitigation grants. Given the lead time needed to secure funding and conduct the planning process, the Hazard Mitigation Implementation Team will begin to prepare for an update of the plan in year three. This will help the Town avoid a lapse in its approved plan status and grant eligibility when the current plan expires.

The Hazard Mitigation Implementation Team will use the information from the annual reviews to identify the needs and priorities for the plan update and seek funding for the plan update process. Potential sources of funding may include FEMA Pre-Disaster Mitigation grants and the Hazard Mitigation Grant Program. Both grant programs can pay for 75% of a planning project, with a 25% local cost share required.

Prepare and Adopt an Updated Local Hazard Mitigation Plan –Once the resources have been secured to update the plan, the Hazard Mitigation Implementation Team may decide to undertake the update themselves, contract with the Metropolitan Area Planning Council to update

the plan or hire another consultant. However the Hazard Mitigation Implementation Team decides to update the plan, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes. The Hull Hazard Mitigation Plan Update will be forwarded to MEMA and DCR for review and to FEMA for approval.

Integration of the Plans with Other Planning Initiatives

Upon approval of the Hull Hazard Mitigation Plan 2018 Update by FEMA, the Local Hazard Mitigation Team will provide all interested parties and implementing departments with a copy of the plan and will initiate a discussion regarding how the plan can be integrated into that department's ongoing work. At a minimum, the plan will be reviewed and discussed with the following departments:

- Fire
- Emergency Management
- Police
- Public Works
- Light
- Planning
- Conservation
- Health
- Building
- Sewer

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

The Hazard Mitigation Plan will be integrated into other town plans and policies as they are updated and renewed, including the Hull Master Plan, Open Space Plan, Comprehensive Emergency Management Plan, and Capital Investment Program.

X. LIST OF REFERENCES

Town of Hull, Annual Report 2016

Town of Hull Zoning By-Laws

Town of Hull Community Development Strategy

Town of Hull Open Space and Recreation Plan, 2000

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

FEMA Flood Insurance Study, Plymouth County, MA, 2012

FEMA, Flood Insurance Rate Maps for Plymouth County, MA, 2012

FEMA, Local Mitigation Plan Review Guide; October 1, 2011.

FEMA LOMR, Effective 12/13/17

Kleinfelder Inc., Coastal Climate Change Vulnerability Assessment and Adaptation Study, 2016

MA Emergency Management Agency, State *Hazard Mitigation Plan*, 2013

MA Geographic Information System, *McConnell Land Use Statistics*, 2005

MA Office of Coastal Zone Management, Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning, December 2013.

MA Office of Dam Safety, Inventory of Massachusetts Dams

Metropolitan Area Planning Council, Geographic Information Systems Lab

New England Seismic Network, Weston Observatory, http://aki.bc.edu/index.htm

Northeast States Emergency Consortium, website http://www.nesec.org/

NOAA, National Climatic Data Center, website

Union of Concerned Scientists, *Confronting Climate Change in the U.S. Northeast*, 2007

U. S. Census, 2010, and American Community Survey, 2015

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APPENDIX A

HAZARD MITIGATION PLANNING TEAM MEETING AGENDAS

Hull Hazard Mitigation Plan 2018 Update
Tuesday, August 8, 2017
Meeting #1
Hull Town Hall

AGENDA

1. Introductions

2. Overview of Planning Process

3. Identify/update local hazards:

    a) Flood Hazard Areas
    b) Fire Hazard Areas (brushfires/wildfires)
    c) Historic Facilities
    d) Other hazards

4. Identify/Update Potential New Development Sites

5. Update Critical Facilities Inventory and Mapping

6. Discuss Public Involvement and Outreach

    a) Identify local stakeholders
    b) Schedule first public meeting

AGENDA

Hull Local Hazard Mitigation Planning Team
Meeting #2
Planning Process to Update the FEMA-Approved 2012 Plan

Wednesday, October 25, 2017 – 10:00 AM
Selectmen's Meeting Room, Town Hall

WELCOME AND INTRODUCTIONS

REVIEW RECOMMENDED MITIGATION MEASURES FROM PREVIOUS 2012 PLAN

- current status
- decide which to carry forward into 2018 plan, note any modifications
- reevaluate priority

PROPOSE NEW MITIGATION MEASURES FOR 2018 PLAN

- establish priority level

REVIEW MITIGATION PLAN GOALS AND UPDATE AS NEEDED

NEXT STEPS

- Review Kleinfelder Report for additional mitigation items

AGENDA

Hull Local Hazard Mitigation Planning Team
Meeting #3
Planning Process to Update the FEMA-Approved 2012 Plan

Wednesday, November 15, 2017 – 10:00 AM
Selectmen's Meeting Room, Town Hall

REVIEW MITIGATION DECISIONS FROM LAST MEETING

- finalize priorities

CONSIDER NEW MITIGATION MEASURES FROM THE COASTAL CLIMATE VULNERABILITY ASSESSMENT AND ADAPTATION STUDY

- establish priority level

REVIEW MITIGATION PLAN GOALS AND UPDATE AS NEEDED

NEXT STEP

- final public presentation in January

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APPENDIX B
HAZARD MAPPING

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

The map series consists of eight maps as described below. The maps in this appendix are necessarily reduced scale versions for general reference. Full sized higher resolution PDF's of the maps can be downloaded from the MAPC File Transfer Protocol (FTP) website at: ftp://ftp.mapc.org/Hazard_Mitigation_Plans/maps/Hull/

Map 1.	Population Density
Map 2.	Potential Development
Map 3.	Flood Zones
Map 4.	Earthquakes and Landslides
Map 5.	Hurricanes and Tornadoes
Map 6.	Average Snowfall
Map 7.	Composite Natural Hazards
Map 8.	Hazard Areas

Map1: Population Density – This map uses the US Census block data for 2010 and shows population density as the number of people per acre in seven categories with 60 or more people per acre representing the highest density areas.

Map 2: Land Use – This map depicts current land use and critical infrastructure sites.

Map 3: Flood Zones – The map of flood zones used the FEMA NFIP Flood Zones as depicted on the FIRMs (Federal Insurance Rate Maps) for Plymouth County as its source. This map is not intended for use in determining whether or not a specific property is located within a FEMA NFIP flood zone. The currently adopted FIRMS for Hull are kept by the Town. For more information, refer to the FEMA Map Service Center website http://www.msc.fema.gov. The definitions of the flood zones are described in detail on this site as well. The flood zone map for each community also shows critical infrastructure and repetitive loss areas.

