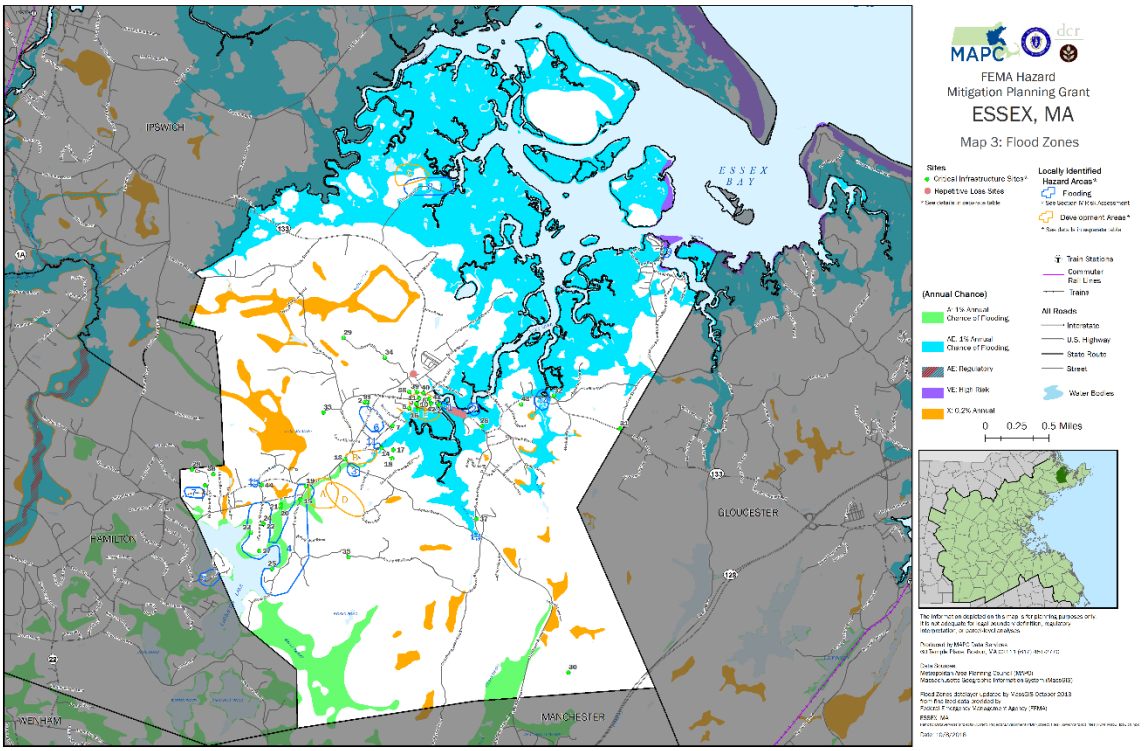
TOWN OF ESSEX
HAZARD MITIGATION PLAN
2019 UPDATE



Final Adopted Approved Plan with Public Comments

July 15, 2019

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TOWN OF ESSEX HAZARD MITIGATION PLAN
2019 UPDATE

ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the Town of Essex 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). The plan was funded by the Federal Emergency Management Agency's (FEMA) Pre-Disaster Mitigation (PDM) Grant Program.

MAPC Officers

President:	Keith Bergman, Town of Littleton
Vice President:	Erin Wortman, Town of Stoneham
Secretary:	Sandra Hackman, Town of Bedford
Treasurer:	Taber Keally, Town of Milton
Executive Director:	Marc. D. Draisen

Credits

Project Manager and Lead Project Planner:	Sam Cleaves
Environmental Planning Director	Martin Pillsbury
Mapping/GIS Services:	Caitlin Spence

Massachusetts Emergency Management Agency

Director:	Kurt Schwartz

Department of Conservation and Recreation

Commissioner:	Leo Roy

Essex Local Hazard Mitigation Planning Team

Paul Francis	Police Chief
Erin Kirchner	Board of Health
Brendhan Zubricki	Town Administrator
Ken Whittaker	Conservation Agent
Michael Galli	DPW Superintendent
Daniel Fialho	Harbormaster

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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

This is an update of the original Essex Hazard Mitigation Plan, which was adopted by Essex on June 4, 2012. Planning for the Hazard Mitigation Plan update was led by the Essex Local Hazard Mitigation Planning Team, composed of staff from a number of different Town Departments. This team met on October 16, 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 Conservation Commission hosted two public meetings, the first on July 10, 2018 and the second on November 20, 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. The town received public comments, which are shown in Appendix C. See list of outreach contacts and press releases in Appendix C.

Risk Assessment

The Essex Hazard Mitigation Plan assesses the potential impacts to the Town from flooding, high winds, winter storms, brush fire, geologic hazards, extreme temperatures, and drought. Flooding, driven by hurricanes, northeasters and other storms, clearly presents the greatest hazard to the Town. These are shown on the map series (Appendix B).

The Essex Local Hazard Mitigation Planning Team identified 44 Critical Facilities. These are also shown on the map series and listed in Table 23, 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 ($3,272.27 thousand to $15,750.64 thousand) as well as earthquakes of magnitudes 5 and 7 ($81.81 million to $474.52 million). Flood damage estimates range from $0 million to $2.9 million.

Hazard Mitigation Goals

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

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

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

3. Increase cooperation and coordination among private entities, Town officials and Boards, State agencies and Federal agencies.

4. Increase awareness of the benefits of hazard mitigation through outreach and education.

Hazard Mitigation Strategy

The Essex Local Hazard Mitigation Planning Team identified a number of mitigation measures that would serve to reduce the Town's vulnerability to natural hazard events. Essex would like to update the Apple Street and Landing Road culverts, also installing sidewalks along Landing Road sidewalks to allow improved access to the DPW garage, considered one of the Town's highest safety issues. Improving the Apple Street culvert is critical to protecting Apple Street as an emergency evacuation and access route during and after severe storm events when Main Street/SR 133 is often flooded.

Informed by the 2017 Great Marsh Adaptation Plan and the Town's 2018 Municipal Vulnerability Preparedness (MVP) study, coastal hazards mitigation are key for building climate resilience and adaptation. Essex wants to address seawall safety and road inundation at Conomo Point, flood proof a key Main Street sewage pump station located in a former salt marsh area that now floods during storm events, continue efforts to study, manage and restore its salt marsh resources, work with partners to understand the movement of sediment and erosion issues in the Essex River and Conomo Point in an effort to better preserve them as climate adaptation resources, review and update current regulations that may be impeding ecological protection and restoration of marshes, beaches and dunes,. Though reconstructed by MA DOT in 2012, the Main Street Causeway was raised only minimally and still experiences significant flooding during winter storm events; the Town sees this as a significant climate resilience challenge and is ready to move forward with both short and long term actions to address the Causeway challenge.

The Town also would like to update the existing tidal culvers adjacent to Farnham's Restaurant on Eastern Ave. /SR 133- also noted as coastal hazard challenge- as well as continue to improve its beaver management program for impacted neighborhoods, particularly near Chebacco Lake. The Town would also like to update its MS4 stormwater permit and extend new water lines along Conomo Point and Southern Avenue as well as complete an inter-connection with Gloucester water system to back feed South Essex water line and hydrants. This is part of a new $15 million dollar capital planning program adopted by the Town.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Essex 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 and in the future. 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

Table 1 Plan Review and Update

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 Community Planning and Development Commission. The plan was also available on the Town's website for public comment.
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 and assessed the potential impacts of flooding using the latest data.
V - Goals	The Hazard Mitigation Goals were reviewed and endorsed by the Essex 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 –	Mitigation measures from the 2012 plan were reviewed and assessed

Hazard Mitigation Strategy	as to whether they were completed, in-progress, or deferred. The Local Hazard Mitigation Planning Team determined whether to carry forward measures into the 2019 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 conditions.
IX – Plan Adoption & Maintenance	This section of the plan was updated with a new on-going plan implementation review and five year update process that will assist the Town in incorporating hazard mitigation issues into other Town planning and regulatory review processes and better prepare the Town for the next comprehensive plan update.

As indicated on Table 28, Essex made progress on implementing mitigation measures identified in the 2012 Hazard Mitigation Plan. Several projects have been completed, including inspection and repairs to the Apple Street Bridge, purchasing a front-end loader and a V-plow to deal with snow and ice removal, improvements to Walnut Street and SR 22 drainage improvements, adding GIS capacity for mapping and planning, and purchasing a new pumper truck to help protect against brush fires.

Other projects were partially completed, most notably the Main Street/Causeway project, completion of the MS4 stormwater permit, improving drainage capacity along Apple Street near Andrews Street and near the Quinn Brothers facility, and the acquisition of land abutting the Town Transfer Station to provide easier access. These will be continued in this 2019 Plan Update.

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.

Though not formally done in the 2012 Plan, the Town will document any actions taken within this iteration of the Hazard Mitigation Plan on challenges met and actions successfully adopted as part of the ongoing plan maintenance to be conducted by the Essex Hazard Mitigation Implementation Team, 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).

The Metropolitan Area Planning Council (MAPC) subcontracted with the Town of Essex to update its local Hazard Mitigation Plans, which was first adopted in 2012. The local Hazard Mitigation Plan update produced under this grant 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 Essex, a part of Essex County, 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 five were due to hurricanes or nor'easters, and four 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)
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
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)

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
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
	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

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
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
Severe Winter Storm (March 2-3, 2019)	FEMA Public Assistance; Hazard Mitigation Grant Program	Essex, Suffolk, Norfolk, Bristol, Plymouth, Barnstable Counties
Severe Winter Storm (March 13-14, 2019)	FEMA Public Assistance; Hazard Mitigation Grant Program	Essex, Suffolk, Norfolk, Worcester Counties

(Source: database provided by MEMA)

FEMA Funded Mitigation Projects

The Town of Essex has received funding from FEMA for one mitigation project under the Hazard Mitigation Grant Program (HMGP).

Project Description/Title	Scope of Work	Total Project Cost (100%)	Federal Funding	Local Funding	Project Status
Town Hall	Installation of emergency generator for Town Hall.	$49,261	$49,261		Completed

Community Profile

Located on Cape Ann, 35 miles northeast of Boston, Essex shares spectacular natural resources with its neighbors, but is unique among them in its socioeconomic and cultural nature as a rural, predominantly working-class community.
It is bounded on the south by the town of Manchester-by-the-Sea, on the west by the towns of Hamilton and Ipswich, on the north by Essex Bay, and on the east by the City of Gloucester. The town is located in the North Coastal watershed, and contains approximately 16 square miles or 9,200 acres, 220 of which are under water, and 3,435 of which are saltmarsh (all the acreage of saltmarsh and water is considered protected under state law, making these areas constitute over 75% of the protected open space in Essex).

(2007 Essex Open Space and Recreation Plan)

The Town is governed by a Board of Selectmen with a Town Administrator. The Town operates under an open Town meeting format. The 2010 population was 3,504 people and there were 1,741 housing units. (2010 US Census)

The Town maintains a website at http://www.essexma.org/Pages/index

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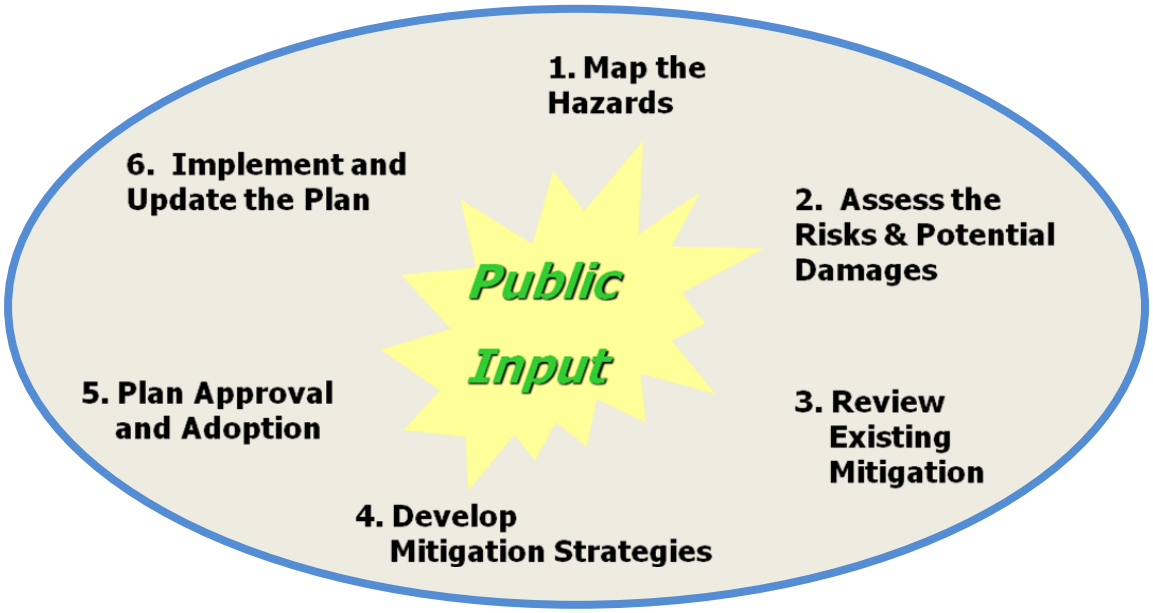
III. PLANNING PROCESS AND PUBLIC PARTICIPATION

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 Regional and 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 six-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. MAPC is also 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, which is collected. 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 Essex, General Bylaws
    - Town of Essex, Zoning Bylaw
    - Town of Essex Strategic Plan 2015 – 2020
    - Town of Essex, MA 2019
      Community Resilience Building Workshop
      Municipal Vulnerability Preparedness Program
    - Great Marsh Coastal Adaptation Plan 2017
    - Town of Essex Open Space and Recreation Plan, 2007
    - Massachusetts State Hazard Mitigation Plan, 2013
    - FEMA, Local Mitigation Plan Review Guide; October 1, 2011
    - FEMA, Flood Insurance Rate Maps for Essex County, MA, 2014
    - 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 Centers for Environmental Information, http://www.ncdc.noaa.gov/
    - Northeast States Emergency Consortium, http://www.nesec.org/
    - USGS, National Water Information System, http://nwis.waterdata.usgs.gov/usa/nwis
    - US Census, 2010 and 2015

- 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.

The Local Multiple Hazard Community Planning Team

MAPC worked with the local community representatives to organize a local Multiple Hazard Community Planning Team for Essex (Local Committee). MAPC briefed the local representatives as to the desired composition of that team as well as the need for representation from the business community, civic organizations and citizens at large.

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 3 below.

The Essex Planning Board, as well as the Essex 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 Core Team and the Conservation Administrator, as well as the Town Administrator, who oversees all town functions. The Conservation Commission hosted two public meetings on the plan, in July, 2018 and November of 2018. In addition, MAPC, the State designated regional planning authority for Essex, works with all agencies that that regulate development in the region, including the listed municipal entities and state agencies, such as the MassDOT.

On October 16, 2018, MAPC conducted a meeting of the Essex Local Committee. The meeting was organized by Town Administrator Brendhan Zubricki. The purpose of the meeting was to review and develop hazard mitigation goals, review the status of mitigation measures identified in the 2012 hazard mitigation plan, identify new potential

mitigation measures and to gather information on local hazard mitigation issues and sites or areas related to these. The meeting also covered measures to be carried forward from the previous plan and to prioritize new measures.

The following Table lists the attendees at each meeting of the team. The agendas for these meetings are included in Appendix A.

The agendas for these meetings are included in Appendix A.

Table 3
Membership of the Essex Hazard Mitigation Planning Team

Name	Representing
Paul Francis	Police Chief
Daniel Fialho	Harbormaster
Erin Kirchner	Erin Kirchner
Michael Galli	DPW Superintendent
Brendhan Zubricki	Town Administrator
Ken Whittaker	Conservation Agent

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 is 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 Essex hazard mitigation planning process during a Conservation Commission meeting on July 10, 2018 held in the Town Hall. The draft plan update was presented at a Conservation Commission meeting held on November 20, 2018 in Essex Town Hall. Both meetings were publicized as regular meetings of Conservation Commission according to the Massachusetts Public Meeting Law. The attendance list for each meeting can be found in Table 4. See public meeting notices in Appendix C.

Table 4
Essex Public Meetings

Name	**Representing**
Meeting #1 July 10, 2018	
Michael Burke, Chair	Essex Conservation Commission
Robert Brophy	Essex Conservation Commission
Angus Bruce	Essex Conservation Commission
Cliff Ageloff	Essex Conservation Commission
Thomas Barrieau	Essex Conservation Commission
Edward Marshall	Essex Conservation Commission
Jack Schylling	Essex Conservation Commission
Sam Cleaves	MAPC
Approximately 6 members of the public	
Meeting #2 November 20, 2018	
Michael Burke, Chair	Essex Conservation Commission
Robert Brophy	Essex Conservation Commission
Angus Bruce	Essex Conservation Commission
Cliff Ageloff	Essex Conservation Commission
Thomas Barrieau	Essex Conservation Commission
Edward Marshall	Essex Conservation Commission
Jack Schylling	Essex Conservation Commission
Sam Cleaves	MAPC
Approximately 7 members of the public	

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: See list of outreach contacts and press releases in Appendix C.

City of Gloucester
Town of Hamilton
Town of Manchester-by-the-Sea
Cape Ann Essex Chamber of Commerce
Essex Planning Board
Gloucester Times
Essex Department Heads

Town Web Site

The draft Essex Hazard Mitigation Plan 2019 Update was posted on the Town's website following 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 hazard. 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.

Planning Timeline

October 16, 2017	Meeting of the Essex Local Hazard Mitigation Planning Team
July 10, 2019	First Public Meeting with Essex Conservation Commission
November 20 ,2018	Second Public Meeting with Essex Conservation Commission
May 14, 2019	Draft Plan Update submitted to MEMA following posting and review
TBD	Revised Draft Plan submitted to MEMA
TBD	Revised Draft Plan submitted to FEMA
TBD	Approval Pending Adoption issued by FEMA
TBD	Final Plan adopted by the Town
TBD	Final Plan Approval issued by FEMA

IV. RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town of Essex as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. Climate change is projected to have significant impacts on many natural hazards. The Town completed climate vulnerability assessments and planning under both the 2017 Great Marsh Coastal Adaptation Plan and through the Essex Municipal Vulnerability Preparedness Workshop held by the Town in 2018. Information from the 2012 Hazard Mitigation Plan was incorporated into both the Great Marsh Plan and the MVP Workshop. Both risk assessment and potential mitigation identified in both of those plans are incorporated in this updated Hazard Mitigation Plan. 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 Essex'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 5 below summarizes the hazard risks for Essex. 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 Essex using the definitions for hazard frequency and severity listed below.