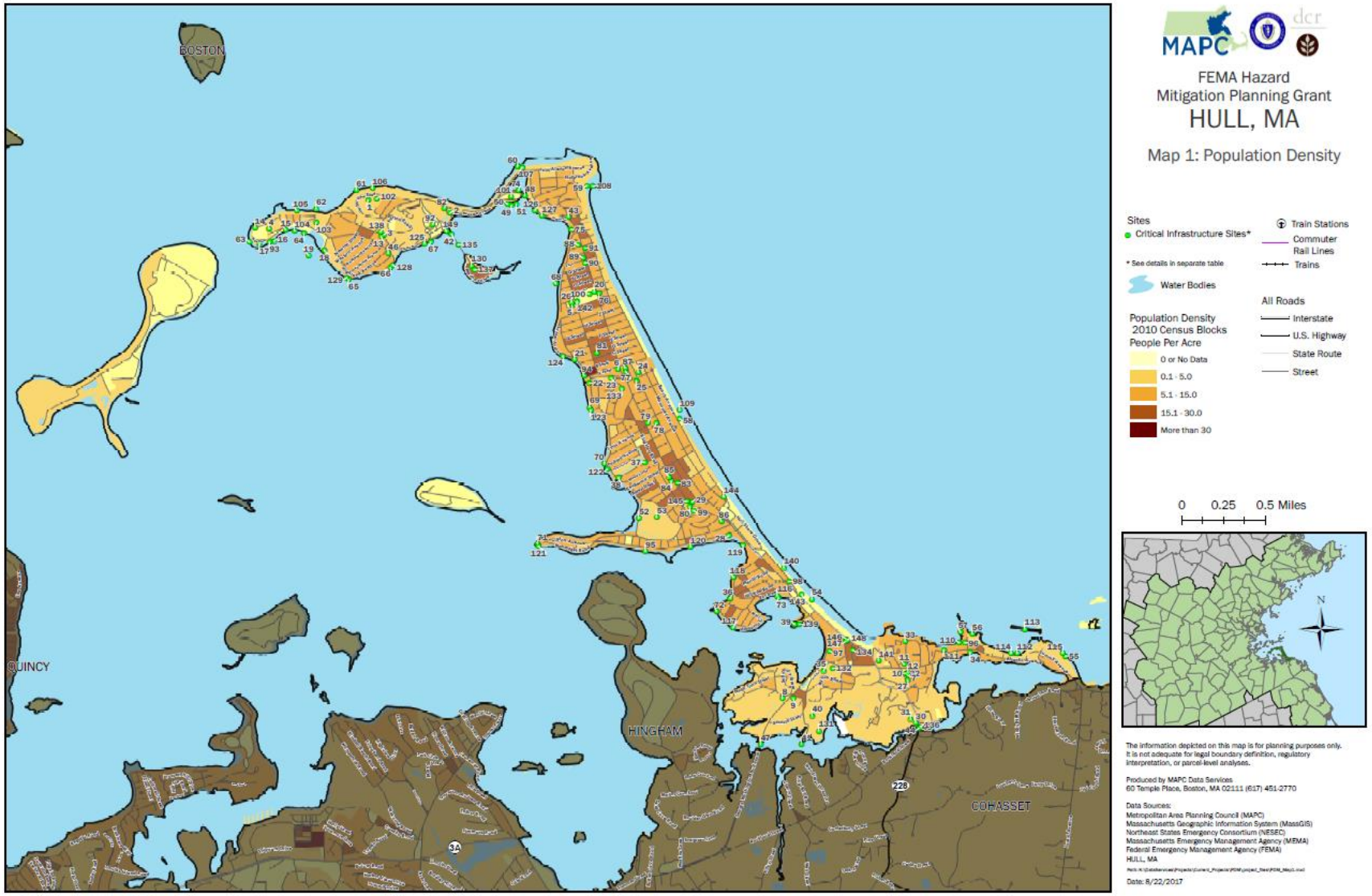
Map 4: Earthquakes and Landslides – This information came from NESEC. For most communities, there was no data for earthquakes because only the epicenters of an earthquake are mapped. The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to http://pubs.usgs.gov/pp/p1183/pp1183.html.

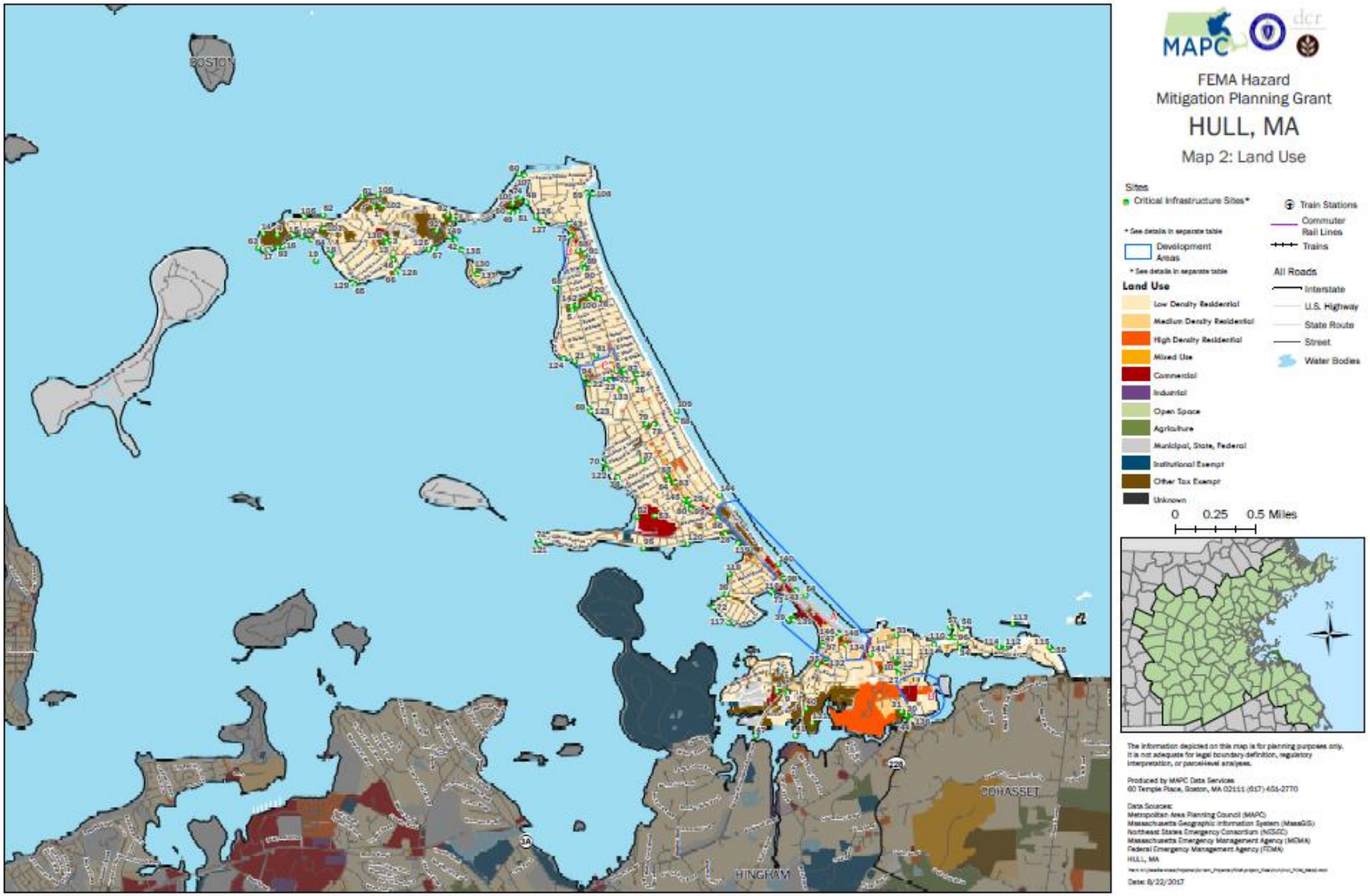
Map 5: Hurricanes and Tornadoes – This map shows a number of different items. The map includes the storm tracks for both hurricanes and tropical storms, if any occurred in this community. This information must be viewed in context. A storm track only shows where the eye of the storm passed through. In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

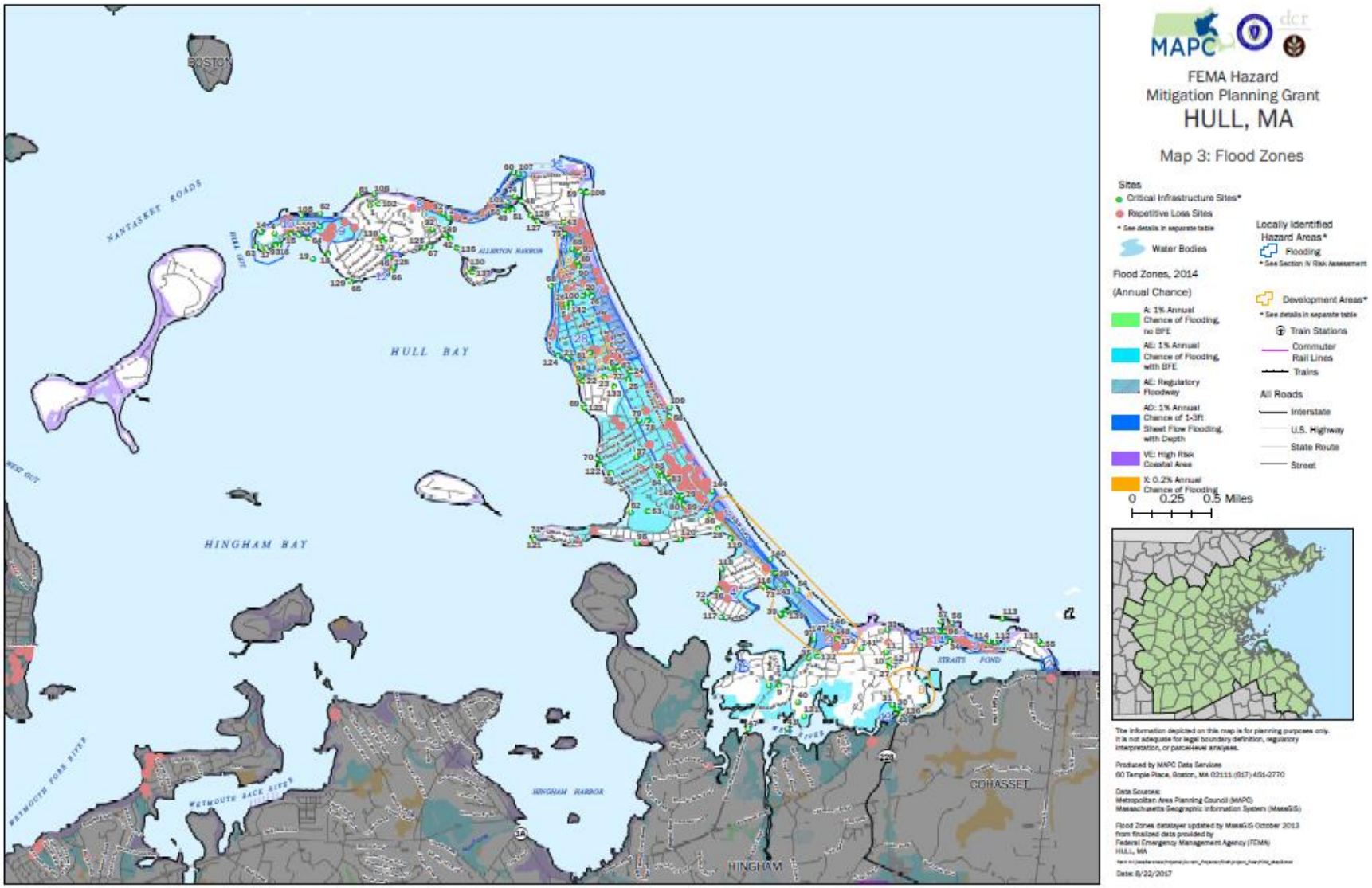
Map 6: Average Snowfall - - This map shows the average snowfall. It also shows storm tracks for nor'easters, if any storms tracked through the community.

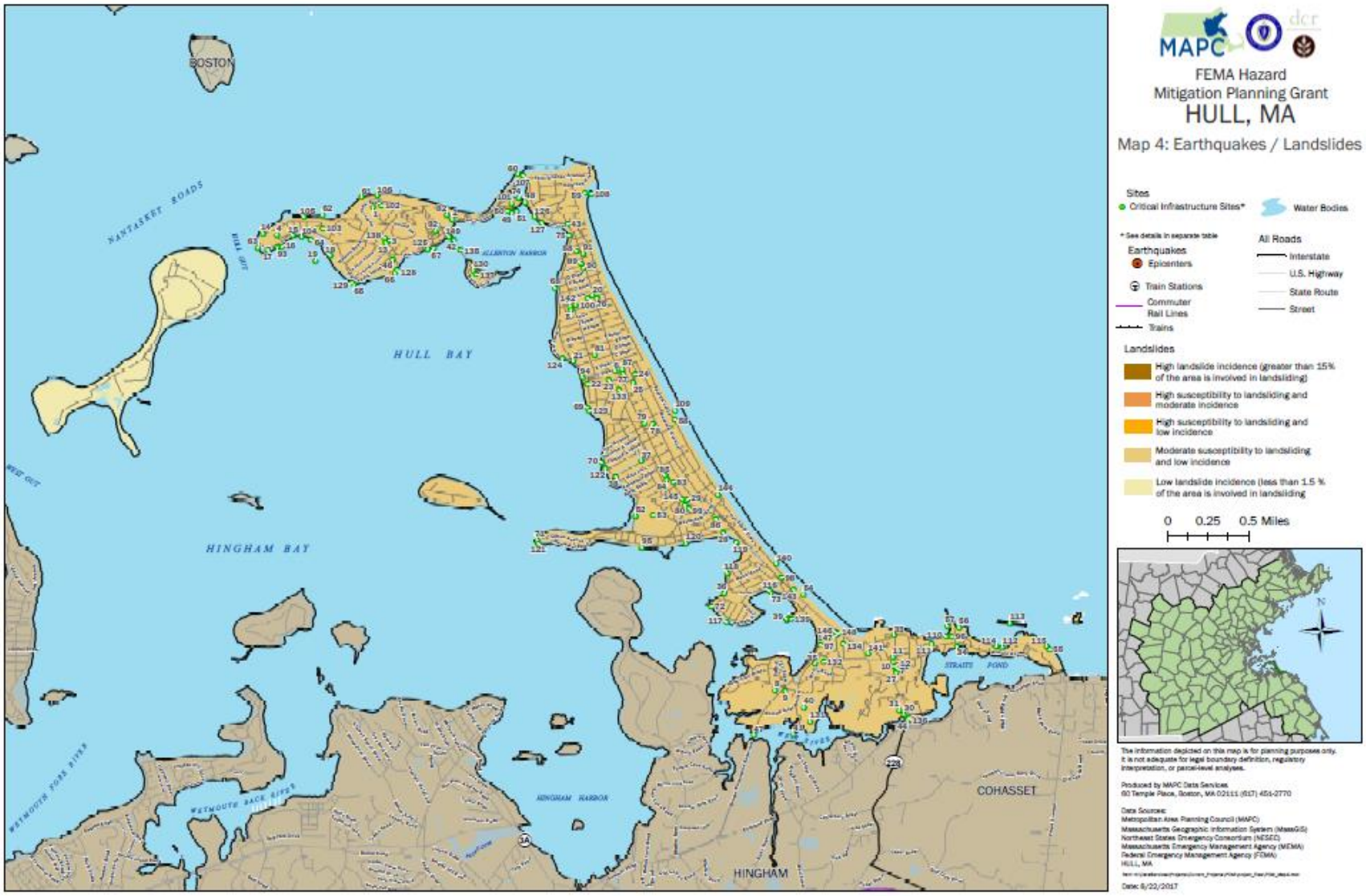
Map 7: Composite Natural Hazards - This map shows four categories of composite natural hazards for areas of existing development. The hazards included in this map are 100 year wind speeds of 110 mph or higher, low and moderate landslide risk, FEMA Q3 flood zones (100 year and 500 year) and hurricane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