Table 5 - Hazard Risks Summary

Hazard	Frequency		Severity	
	Massachusetts	Essex	Massachusetts	Essex
Flooding	High	High	Serious	Serious
Dam failures	Very Low	NA	Extensive	NA
Hurricane/Tropical Storm	Medium	Medium	Serious	Serious
Tornadoes	Medium	Very Low	Serious	Serious
Thunderstorms	High	High	Minor	Minor
Nor'easter	High	High	Minor	Minor

Winter-Blizzard/Snow	High	High	Minor	Minor
Winter-Ice Storms	Medium	Medium	Minor	Minor
Earthquakes	Very Low	Very Low	Serious	Serious
Landslides	Low	Very Low	Minor	Minor
Brush fires	Medium	High	Minor	Minor
Extreme Temperatures	Medium	Medium	Minor	Minor
Drought	Low	Low	Minor	Minor
Coastal Hazards	High	High	Serious	Serious
Tsunami	Very Low	Very Low	Extensive	Extensive
Major Urban Fires	Low	N/A	Serious	N/A
Ice Jams	Low	N/A	Minor	N/A

Source, Massachusetts State Hazard Mitigation Plan, 2013, modified for Essex

Note: Of the hazards listed in the 2019 Massachusetts State Hazard Mitigation Plan, several categories are not applicable to Essex:

- Major Urban Fires, due to the lack of significant wildfire areas in close proximity to urban development that could pose a significant threat of urban fire.
- Ice Jams, due to the lack of a freshwater river subject to ice jams in Essex.
- Dam Failures, due to Essex having no dams.
- Also, due to the very low probability of Tsunamis, the Town chose to include this hazard as a secondary hazard, profiled under earthquake hazards.

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.

Flood Related Hazards

Flooding was the most prevalent serious natural hazard identified by local officials in Essex. 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 leading to heavier storms.

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 Essex have included:

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991 ("The Perfect Storm") Considered to be a 100-year storm.
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- December 2010
- March 2013
- January 2018
- March 2018

The best available local data on previous occurrences of flooding are provided by NOAA's National Centers for Environmental Information for Essex County, which includes Essex. Essex County experienced 47 flood events from 1996 to 2018 (see Table 6). There were 2 deaths and 3 injuries reported and the total property damage in the county was $20.69 million dollars.

Table 6 Essex County Flood Events, 1996- 2018
Source: NOAA, National Centers for Environmental Information

Date	Deaths	Injuries	Property Damage $
10/22/1996	0	0	0.00K
06/17/1998	0	0	0.00K
06/18/1998	0	0	0.00K
03/05/2001	0	0	0.00K
04/03/2004	0	0	0.00K

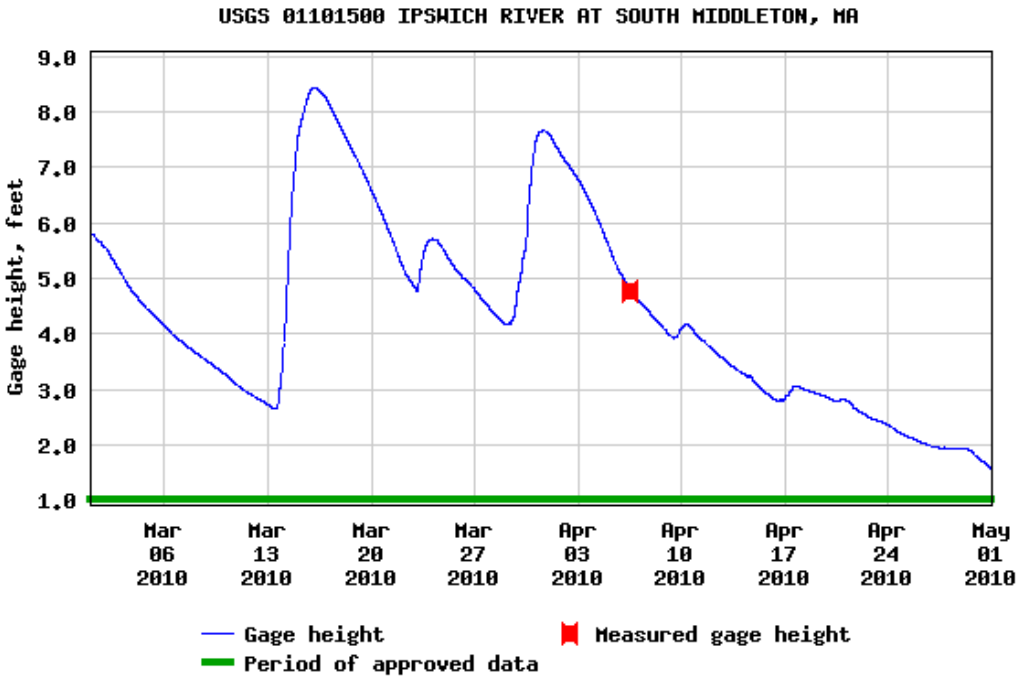
Date	Deaths	Injuries	Property Damage $
10/15/2005	0	0	50.00K
10/25/2005	0	0	45.00K
05/13/2006	2	0	7.000M
07/11/2006	0	0	10.00K
07/28/2006	0	0	20.00K
03/02/2007	0	0	20.00K
04/16/2007	0	0	45.00K
02/13/2008	0	0	30.00K
03/08/2008	0	0	0.00K
08/08/2008	0	0	25.00K
09/06/2008	0	0	5.00K
03/14/2010	0	1	9.800M
03/30/2010	0	2	3.270M
04/01/2010	0	0	0.00K
08/05/2010	0	0	7.00K
08/25/2010	0	0	0.00K
10/04/2011	0	0	305.00K
06/23/2012	0	0	0.00K
08/10/2012	0	0	0.00K
06/24/2013	0	0	5.00K
07/01/2013	0	0	0.00K
07/27/2014	0	0	0.00K
10/23/2014	0	0	30.00K
12/09/2014	0	0	0.00K
08/18/2015	0	0	0.00K
09/30/2015	0	0	0.00K
06/29/2016	0	0	0.00K
04/06/2017	0	0	0.00K
06/27/2017	0	0	2.00K
07/08/2017	0	0	0.00K
07/18/2017	0	0	0.00K
09/06/2017	0	0	0.00K
09/15/2017	0	0	10.00K
09/30/2017	0	0	4.00K
10/25/2017	0	0	0.00K
01/13/2018	0	0	5.00K
TOTAL	2	3	**20.69M**

Most severe flooding event within last 10 years

The most severe flooding event in Essex County in the last 10 years occurred during March 2010, when a total of 14.83 inches of rainfall accumulation was recorded by the National Weather Service (NWS). The weather pattern that consisted of early springtime prevailing westerly winds that moved three successive storms, combined with tropical moisture from the Gulf of Mexico, across New England. Torrential rainfall caused March 2010 to be the wettest month on record.

One indication of the extent of flooding is the gage height at the nearest USGS streamflow gauging station, which is on the Ipswich River in South Middleton. The USGS gage height, shown in Figure 1, exceeded 8 feet on March 16, 2010 and exceeded 7 feet on March 31, 2010. Normal gage height in March is about 4 feet.

Figure 1- Ipswich River Gage Heights, March-April 2010



Source, US Geological Service, National Water Information System

Overview of the North Coastal Watershed and Flooding

The North Coastal Watershed is a study in contrasts. The northern reaches of the North Coastal Watershed include the southern tier of the Hampton and the Seabrook salt marsh complexes, while further south, the watershed is dominated by the rocky shores of Cape Ann, which provide the most distinctive rocky coastline in all of Massachusetts. The

southern reaches of the watershed consist of an irregular coastline of rocky peninsulas, interspersed with embayments, pockets of salt marsh and vibrant estuaries.
The North Coastal Watershed has a total drainage area of approximately 168 square miles. It encompasses all or part of five river sub-basins, including the Danvers, Essex, Saugus, Pines, and Annisquam Rivers. There are approximately 2,428 acres of lakes and ponds in the watershed. The North Coastal encompasses all or part of 26 Massachusetts municipalities, and supports a population of approximately 500,000 people. The major resources in the region include a major lobster fishery, as well as shell fishing.

Watershed Priorities

- Work to reduce contaminated stormwater emanating from street drainage systems along highways and local roads
- Implement sustainable growth management techniques and innovative land use planning, specifically in the Town of Essex, by addressing wastewater management
- Conserve and protect open space
- Prevent the introduction of invasive plant species and reduce the loss of productive shellfish habitat
- Determine the impacts of growth on drinking water supplies and work to maintain adequate base flows in rivers and streams

(From: MA Office of Energy and Environmental Affairs)

Substantial flooding occurs regularly in Essex due to tidal inundation of the Route 133 causeway, and periodic flooding of Alewife Brook and the Essex River also occur during and after major storm events.

The majority of the town's infrastructure is located along the Route 133/Main Street Causeway. The causeway stretches for 0.8 miles and spans both salt marsh and the Essex River. The causeway is a critical connective corridor between Cape Ann and other North Shore communities; it is the main bus route for students traveling between Essex and Manchester and also provides access to a number of restaurants, stores, churches, and marinas in the town center. (MAPC, 2004, *Essex Community Development Plan)*

The only alternate route in town is Apple Street, and that road can become impassible during winter months because of its steep grade and sharp curves. In 2012, construction was completed on the Route 133/Main Street Causeway that raised the road 8 inches -the maximum height allowed without creating an undue burden on businesses with adjoining driveways and parking lots. Tide flaps were also installed to further reduce flooding. These efforts have reduced the frequency of flooding, however the causeway is still subject to flooding multiple times a year. (*Great Marsh Regional Coastal Adaptation Plan,* 2017)

Some limited flooding of residences around Chebacco Lake also occurs due to beaver activity, although measures are being taken to mitigate this using "Beaver Deceivers" to lower water levels. It is important to note that the substantial saltwater and freshwater wetland acreage within the Town provides vital buffer from flooding due to the immense water storage capacity of these ecosystems. Coupled with the relatively low impervious surface coverage in Essex, which allows more natural rates of water infiltration, flooding is currently less of a problem in Essex than it may be under future, more developed conditions. (2007 Open Space and Recreation Plan)

Potential Flood Hazard Areas

Information on potential flood hazard areas was taken from two 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.

Flood Insurance Rate Map Zone Definitions

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

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

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

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

Locally Identified Areas of Flooding

The second was discussions with local officials. The locally identified areas of flooding described below 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. Some of these sites were carried over from the 2012 Hazard Mitigation Plan, and others were added to this plan update. The numbers correspond to the numbers on Map 8, "Hazard Areas". The numbers do not reflect priority order.

9. *Apple Street Culvert near Southern Ave. and Andrews Street*
Undersized culvert becomes flooded during large storms. Upgrading this culvert is key to maintaining Apple Street as an emergency evacuation route for the Town.

11. Landing Road Culvert- Located near 9 Landing Road, this culvert is located within a Vulnerable Area of Special Concern and floods during coastal storms and high precipitation events. Flooding on Landing Road cuts off access to the Town's DPW garage.

14. Eastern Ave. /SR 133 Culvert near 88 Eastern Ave.
This is a carryover from the 2012 plan. Ebben's Creek flows under Eastern Avenue near Farnham's Restaurant and floods during severe coastal storm events. Eastern Avenue is a major artery in and out of Essex, and maintaining its functionality is essential for emergency response and evacuation. Flooding is attributed to an undersized culvert. See also Coastal Hazards.

4. Beaver Management Plan/ Lake Chebacco area
This is a carryover from the 2012 plan. Beaver activity within the watershed of Chebacco Lake causes considerable flooding throughout and extended past its predetermined FEMA floodplains. Centennial Grove Road, located just north of the lake sustains regular flooding. Nearly all the roadways east of the lake, including Pond Street, Wood Drive, Coral Hill, and Pine Ridge Road, experience flooding related Lake Chebacco drainage. There are dozens of properties affected by this flooding, with the most substantial damages to properties along Centennial Grove Road. In large storm events, the water filtration plant is cut off by flood waters. This plant provides potable water to about two thirds of the town.

6. Walnut Park
This is a carryover from the 2012 plan. Flooding in the Walnut Park vicinity stems from an outdated and inadequate drainage system. The system starts north of the Western Avenue and Walnut Park intersection. The drainage in this vicinity flows as follows: water flows down a hill west of Western Avenue (threatening to flood the house at this location), then into a storm drain (opposite the at-risk home), then goes through an underground pipe and resurfaces at Walnut Park. During large rain storms or in an annual spring event, Walnut Street sustains flooding. Flooding results in roadway closures and minor damage to several single family homes along Walnut Street. Potential mitigation for this issue includes increasing diameter of the underground drainage pipe and maintaining the entire pipe subterranean from Western Avenue to Martin Street. The town has partially addressed drainage in this area.

7. Quinn Brothers Facility This is a carryover from the 2012 plan. During large rain events, drainage from the Quinn Brother**s** facility flows downs their driveway and causes roadway flooding. In the past, the flooding caused damages to a single family house in the vicinity, but the town installed a berm which has partially mitigated the problem.

8. *Island Road*
During high tides or in large storm events with northeast winds (Nor' Easters) tidal surge results in portions of Island to flood. This flooding causes partial to complete road closures. Island Road has only one outlet to the rest of Essex at John Wise Avenue. Blockage of the roadway is a serious evacuation and emergency response concern.

Repetitive Loss Structures

As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. For more information on repetitive losses see http://www.fema.gov/business/nfip/replps.shtm.

There are nine repetitive loss structures in Essex, three more than were listed in the 2012 plan. Two of the properties are single family residences.

Table 7 summarizes the number and type of repetitive loss structures located within Essex and the number of losses and total claims associated with them.

Table 7- Summary of Repetitive Losses and Claims 1979- 2017

	Single Family Residential	Other Residential	Non-Residential	Total
Number of Properties	2	2	5	9
Number of Losses	5	6	24	35
Total Claims	$46,378.58	$27,773.58	$902,639.54	$976,791.70

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

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

Dams and Dam Failure

Dam failure can occur as a result of structural failure, independent of a hazard event, or as the result of the impacts of a hazard event such as flooding associated with storms or an earthquake. In the event of 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.

DCR defines dam hazard classifications as follows:

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

Dam failure is a highly infrequent occurrence but a severe incident could result in loss of lives and significant property damage. Since 1984, three dams have failed in or very near to Massachusetts, one of which resulted in a death**.**

Essex Dams

There are no publicly or privately owned dams listed by the Department of Conservation Dam Safety Office for Essex.

Coastal Hazards

Coastal flooding is associated with severe coastal storms that, through the combination of winds and tides, drive tidal waters to higher levels than normally experienced. This can lead to the inundation of low-lying land areas and the overtopping of seawalls.

A detailed analysis of coastal inundation in Essex, conducted by the Woods Hole Group and USGS, confirms that the Town of Essex has high exposure to sea level rise and storm surge. Present day estimates (which are for the year 2013) indicate approximately 27% of the town is vulnerable to coastal inundation – depending on the severity of the storm. That number climbs marginally to 30% in 2070. Of the area subject to coastal inundation,

a significant portion is developed land that is subject to nearly annual or semi-annual flooding – now and in 2070. [1]

Coastal flooding issues in Essex include tidal surge and sea level rise; as well as coastal erosion (beaches, dunes, banks). Impacts to infrastructure, such as flooded roads, culverts blown out or clogging with debris, and power lines knocked down from high winds are also a significant concern in Essex.

A primary site carried over from the 2012 plan, now reclassified as a Coastal Hazard is listed as Area of Concern #2 on Map 8.

2. Finish Reconstruction of Main Street St. Causeway/Woodman's Beach (Flooding)
This is a carryover from the 2012 plan. The portion Main Street (Route 133) known as the "Causeway" divides the eastern and western portions of Essex. The Causeway resides in both 100 year and 500 year flood plains. According to the Local Committee, the Causeway sustains flooding in significant rain storms and during tidal storm surges. Woodman's Beach is located on at the far eastern portion of the previously described Causeway. The beach resides on northern side of the Causeway. The beach and abutting roadway reside on a low laying gradient, resulting in reoccurring flooding. Mass Highway also owns this portion of roadway. Heavy winter storms causing tidal surges can also cause flooding. Flooding results in property damage and roadway closures. The Causeway is the primary access road between the eastern and western portions of Essex. The Police and Fire Departments are both located in the western portion of town. To maintain public safety access, both departments transfer necessary vehicles and personnel to the western portion of town when flooding is imminent. Additionally, closure of the Causeway causes major business interruptions to the restaurants shops along on the Causeway, and on either end.
Flooding is caused by ocean surges coming up through the culverts and storm drains on the causeway and overflowing onto the street. Also, during especially high tides, water comes over the sea walls.

The Causeway is owned and operated by Mass Highway. They conducted a major reconstruction of the roadway in 2010 which included drainage mitigation and limited roadbed elevation. The town hoped that the proposed work would mitigate the majority of the flooding but the road elevation was limited to 8 inches due to problems with access that would have been experienced by abutting businesses on the Causeway. MA DOT is also planning to replace the Causeway Bridge over the Essex River beginning in 2021. The limited improvements gained by the 2010 reconstruction still leaves the town vulnerable to coastal flooding impacts and climate change, leaving Apple Street as the primary emergency road access in case of flooding. This is an ongoing climate change resilience issue for the town.

[1] 2017 Great Marsh Coastal Adaptation Plan, pg. 109.

The 2017 *Great Marsh Regional Coastal Adaptation Plan,* which identified many of the same sites as the local hazard mitigation team and in addition, made mitigation recommendations for the following coastal storm flooding sites: The following sites can be found on Map 8:

- Eastern Ave. at Ebben Creek # 14
- Conomo Point Road- Area of Concern #9
- Richdale's Gas Station on Eastern Ave.#15
- Crane Beach/Essex River # 16- also noted by MVP Program workshop below

In 2018, the Town conducted a community resiliency building workshop through the Massachusetts Municipal Vulnerability Program (MVP). With the completion of the program and submittal of findings of the workshop to the MVP program, Essex became an MVP Certified Community and is eligible to apply for MVP Action Grants. Top recommendations from workshop participants to address climate resiliency as they relate to coastal hazards for the Town included the following:

Salt Marsh Restoration and Management – Multiple strategies are underway and should be continued and enhanced to restore and protect the Essex salt marsh. These strategies may include: addressing erosion of degraded marsh banks by building mussel reefs and other strategies; studying the movement of sand and sediment throughout the marsh; land protection for marsh migration; exploring opportunities to beneficially reuse dredged material; study and exploration of the development of oyster beds; invasive species removal; planting eel grass to help with wave attenuation during storms; using green infrastructure to reduce stormwater pollution so as to keep shellfish beds open and healthy; and more.- multiple areas; not listed on Map 8.