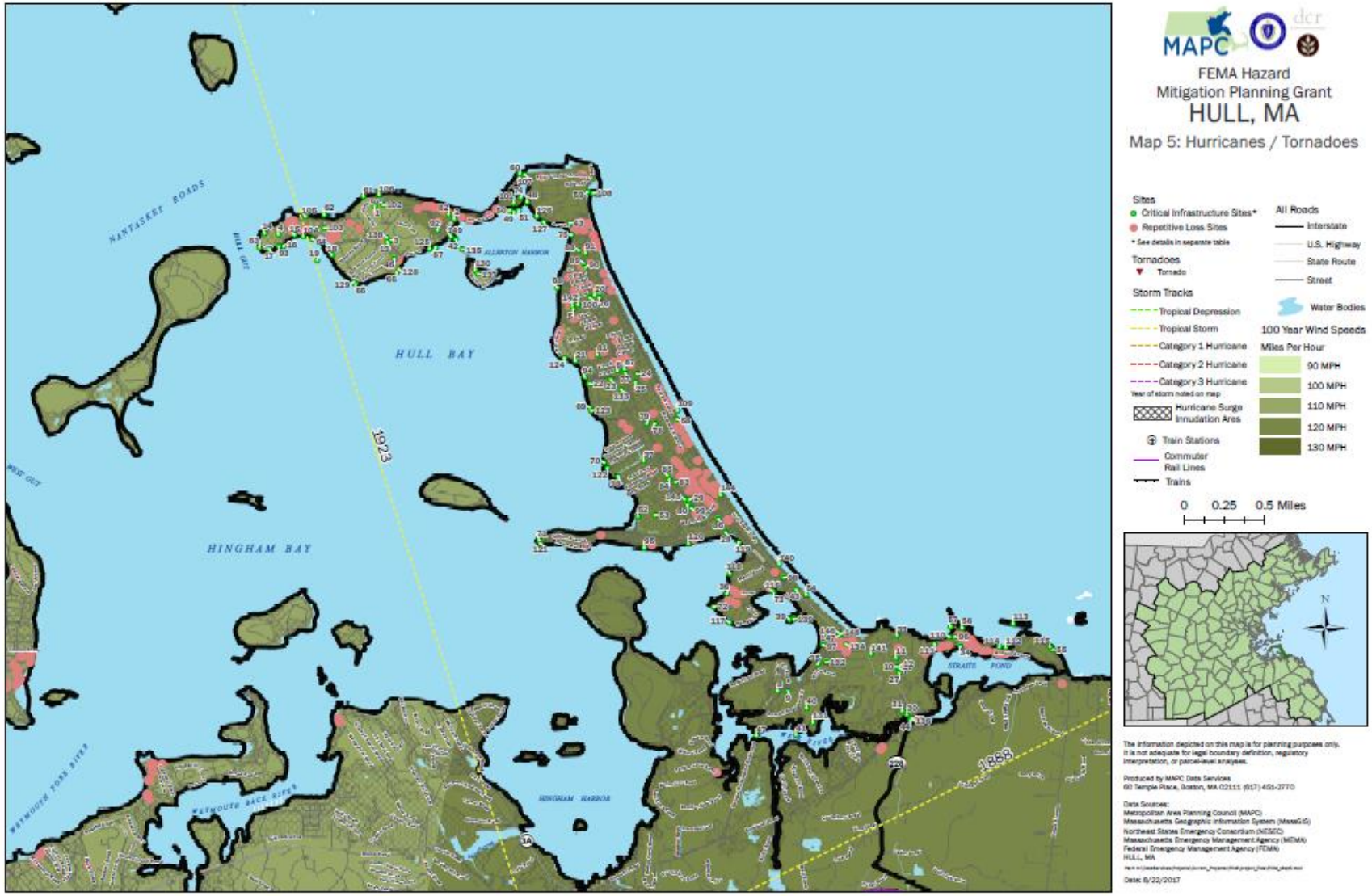
Map 8: Hazard Areas and Future Development – For each community, locally identified hazard areas are overlaid on an aerial photograph dated April, 2008. The critical infrastructure sites are also shown. The source of the aerial photograph is Mass GIS. This map also shows potential future development areas. MAPC consulted with town staff to determine areas that were likely to be developed or redeveloped in the future

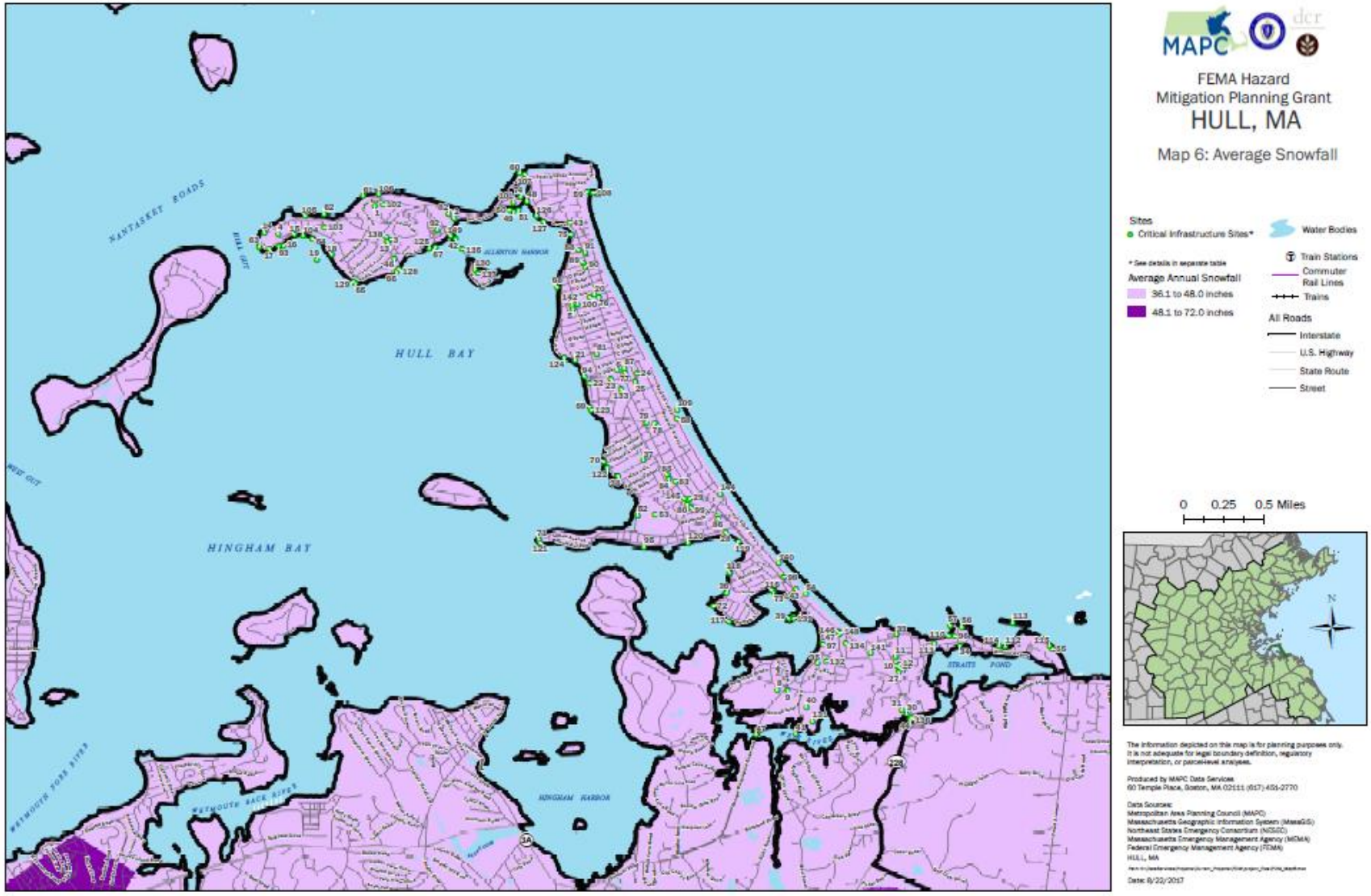

BOSTON
QUINCY
HINGHAM
COHASSET
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HULL, MA
Map 1: Population Density
Sites
Critical Infrastructure Sites*
* See details in separate table
Water Bodies
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Population Density
2010 Census Blocks
People Per Acre
0 or No Data
0.1 - 5.0
5.1 - 15.0
15.1 - 30.0
More than 30
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HULL, MA
Date: 8/22/2017


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HULL, MA
Map 2: Land Use
Sites
Critical Infrastructure Sites*
* See details in separate table
Development Areas
* See details in separate table
Land Use
Low Density Residential
Medium Density Residential
High Density Residential
Mixed Use
Commercial
Industrial
Open Space
Agriculture
Municipal, State, Federal
Institutional Exempt
Other Tax Exempt
Unknown
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Water Bodies
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NSSEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HULL, MA
Date: 8/22/2017
BOSTON
HINGHAM
COHASSET