Mouth of the Essex River Study and Management – Efforts should continue to work with partners to study and better understand the movement of sediment at the mouth of the Essex River and throughout Essex Bay, including analyses of channel and creek hydrology, marsh platform elevation changes and response to sea level rise, marsh bank stability, and the erosion of the protective tip of Crane Beach (which has begun to allow tidal and storm energy to adversely affect the Conomo Point Seawall system). See #__, Map 8. (Town of Essex, MA, Community Resilience Building Workshop Municipal Vulnerability Preparedness Program, Summary of Findings June, 2018)

Essex continues to work on coastal resilience issues as part of a larger effort to protect and restore the Great Marsh within its borders and increase community resiliency. Working with the National Fish and Wildlife Foundation, Boston University and other local partners, the project received follow up funding to the 2014 grant that produced the Great Marsh Adaptation Plan for several Great Marsh bordering communities, including Essex. It will go towards toward drainage of marsh pools, restoration of native vegetation such as eelgrass, and removal of invasive species. The marsh arches north from Gloucester to Essex, Ipswich, Rowley, Newbury, Newburyport and Salisbury. Most recently, the Town, working with Boston University and the Trustees of Reservations applied for a MVP Action Grant. The project involves sediment dynamics on Castle Neck

Island (Crane Beach). Learning more about this situation would be beneficial to both Essex and the neighboring town of Ipswich. Essex is also partnering with the University of New Hampshire to apply to the MVP program for a second year of monitoring with respect to the natural sediment deposition event that occurred back in January of 2018 and learning how it may benefit coastal resiliency efforts.

See photos of recent impacts to one of these areas in Figure 2.

The best available local data coastal flooding occurrences is for Essex County through the National Centers for Environmental Information (see Table 8). Essex County, which includes the Town of Essex, experienced 30 coastal flood events from 2006 to 2018. No deaths or injuries were reported and the total reported property damage in the county was $7.10 million dollars. Damages from the February and March 2013 coastal floods in Essex County accounted for $6.8 million of that total.

Photo of Coastal Flooding in Essex

Route 133/Main St. "Essex Causeway"- Essex, MA- March 2, 2018 [2]

[2] Photo courtesy of Essex Municipal Vulnerability Preparedness Workshop Summary of Finding Report, 2018

Table 8- Essex County Coastal Flood Events, 2006-2018

Date	Deaths	Injuries	Property Damage $
1/31/2006	0	0	60.00K
4/15/2007	0	0	5.00K
4/16/2007	0	0	5.00K
4/17/2007	0	0	20.00K
11/3/2007	0	0	10.00K
11/25/2008	0	0	0.00K
6/21/2009	0	0	0.00K
1/2/2010	0	0	0.00K
2/25/2010	0	0	0.00K
3/1/2010	0	0	0.00K
3/4/2010b	0	0	0.00K
3/15/2010	0	0	0.00K
12/27/2010	0	0	75.00K
10/30/2011	0	0	10.00K
6/2/2012	0	0	0.00K
6/3/2012	0	0	30.00K
6/4/2012	0	0	0.00K
6/4/2012	0	0	0.00K
12/27/2012	0	0	0.00K
2/9/2013	0	0	5.800M
3/7/2013	0	0	1.000M
1/2/2014	0	0	0.00K
1/3/2014	0	0	0.00K
1/27/2015	0	0	50.00K
1/24/2016	0	0	0.00K
2/8/2016	0	0	0.00K
5/25/2017	0	0	40.00K
1/4/2019	0	0	0.00K
1/30/2018	0	0	0.00K
3/2/2018	0	0	0.00K
TOTAL	**0**	**0**	**7.105M**

Source: NOAA, National Centers for Environmental Information

The NOAA records for Essex County show a total of $7.1 million in damages from coastal flooding from 2006 to 2019. Based on the record of previous occurrences coastal flooding in Ipswich is a high frequency event as defined by the Massachusetts State

Hazard Mitigation Plan. This hazard may occurs more frequently than once in 5 years (greater than 20% chance per year).

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 Essex. 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. There has been one recorded storm tracks through Essex, a tropical storm in 1923. However, Essex 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 9) The hazard mapping indicates that the 100 year wind speed in Essex is 110 miles per hour (see Appendix B).

Table 9- Hurricane Records for Massachusetts, 1938 – January, 2019

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 Essex. Potential hurricane damages to Essex have been estimated using HAZUS-MH. Total damages are estimated at $3,272.27 for a Category 2 hurricane and $15,750.64 thousand for a Category 4 hurricane. Other potential impacts are detailed in Table 21.

Based on records of previous occurrences, hurricanes in Essex are a Medium frequency event as defined by the 2019 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.

Tornadoes

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. These events are spawned by thunderstorms and occasionally by hurricanes, and may occur singularly or in multiples. They develop when cool air overrides a layer of warm air, causing the warm air to rise rapidly. Most vortices remain suspended in the atmosphere. 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, 2019

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, Revere in 2014 and most recently in Concord (Middlesex County) on August 23, 2016. The Concord EF-1 tornado damaged 39 homes but no injuries or deaths were reported. (Source: *Concord Patch*) The Springfield tornado caused significant damage and resulted in 4 deaths in June of 2011. The Revere tornado touched down in Chelsea just south of Route 16 and moved north into Revere's business district along Broadway and ended near the intersection of Routes 1 and 60. The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour. Approximately 65 homes had substantial damages and 13 homes and businesses were uninhabitable.

Although there have been no recorded tornadoes within the limits of the Town of Essex, team members recall seeing a funnel cloud in Essex in 2014 but no tornado formed. Since 1956 there have been 11 tornadoes in surrounding Essex County recorded by the NCDC. T No tornados were F3, one was F2, eight were F1 and two were F 0. These 11 tornadoes resulted in no fatalities and four injuries and up to $560,280 in damages, as summarized in Table 10.

Table 10 - Tornado Records for Essex County

Location	Date	Type	Fujita Scale	Deaths	Injuries	Property Damage $	Length	Width
ESSEX CO.	6/13/1956	Tornado	F1	0	0	2500	1	10
ESSEX CO.	11/21/1956	Tornado	F2	0	0	25000	0.8	17
ESSEX CO.	12/18/1956	Tornado	F1	0	0	250	0.5	23
ESSEX CO.	7/13/1960	Tornado	F0	0	0	30	0.1	33
ESSEX CO.	7/21/1962	Tornado	F1	0	3	25000	2.7	33
ESSEX CO.	5/19/1964	Tornado	F0	0	0	2500	0.1	300
ESSEX CO.	5/19/1964	Tornado	F1	0	0	2500	2	300
ESSEX CO.	8/10/1965	Tornado	F1	0	0	0	3.6	33
ESSEX CO.	7/1/1968	Tornado	F1	0	1	250000	0.3	100
ESSEX CO.	7/21/1972	Tornado	F1	0	0	2500	0.3	20
ESSEX CO.	8/15/1991	Tornado	F1	0	0	250000	0.8	300
Total				**0**	**4**	**$560,280**		

Source: National Centers for Environmental Information

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 Essex, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Essex would greatly depend on the track of the tornado. Generally the downtown and portions of the Town nearer Main Street, Southern Avenue and John Wise Avenue are more densely developed and 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 Essex are a Medium frequency event as defined by the 2019 Massachusetts State Hazard Mitigation

Plan. This hazard may occur from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

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:

February 1978	Blizzard of 1978
October 1991	Severe Coastal Storm ("Perfect Storm")
December 1992	Great Nor'easter of 1992
January 2005	Blizzard/N or'easter
October 2005	Coastal Storm/Nor'easter
April 2007	Severe Storms, Inland & Coastal Flooding/Nor'easter
January 2011	Winter Storm/Nor'easter
October 2011	Severe Storm/Nor'easter
Blizzard of 2013	February 2013
Blizzard of 2015	January 2015
January 2019	Severe Storm, Coastal Flooding/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, January 2015 and January 2019 were all large nor'easters that caused significant snowfall amounts.

Essex 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 Essex could be at risk from the wind, rain or snow impacts from a nor'easter, depending on the track and radius of the storm, with low lying coastal areas at greatest risk.

Based on the record of previous occurrences, nor'easters in Essex are high frequency events as defined by the 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. Generally defined as a storm that includes thunder, which always accompanies lightning, a thunderstorm is a storm event featuring 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 Town does not keep records of thunderstorms, but estimates that at least eight to ten occur each year. Team members remembered severe thunderstorms in 2015 in the Town Center and South End. Trees were downed by high wind and the power was out for two hour town wide. Also in 2015, another severe thunderstorm occurred near Lowell Street in the Timberhill neighborhood. Two houses were damaged by trees knocked down by high winds and power was lost. Team members recall several instances of severe thunderstorms with high winds, downed trees and lost power in part of Essex during 2014 and 2015. The Town's drinking water filtration power lines were replaced during this time by National Grid to prevent downing by high wind.

The best available data on previous occurrences of thunderstorms in Essex is for Essex County through the National Centers for Environmental Information (NCDC). Between 1995 and 2018 NCDC records show 194 thunderstorm events in Essex County communities (Table 11). These storms resulted in a total of $2.573 million in property damages. There were no injuries and no deaths reported.

Table 11 Essex County Thunderstorm Wind Events, 1995-November, 2018

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	9/14/1995	Thunderstorm Wind	0	0	0	0
ESSEX CO.	8/3/1997	Thunderstorm Wind	50	0	0	0
ESSEX CO.	5/29/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	5/31/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	5/31/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	8/11/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	9/7/1998	Thunderstorm Wind	50	0	0	0
ESSEX CO.	4/26/1999	Thunderstorm Wind	52	0	0	1000

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	6/23/1999	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/1999	Thunderstorm Wind	52	0	0	0
ESSEX CO.	7/24/1999	Thunderstorm Wind	75	0	0	0
ESSEX CO.	7/24/1999	Thunderstorm Wind	52	0	0	0
ESSEX CO.	7/25/1999	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/27/2000	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/18/2000	Thunderstorm Wind	50	0	0	0
ESSEX CO.	5/12/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/30/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/30/2001	Thunderstorm Wind	55	0	0	0
ESSEX CO.	7/1/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/1/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/1/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	8/10/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	8/10/2001	Thunderstorm Wind	50	0	0	0
ESSEX CO.	5/31/2002	Thunderstorm Wind	50	0	0	4000
ESSEX CO.	6/2/2002	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/23/2002	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/27/2003	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/27/2003	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/2/2004	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	8/20/2004	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/26/2005	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/29/2005	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/27/2005	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/27/2005	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	8/5/2005	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	8/5/2005	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	5/21/2006	Thunderstorm Wind	50	0	0	30000
ESSEX CO.	5/21/2006	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/11/2006	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/11/2006	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/11/2006	Thunderstorm Wind	78	0	0	500000
ESSEX CO.	7/28/2006	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/1/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	70	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/2/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/5/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/5/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/5/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/5/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/6/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/28/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/28/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/28/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/28/2007	Thunderstorm Wind	50	0	0	0
ESSEX CO.	9/8/2007	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/8/2007	Thunderstorm Wind	50	0	0	8000
ESSEX CO.	9/8/2007	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	5/27/2008	Thunderstorm Wind	50	0	0	2000
ESSEX CO.	5/27/2008	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/10/2008	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/10/2008	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/10/2008	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/10/2008	Thunderstorm Wind	50	0	0	4000
ESSEX CO.	6/22/2008	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/27/2008	Thunderstorm Wind	50	0	0	7000
ESSEX CO.	6/27/2008	Thunderstorm Wind	50	0	0	500
ESSEX CO.	7/1/2008	Thunderstorm Wind	50	0	0	20000
ESSEX CO.	7/1/2008	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/1/2008	Thunderstorm Wind	50	0	0	4000
ESSEX CO.	7/2/2008	Thunderstorm Wind	50	0	1	10000
ESSEX CO.	7/2/2008	Thunderstorm Wind	50	0	0	0
ESSEX CO.	7/3/2008	Thunderstorm Wind	50	0	1	3000

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	7/3/2008	Thunderstorm Wind	54	0	0	5000
ESSEX CO.	7/3/2008	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/18/2008	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/19/2008	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	9/9/2008	Thunderstorm Wind	50	0	0	12000
ESSEX CO.	9/9/2008	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	9/9/2008	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/26/2009	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/31/2009	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/31/2009	Thunderstorm Wind	50	0	0	40000
ESSEX CO.	7/31/2009	Thunderstorm Wind	50	0	0	500
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/3/2010	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	6/5/2010	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	6/5/2010	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/6/2010	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	6/6/2010	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/6/2010	Thunderstorm Wind	52	0	0	75000
ESSEX CO.	6/6/2010	Thunderstorm Wind	50	0	0	500
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	0
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	250
ESSEX CO.	6/24/2010	Thunderstorm Wind	50	0	0	500
ESSEX CO.	7/12/2010	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/12/2010	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/19/2010	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	20000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	6/9/2011	Thunderstorm Wind	50	0	0	3000

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	7/4/2011	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/4/2011	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/4/2011	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/4/2011	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/18/2011	Thunderstorm Wind	39	0	0	20000
ESSEX CO.	8/19/2011	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	8/19/2011	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	8/19/2011	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	10/4/2011	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/23/2012	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	6/23/2012	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	6/23/2012	Thunderstorm Wind	40	0	0	500
ESSEX CO.	6/25/2012	Thunderstorm Wind	40	0	0	5000
ESSEX CO.	7/4/2012	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	6/24/2013	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	6/24/2013	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/1/2013	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	7/1/2013	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/3/2014	Thunderstorm Wind	50	0	0	50000
ESSEX CO.	7/3/2014	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/3/2014	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/15/2014	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/28/2014	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/28/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/2/2014	Thunderstorm Wind	45	0	0	5000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	3000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	30000
ESSEX CO.	9/6/2014	Thunderstorm Wind	85	0	0	100000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	30000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	9/6/2014	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	5/28/2015	Thunderstorm Wind	61	0	0	50000
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	15000

Location	Date	Type	Magnitude-knots	Deaths	Injuries	Damage-$
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	30000
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	5/28/2015	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/23/2015	Thunderstorm Wind	60	0	0	5000
ESSEX CO.	7/27/2015	Thunderstorm Wind	45	0	0	1000
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	8/4/2015	Thunderstorm Wind	50	0	0	20000
ESSEX CO.	2/25/2016	Thunderstorm Wind	45	0	0	5000
ESSEX CO.	2/25/2016	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	2/25/2016	Thunderstorm Wind	50	0	0	1000
ESSEX CO.	6/29/2016	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/1/2016	Thunderstorm Wind	40	0	0	5000
ESSEX CO.	7/1/2016	Thunderstorm Wind	50	0	0	10000
ESSEX CO.	7/18/2016	Thunderstorm Wind	70	0	0	100000
ESSEX CO.	7/18/2016	Thunderstorm Wind	40	0	0	5000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	15000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	20000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	35000
ESSEX CO.	7/23/2016	Thunderstorm Wind	50	0	0	25000
ESSEX CO.	9/11/2016	Thunderstorm Wind	50	0	0	5000
ESSEX CO.	9/11/2016	Thunderstorm Wind	50	0	0	5000
Total				**0**	**2**	**$2,573,750**

Source: NOAA, National Centers for Environmental Information

Magnitude refers to maximum wind speed in knots.

Severe thunderstorms are a Town-wide hazard for Essex. 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 Essex are high frequency events as defined by the 2019 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 increases 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, 2019

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 Essex blizzards and severe winter storms have occurred in the following years:

Table 12- 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
Blizzard of 2018	January, 2019

Source: National Oceanic and Atmospheric Administration

The average annual snowfall for all of Essex is 48 - 72 inches. (See Map 6 in Appendix B).

The Town of Essex does not keep local records of winter storms. Data for Essex County, which includes Essex, is the best available data to help understand previous occurrences and impacts of heavy snow events. According to the National Climate Data Center (NCDC) records, from 1995 to January, 2017, Essex County experienced 113 heavy snowfall events, resulting in no deaths, no injuries, and $7.353 million dollars in property damage. See Table 13 for heavy snow events and impacts in Essex County.

Table 13 - Heavy Snow events and Impacts in Essex County 1996 – 2018

Location	Date	Type	Deaths	Injuries	Damage-$
EASTERN ESSEX (ZONE)	1/2/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/2/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/7/1996	Heavy Snow	0	0	1000000

Location	Date	Type	Deaths	Injuries	Damage-$
WESTERN ESSEX (ZONE)	1/7/1996	Heavy Snow	0	0	1000000
EASTERN ESSEX (ZONE)	1/10/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/12/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/2/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/16/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/2/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/2/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/7/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/7/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	4/9/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	4/9/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/6/1996	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/6/1996	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/7/1996	Heavy Snow	0	0	1360000
WESTERN ESSEX (ZONE)	12/7/1996	Heavy Snow	0	0	1360000
EASTERN ESSEX (ZONE)	2/16/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/31/1997	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/31/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	4/1/1997	Heavy Snow	0	0	2500000
EASTERN ESSEX (ZONE)	4/1/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	11/14/1997	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	11/14/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/23/1997	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/23/1997	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/15/1998	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/15/1998	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/14/1999	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/14/1999	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/6/1999	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/6/1999	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/15/1999	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/15/1999	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/13/2000	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/13/2000	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/18/2000	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/18/2000	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/30/2000	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/20/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/20/2001	Heavy Snow	0	0	0

Location	Date	Type	Deaths	Injuries	Damage-$
WESTERN ESSEX (ZONE)	2/5/2001	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/5/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/5/2001	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/5/2001	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/9/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/9/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/30/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/8/2001	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/1/2003	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/1/2003	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/16/2004	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/16/2004	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/21/2005	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/23/2006	Heavy Snow	0	0	20000
EASTERN ESSEX (ZONE)	12/13/2007	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/13/2007	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/16/2007	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/16/2007	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/19/2007	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/19/2007	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/14/2008	Heavy Snow	0	0	28000
WESTERN ESSEX (ZONE)	1/14/2008	Heavy Snow	0	0	20000
WESTERN ESSEX (ZONE)	2/22/2008	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/22/2008	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/19/2008	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/19/2008	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/21/2008	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/31/2008	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/31/2008	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/11/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/11/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/18/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/1/2009	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/1/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/9/2009	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/20/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/20/2009	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/18/2010	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/16/2010	Heavy Snow	0	0	15000

Location	Date	Type	Deaths	Injuries	Damage-$
WESTERN ESSEX (ZONE)	2/16/2010	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/12/2011	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/26/2011	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/26/2011	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/8/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/8/2013	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/7/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/7/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	3/18/2013	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	3/18/2013	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/14/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/14/2013	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	12/17/2013	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	12/17/2013	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/2/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/2/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/18/2014	Heavy Snow	0	0	10000
EASTERN ESSEX (ZONE)	2/5/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/5/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/13/2014	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/13/2014	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/18/2014	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	1/24/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/24/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	1/26/2015	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/2/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/2/2015	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/8/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/8/2015	Heavy Snow	0	0	0
EASTERN ESSEX (ZONE)	2/14/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/14/2015	Heavy Snow	0	0	0
WESTERN ESSEX (ZONE)	2/5/2016	Heavy Snow	0	0	40000
Total			**0**	**0**	**$7,353,000**

The Town's overall vulnerability to heavy snow and blizzards is primarily related to restrictions on travel on roadways, temporary road closures, school closures, and potential restrictions on emergency vehicle access. Other vulnerabilities include power outages due to fallen trees and utility lines, and damage to structures due to heavy snow loads.

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 Essex. The best available local data is for Essex County through the National Centers for Environmental Information (see Table 14). Essex County, which includes the Town of Essex, experienced one ice storm event from 1995 – April, 2018. No deaths or injuries

were reported and the total reported property damage in the county was $2.0 million dollars.

Table 14- Essex County Ice Storm Events, 1995- November, 2018

Date	Date	Type	Deaths	Injuries	Damage-$
WESTERN ESSEX (ZONE)	12/11/2008	Ice Storm	0	0	$2,000,000

Source: NOAA, National Centers for Environmental Information

Ice storms are considered to be medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs once in 5 years to once in 50 years, with 2% to 20% chance of occurring each year.

The impacts of winter storms are often related to the weight of snow and ice, which can cause roof collapses and also causes tree limbs to fall which can in turn cause property damage and potential injuries.

Winter storms are a potential Town-wide hazard in Essex. The Town's vulnerability is primarily related to restrictions to travel on roadways, temporary road closures, school closures, and potential restrictions on emergency vehicle access. The Town works to clear roads and carries out general snow removal operations, and bans on-street parking during snow removal to ensure that streets can be plowed and public safety vehicle access is maximized. Transit operations may also be impacted, as they were in the 2015 blizzard which caused the closure of the MBTA system for one day and limited services on several transit lines for several weeks. Another winter storm vulnerability is power outages due to fallen trees and utility lines.

Winter storms 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 twenty percent 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 Essex 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 2010, 544 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 Ann. 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

Table 15- Historical Earthquakes in Massachusetts or Surrounding Area

Location	Date	Magnitude
MA – Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA – Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA – Cape Ann	1/7/1925	4
MA – Nantucket	10/25/1965	NA
MA – Boston	12/27/74	2.3
VA –Mineral	8/23/11	5.8
MA - Nantucket	4/12/12	4.5
ME - Hollis	10/17/12	4.0

Source: (NESEC).

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. Essex is in the middle part of the range for Massachusetts, at 14g to 16g, 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. There have been no recorded earthquake epicenters within Essex.

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 Essex. 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 Essex have been estimated using HAZUS-MH. Total building damages, including business interruption losses are estimated at $81.81 million for a 5.0 magnitude earthquake and $474.52 million for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 22.

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

The entire Town has been classified as having a low incidence risk for landslides, less than 1.5 % of the area is involved in land sliding. (Map 4, Appendix B) The Town does not have records of any damages caused by landslides in Essex. Because of this, no specific mitigation measures for landslides have been included in the plan update.

Potential damages would depend on how many properties were affected. Given the relatively high assessed value of property in Essex, damages affecting a single residence could exceed $500,000, and damages affecting several homes or business properties could theoretically extend from $1 million to several million. However, there are no data available on landslide damages in Essex, as there are no records of any damages caused by landslides in the town.

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

Based on past occurrences and the Massachusetts Hazard Mitigation Plan, landslides are of Low frequency, events that can occur once in 50 to 100 years (a 1% to 2% chance of occurring each year).

Tsunami

An additional natural hazard associated with earthquakes are tsunamis. Tsunamis are created when the epicenter of an earthquake, the area of the fault where a sudden rupture occurs, is beneath the ocean floor. This can sometimes create immense sea waves if the earthquake causes upward or downward movement of the sea floor. According to the National Centers for Environmental Information, there have been no Tsunami's reported in the Northeast area of the United States. The Massachusetts Natural Hazard Mitigation Plan reports tsunamis have a very low frequency with extensive severity across the coast of Massachusetts. Essex has a very low risk frequency of tsunami but if it were to occur, the damage would likely be extensive.

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. 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.

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.

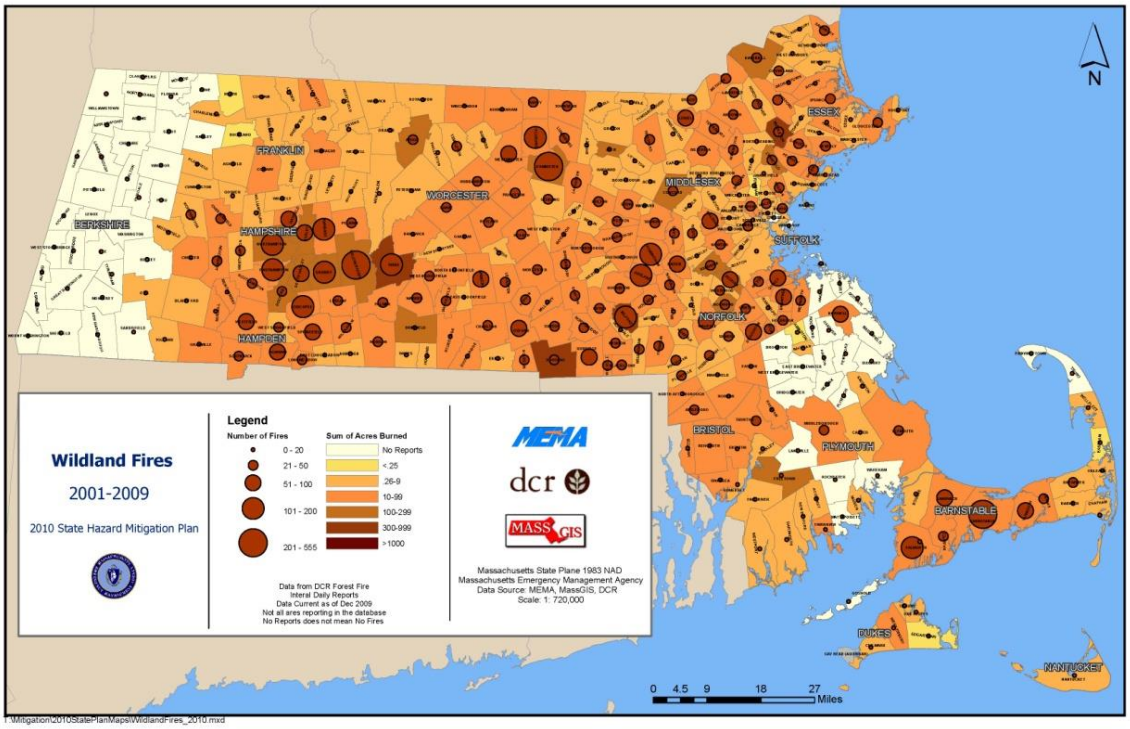
The Fire Department responds to approximately six to ten brush fires annually, approximately the same number as the previous planning period. None of these involved significant property damage and none have resulted in any injuries or deaths. Most brush fires are caused by weather conditions such as lack of rainfall, winds and lightning, a few by campers.

The following areas of Town were identified as having the highest potential for brush fires based on past occurrences and their potential for the accumulation of dried vegetation growth. Areas with the highest incidents of brush fire include near Pond Street and the wooded areas adjacent to West Gloucester and Manchester. Brush fire areas can be found Map 8, “Hazard Areas”.

Essex participated in a climate resilience building workshop in 2018 as part of the Massachusetts Municipal Vulnerability Preparedness Program (MVP). The workshop summary report identified the following actions for the Town to follow regarding forest management, climate resilience and fire prevention: Forest Protection and Management – Town committees and staff should work with local and regional non-profit partners to better understand the impacts of climate change on the forested areas of the town, including both public and private lands, and to develop strategies for ecosystem protection. Resiliency and management actions should address the threats of forest disease, loss of biodiversity, forest fire, invasive species, etc.

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 2 below, indicates that the wildfire extent in Essex consists of .26 - 9 acres burned, with 0-20 fires from 2001 to 2009.

Figure 2 Massachusetts Wildfires 2001-2009



Source: 2013 Massachusetts State Hazard Mitigation Plan

Potential vulnerabilities to wildfires include damage to structures and other improvements, and impacts on natural resources such as the wooded lands off Southern Avenue. 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 Essex would depend on the extent and type of land affected. There could be the need for post-fire revegetation to restore burned properties, 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 High frequency, events that occur more frequently than once in 5 years (Greater than 20% per year)

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. Essex 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.

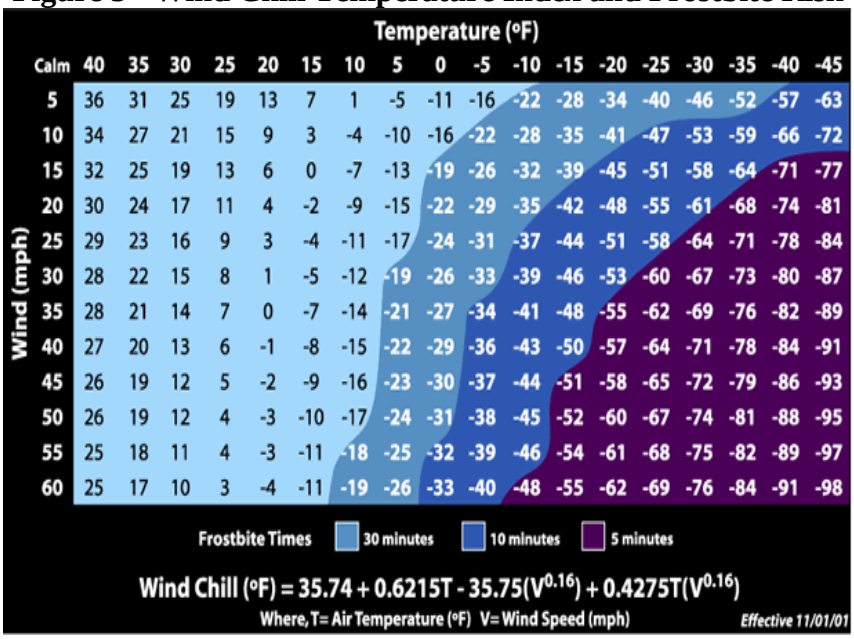
Extreme Cold

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 3 below.

Extreme cold is also 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 elderly and people with disabilities are often most vulnerable. In Essex, 14.9 percent of the population are over 65 and 4.5% of the population has a disability.

Figure 3 - Wind Chill Temperature Index and Frostbite Risk



The Town of Essex does not collect data for previous occurrences of extreme cold. The best available local data are for Essex County, 1995- 2016, through the National Centers for Environmental Information (NCDC). There are four extreme cold events on record which caused no deaths and no injuries, and no property damage (see Table 16).

Table 16 – Essex County Extreme Cold and Wind Chill Occurrences

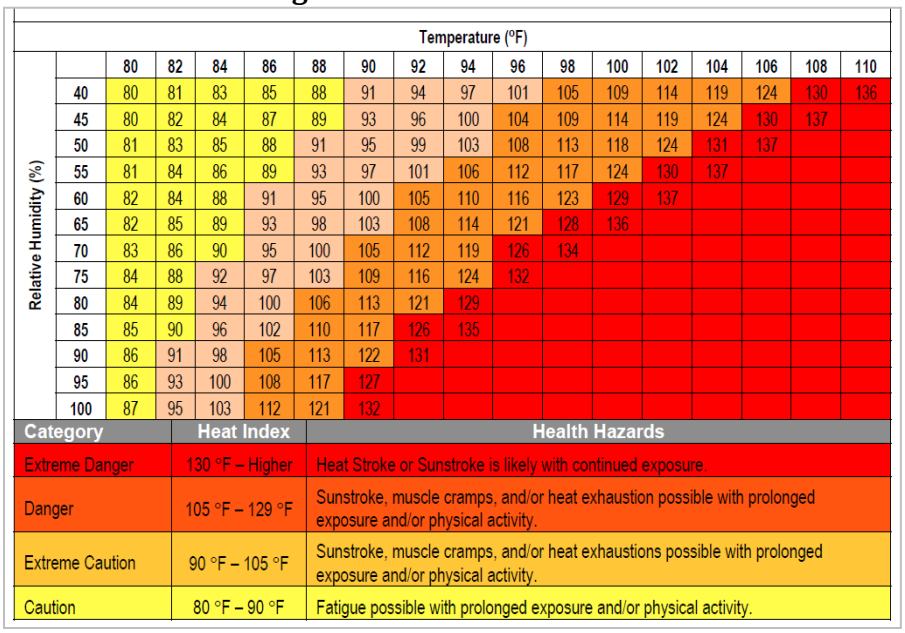
Location	Date	Type	Deaths	Injuries	Damage-$
EASTERN ESSEX	2/15/2015	Extreme Cold/Wind Chill	0	0	0
WESTERN ESSEX	2/16/2015	Extreme Cold/Wind Chill	0	0	0
WESTERN ESSEX	2/13/2016	Extreme Cold/Wind Chill	0	0	0
EASTERN ESSEX	2/13/2016	Extreme Cold/Wind Chill	0	0	0

Source: NOAA, National Centers for Environmental Information

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 4) is forecast to exceed 100 degree Fahrenheit (F) for 2 or more hours; an excessive heat advisory is issued if forecast predicts the temperature to rise above 105 degree F.

Figure 4- Heat Index Chart



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 Essex does not collect data on excessive heat occurrences. The best available local data are for Essex County, through the National Centers for Environmental Information. From 1995 – April, 2017, there has been a total of one excessive heat event, with no reported deaths, no 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 – Essex County Extreme Heat Occurrences 1995 to November, 2018

Date	Type	Deaths	Injuries	Damage
7/22/2011	Excessive Heat	0	0	0

Source: NOAA, National Centers for Environmental Information

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. Essex is located in the Northeast Region. In Essex 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.

In the face of climate change impacts and concern for drinking water supply and management in the face of potential drought, the Essex Municipal Vulnerability Summary Report of 2018 recommended the following:

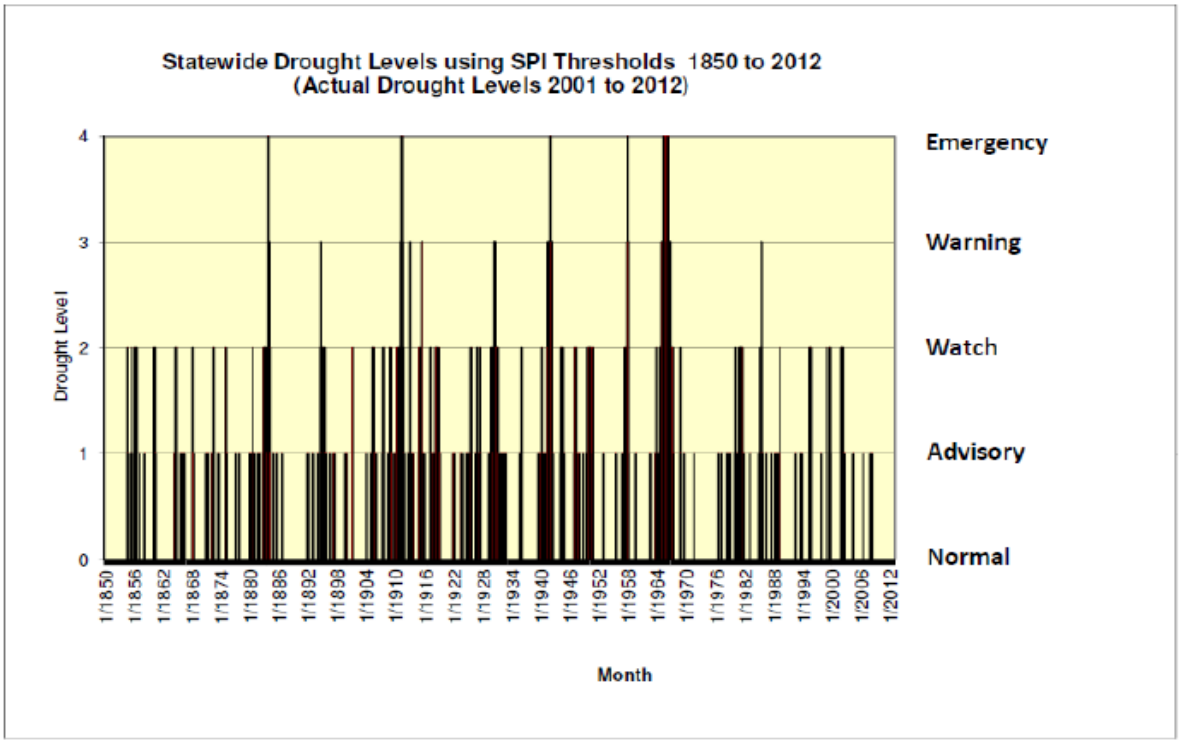
Chebacco Lake Watershed Protection – The municipality should work with partners to prioritize the protection of the Chebacco Lake ecosystem, including preservation of wildlife habitat and protection of water supplies. Strategies may include water quality monitoring, management of invasive species, land protection of the watershed, identification of opportunities and implementation of green infrastructure, education of property owners about stormwater pollution, etc.

Previous Occurrences

Essex does not collect data relative to drought events. Because drought tends to be a regional natural hazard, this plan references state and county 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 5 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 17 summarizes the chronology of major droughts from 1929 to 2018.

Figure 5 - 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 2012: 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, and 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.

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. 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 and 2002.

On July 8, 2016, following four continuous months of unusually dry weather, Massachusetts Energy and Environmental Affairs (EEA) Secretary Matthew Beaton declared a Drought Watch for Central and Northeast Massachusetts, which includes the Town of Essex, and a Drought Advisory for Southeast Massachusetts and the Connecticut River Valley. In August 2016 the Northeast Region was upgraded to a Drought Warning. As of January 1, 2017, four of the six statewide regions in Massachusetts were listed in Drought Warning, the second highest drought stage, and the Northeast Region was listed in the third-ranked Drought Watch stage. By June 1, 2017 all areas of the state were listed as being in a normal condition.

The overall frequency of being in a drought Watch is 8 percent on a monthly basis over the 162-year period of record.

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	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.

Data on drought occurrences for Essex County, is available through the National Centers for Environmental Information. From 1995 – December, 2019, there have been a total of 8 months of drought events, with no reported deaths, no injuries, and no property damage resulting from drought (see Table 19).

Table 19 – Essex County Drought Occurrences 1995- December, 2019

Location	Date	Type	Deaths	Injuries	Damage-$
WESTERN ESSEX	4/12/2012	Drought	0	0	0
WESTERN ESSEX	7/5/2016	Drought	0	0	0
WESTERN ESSEX	8/1/2016	Drought	0	0	0
WESTERN ESSEX	9/1/2016	Drought	0	0	0
WESTERN ESSEX	10/1/2016	Drought	0	0	0
WESTERN ESSEX	11/1/2016	Drought	0	0	0
WESTERN ESSEX	12/1/2016	Drought	0	0	0
WESTERN ESSEX	1/1/2017	Drought	0	0	0
Total			0	0	0

Source: NOAA, National Centers for Environmental Information

Under a severe long term drought the Essex 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 in Essex, there are no data or estimates of potential damages, but under a severe drought scenario it would be reasonable to expect a range of potential damages from several million to tens of millions of dollars. However, given the resilience of the MWRA water system due to its large amount of storage in the Quabbin and Wachusett Reservoirs, (equivalent to five years of water demand), severe impacts on the Town is unlikely. For example, even during the multi-year drought of record in the 1960s, there were no severe limitations of supply from the regional water system, which at the time was operated by the Metropolitan District Commission.