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HULL, MA
Map 3: Flood Zones
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
Locally Identified
Hazard Areas*
Flooding
* See Section IV Risk Assessment
Flood Zones, 2014
(Annual Chance)
A: 1% Annual Chance of Flooding, no BFE
AE: 1% Annual Chance of Flooding, with BFE
AE: Regulatory Floodway
AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding, with Depth
VE: High Risk Coastal Area
X: 0.2% Annual Chance of Flooding
Development Areas*
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
0 0.25 0.5 Miles
BOSTON
NANTASKET ROADS
HULL BAY
HINGHAM BAY
WEST GUT
WEYMOUTH FORE RIVER
WEYMOUTH BACK RIVER
HINGHAM HARBOR
STRAITS POND
COHASSET
HINGHAM
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Flood Zones datalayer updated by MassGIS October 2013 from finalized data provided by Federal Emergency Management Agency (FEMA)
HULL, MA
Date: 6/22/2017


BOSTON
NANTASKET ROADS
HULL BAY
HINGHAM BAY
WEIR CUT
WEYMOUTH FORE RIVER
WEYMOUTH BACK RIVER
HINGHAM HARBOR
STRAITS POND
COHASSET
HINGHAM
3A
228
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HULL, MA
Map 4: Earthquakes / Landslides
Sites
Critical Infrastructure Sites*
Water Bodies
* See details in separate table
All Roads
Earthquakes
Epicenters
Interstate
U.S. Highway
Train Stations
State Route
Commuter Rail Lines
Street
Trains
Landslides
High landslide incidence (greater than 15% of the area is involved in landsliding)
High susceptibility to landsliding and moderate incidence
High susceptibility to landsliding and low incidence
Moderate susceptibility to landsliding and low incidence
Low landslide incidence (less than 1.5 % of the area is involved in landsliding
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HULL, MA
Date: 8/22/2017


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HULL, MA
Map 5: Hurricanes / Tornadoes
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Tornadoes
Tornado
Storm Tracks
Tropical Depression
Tropical Storm
Category 1 Hurricane
Category 2 Hurricane
Category 3 Hurricane
Year of storm noted on map
Hurricane Surge Innudation Area
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
Water Bodies
100 Year Wind Speeds
Miles Per Hour
90 MPH
100 MPH
110 MPH
120 MPH
130 MPH
0 0.25 0.5 Miles
N
HULL BAY
HINGHAM BAY
HINGHAM HARBOR
STRAITS POND
1923
1938
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HULL, MA
Date: 8/22/2017


MAPC
FEMA Hazard
Mitigation Planning Grant
HULL, MA
Map 6: Average Snowfall
Sites
Critical Infrastructure Sites*
* See details in separate table
Average Annual Snowfall
36.1 to 48.0 inches
48.1 to 72.0 inches
Water Bodies
Train Stations
Commuter Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
0 0.25 0.5 Miles
N
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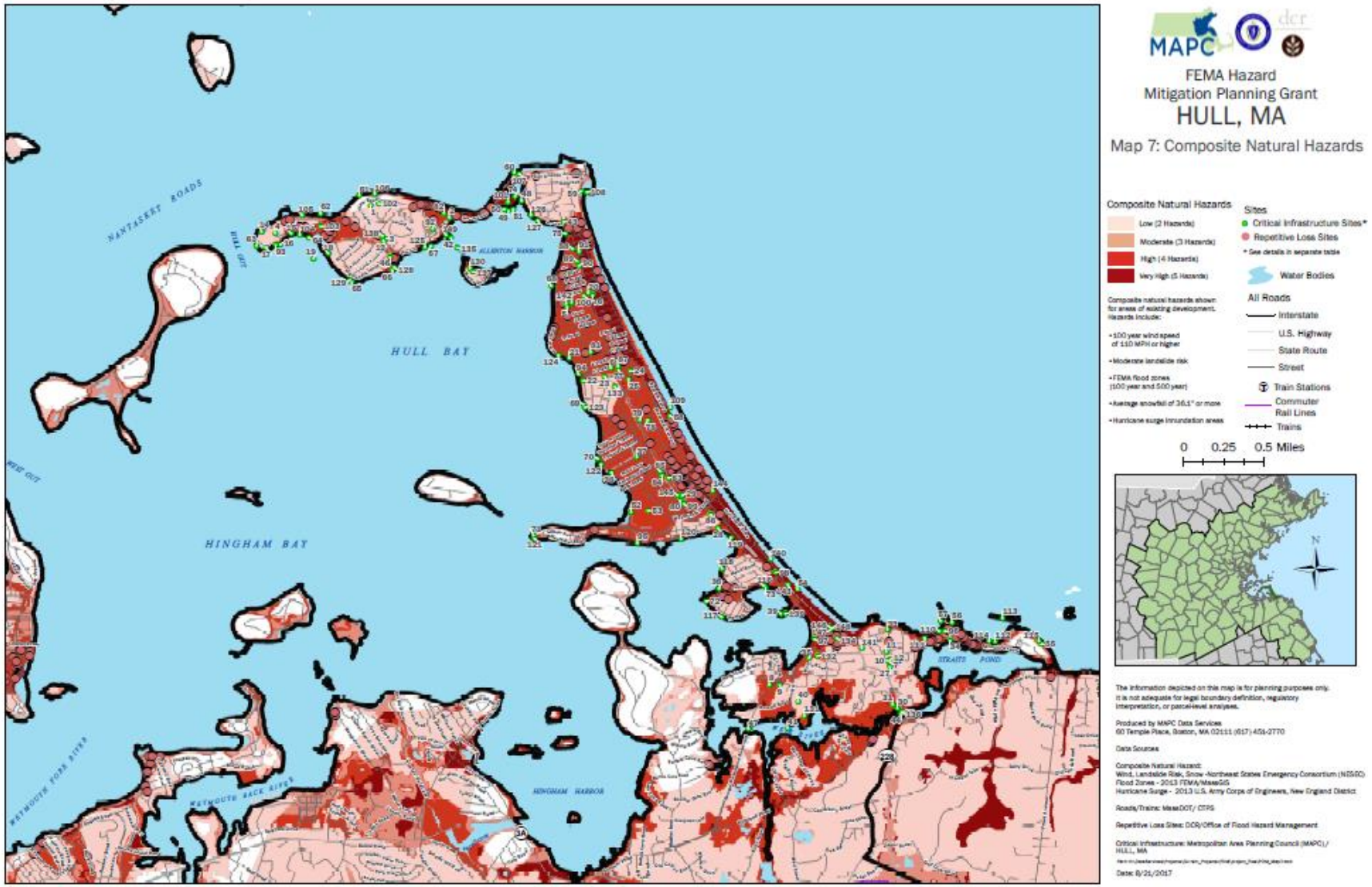
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
HULL, MA
Date: 6/22/2017
HULL BAY
HINGHAM BAY
NANTASKET ROADS
HINGHAM HARBOR
STRAITS POND


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HULL, MA
Map 7: Composite Natural Hazards
Composite Natural Hazards
Low (2 Hazards)
Moderate (3 Hazards)
High (4 Hazards)
Very High (5 Hazards)
Composite natural hazards shown for areas of existing development. Hazards include:
•100 year wind speed of 110 MPH or higher
•Moderate landslide risk
•FEMA flood zones (100 year and 500 year)
•Average snowfall of 36.1" or more
•Hurricane surge inundation areas
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Train Stations
Commuter Rail Lines
Trains
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources
Composite Natural Hazard:
Wind, Landslide Risk, Snow -Northeast States Emergency Consortium (NESEC)
Flood Zones - 2013 FEMA/MassGIS
Hurricane Surge - 2013 U.S. Army Corps of Engineers, New England District
Roads/Trains: MassDOT/ CTPS
Repetitive Loss Sites: DCR/Office of Flood Hazard Management
Critical Infrastructure: Metropolitan Area Planning Council (MAPC)/ HULL, MA
Date: 8/21/2017
NANTASKET ROADS
HULL BAY
HINGHAM BAY
HINGHAM HARBOR
STRAITS POND
WEIR CUT
WEYMOUTH FORE RIVER
WEYMOUTH BACK RIVER