Probability of Future Occurrences

The state has experienced Emergency Droughts five times between 1850 and 2012. 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, 2019.

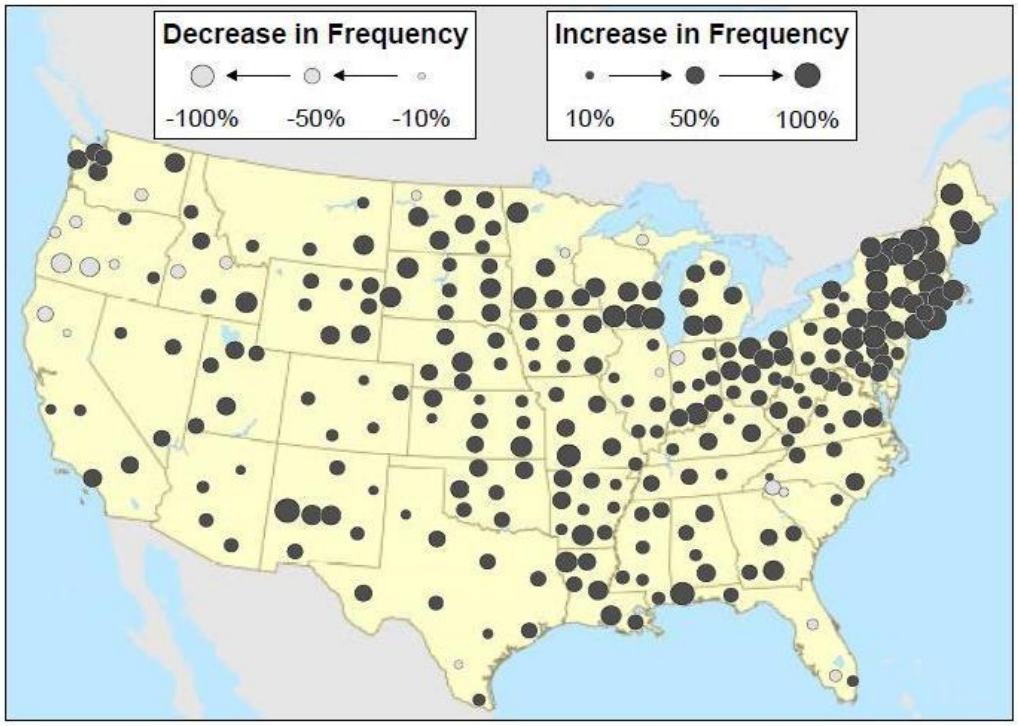
Impacts of Climate Change

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

Climate Change Impacts: Extreme Precipitation

Essex's average annual precipitation is 49 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 6). 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 6- 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

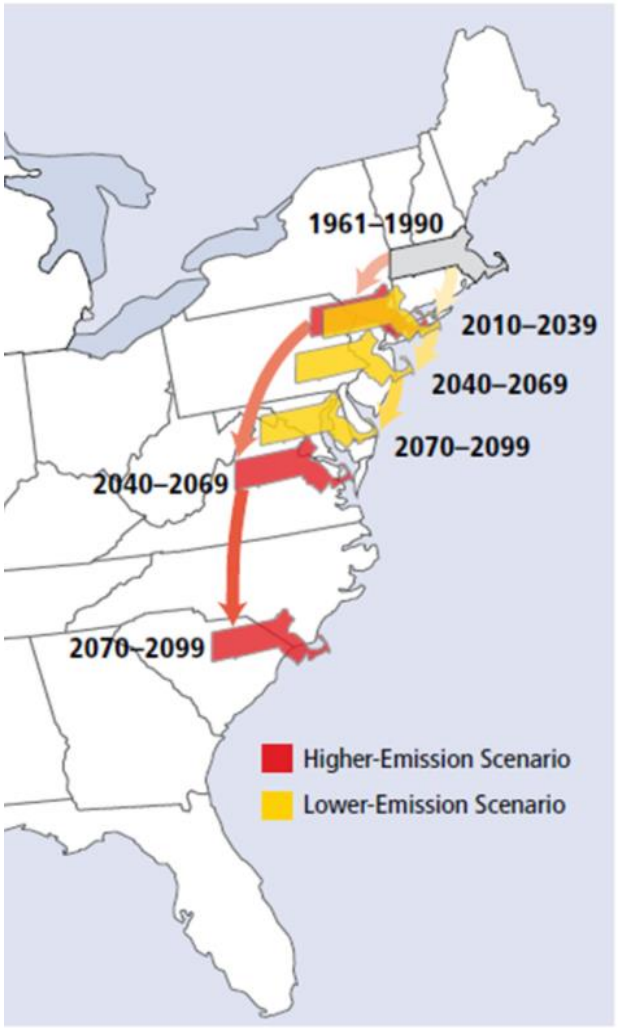
Not only are these intense storm events more frequent, they are also more severe: the largest annual storms now produce 10 percent more precipitation, on average, than in

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 (discussed below) 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.



Source: Union of Concerned Scientists

Figure 7 – Mass. Extreme Heat Scenarios
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 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 12). Furthermore, the number of days with poor air quality could quadruple in Boston by the end of the 21st century under 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 20 shows the acreage and percentage of land in 10 categories. If the three residential categories are aggregated, residential uses make up 8.9 % of the area of the Town (810.3 acres). Commercial and industrial uses combined make up 1.1 % of the Town, or 103 acres.

Table 20- 2005 Land Use

High Density Residential	56.8
Medium Density Residential	242.7
Low Density Residential	510.8
Non-Residential Developed	112.1
Commercial	67.2
Industrial	35.8
Transportation	4.3
Agriculture	694.6
Undeveloped	4,163.1
Undeveloped Wetlands	3,236.8
TOTAL ACRES	9,124.2

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.

Description and Economic Elements

Long noted as one of the original maritime centers of New England, the Town of Essex, MA is located just 30 miles northeast of Boston. Situated north of Manchester-by-the-Sea and east of Hamilton and Ipswich, Essex is the northwestern most town of Cape Ann.

The town encompasses approximately 16 square miles, of which approximately 48% is forested.
Essex is located within the Essex Bay and Ipswich Bay systems of the North Coastal Watershed. The majority of the town's surface water drains into the Essex Bay through the Essex River. Also feeding into the Essex River is Chebacco Lake, a 209-acre Great Pond located within the borders of Essex and Hamilton. The southwestern portion of Essex drains into Cat Brook which flows southwest into the Manchester Harbor. Like many North Shore communities, much of Essex is low-lying, exposing it to sea level rise and flooding hazards. Penetrating storm surge and increased precipitation could exacerbate existing choke points along rivers, leading to coastal and riverine flooding.

According to the 2010 Federal Census, there were approximately 3,504 residents living in Essex. Compared to neighboring towns, like Ipswich and Gloucester, Essex has experienced a relatively low rate of development. The majority of the town's infrastructure is located along the Route 133/Main Street Causeway. The causeway stretches for 0.8 miles and spans both salt marsh and the Essex River. The causeway is a critical connective corridor between Cape Ann and other North Shore communities; it is the main bus route for students traveling between Essex and Manchester and also provides access to a number of restaurants, stores, churches, and marinas in the town center. (Great Marsh Coastal Adaptation Plan, 2017)

The estimated median income for a household in the town as of 2017 was $109,327, and the median income for a family was $121,736, which are both well over the national averages. Males had a 2107 estimated median income of $66,413 versus $34,722 for females. The per capita income for the town was $42,259. (American Fact Finder)

Historic, Cultural, and Natural Resource Areas

Distinctive coastal landscape features were instrumental in shaping the history of Essex, from the earliest use of the land by Native Americans to its shipbuilding, fishing and farming traditions.[4] Essex was first settled by European settlers in 1634, originally as part of Ipswich known as Chebacco Parish. Until then, and for thousands of years, the land now known as Essex and surrounding areas were inhabited by Native Americans of the Agawam tribe. Long a center of shipbuilding, a substantial number of antique shops and restaurants now dot the causeway that once hosted most of the shipyards. The town has become a magnet for visitors who come for recreation on the river (in the form of boating, kayaking, hunting, and fishing), dining experiences with beautiful river vistas, and the rural New England town atmosphere that still exists here. Essex is also home to many home-based businesses, independent clammers, tradespeople, and an increasing population of white-collar commuters. Essex/Manchester Woods with Manchester, Gloucester, and Hamilton. Chebacco Lake is the last remaining Alewife breeding grounds on the North Shore, while the Woods are characterized as some of the most outstanding habitat remaining on the entire Atlantic seaboard, sheltering several rare and endangered species. Along with Ipswich and Gloucester, Essex makes up the Essex River estuary, which itself is a component of the Parker River/Essex Bay's "Area of Critical Environmental Concern" (ACEC).

Development patterns, which historically centered around the causeway and its environs, have expanded out toward some of the wooded areas once reserved as wood lots, as well as farmlands on the west side of town. (Essex Open Space and Recreation Plan 2007)

Essex has an open town meeting form of government, headed by a three-member Board of Selectmen and a Town Administrator.

Development Trends

While the antiques trade and restaurants remain important components of the Essex economy, the number of such businesses is steady or slowly declining, while resource-based tourism such as boating and kayaking continues to grow. There has also been growth of light industrial development along the Route 22 corridor.

Between 1951 and 1980**,** developed land nearly doubled from 423 acres to 806 acres. The largest gain was reflected in commercial land use; the largest loss in agricultural and open space land resulting in more land being lost since 1951 than in the prior 200 years.[11] Since then, new dwellings have continued to be built in the town, averaging ten new dwellings per year since 1997. Most of these developments are subdivisions placed on the outskirts of town, often carved from the woods or placed in former agricultural fields. Not much additional development has occurred in the town center, where most new development could be centralized around services and schools.

Essex does not have formal zoning beyond the state minimum requirements, although it does have a water resources overlay district, wetlands overlay district, and two Conomo Point overlay districts. An Open Space Residential Design Bylaw has been adopted.

The Office of Coastal Zone Management has recommended that formal zoning bylaws be enacted to protect the estuary however, much resistance remains due to the belief that a formal zoning bylaw will facilitate development by giving developers a defined process, and that numerous problems would arise from current nonconforming uses. (Essex Open Space and Recreation Plan 2007)

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 two developments in the Town of Essex since 2012, both were completed.

The database also includes several attributes of the new development, including site acreage, housing units, and commercial space. The developments in Essex include a total of 17 housing units, and are sited on a total of 17 acres (see Table 22).

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 three of the developments are located within a flood zone.

Recent and Potential Future Development

MAPC consulted with Town staff to determine areas that have been recently developed or may be developed in the future, based on the Town's comprehensive planning efforts and current trends and projects. These areas are described below. All three of these sites are in a flood hazard zone, located in an AE or A zone with a 1 % annual chance of flooding. All of the developments are in the areas defined as "Low Landslide Incidence." None of the developments are in locally identified areas at high risk for brush fires. Other hazards are categorized at the same level throughout town. For snowfall, all of Essex is in the zone of 48 to 72 inches average annual snowfall. With respect to wind, there is no variation across different sites in the town; the hazard map depicts the entire town of Essex within a 100-year wind speed of 110 miles per hour. (See hazard maps in Appendix B).

Table 21
Relationship of Recent and Potential Development to Hazard Areas

Parcel	Landslide risk	Flood Zone	Brush Fire Area
Hardy Property	Low incidence	44.17% in AE: 1% Annual Chance of Flooding, with BFE	No
Essex Park Road	Low incidence	17.34% in A: 1% Annual Chance of Flooding, no BFE	No
Lowland Farms	Low incidence	9.28% in AE: 1% Annual Chance of Flooding, with BFE	No

Table 22- Summary of Built Essex Developments 2012-2016

DEVELOPMENTS COMPLETED 2012-2019	Acres	HOUSING UNITS	COMMERCIAL (SQ FEET)	PROJECT TYPE
R Way Farm	6	6	-	6 lot subdivision of former flower farm
Lowland Farm Road	11	11	-	11 single family homes
Total	17	17		

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 45 facilities identified in Essex. These are listed in Table 23 and are shown on the maps in Appendix B.

Explanation of Columns in Table 23

Column 1: ID #: The first column in Table 10 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. If no name appears in this column, this information was not provided to MAPC by the community.

***Column 3: Type*:** The third column indicates what type of site it is.

Column 4: Landslide Risk: The fourth column indicates the degree of landslide risk for that site. This information came from NESEC. 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.

***Column 5: 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.

Column 6.Brush Fires- Areas determined by Local Hazard Mitigation Team to be at risk for brush fires.

Table 23- Critical Facilities and Relationship to Hazard Areas

PDM_ ID	NAME	TYPE	Landslides	Within FEMA Flood Zone	Within Locally Identified Area of Flooding	Within Brush Fire Area
92-001	Lil' Sprouts	Child Care	Low incidence	No	No	No
92-002	Essex Elementary School	School	Low incidence	No	No	No
92-003	Essex Fire Department	Fire Station	Low incidence	No	No	No
92-004	Essex Police Department	Police Station	Low incidence	No	No	No
92-005	Essex Town Hall	Municipal	Low incidence	No	No	No
92-006	Dr. Timothy D. Isabel, D.D.S.	Medical Facility	Low incidence	No	No	No
92-007	Lahey Essex	Medical Facility	Low incidence	No	No	No
92-008	Essex EOC-Backup	Emergency Operations Center	Low incidence	No	No	No
92-009	EDS Emergency Distribution Site	Emergency Distribution Site	Low incidence	No	No	No
92-010	Essex Dispatch Center	Emergency Operations Center	Low incidence	No	No	No
92-011	Essex EOC - Primary	Emergency Operations Center	Low incidence	No	No	No
92-012	Causeway Bridge	Bridge	Low incidence	AE: 1% Annual Chance of Flooding; with BFE	Main Street Causeway	No
92-013	Apple Street Bridge	Bridge	Low incidence	No	No	No
92-014	Landing Road	Bridge	Low incidence	AE: 1% Annual	No	No

Table 23- Critical Facilities and Relationship to Hazard Areas

PDM_ ID	NAME	TYPE	Landslides	Within FEMA Flood Zone	Within Locally Identified Area of Flooding	Within Brush Fire Area
	Bridge			Chance of Flooding; with BFE		
92-015	Pond Street Bridge	Bridge	Low incidence	A: 1% Annual Chance of Flooding; no BFE	Lake Chebacco	No
92-016	Sewer Pump Station #4	Sewer Pump Station	Low incidence	X: 0.2% Annual Chance of Flooding	No	No
92-017	DPW Barn	Municipal	Low incidence	No	No	No
92-018	Transfer Station	Transfer Station	Low incidence	No	No	No
92-019	Sewer Pump Station #5	Sewer Pump Station	Low incidence	No	Lake Chebacco	No
92-020	Water Pump Station #1	Water Pump Station	Low incidence	No	No	No
92-001	Water Pump Station #2	Water Pump Station	Low incidence	A: 1% Annual Chance of Flooding; no BFE	No	No
92-002	Water Filtration Plant	Waste Water Treatment	Low incidence	No	Lake Chebacco	No
92-003	Water Pump Station #3	Water Pump Station	Low incidence	No	Lake Chebacco	No
92-004	Water Filtration Plant	Hazardous Material Site	Low incidence	No	Lake Chebacco	No

Table 23- Critical Facilities and Relationship to Hazard Areas

PDM_ ID	NAME	TYPE	Landslides	Within FEMA Flood Zone	Within Locally Identified Area of Flooding	Within Brush Fire Area
92-005	Camp Menora - Seasonal	Child Care	Low incidence	No	Lake Chebacco	No
92-006	Sewer Pump Station #3	Sewer Pump Station	Low incidence	No	No	No
92-007	Summer Recreation Program- Seasonal	Child Care	Low incidence	No	Lake Chebacco	No
92-008	Cell Tower	Communication Tower	Low incidence	No	No	No
92-009	Cell Tower	Communication Tower	Low incidence	No	No	No
92-010	Morse Hill	Fire Station	Low incidence	No	No	No
92-011	Sewer Pump Station #1	Sewer Pump Station	Low incidence	No	No	No
92-012	Sewer Pump Station #2	Sewer Pump Station	Low incidence	No	No	No
92-013	Water Storage Tank	Water Storage Tank	Low incidence	No	No	No
92-014	Tree Hill Road Standpipe - Private	Water Stand Pipe	Low incidence	No	No	No
92-015	Rocky Hill Road Standpipe - Private	Water Stand Pipe	Low incidence	No	No	No
92-016	Holden Fuel Propane Storage	Hazardous Material Site	Low incidence	No	No	No
92-017	Tennessee Gas	Gas Pipeline	Low incidence	No	No	No

Table 23- Critical Facilities and Relationship to Hazard Areas

PDM_ ID	NAME	TYPE	Landslides	Within FEMA Flood Zone	Within Locally Identified Area of Flooding	Within Brush Fire Area
	Pipeline Pump Station					
92-018	Chebacco Terrace Assisted Living	Elder Housing	Low incidence	No	No	No
92-019	Essex Senior Center	Place of Assembly	Low incidence	No	No	No
92-020	First Congregational Church	Church	Low incidence	No	No	No
92-021	Saint John's Baptiste Catholic Church	Church	Low incidence	No	No	No
92-022	First Universalist Church Essex	Church	Low incidence	No	No	No
92-023	North Shore Bible Church	Church	Low incidence	No	No	No
92-024	Emmanuel Unity Church	Church	Low incidence	No	No	No
92-025	Lil' Sprouts	Child Care	Low incidence	No	No	No
92-026	Essex Elementary School	School	Low incidence	No	No	No
92-027	Essex Fire Department	Fire Station	Low incidence	No	No	No
92-028	Essex Police Department	Police Station	Low incidence	No	No	No
92-029	Essex Town Hall	Municipal	Low incidence	No	No	No
92-030	Dr. Timothy	Medical	Low	No	No	No

Table 23- Critical Facilities and Relationship to Hazard Areas

PDM_ ID	NAME	TYPE	Landslides	Within FEMA Flood Zone	Within Locally Identified Area of Flooding	Within Brush Fire Area
	D. Isabel, DDS	Facility	incidence			
92-031	Lahey Essex	Medical Facility	Low incidence	No	No	No
92-032	Essex EOC-Backup	Emergency Operations Center	Low incidence	No	No	No
92-033	EDS Emergency Distribution Site	Emergency Distribution Site	Low incidence	No	No	No
92-034	Essex Dispatch Center	Emergency Operations Center	Low incidence	No	No	No
92-035	Essex EOC - Primary	Emergency Operations Center	Low incidence	No	No	No
92-036	Causeway Bridge	Bridge		AE: 1% Annual Chance of Flooding; with BFE	Main Street Causeway	No
92-037	Apple Street Bridge	Bridge	Low incidence	No	No	No
92-038	Landing Road Bridge	Bridge	Low incidence	AE: 1% Annual Chance of Flooding; with BFE	No	No
92-039	Pond Street Bridge	Bridge	Low incidence	A: 1% Annual Chance of Flooding; no BFE	Lake Chebacco	No
92-040	Sewer Pump Station #4	Sewer Pump Station	Low incidence	X: 0.2% Annual Chance	No	No

Table 23- Critical Facilities and Relationship to Hazard Areas

PDM_ ID	NAME	TYPE	Landslides	Within FEMA Flood Zone	Within Locally Identified Area of Flooding	Within Brush Fire Area
				of Flooding		
92-041	DPW Barn	Municipal	Low incidence	No	No	No
92-042	Transfer Station	Transfer Station	Low incidence	No	No	No
92-043	Sewer Pump Station #5	Sewer Pump Station	Low incidence	No	Lake Chebacco	No
92-044	Water Pump Station #1	Water Pump Station	Low incidence	No	No	No

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 Essex, 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 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 24 - Estimated Damages from Hurricanes

	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	1,519	
Estimated total building replacement value (2014$)	$542	
Millions of dollars		

Building Damages		
# of buildings sustaining minor damage	52	282
# of buildings sustaining moderate damage	4	57
# of buildings sustaining severe damage	0	5
# of buildings destroyed	0	3
Population Needs		
# of households displaced	0	0
# of people seeking public shelter	0	0
Debris		
Building debris generated (tons)	4,701	12,526
Tree debris generated (tons)	622	1,580
# of truckloads to clear building debris	7	41
Value of Damages (Thousands of dollars)		
Total property damage (buildings and content)	$3,272.27	$15,750.64
Total losses due to business interruption	$142.14	$1,349.33

Estimated Damages from Earthquakes

The HAZUS 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-25
Estimated Damages from Earthquakes

	Magnitude 5.0	**Magnitude 7.0**
Building Characteristics		
Estimated total number of buildings	1,519	
Estimated total building replacement value (2010 $) Millions of dollars	$542	
Building Damages		
# of buildings sustaining slight damage	446	165
# of buildings sustaining moderate damage	247	501

# of buildings sustaining extensive damage	71	388
# of buildings completely damaged	19	440
Population Needs		
# of households displaced	56	505
# of people seeking public shelter	26	236
Debris		
Building debris generated (million tons)	0.02	0.10
# of truckloads to clear debris (@ 25 tons/truck)	600	4,080
Value of Damages (Millions of dollars)		
Total property damage	$81.81	$474.52
Total losses due to business interruption	$13.55	$65.69

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-26
Estimated Damages from Flooding

	100 Year Flood	**500 Year Flood**
Building Characteristics		
Estimated total number of buildings	1,519	
Estimated total building replacement value (2010 $) Millions of dollars	$542	
Building Damages		
# of buildings sustaining slight damage (1-10%)	0	4
# of buildings sustaining moderate damage (11-50%)	0	2
# of buildings sustaining substantial damage (>50%)	0	0

Value of Damages (millions of dollars)		
Total property damage	0	2.98
Total losses due to business interruption	0	0.02

V. HAZARD MITIGATION GOALS

The Essex Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2012 Hazard Mitigation Plan for the Town of Essex. The Team modified their 2012 goals to reflect a more inclusive and streamlined approach for this plan update. All of the goals are considered critical for the Town and they are not listed in order of importance.

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

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

3. Increase cooperation and coordination among private entities, Town officials and Boards, State agencies and Federal agencies.

4. Increase awareness of the benefits of hazard mitigation through outreach and education.

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VI. EXISTING MITIGATION MEASURES

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

The Town's existing mitigation measures are listed by hazard type here and are summarized in Table 25 below.

Flooding – Existing Town-wide mitigation

Essex 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) – Essex participates in the NFIP with 55 policies in force as of the September 30, 2019. 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 Town complies with the NFIP by enforcing floodplain regulations, maintaining up-to-date floodplain maps, and providing information to property owners and builders regarding floodplains and building requirements.

The following information is provided for the Town of Essex:

Flood insurance policies in force (as of February 28, 2019)	55
Coverage amount of flood insurance policies	$16,786,888
Premiums paid	$122,888
Total Number of Closed Paid Losses	81
Number of Substantial Damage Closed Paid Losses	6
Closed Paid Losses	$1,846,550

Massachusetts State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads. The Town has adopted the state building code.

Street sweeping – Every street gets swept once a year or as needed. Street sweeping is contracted out.

Catch basin cleaning – All 270 catch basins are cleaned out once a year. This service is contracted out.

Roadway treatments – The town uses calcium chloride.

Subdivision Rules and Regulations – The subdivision rules and regulations contain a number of requirements that address flood hazard mitigation. Some of these provisions also relate to other hazards.

Section 7.01 General Requirements and Design Standards for All Subdivision Plans

Design and construction are to minimize:

- volume of cut and fill;
- area of disturbed vegetation;
- removal of larger trees;
- altered or relocated waterways;
- dimensions of paved areas, especially in aquifer/recharge areas.

  Designs shall emphasize the maintenance within the subdivision of runoff and vegetative cover equivalent to conditions before development.

8. *Lot Drainage*

Lots shall be prepared and graded consistent with drainage into the subdivision and in such a manner that development of one shall not cause detrimental drainage on another or on areas outside the subdivision, to the extent permitted by law. If provision is necessary to carry drainage to or across a lot, an easement or drainage right-of-way of a minimum width of twenty feet (20') and proper side slope shall be provided.

9. *Land Not Suitable for Housing*

Land susceptible to flooding and land not suitable for housing or street development and land which may be hazardous to life, health or property shall not be accepted as part of a subdivision for residential purposes, but may be used, with the approval of the Board, for parks, playgrounds or other open space uses as determined by the Board of Health.

Sediment Control

In order to reduce erosion accompanying the installation of ways, utilities and drainage, and the resultant pollution of streams, wetlands and natural drainage areas, the applicant shall submit a sediment control plan, including control methods such as berms, dikes, detention ponds, mulching and temporary sodding.

Zoning

Flood Plain Overlay District. Applicability
The Flood Plain District is established as an overlay district to all other districts. All development in the district, including structural and non-structural activities, whether permitted by right or by special permit, must be in compliance with Chapter 131, Section 40 of the Massachusetts General Laws and with the following:
a. Section of the Massachusetts State Building Code which addresses floodplain and coastal high hazard areas.
b. Wetlands Protection Regulations, Department of Environmental Protection (DEP) (currently 310 CMR 10.00)
c. Inland Wetlands Restriction, DEP (currently 310 CMR 13.00)
d. Coastal Wetlands Restriction, DEP (currently 310 CMR 12.00)
e. Minimum Requirements for the Subsurface Disposal of Sanitary Sewerage, DEP (currently 310 CMR 15, Title 5)

Any variances from the provisions and requirements of the above referenced state regulations may only be granted in accordance with the required variance procedures of these state regulations.

The Flood Plain District includes only the Special Flood Hazard Areas (SFHAs) within the Town of Essex designated as Zone A, AE, and VE on the Essex County Flood Insurance Rate Maps (FIRM) issued by the Federal Emergency Management Agency (FEMA) for the administration of the National Flood Insurance Program.

The exact boundaries of the District are defined by the 100-year base flood elevations shown on the FIRM and further defined by the 100-year (1-percent-annual-chance flood plain boundary) flood elevations contained in the Essex County Flood Insurance Study (FIS) report dated July 16, 2014.

The following development requirements apply in the Flood Plain District:
a. UN-NUMBERED ZONE A: Within any unnumbered Zone A, since the base flood elevation is not provided on the FIRM, the applicant shall obtain any existing base flood elevation data and it shall be reviewed by the Building Inspector for its reasonable utilization toward meeting the elevation or flood- proofing requirements, as appropriate, of the State Building Code. Base flood elevation data is required for subdivision proposals or other developments greater than 50 lots or 5 acres, whichever is lesser, within unnumbered Zone A.

b. Within areas designated as coastal high hazard areas (Zone VE), all development shall be located landward of the reach of mean high tide, since these areas are extremely hazardous due to high velocity waters from tidal surges and hurricane wave wash.

c. Man-made alteration of sand dunes within Zone VE which would increase potential flooding damage are prohibited.

d. SUBDIVISIONS: All subdivision proposals must be designed to assure that:
1. Such proposals minimize flood damage
2. All public utilities and facilities are located and constructed to minimize or eliminate flood damage; and
3. Adequate drainage is provided to reduce exposure to flood hazards.

e. In Zone AE, along watercourses that have a regulatory floodway designated on the FIRM, encroachments are prohibited in the regulatory floodway which would result in any increase in flood levels within the Town during the occurrence of the base flood discharge (i.e., one-hundred year flood). In Zones A and AE, along watercourses that have not had a regulatory floodway designated, the best available Federal, State, local, or other floodway data shall be used to prohibit such encroachments.

Water Resource Protection Overlay District.
The purpose of the Water Resource Protection District is to protect the public health, safety and welfare, by preserving and maintaining the existing and potential groundwater supply, groundwater recharge areas, and municipal wellfields providing water supply for the Town of Essex.

6-10.3.2 Establishment and Delineation of Water Resource Protection District.
For the purpose of this Bylaw there is hereby established a Water Protection District, which comprises all areas within Essex which are within the drainage basins of either Chebacco Lake or Cedar Swamp, as illustrated on the map "Water Resource Protection District" dated December 15, 1990, on file in the Office of the Town Clerk, and hereby made a part of this Bylaw.
Where the bounds delineated are in doubt or in dispute, the burden of proof shall be upon the owner(s) of the land in question to show where they should be properly located. At the request of the owner(s) the town may engage a Registered Land Surveyor or Professional Engineer to determine more accurately the location and extent of the drainage basins, and shall charge the owner(s) for the cost of the investigation.

6-10.3.3 Use Regulations.
The Water Resource Protection District shall overlay other zoning districts established in this Bylaw. Land in a Water Resource Protection District may be used for any use otherwise permitted at that location, subject to the following regulations:
a. The following activities are prohibited within the Water Resource Protection District:
1. Disposal of solid waste, other than brush and stumps;
2. The operation of a solid waste transfer station;
3. Storage of fuel oil, gasoline, or other refined petroleum products, except within buildings in which they are used or above ground, provided the storage and its containment is designed to contain spills and prevent any flow of petroleum product to floor drains or exposed soils;

4. The disposal of liquid or leachable wastes, except sanitary sewage waste disposal systems;
5. Commercial or industrial uses which discharge process waste water on site;
6. Storage of road salt or other deicing chemicals except in confined and covered areas;
7. Dumping of snow containing salt or other deicing chemicals which is brought in from outside the district;
8. Mining of land except as necessary and incidental to a permitted use;
9. The treatment, storage, discharge, or disposal of hazardous materials;
10. Automobile or motor vehicle service, washing, or repair shops, used parts, and salvage yards;
11. Junk yards;
12. Dry cleaning or laundry businesses;
13. Land use which renders impervious more than 15 percent of a lot, except as allowed by Section 6- 10.3.3.b.7.
14. Earth removal to within 4 feet of historical high groundwater unless regarded to a higher level within 45 days, except for excavations for building foundations or utility works;
15. Storage of animal manure unless covered and contained in accordance with US Soil Conservation Service specifications;
16. Storage of commercial fertilizers and soil conditioners unless within a structure designed to prevent escape of leachate and runoff.

b. The following uses are permitted by Special Permit, subject to the approval of the Special Permit Granting Authority under such conditions as they may require and also subject to section a. above, to be approved upon finding that the proposal as planned will not have adverse impact upon ground or surface water quality within the Water Resource Protection District, and that safeguards will be provided to adequately reduce risk of accidental water quality damage:

1. Except for single-family dwellings, on site sewage disposal systems having an estimated sewage flow exceeding 60 gallons per day per 10,000square feet lot area;
2. Regardless of lot size, any on-site sewage disposal having more than15,000 gallons per day of sewage;
3. Any use having on-site disposal of industrial waste, as determined under Title 5 of the State Environmental Code: 310 CMR 15.00;
4. The application of pesticides for non-domestic or non-agricultural uses provided that all necessary precautions shall be taken to prevent hazardous concentrations of pesticides in the water and on the land within the Water Resource Protection District as a result of such application (Such precautions include, but are not limited to, erosion control techniques, the control of runoff water or the use of pesticides having low solubility in water, the prevention of volatilization and re-deposition of pesticides and the lateral displacement, i.e. wind drift, of pesticides);
5. The application of fertilizers for non-domestic or non-agricultural uses provided that such application shall be made in such a manner as to minimize adverse impacts on surface and groundwater due to nutrient transport and deposition and sedimentation;

6. Those commercial and industrial activities otherwise permitted, with a documented procedure to prevent compaction and siltation, loss of recharge, exfiltration for sewer pipes and contamination by oil, chemicals, nutrients, or the generation of hazardous waste or storage of sludge and septage, except as allowed under DEP Wellhead Regulations (310 CMR 22.21) etc.;
7. Rendering impervious more than 2500 square feet or fifteen percent of lot area (whichever is greater) will require a plan for recharging storm water runoff such that it will not degrade ground water quality. For non- residential uses, recharge shall be by storm water infiltration basins or similar system covered with natural vegetation, and dry wells shall be used only where other methods are infeasible. For all non-residential uses, all such basins and wells shall be preceded by oil, grease, and sediment traps to facilitate removal of contamination. Any and all recharge areas shall be permanently maintained in full working order by the owner.
c. Boundary Lots. For the purpose of this Bylaw, any lot which has one third or more of its total area falling within the Water Resource Protection District must meet all the requirements of the Water Resource Protection District.

Site Plan Review
No building permit for the new construction, reconstruction, or relocation of any building with a ground floor footprint of greater than or equal to 2,500 square feet, or any change of use for any building or site, shall be given except in conformity with a site plan approval by the Planning Board. Required approval includes proposals for commercial, industrial, office, multifamily dwelling, residential development, municipal, utility, and recreational purposes.

Site Plan Criteria.
a. Traffic: Convenience and safety of both vehicular and pedestrian movement within the site and in relationship to adjoining ways and properties.
b. Parking: Provisions for the off-street loading and unloading of vehicles incidental to the normal operation of the establishment, adequate parking, adequate lighting, and internal traffic control, including any provisions for delivery, pick-up, and location of trash receptacle.
c. Drainage Control: Adequacy of methods for surface waters and ground water control. This includes minimizing soil erosion both during and after construction. The applicant shall prove that the proposed project meets the minimum standards for state storm water management as specified in the most current edition of the Storm water Management Policy Handbook.
d. Existing Vegetation: Minimizing the area over which existing vegetation is to be removed. Where tree removal is required, special attention shall be given to planting of replacement trees and undergrowth.
e. Amenities: The applicant's efforts to integrate the proposed development into the existing landscape through design features such as vegetative buffers, roadside plantings, and the retention of open space and agricultural land.
f. Town Character: The (building setbacks) area and location of parking, architectural compatibility, signage, and landscaping of the development, and how these features

harmonize with the surrounding townscape, neighborhood, and the natural landscape, as far as practicable by minimizing any grade changes and vegetation and soil removal.
g. Screening: Screening consisting of a solid fence, wall or evergreen planting, in all cases not less than six (6) feet in height or as specified by the Planning Board, shall be provided, erected and maintained wherever feasible to shield the business and light and industrial uses for any residential property.
h. Hazardous Material: Plans for use, storage, or disposal of any hazardous materials as defined by MEP.
i. Site and or project-specific criteria may be considered in addition to the items above.

Wetlands Overlay District
Purpose
The purpose of the wetlands district is to:
a. Protect the public health and safety of persons and property against the hazards of flood water inundation.
b. Preserve and maintain the water table and water recharge areas within the town so as to preserve and protect potential water supplies for the public health and safety.
c. Protect the community from costs which may be incurred when unsuitable development occurs in swamps, marshes, along water courses, or in areas subject to floods.
d. Conserve natural conditions, wildlife and open spaces for education, recreation and general welfare of the public.

Wetland Use Regulations
a. Permitted Uses. The following uses are exempt from provisions of this by-law, and the only ones permitted as a matter of right and only insofar as not otherwise prohibited by other zoning bylaws and only insofar as these uses comply with provisions under Massachusetts General Law, Chapter 131, Section 40, and Title 5 of the Commonwealth of Massachusetts Sanitary Code.
1. Conservation area for water, water supply, plants and wildlife and dams and management shelters necessary for achieving this purpose.
2. Outdoor recreation including play and sporting areas, nature study, boating, fishing and hunting (where legally permitted), footpaths and any non-commercial recreational use.
3. Forestry, raising of livestock, agriculture, aquiculture, nurseries, truck gardening, growing and harvesting of crops, fish and shellfish.
4. Maintenance and repair of existing structures, roadways and utilities.
5. Temporary non-residential structures used in connection with fishing or growing, harvesting, storage or sale of crops, fish and shellfish, raised on the premises.
6. Accessory uses such as flower and vegetable gardens, lawn, fences, flagpoles and non-commercial signs when and as permitted in the underlying district.
7. Dams, excavations, dredging, filling, or grading consistent with the purposes of this section to create or maintain ponds, pools, or other changes in water courses for swimming, fishing or other recreation uses, agricultural uses, aquiculture uses, scenic feature, or drain improvement, not otherwise prohibited.

8. Duck blinds, private boathouses and landings.
9. All existing non-commercial uses of land prior to the adoption of this bylaw and within the jurisdiction of this bylaw may remain. be maintained, sold, and operated to its fullest capacity by the owner provided that no action is taken to encroach further on the wetlands.
10. Dredging required to maintain existing marine operations, not otherwise prohibited.
11. Dredging, enlarging or draining for mosquito or flood control authorized by public agency.

b. Restrictions. Except as provided under this chapter, none of the following shall be permitted in a wetland district:

1. Land fill or dumping.
2. Construction of buildings or other structures.
3. Dredging.
4. Permanent storage of materials or equipment.

Coverage

All provisions of the wetland district bylaw shall apply to land within the bank or boundary of any stream, river, water course or any wetland shown on the wetlands map of the Town of Essex.

Open Space Residential Development

Purpose

1. The primary purposes for Open Space Residential Development ("OSRD") are the following:

a. Allow for greater flexibility and creativity in the design of residential developments;

b. Encourage the permanent preservation of open space, agricultural land, woodland, wildlife and rare species habitat, other natural resources and features, including aquifers, water bodies, and wetlands, recreational, historical and archeological resources, in a manner that is consistent with all current plans adopted by the Town of Essex, including such plans as the Town of Essex Community Development Plan; Town of Essex Watershed Protection Plan and Town of Essex Open Space and Recreation Plan;

c. Encourage a less sprawling, more efficient and compact form of development that disturbs less open land and natural materials and conforms to existing topography and natural features better than a conventional or grid subdivision;

d. Minimize the total amount of disturbance on the site;

e. Further the goals and policies of the all current plans adopted by the Town of Essex, including such plans as Town of Essex Community Development Plan, Town of

Essex Watershed Protection Plan and Town of Essex Open Space and Recreation Plan; as amended from time to time;

f. Facilitate the construction and maintenance of housing, streets, utilities, and public services in a more economic and efficient manner, that are in harmony with the architectural heritage of the Town of Essex; and

g. Promote affordable housing and a more diversified housing stock.