BOSTON
QUINCY
WEYMOUTH
HINGHAM
COHASSET
3A
228
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
HULL, MA
Map 8: Local Hazard Areas
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Locally Identified
Hazard Areas
Brush Fires
Flooding
Historic
* See Section IV Risk Assessment
Development Sites
* See details in separate table
Train Stations
Commuter
Rail Lines
Trains
All Roads
Interstate
U.S. Highway
State Route
Street
0
0.5
1 Miles
N
The information depicted on this map is for planning purposes only.
It is not adequate for legal boundary definition, regulatory
interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google
HULL, MA
Date: 2/26/2018

APPENDIX C
DOCUMENTATION OF PUBLIC MEETINGS

Amanda Linehan, Communications Manager, Metropolitan Area Planning Council
617-933-0705, alinehan@mapc.org

CALENDAR LISTING / MEDIA ADVISORY

HULL'S DRAFT HAZARD MITIGATION PLAN TO BE PRESENTED AT SEPTEMBER 19 PUBLIC MEETING

Meeting to present the 2018 update of Hull's Hazard Mitigation Plan and solicit public comments

Who: Hull residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards.

What: At the Hull Capital Outlay Committee meeting on Tuesday, September 19 at 7:00 PM, a presentation will be made by the Metropolitan Area Planning Council (MAPC), which is assisting the Town on the 2018 update of its Hazard Mitigation Plan.

The Town of Hull adopted its first Hazard Mitigation Plan in 2007, which was approved by the Federal Emergency Management Agency (FEMA). This plan will update the 2012 plan. The plan identifies natural hazards affecting Hull such as floods, hurricanes, winter storms, and earthquakes, as well as actions that the Town can take to reduce its vulnerability to these hazards.

When: Tuesday, September 19, 2017, 7:00 PM

Where: Hull High School Exhibition Room

MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at www.mapc.org.

##

HAZARD MITIGATION PLAN PUBLIC MEETING

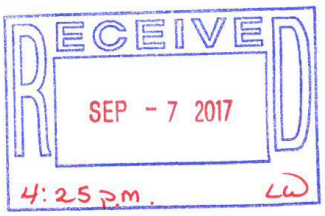
Natural hazards can have serious impacts on the Town of Hull and its residents

The Hull Hazard Mitigation Plan is being updated to help the town reduce its vulnerability to natural hazard events including flooding, hurricanes and winter storms. Please join the Town for a public presentation and discussion about the update to the Hull Hazard Mitigation Plan at a public meeting of the Capital Outlay Committee:

Date: **Tuesday, September 19, 2017**
Time: **7:00 PM**
Location: **Hull High School**
Exhibition Room

For more information, please contact Anne Herbst via phone at (617) 933-0781 or email aherbst@mapc.org

MAPC
METROPOLITAN AREA PLANNING COUNCIL



CAPITAL OUTLAY COMMITTEE MEETING

TUESDAY, SEPTEMBER 19, 2017

TIME: 7:00 P.M.

MEETING TO BE HELD AT:

HULL HIGH SCHOOL EXHIBITION ROOM

AGENDA

PRESENTATION AND DISCUSSION - RE: THE HULL HAZARD MITIGATION PLAN

Amanda Linehan, Communications Manager, Metropolitan Area Planning Council
617-933-0705, alinehan@mapc.org

CALENDAR LISTING / MEDIA ADVISORY

HULL'S DRAFT HAZARD MITIGATION PLAN TO BE PRESENTED AT FEBRUARY 8 PUBLIC MEETING

Meeting to present the 2018 update of Hull's Hazard Mitigation Plan and solicit public comments

Who: Hull residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards.

What: The Hull Hazard Mitigation Team will hold a public meeting to present an overview of the draft Hull Hazard Mitigation Plan Update 2018. The Metropolitan Area Planning Council (MAPC) is assisting the Town on the plan update, and a representative of MAPC will present an overview of the plan update.

The Town of Hull adopted its first Hazard Mitigation Plan in 2017, which was approved by the Federal Emergency Management Agency (FEMA). The plan identifies natural hazards affecting Hull such as floods, hurricanes, winter storms, and earthquakes, as well as actions that the Town can take to reduce the impacts of these hazards. FEMA requires that plans be updated regularly, so MAPC is assisting the Town prepare a 2018 updated plan.

When: Thursday, February 8, 2018, 7:30 PM
Hull Board of Selectmen meeting

Where: Hull Town Hall, 253 Atlantic Avenue, Hull, MA

MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at www.mapc.org.

##

HAZARD MITIGATION PLAN PUBLIC MEETING

Natural hazards can have serious impacts on the Town of Hull and its residents

The Hull Hazard Mitigation Plan is being updated to help the town reduce its vulnerability to natural hazard events including flooding, hurricanes and winter storms. Please join the Town for a public presentation and discussion about the draft 2018 update to the Hull Hazard Mitigation Plan at a public meeting of the Hull Board of Selectmen.

Date: **Thursday, February 8, 2018**
Time: **7:30 PM**
Location: **Hull Town Hall, 253 Atlantic Avenue**
Selectmen's Meeting Room

For more information, please contact Anne Herbst via phone at (617) 933-0781 or email aherbst@mapc.org

MAPC
METROPOLITAN AREA PLANNING COUNCIL

MEETING NOTICE POSTING
&
AGENDA

TOWN OF HULL

Pursuant to MGL Chapter 30A, § 18-25 all Meeting Notices must be filed and time stamped in the Town Clerk's Office and posted at least **48 hours prior to the meeting** (excluding Saturdays, Sundays and Holidays). Please be mindful of the Town Clerk's business hours of operation and make the necessary arrangements to ensure this Notice is received and stamped in by the Town Clerk's Office and posted by at least **30 minutes** prior to the close of business on the day of filing.

TOWN CLERK'S STAMP

Board or Committee	**Board of Selectmen**
Date & Time of Meeting	**February 8, 2018 at 7:30pm**
Meeting Location Full Address	**Hull Town Hall, Louis C. Costa Room, 253 Atlantic Ave**
Requested By:	**Philip Lemnios, Town Manager**

AGENDA

MINUTES

November 16, 2017

APPOINTMENTS

7:30 Andrew Grosso, 7 Tierney Ave-re-Letter of Interest to serve on the Permanent Sewer Commission

7:40 William O'Brien, 114 A Atlantic Ave-re-Letter of Interest to serve on the Permanent Sewer Commission

7:43 Jason Earl, 44 Westminster Rd-re-Letter of Interest to serve on the Permanent Sewer Commission

7:45 Chris Krahforst, Conservation Agent/Anne Herbst-MAPC-re-Hazard Mitigation Plan presentation to the Board of Selectmen

8:15 Continued Discussion of Town Meeting Warrant Articles

8:30 Executive Session-re-discussion of Union Contracts Public Works

APPROVALS

1. Lori West, Town Clerk-re-Appointment of Town Meeting/Election Workers
2. Victoria Stevens, Executive Director Hull Lifesaving Museum-re-One Day Liquor License on February 16, 2018 from 5:00pm-11:00pm for the Sea and Sky Art Show Reception

The listings of items are those reasonably anticipated by the Chair which may be discussed. Not all items listed may in fact be discussed and other items not listed may also be discussed to the extent permitted by law

APPENDIX D
SUMMARY OF REPETITIVE LOSS AREA ANALYSIS

January 2018

SUMMARY

Town of Hull Repetitive Loss Area Analysis

The National Flood Insurance Program (NFIP) is continually faced with the task of paying claims while trying to keep the price of flood insurance at an affordable level. The NFIP has a particular problem with flood loss properties, which are estimated to cost $3.5 million per year in flood insurance claim payments throughout the United States. Repetitive loss properties represent only 1.4% of all flood insurance policies, yet historically the have accounted for nearly one-fourth of the claim payments. From 2006 through 2015, more than $19 billion in flood claims has submitted to the NFIP. Mitigating these repeatedly flooded properties will reduce the overall cost to the NFIP, the communities in which they are located, and the individual homeowners. The Town of Hull conducted an area analysis based on repetitive loss property data supplied by FEMA for the period of 1978 – 2015 in accordance to the NFIP's Community Rating System. This Repetitive Loss Area Analysis (RLAA) follows FEMA guidelines to determine why an area has repeated flood losses and what alternative flood protection measures would help break the cycle of repetitive flooding.