Applicability
Land Area: The proponent of any proposed residential development that is on a parcel of five (5) acres or more or on contiguous parcels totaling five (5) acres or more.

Stormwater Management Bylaw and Regulations- Essex has a stormwater bylaw and regulations. The purpose of this by-law is to regulate illicit connections and discharges to the storm drain system.

Public Education on Stormwater-The Town DPW maintains a web page on good housekeeping practices and stormwater management frequently asked questions at: https://www.essexma.org/highway-department/pages/stormwater-management-program

Flooding – Existing Site Specific Mitigation

2012 Plan Flooding Areas of Concern mitigation measures and existing status.

1. Landing Road culvert– The culvert has been inspected but the Town would like to replace undersized culvert and sidewalks to allow access to DPW garage; this is the one of the Town's highest public safety issues.

2. Apple Street Bridge -Inspected by MA DOT and minor repairs done; stream channel cleared for fish passage. Maintaining this bridge and culvert are key to keeping Apple Street available as an emergency access route during storm and high coastal surge events.

3. Main Street/Causeway/Bridge/Woodman's Beach– Causeway rebuild completed; bridge may need to be replace by MA DOT in next 5 years; Causeway elevated only 8 inches during reconstruction due to business access issues; remains an ongoing climate resilience issue. This site is also noted as a Coastal Hazard concern.

5. Culvert near Farnham's Restaurant on State Route 133/ Eastern Avenue – inspected and cleaned; remains a project for 2019 plan update. This site is also noted as a Coastal Hazard concern.

6. *MS4 permit and stormwater drainage infrastructure improvements* – The Town adopted a bylaw preventing illegal connection and discharge to its storm drain system and developed a stormwater management web page on its web site.

7. Beaver Management Plan/Chebacco Lake – The Town developed and implemented a beaver management plan to help mitigate flooding in residential areas.

8. Route 22 Culvert – An undersized culvert near County Road was replaced since the last NHM plan update.

Dams – There are no dams located within Essex.

Existing Wind Hazard Mitigation Measures

Existing Wind Hazard Mitigation Measures

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 hires outside contractors on occasion to help with tree maintenance. The electrical utility company National Grid does a full tree inspection of its power line corridors every three years and takes down problem trees as needed.

Existing Winter Hazard Mitigation Measures

Roadway treatments –The Town treats its roads with calcium chloride to prevent icing and snow buildup before and during winter storm conditions.

Catch basin Cleaning: The Essex DPW clears snow from clogged catch basins to prevent flooding.

Snow disposal –The town conducts general snow removal operations with its own equipment and hires outside contractors as needed. The Mass DOT handles snow removal for portions of Route 133 in Essex.

Massachusetts State Building Code: The Town enforces the Massachusetts State Building Code, which contains regulations regarding snow loads on building roofs. The Town has adopted the state building code.

Existing Brush Fire Hazard Mitigation Measures

The Essex Fire Department responds to approximately 6 brush fires annually and considers brush fires a moderate hazard. The Fire Department has some dedicated forest fire apparatus. There have been no deaths as a result of brush fires.

The areas with the highest incidence of brush fires are forested parts of the town adjacent to the West Gloucester and Manchester woods, and areas near Pond Street.

Subdivision review - The Fire Department is involved in reviewing subdivision plans from conceptual design through occupancy to ensure that there is adequate access for fire trucks and an adequate water supply.

Permits Required for Outdoor Burning – The Fire Department requires a written permit for outdoor burning, which is permitted only between January 1 and April 30

Existing Geologic Hazard Mitigation Measures

Massachusetts State Building Code – The State Building Code, updated in 2010, 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 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.

<u>Existing Multihazard Mitigation</u>

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. The Town of Essex's current CEMP was updated in 2017.

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

Participation in the regional emergency committee--Ipswich is a member of the Cape Ann Emergency Preparedness Committee.

Natural Hazards Public Education- Essex's Emergency Management site maintains links to winter safety, flood hazard, fire and hurricane safety at: at: https://www.essexma.org/fire-department/pages/emergency-preparedness.

Table 27- Existing Mitigation Measures

Hazard	**Area**	**Mitigation Measure**	**Effectiveness**
Flood –Related	Town-Wide	A) The town participates in the National Flood Insurance Program and adopted the FIRM maps. There are 55 policies in force. The town actively enforces floodplain regulations.	Effective
		B) All streets and catch basins (270) are cleaned annually.	Effective- may need to be modified to meet MS4 permit
		C) Calcium chlorides is used for winter road treatments.	Effective- may need to be modified to meet MS4 permit
		D) Drainage infrastructure and maintenance performed using MA Chapter 90 funds.	Effective- may need to be modified to meet MS4 permit
		E) Subdivision Rules for drainage	Effective Effective
		F) Water Resource Protection District	Effective
		G) Site Plan Review for stormwater and erosion	Effective
		H) Wetlands District	Effective- may need to be updated to meet MS4 permit

Hazard	Area	Mitigation Measure	Effectiveness
		I) Open Space Residential Developments allowed J) Water Resources Protection Bylaw K) Discharges to MS4 Bylaw L) 2019 Open Space Plan M) Community Preservation Act adopted in	Effective- may need to be updated to meet MS4 permit Effective Effective
Wind-Related	**Town-Wide**	A) Outside contract for tree trimming. National Grid maintains trees within its power line corridors**.** B) The town enforces the MA State Building Code.	Effective Effective
Winter-Related	**Town-Wide**	A) Standard snow operations with calcium chloride.	Effective
Brush Fire-Related	**Town-Wide**	A) The Fire Department requires a written permit for outdoor burning. B) The Fire Department reviews all subdivision development plans.	Effective Effective
Geologic - ***Earthquake***	**Town-Wide**	A) The town enforces the MA State Building Code. B) Evacuation plans in CEMP C) Shelters and backup facilities available	Effective Effective Effective
Geologic- ***Landslide***	**Town-Wide**	A) The town enforces the MA State Building Code.	Effective
Multi-Hazard	**Town-Wide**	A) The town enforces the MA State Building Code.	Effective

Hazard	Area	Mitigation Measure	Effectiveness
		B) Comprehensive Emergency Plan	Effective
		C) Town utilizes NEMLAC and the MA Emergency Incident Command Unit.	Effective
		D) Town has Connect CTY, a form of Reverse 911.	Effective
		E) The town has its own Local Emergency Planning Committee.	Effective
		F) Police and Fire Stations share a fixed, natural gas generator. New generators at Town Hall and Senior Center. Elementary school now uses old generator from High School; Fire/Police and DPW all have generators. The water filtration plant has a fixed, diesel generator and all five sewer pump stations have fixed, natural gas generators.	Effective
		H) Multi department review of all developments.	Effective

Local Capacity for Implementation

Under the Massachusetts system of "Home Rule," the Town of Essex 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, such as the Community Planning and Development Board or Conservation Commission.

The Town of Essex has recognized several existing mitigation measures that require implementation or improvements, and has the capacity within its local boards and

departments to address these. The Essex Department of Public Works and Engineering Department will address the needs for catch basin cleaning, repairs and upgrades to drainage infrastructure. The Planning Board will address the updates to the Master Plan and implementation of the Zoning Ordinance, Floodplain District, and Subdivision Rules and Regulations. The Conservation Commission will oversee implementation of the Wetlands Bylaw and the Open Space Plan. The Department of Public Works together with the Planning Board and Conservation Commission will coordinate implementation and enforcement of the Stormwater Bylaw.

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VII. MITIGATION MEASURES FROM THE 2012 PLAN

Implementation Status of the Previous Plan

At a meeting of the Essex Hazard Mitigation Planning Committee, Town staff reviewed the mitigation measures identified in the 2012 Essex 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 2019 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 28 summarizes the status of mitigation measures, and mitigation projects completed are described in more detail below.

Table 28- Mitigation Measures from the 2012 Plan

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2019 Plan/Priority
Landing Road Culvert at Alewife Brook: Replace undersized culvert/ sidewalks to allow access to DPW garage; highest public safety issue.	High	DPW	Not completed: The culvert has been inspected but the Town would still like to upgrade.	Yes- High
Apple Street Culvert near Southern Ave and Andrews Street: This area now floods during storm surge events Replace existing culvert with a larger culvert and elevate section of Apple Street road bed prior to where it meets Southern Ave.	High	DPW	Not completed: Town is pursuing a MA DER grant to cover cost of culvert and road elevation redesign. Maintains Apple Street as climate resilience emergency access route.	Yes- High

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2019 Plan/Priority
Gregory Island Road: Elevate approximately 100 yards of low lying road.	High	DPW	Not completed: Private road that hasn't flooded since May, 2010 storm.	No
Main Street/ Causeway/Bridge Woodman's Beach: Finish re-construction of Main Street/Causeway	High	DPW	Completed; bridge may need to be replace by MA DOT in next 5 years; Causeway elevated only 8 inches during reconstruction due to business access issues.	Yes-carry over as Medium priority for 2019 plan as ongoing climate resilience issue for the Town.
State Route 133/ Eastern Avenue: Replace existing tidal culvert adjacent to Farnham's Restaurant with larger culvert	High	MA DOT	Not completed	Not complete; carry over to 2019 as Medium, MA DOT
MS4 permit completion: More resources are needed for permit completion, continued updating of drainage infrastructure and the implementation of new storm water strategies.	High	DPW	Partially completed	Yes- High
Beaver Management Plan/Chebacco Lake: Develop a long-term beaver management program	High	DPW/ Conservation Commission	Not completed: Progress made but this is an ongoing management issue. Carry forward, High, $5,000 per year	Yes- High

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2019 Plan/Priority
Island Road: install snow fence.	High	DPW	Not complete: carry forward as is, $5,000 per year, DPW budget. Town purchased front end loader and V plow for winter storms to remove heavy snow volumes as alternative action to installing snow fence.	Yes- High
John Wise Avenue: Extend water lines on Route 133/John Wise Avenue further to the Ipswich town line, installing at least five more new fire hydrants along the water line.	High	DPW	Not completed: carry forward as High priority project; approx. one mile of road; part of town-wide $15 million dollar capital spending project to upgrade all water lines	Yes- High
Conomo Point/ Southern Avenue: Install hydrants at Conomo Point and along Southern Avenue.		DPW	Not completed: carry forward for 2019 plan; High; part of town-wide capital project to replace water lines and install hydrants	Yes- High
Apple St.: Loop the Apple Street water line to back feed South Essex water lines and hydrants.	High	DPW	Not completed: Inter-connection with Gloucester water system; carry forward for 2019 plan; High; part of town-wide capital project to replace water lines and install hydrants	Yes- High

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2019 Plan/Priority
Fixed Generators: Install new, fixed, multi-fuel generators at the Essex Elementary School, Town Hall, Essex Senior Center and the Department of Public Works.	High	Fire/ DPW	Complete: New generators at Town Hall, and Senior Center, Elementary school now uses old generator from High School; Fire/Police and DPW all have generators.	No
Walnut Park Drainage: Replace the existing pipe and clean the entire drainage system from Western Avenue to Martin Street.	Medium	DPW	Partially complete: pipe has been cleaned and some new drainage infrastructure installed; culvert under Western Ave. still needs to be upgraded; floods about 5 times per year; carry forward as Medium priority, $75,000 cost estimate.	Yes- Medium
Quinn Brothers Facility: Replace existing culvert with a larger culvert.	Medium	DPW	Not completed: carry forward into 2018 plan, Medium, $75,000.	Yes- Medium
Route 22 Culvert: Replace existing culvert with a larger culvert.	Medium	DPW	Complete	No
Apple Street Bridge at Western Ave.: Replace existing bridge structure with new arched bridge and include fish ladder for migrating alewives. Maintain as part of Apple Street emergency access route as needed.	High	DPW	Partially complete: Inspected by MA DOT and minor repairs done; stream channel cleared for fish passage. Carry forward as medium priority to maintain Apple Street as emergency access route.	Yes- Medium

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2019 Plan/Priority
Town Wide: Create a town-based GIS wetlands map that would overlay the town's existing assessor's map data base	Medium	Conservation Commission/ Assessor	Completed: No longer needed; town uses MA GIS resources instead.	No
Town wide: Additional manpower funding is needed for flood preparation/response details and police details before and after flooding and storm events.	Medium	Police/DPW	Completed: Staffing is adequate; do not carry forward	No
Town Wide: Provide Public Information on NFIP Compliance	Medium	Planning/DPW	Complete: The town has successfully completed an amendment to its 2012 plan and the map is available on the town website.	No
Town wide: The town needs a new front end loader for snow and debris removal.	Medium	DPW	Complete: town purchased new front end loader.	No
Apple Street: Acquire land abutting town transfer station on Apple Street to provide safer, easier access to the transfer station.	Medium	Community Preservation Committee/DPW	Not completed	Yes- Low
Town wide: Purchase two, 4x4, forest fire fighting trucks each with 300 gallon water capacity.	Medium	Fire	Partially complete: bought one new pumper truck; do not carry forward.	No

TOWN OF ESSEX HAZARD MITIGATION PLAN
2019 UPDATE

Essex has made progress on implementing mitigation measures identified in the 2012 Hazard Mitigation Plan, including upgrading drainage at Route 22, inspecting the Apple Street Bridge and making repairs, finishing the reconstruction of the Main Street Causeway/ SR 133, making progress in updating its stormwater management plan and meeting its MS4 permit obligations. It has also installed new backup generating capacity at Town Hall, Senior Center and in schools, added GIS mapping capacity, added brush fire fighting capacity and snow removal capacity, continued with beaver management, and partially addressed drainage updates at key commercial sites.

Critically, the Town took part in climate resilience planning actions through the Great Marsh Coastal Adaptation planning process in 2016 - 2017 conducted a climate vulnerability preparedness workshop with the MA Municipal Vulnerability Preparedness (MVP) Program, of which it is now a certified community. Through those plans, it has begun to established climate resilience priorities, including the maintenance of Apple Street as an emergency access route during and following coastal storm events. Both risk assessment and mitigation from the Great Marsh Adaptation Plan and the MVP Workshop are incorporated in this updated Hazard Mitigation Plan.

It is also updated its 2007 Open Space and Recreation Plan , created a Strategic Plan for 2015- 2020 and updated its flood plain maps in 2014.

Overall, eleven mitigation measures from the 2012 plan will be carried forward in the plan update.

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. Those will include mitigation found in the 2017 Great Marsh Coastal Adaptation Plan and the Town's 2018 MVP Workshop.

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.

http://www.fema.gov/government/grant/hmgp/index.shtm
http://www.fema.gov/government/grant/pdm/index.shtm
http://www.fema.gov/government/grant/fma/index.shtm

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 issues that involve cooperation between two or more municipalities. There is a third level of mitigation which is regional; involving a state, regional or federal agency or an issue that involves three or more municipalities.

Regional Partners

In the densely developed communities of the study area, 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 City of Gloucester, Cape Ann Transportation Authority, Northeast Massachusetts Mosquito Control Board, the Department of Conservation and Recreation (DCR), the Massachusetts Water Resources Authority (MWRA), and the Massachusetts Department of Transportation (MA DOT). 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 to be undertaken by these other agencies. Implementation of these recommendations will require that all parties work together to develop solutions.

According to members of the Essex Multiple Hazard Community Planning Team, the town is not currently experiencing any significant regional natural hazard problems with its neighboring communities. The Town has worked closely with the neighboring Town of Ipswich in recent years to solidify protection of the Great Marsh, which each share a part of, and to communicate on issues of climate resilience and adaptation.

Process for Setting Priorities for Mitigation Measures

The last step in developing Essex'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 29 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 29- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Flood Hazard Mitigation				
Apple Street Culvert near Southern Ave and Andrews Street- Replace existing culvert with a larger culvert and elevate section of Apple Street road bed prior to where it meets Southern Ave.	South Essex	High	High	High
Landing Road Culvert at Alewife Brook. - Replace undersized culvert and add sidewalks to strengthen and improve the only access to DPW garage.	South Essex	High	High	High
State Route 133/ Eastern Avenue - Replace existing tidal culvert adjacent to Farnham's Restaurant with larger culvert.	Eastern Essex	Moderate	Medium	Medium
Flood proof critical sewer pump station behind Richdale's/gas station on Main Street- (from MVP)	Main Street.	High	Medium	High
Walnut Park Drainage- Replace the existing pipe and clean the entire drainage system from Western Avenue to Martin Street	Walnut Park	Moderate	High	Medium
Culvert at Lufkin Creek- Replace culvert with structure designed to pass higher flows and meet the MA Stream Crossing standards.	Lufkin Street	Medium	Medium	Medium
Crossing at Story Street/Western Ave- Replace culvert which will pass higher flows and meet the MA Stream Crossing standards	Crossing at Story Street/Western Ave	High	Medium	High
Coastal Hazards Mitigation				
Main Street/ Causeway/Bridge	Downtown	High	High	High

Table 29- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Woodman's Beach- Causeway elevated only minimally during reconstruction due to business access and adjacent private property elevation issues.				
Main Street/ Causeway/Bridge Woodman's Beach-Short term actions to 2030: *Create live video feed showing the Causeway so residents and travelers can go online and see in real-time if it's flooded/impassable. *Track and monitor flow beneath Causeway. *Convene Essex Causeway working-group.	Downtown	High	Low	High
Low-lying portions of Conomo Point Road and Robbins Road- Tidal and storm-driven flooding. Flooded road blocks off homes, emergency access, and impacts boat launches, commercial clamming access and recreation areas.- **Short term actions to 2030:** *****Replace entirety of Conomo Point Seawall System. *****Create early warning system to alert residents when the road is likely to be flooded or is flooded. *Regularly evaluate evacuation plans, ensuring enough notice will be given prior to the road becoming impassible. *Monitor flood frequency and depth to help with	Conomo Point	High	High	High

Table 29- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
future road planning efforts *Require any redesign to take sea level rise and increased storm surge into consideration. *Consider hybrid living shoreline near Clammers Beach to stabilize the shoreline and reduce wave energy. *Ensure that long-term data for flooding and sea level rise is incorporated into town's Conomo Point planning and management strategies.				
81 Eastern Ave to 97 Eastern Ave. - Flood map shows road within 100yr flood plain. Would be highly vulnerable to 6' of sea level rise.- **Short term actions to 2030:** *Regularly monitor scouring to ensure road stability. *Regularly remove debris caught in the culvert to ensure maximum flow. *Update 2005 study of the restriction, focusing on impact to the marsh and flooding relative to updated inundation modeling data. Study should evaluate whether upgraded culvert would affect neighborhoods upstream. *Re-evaluate flood hazard based on updated modeling and sea level rise estimates.	Eastern Ave.	High	Medium	High
Salt Marsh Restoration and Management –	All Town-wide impacted salt	High	Medium	High