The study area for this RLAA is located in the main peninsula of the Town of Hull and includes Spinnaker Island. Much of the results contained in the RLAA includes information about private property and is protected by the Privacy Act of 1974 and thus not available for general public review. Individual home owners of RLPs are encouraged to contact the Town's CRS coordinator to review information provided by FEMA about their property and to add to the knowledge base about local flooding causes in order to develop more effective flood protection measures for their home.

Tables 1 and 2 summarize the FEMA data provided for this RLAA which lists the total number of Repetitive Loss Properties (RLPs) and their respective number of NFIP claims during the RLAA study period for unmitigated and mitigated RLPs, respectively.

Table 1. Unmitigated repetitive loss properties, number of NFIP claims, and the amount paid out, Town of Hull, 1978-2015

	Single Family Residential	Multi Family Residential	Commercial	Total
Number of Properties	204	20	5	229
Number of Losses	660	71	18	749
Total Claims	**$6,448,017**	**$627,105**	**$543,324**	**$7,618,446**

Note: Multi-Family Residential includes 9 2-Family, 1 3-Family, 6 Apt buildings,1 condo, and 3 boarding houses; Commercial includes the Post Office, and 2 "charitable" properties (Wellspring and Lifesaving Museum)

Table 2. Mitigated repetitive loss properties, number of NFIP claims, and the amount paid out, Town of Hull, 1978-2017.

	Single Family Residential	Multi Family Residential	Commercial	Total
Number of Properties	17	0	1	18
Number of Losses	77	0	2	79
Total Claims	**$1,605,182**		**$9,006**	**$1,614,188**

Note: One commercial building in the HRA lot has been removed and that parcel is no longer recognized on the Assessor's Maps.

Flooding in Hull is caused by high tides, heavy rain, and storm surge from coastal storms. Flooding is exacerbated by five general conditions:

- Slightly more than 60% of the town is low lying and considered by FEMA as land subjected to coastal storm flowage and surrounded by the waters of Boston Harbor and Massachusetts Bay (Fig. 1)
- Low-lying areas in the Town's relatively flat floodplain are developed and accumulate either stormwater runoff from streets draining neighboring hills and overwash from coastal storm surge. These areas drain more slowly during periods of high tide as infiltration into the relatively porous sanding soils is restricted by the effects high tide on the ground water table.
- Street drainage systems are often impacted by drifting sand and lie close to tide water and ground water elevations. Therefore water can pond more significantly in the lowest lying areas of the town and tend to drain slowly to the harbor and bay. This effect is more pronounced in the low-lying areas of the Town's flood plain.
- Natural dunes systems that protect mainly the ocean side (Massachusetts Bay) of the peninsula are in need of nourishment to offset the loss of sand due to coastal storms. Many of the storm protection structures like seawalls and revetments are antiquated and in need of repair. Some of these structures have been repaired or are being elevated to improve storm surge flooding protection in light of sea level rise (SLR) and the increased frequency and intensity of coastal storms.
- Adjacent Boston Harbor has experienced approximately 1 foot of sea level rise (SLR) in the past 100 years. The Town of Hull's Coastal Climate Change Vulnerability Assessment and Adaption Study (2016) predicts an additional SLR of 0.7 ft by 2030 and nearly 3 ½ feet by 2070. The frequency and power of coastal storms are also expected to increase.

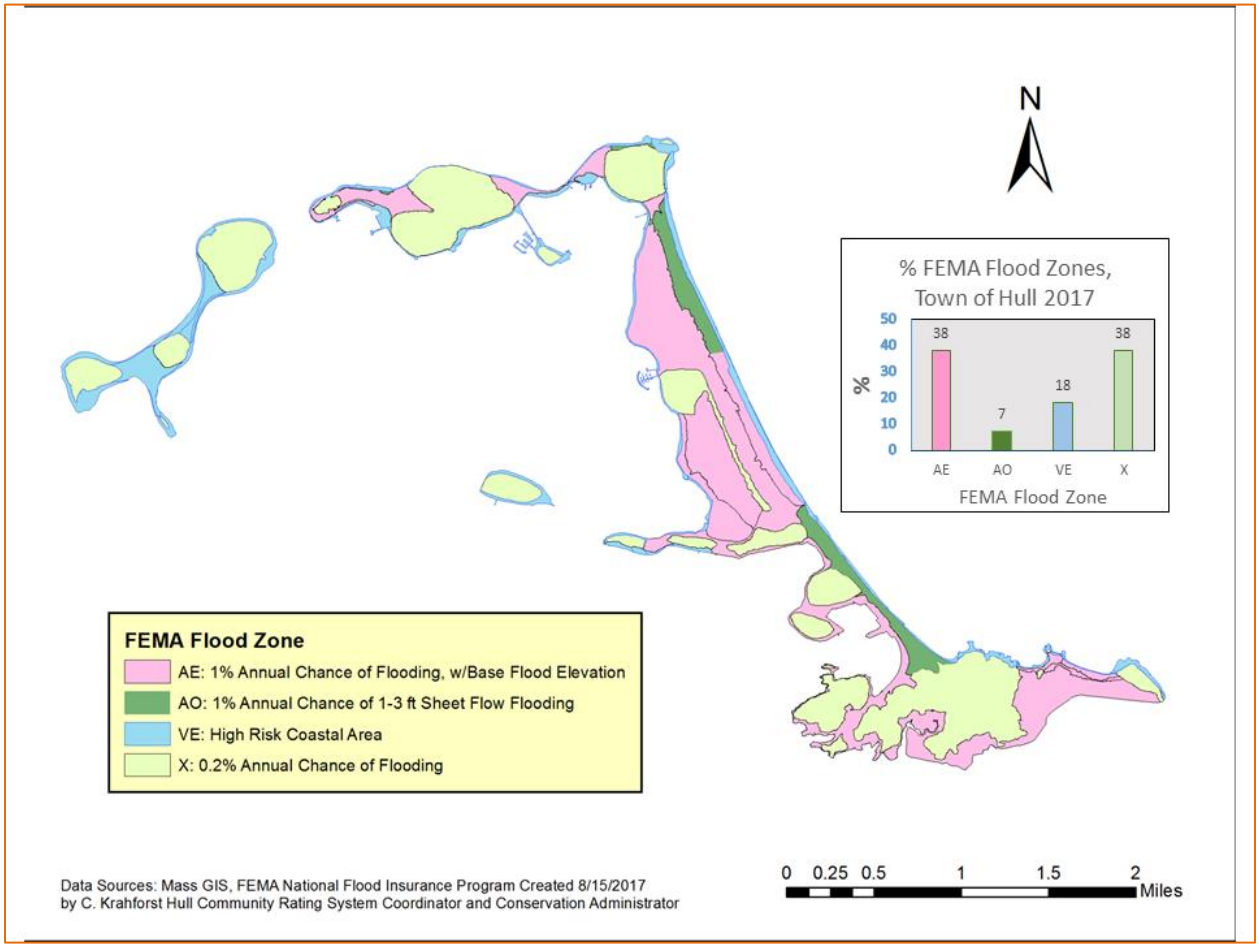


Figure 1. Geospatial distribution of FEMA Flood Zones, Town of Hull.

There have been some drainage improvements, dune grass planting, and structural repairs to storm surge protection structures but flood damage has not been eliminated.

Recommendations:

- Encourage RLP owners to pursue mitigation measures.
- Continue to maintain and improve town wide storm drainage systems.
- Clean and remove accumulated material in flood control channels and canals
- Continue to seek out and secure funding for seawall repair, maintenance, and improvements
- Seek out and secure funding for sand nourishment for Nantasket Beach, possibly through the beneficial reuse of dredge material with the US Army Corps of Engineers
- Incorporate the findings and recommendations of the 2016 Climate Change and Vulnerability Study for projects designed to improve and repair the Town's infrastructure and facilities.
- Improve the Town's CRS classification

For Residents of the Town of Hull:

- Contact the Town of Hull's Conservation and Building Departments for more information for flood mitigation and possible funding opportunities
- Obtain Elevation Certificates for homes located in FEMA designated A and V Flood zones
- Review alternative mitigation measures discussed in this analysis and implement those that are most appropriate.

The Town has identified 10 areas were the majority of repetitive loss properties exist. These concentrated repetitive loss areas (CRLAs) are shown in Fig. 2.

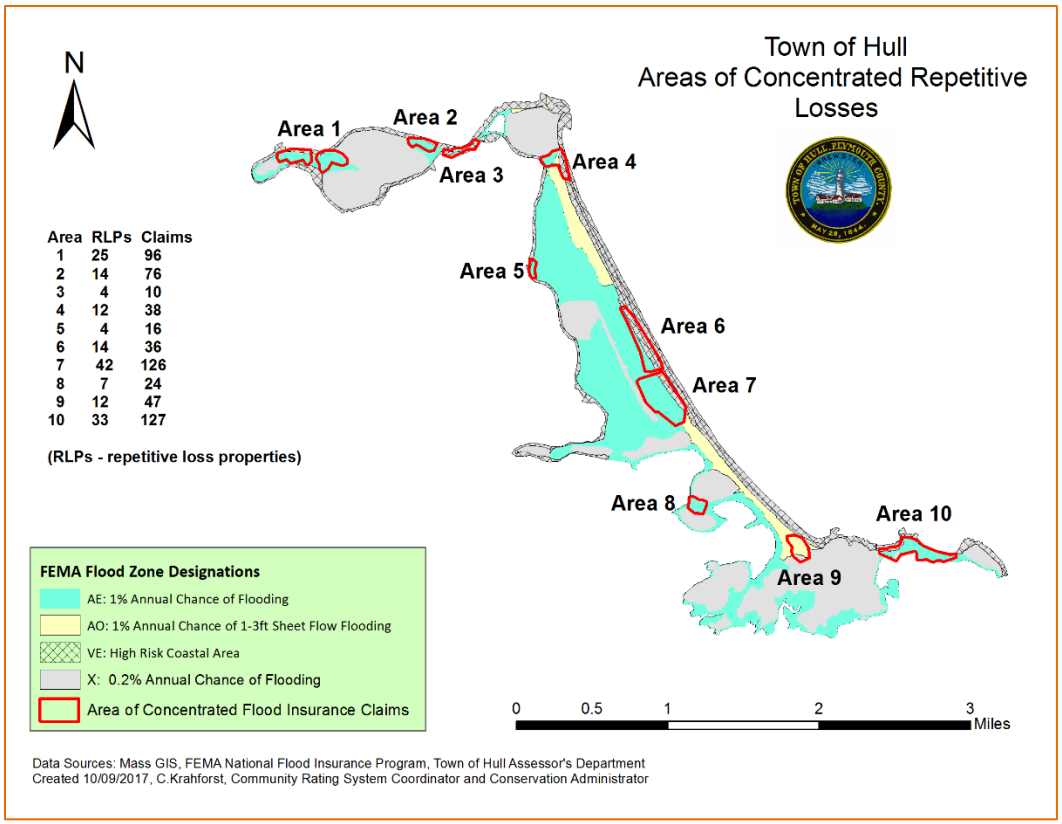


Figure 2. Areas of Concentrated Repetitive Loss Properties and National Flood Insurance Program Claims, 1978 - 2015.

A review of the major storms that have occurred during the period of study (from 1978 – 2015) shows that 8 coastal storms account for nearly 80% (77.7%) of all claims (Fig.3). The characteristics of these storms have been detailed in the RLAA as well as which storm events contributed to the most claims in each CRLAs. All of the RLPs, including those outside of any CRLA, were evaluated for recommended mitigation measures to reduce flood insurance claims, the bulk of which, based on remediation cost and feasibility, recommend wet proofing measures (e.g., filling in of basements, adding flood vents). For

homes located in FEMA VE Zones, the preferred RLAA recommendation is to elevate the home and their utility systems to a minimum of two feet above the base flood elevation.

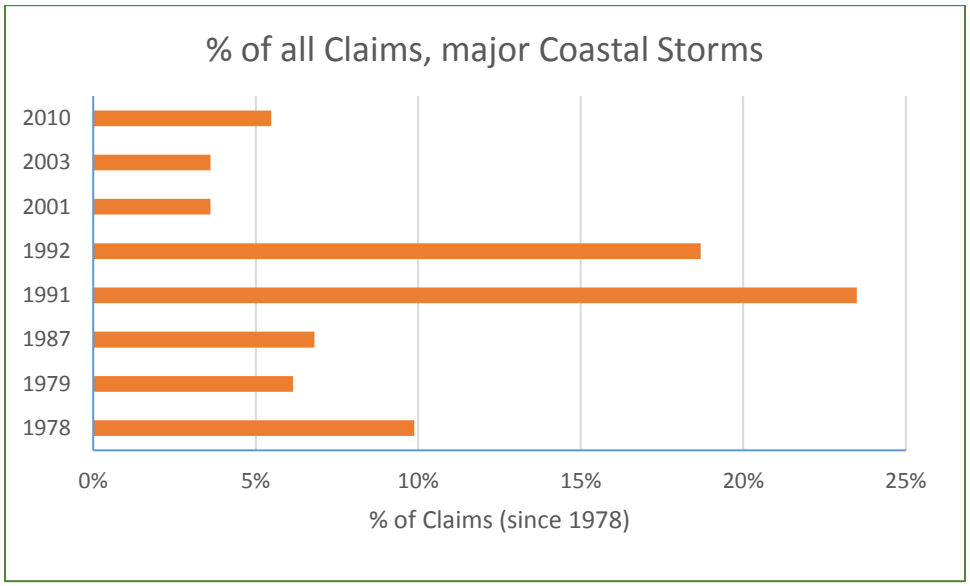


Figure 3 Storm events that have contributed to more than 4% of the number of NFIP flood insurance claims, Town of Hull, 1978 – 2015.

APPENDIX E
DOCUMENTATION OF PLAN ADOPTION

TOWN OF HULL

253 Atlantic Avenue
Hull, Massachusetts 02045

781-925-2000
Fax: 781-925-0224

TOWN OF HULL HAZARD MITIGATION PLAN
DRAFT 2018 UPDATE

CERTIFICATE OF ADOPTION
BOARD OF SELECTMEN
TOWN OF HULL, MASSACHUSETTS

A RESOLUTION ADOPTING THE
TOWN OF HULL HAZARD MITIGATION PLAN 2018 UPDATE

WHEREAS, the Town of Hull established a Committee to prepare the Town of Hull Hazard Mitigation Plan 2018 Update; and

WHEREAS, the Town of Hull Hazard Mitigation Plan 2018 Update contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Hull, and

WHEREAS, duly-noticed public meetings were held by the LOCAL HAZARD MITIGATION PLANNING TEAM on September 19 2017, and February 8, 2018 and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Hull BOARD OF SELECTMEN adopts the Town of Hull Hazard Mitigation Plan 2018 Update, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Hull.

ADOPTED AND SIGNED this Date. 26TH DAY OF APRIL, 2018

Name(s) KEVIN RICHARDSON

Title(s) CHAIRMAN, BOARD OF SELECTMEN

Signature(s) Kevin P. Richardson

ATTEST