Table 29- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Multiple strategies are underway and should be continued and enhanced to restore and protect the Essex salt marsh.	marsh areas			
Winter Storms Mitigation				
Island Road: Access and snow removal.	Northern Essex	Medium	Low	High
New Public Safety Building: add back up power generator	Town-wide	Police/Fire	Medium	High
Brushfire Mitigation				
John Wise Avenue - Extend water lines on Route 133/John Wise Avenue further to the Ipswich town line, installing at least five more new fire hydrants along the water line.	Route 133/John Wise Ave.	Medium	High	High
Install fire hydrants at Conomo Point and along Southern Avenue; part of town-wide capital project to replace water lines and install hydrants.	Conomo Point/Southern Avenue	Medium	High	High
Apple St. - Loop the Apple Street water line to back feed South Essex water lines and hydrants; part of town-wide capital project to replace water lines and install hydrants.	South Essex	High	High	High
Earthquake Mitigation				
Determine which buildings may be most vulnerable to earthquake damage and conduct a structural assessment if needed.	Town-Wide	Medium	Low	Low
Assess the vulnerability of roadways and utilities in high liquefaction susceptibility areas.	Localized	Low	Low	Low

Table 29- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Extreme Temperature Mitigation				
Green Site Design to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways. Promote Green Infrastructure, adopt Net Zero Water Use policies and regulations	Town-Wide	Medium	Medium	Medium
Promote Green Building and Cool Roof designs.	Town-Wide	Medium	Low	Medium
Assess placement of cooling centers at schools, senior center and emergency shelters.	Town-wide	Medium	Low	High
Drought Mitigation				
Promote Green Infrastructure, adopt Net Zero Water Use policies and regulations, use drought tolerant landscaping and site design measures.	Town-Wide	Medium	Low	Medium
Climate Resilience/Adaptation				
Adaptation Plan – Formally adopt the 2017 Great Marsh Plan and develop a process and structure for implementation.	Town-wide	High	Low	High
Incorporate climate resilience/adaptation	Town-Wide	High	Medium	High

Table 29- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
actions and policies into town strategic, open space, and master plans update.				
Forest Protection and Management – Town committees and staff should work with local and regional non-profit partners to better understand the impacts of climate change on the forested areas of the town.	Town-Wide	Medium	High	Medium
Acquire land abutting town transfer station on Apple Street to provide safer, easier access to the transfer station.	Town-wide	Medium	High	Low
Multi-faceted Emergency Warning Systems and Supplies – development of a comprehensive system of communications and provisions/services for the public in times of emergency	Town-wide	High	Low	High
Climate Resiliency Municipal Outreach & Education Program – Develop and implement a program using a "top down" approach led by the Town's Strategic Planning Committee and other municipal committees and boards.	Town-wide	High	Low	High
Community Database - Create and maintain a database of vulnerable citizens.	Town-wide	High	Low	High
Chebacco Lake Watershed Protection – The municipality should work with partners to prioritize the protection of the Chebacco Lake ecosystem, including	Town-wide	High	High	Medium

Table 29- Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
preservation of wildlife habitat and protection of water supplies.				

Introduction to Potential Mitigation Measures Table (Table 30)

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 29, 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/stream bank protection, flood damage reduction, flood plain management services and planning services.

Massachusetts Emergency Management Agency (MEMA) – The grants page http://www.mass.gov/dem/programs/mitigate/grants.htm has a useful table that compares eligible projects for the Hazard Mitigation Grant Program and the Flood Mitigation Assistance Program.

Abbreviations Used in Table 29

FEMA Mitigation Grants includes:
- FMA = Flood Mitigation Assistance Program.
- HMGP = Hazard Mitigation Grant Program.
- PDM = Pre-Disaster Mitigation Program

ACOE = Army Corps of Engineers.
DHS/EOPS = Department of Homeland Security/Emergency Operations
DEP (SRF) = Department of Environmental Protection (State Revolving Fund)
USDA = United States Department of Agriculture
MA DOT = Massachusetts Department of Transportation
DCR = MA Department of Conservation and Recreation
CIP= Capital Improvement Program
HMPT=Hazard Mitigation Planning Team
CIP= Capital Improvement Plan
MVP= MA Municipal Vulnerability Preparedness Program
NCRF= National Coastal Resilience Fund
MA CRG= MA Coastal Resilience Grants
CRMAG= MA Dept. of Environmental Restoration Culvert Replacement Municipal Assistance Grant

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
FLOODING					
Apple Street Culvert near Southern Ave and Andrews Street- Replace existing culvert with a larger culvert and elevate section of Apple Street road bed prior to where it meets Southern Ave.	High	Public Works	Long Term 2019-2024	High Estimated at $1 million for design and construction	Essex CIP/FEMA/DER Culvert Replacement Municipal Assistance Grant (CRMAG)/MVP/ NCRF
Landing Road Culvert at Alewife Brook. - Replace undersized culvert and add sidewalks to strengthen and improve the only access to DPW garage.	High	Public Works	Long Term 2019-2024	High Estimated at $1 million for design and construction	Essex CIP/FEMA/DER Culvert Replacement Municipal Assistance Grant (CRMAG)/MVP/ NCRF
State Route 133/ Eastern Avenue - Replace existing tidal culvert adjacent to Farnham's Restaurant with larger culvert.	Medium	MA DOT	Long Term 2019-2024	High $150,000	MA DOT
Flood proof critical sewer pump station behind Richdale's/gas station on Main Street- (from MVP)	Medium	Public Works	Long Term 2019-2024	Medium $50,000	Essex CIP /Town Bond/FEMA/ MVP/NCRF

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
Walnut Park Drainage- Replace the existing pipe and clean the entire drainage system from Western Avenue to Martin Street	Medium	Public Works	Long Term 2019-2024	Medium $75,000	Essex CIP
Culvert at Lufkin Creek- Replace culvert with structure designed to pass higher flows and meet the MA Stream Crossing standards.	Medium	Public Works	Long Term 2019-2024	High $150,000	Essex CIP /Town Bond/FEMA/MVP/ NCRF
Crossing at Story Street/Western Ave- Replace culvert which will pass higher flows and meet the MA Stream Crossing standards	Medium	Public Works	Long Term 2019-2024	High $150,000	Essex CIP /Town Bond/FEMA/MVP/ NCRF
COASTAL HAZARDS					
Main Street/ Causeway/Bridge Woodman's Beach- Causeway elevated only minimally during reconstruction due to business access and adjacent private property elevation issues.	High	MA DOT	Long Term 2019-2024	High- Estimated at $5 million	MA DOT

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
Main Street/ Causeway/Bridge Woodman's Beach-Short term actions to 2030: *Create live video feed showing the Causeway so residents and travelers can go online and see in real-time if it's flooded/impassable. *Track and monitor flow beneath Causeway. *Convene Essex Causeway working-group.	High	Town Administrator /Conservation Commission/ Chamber of Commerce	Short term 2019-2020	Low $10,000	Essex/ Donations/ MVP

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
Low-lying portions of Conomo Point Road and Robbins Road- Tidal and storm-driven flooding. Flooded road blocks off homes, emergency access, and impacts boat launches, commercial clamming access and recreation areas.- **Short term actions to 2030:** *****Replace entirety of Conomo Point Seawall System. *****Create early warning system to alert residents when the road is likely to be flooded or is flooded. *Regularly evaluate evacuation plans, ensuring enough notice will be given prior to the road becoming impassible. *Monitor flood frequency and depth to help with future road planning efforts	High	Public Works/ Conservation Commission/ Fire/Police	Long Term 2019-2024	Seawall: High > $1m. Short term actions to 2030: Medium $25,000	Essex CIP /Town Bond/FEMA/MVP/ NCRF/MA Dam and Seawall Repair Program

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
*Require any redesign to take sea level rise and increased storm surge into consideration. *Consider hybrid living shoreline near Clammers Beach to stabilize the shoreline and reduce wave energy. *Ensure that long-term data for flooding and sea level rise is incorporated into town's Conomo Point planning and management strategies.					
81 Eastern Ave to 97 Eastern Ave. - Flood map shows road within 100yr flood plain. Would be highly vulnerable to 6' of sea level rise.- **Short term actions to 2030:** *Regularly monitor scouring to ensure road stability. *Regularly remove debris caught in the culvert to ensure maximum flow.	Medium	Public Works/ Conservation Commission	Long Term 2019-2024	Low $10,000	Essex CIP /Town Bond/FEMA/MVP/ NCRF

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
*Update 2005 study of the restriction, focusing on impact to the marsh and flooding relative to updated inundation modeling data. Study should evaluate whether upgraded culvert would affect neighborhoods upstream. *Re-evaluate flood hazard based on updated modeling and sea level rise estimates.					
Salt Marsh Restoration and Management – Multiple strategies are underway and should be continued and enhanced to restore and protect the Essex salt marsh.	High	Public Works/ Conservation Commission/ Project Partners	Long Term/ Ongoing 2019-2024	High >$100,000	MVP/MA Coastal Resilience Grants/NCRF
Crane Beach, Essex River and Great Marsh areas/Conomo Point –Work with partners to study and better understand the movement of sediment at the mouth of the Essex River and throughout Essex Bay.	High	Public Works /Conservation Commission/ Project Partners	Long Term/ Ongoing 2019-2024	High >$100,000	MVP/MA Coastal Resilience Grants/NCRF

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
This includes analyses of channel and creek hydrology, marsh platform elevation changes and response to sea level rise, marsh bank stability, and the erosion of the protective tip of Crane Beach (which has begun to allow tidal and storm energy to adversely affect the Conomo Point Seawall system.					
Coastal Resource Regulatory Issues – The Town should work with the state and local and regional partners to review regulations and policies that may impede or slow ecological protection and restoration of marshes, beaches and dunes.	High	Planning Board/Conservation Commission/Project partners	Long Term 2019-2024	Medium $50,000	Essex /MVP/MA Coastal Resilience Grants
WINTER STORMS					
Island Road: Access and snow removal.	High	Public Works	Long Term 2019-2024	Low $5,000 per year f	Essex
New Public Safety Building: add back up power generator	High	Police/Fire	Short Term 2020 - 2022	Medium $25,000	Essex/ FEMA

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
BRUSHFIRES					
John Wise Avenue - Extend water lines on Route 133/John Wise Avenue further to the Ipswich town line, installing at least five more new fire hydrants along the water line.	High	Public Works	Medium Term 2020 - 2022	High- part of town-wide $15 million dollar capital spending project to upgrade all water lines	Essex CIP/Bond/FEMA
Install fire hydrants at Conomo Point and along Southern Avenue; part of town-wide capital project to replace water lines and install hydrants.	High	Public Works	Medium Term 2020 - 2022	High- part of town-wide $15 million dollar capital spending project to upgrade all water lines	Essex CIP/Bond/FEMA
Apple St. - Loop the Apple Street water line to back feed South Essex water lines and hydrants; part of town-wide capital project to replace water lines and install hydrants.	High	Public Works	Medium Term 2021 - 2022	High- part of town-wide $15 million dollar capital spending project to upgrade all water lines	Essex CIP/Bond/FEMA
EARTHQUAKE MITIGATION					
Determine which buildings may be most vulnerable to earthquake damage and conduct a structural assessment if needed.	Low	Public Works	Long Term 2019-2024	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
Assess the vulnerability of roadways and utilities in high liquefaction susceptibility areas.	Low	Public Works/HMPT	Long Term 2019-2024	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
EXTREME TEMPERATURES					
Green Site Design to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways. Promote Green Infrastructure, adopt Net Zero Water Use policies and regulations	Medium	Planning Board/DPW	Long Term 2019-2024	Medium $25,000	Town Budget
Promote Green Building and Cool Roof designs.	Low	Building/ Planning Board	Long Term 2019-2024	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
Assess placement of cooling centers at schools, senior center and emergency shelters.	Low	Fire/HMPT	Short Term 2019-2019	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
DROUGHT					
Promote Green Infrastructure, adopt Net Zero Water Use policies and regulations, use drought tolerant landscaping and site design measures.	Low	Planning Board	Long Term 2019-2024	Low Estimated costs less than $5,000 per year staff time	Staff time / Town general operating budget
CLIMATE RESILIENCE/ ADAPTATION					
Adaptation Plan – Formally adopt the 2017 Great Marsh Plan and develop a process and structure for implementation.	High	Board of Selectmen	Short Term 2019-2020	Low Estimated costs less than $10,000 and/or staff time	Staff time / Town general operating budget
Incorporate climate resilience/adaptation actions and policies into town strategic, open space, and master plans update.	Medium	Planning Board/Board of Selectmen/Conservation Commission	Long Term 2019-2024	Medium $20,000	Staff time / Town general operating budget
Forest Protection and Management – Town committees and staff should work with local and regional non-profit partners to better understand the impacts of climate change on the forested areas of the town.	Medium	Conservation Commission/ Planning Board	Long Term 2019-2024	High >$100,000	MVP/MA Coastal Resilience Grants/NCRF/FEMA

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
Acquire land abutting town transfer station on Apple Street to provide safer, easier access to the transfer station.	Low	Community Preservation Committee/BOS	Long Term 2019-2024	High >$100,000	Essex Town Bond/FEMA
Multi-faceted Emergency Warning Systems and Supplies – development of a comprehensive system of communications and provisions/services for the public in times of emergency	High	Strategic Planning Committee/ HMPT	Medium Term 2021 - 2022	Medium $25,000	Town budget/ FEMA/MVP
Climate Resiliency Municipal Outreach & Education Program – Develop and implement a program using a "top down" approach led by the Town's Strategic Planning Committee and other municipal committees and boards.	High	Strategic Planning Committee/ HMPT	Long Term 2019-2024	Low $5,000 per year	Town budget
Community Database - Create and maintain a database of vulnerable citizens.	High	Strategic Planning Committee/ HMPT	Long Term 2019-2024	Low $2,000 per year	Town budget

Table 30 – Potential Mitigation Measures					
Mitigation Measure	**Priority**	**Lead Dept./Group**	**Time Frame**	**Estimated Cost**	**Potential Funding Sources**
Chebacco Lake Watershed Protection – The municipality should work with partners to prioritize the protection of the Chebacco Lake ecosystem, including preservation of wildlife habitat and protection of water supplies.	Medium	Conservation Commission/Planning Board	Long Term 2019-2024	Low $5,000 per year	Town budget

IX. PLAN ADOPTION AND MAINTENANCE

Plan Adoption

The Essex Hazard Mitigation Plan 2019 Update was adopted by the Board of Selectmen on [ADD DATE]. 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]. – To be completed following MEMA and FEMA review.

Plan Maintenance

Although several of the mitigation measures from the Town's previous Hazard Mitigation Plan have been implemented, since that plan was adopted there has not been an ongoing local process to guide implementation of the plan. Such a process is needed over the next five years for the implementation of this plan update, and will be structured as described below.

MAPC worked with the Essex Hazard Mitigation Planning Team to prepare this plan. After approval of the plan by FEMA, this group will meet on a regular basis, at least annually, to function as the Hazard Mitigation Implementation Team, with the Director of Public Works 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

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

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

Begin to prepare for the next Plan Update -- Given the lead time needed to secure funding and conduct the planning process, the Hazard Mitigation Implementation Team will

begin to prepare for an update of the plan in year three. The team will use the information from the Mid-Term progress review to identify the needs and priorities for the plan update and seek funding for the plan update process. Potential sources of funding may include FEMA 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 – FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the Town's approved plan status and its eligibility for FEMA mitigation grants. Once the resources have been secured to update the plan, the Hazard Mitigation Implementation Team may decide to undertake the update themselves, contract with the Metropolitan Area Planning Council to update the plan or to 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 Essex 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 Essex Hazard Mitigation Plan 2019 Update by FEMA, the Local Hazard Mitigation Team coordinator will provide all interested parties and implementing departments with a copy of the plan and will initiate a discussion regarding how the plan can be integrated into that department's ongoing work. The plan will be reviewed and discussed with the following departments during the first six (6) months following plan adoption. During updates of any town department's plans or policies, the relevant portions of this mitigation strategy will be incorporated.

- Fire Department
- Emergency Management
- Police Department
- Public Works Department
- Engineering
- Planning Board/Planning and Community Development
- Conservation Commission
- Parks and Recreation
- Public Health
- Building

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 a 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, which incorporates risk assessment and mitigation actions on climate change from the 2017 Great Marsh Adaptation Plan and the Town's 2018 MVP Workshop, will be integrated into other Town plans and policies as they are updated and renewed, including the Essex Master Plan, Town Zoning and Subdivision Control Regulations, Open Space Plan, Strategic Plan, Comprehensive Emergency Management Plan, and Capital Investment Program.

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X. LIST OF REFERENCES

Essex Comprehensive Emergency Management Plan, 2017

Great Marsh Coastal Adaptation Plan, 2017
https://www.essexma.org/sites/essexma/files/uploads/nwf-report_great-marsh-coastal-adaptation-plan_2017.pdf

Town of Essex, MA Community Resilience Building Workshop Municipal Vulnerability Preparedness Program Summary of Findings June, 2018
https://www.essexma.org/sites/essexma/files/uploads/essex_municipal_vulnerability_preparedness_final_report.pdf

Town of Essex Strategic Plan, 2015 – 2020
https://www.essexma.org/sites/essexma/files/uploads/essex_strategic_plan_12-2005_draft.pdf

Open Space and Recreation Plan for the Town of Essex,
Essex Conservation Commission, 2007

Essex Town By-Laws
https://www.essexma.org/sites/essexma/files/uploads/essex_bylaw_-_2019_v.19.1_0.pdf

Essex Zoning By-Law
https://www.essexma.org/sites/essexma/files/uploads/essex_bylaw_-_2019_v.19.1_0.pdf

Essex Subdivision Regulations
https://www.essexma.org/planning-board/pages/subdivision-control

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

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

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

MA Emergency Management Agency, State *Hazard Mitigation Plan*, 2013
http://www.mass.gov/eopss/docs/mema/resources/plans/state-hazard-mitigation-plan/section-01-introduction-cover-and-executive-summary.pdf

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

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 Centers for Environmental Information, https://www.ncdc.noaa.gov/stormevents/

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

USGS, National Water Information Center, https://waterdata.usgs.gov/nwis

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APPENDIX A

HAZARD MITIGATION PLANNING TEAM MEETING AGENDAS

Meeting Agenda
Local Natural Hazard Mitigation Plan
Town of Essex, Town Hall
October 16, 2017, 10:00 AM – 11:30 AM

Local Team Meeting (Information Gathering)

a) Hazard Mitigation Planning Map Series and Digitized Ortho Photo Map
b) Review 2012 mitigation actions
c) Identify Critical Facilities
d) Identify local hazards:
   i) Flood Hazard Areas
   ii) Fire Hazard Areas (brushfires/wildfires)
   iii) Dams
   iv) Ice jams
   v) Thunderstorms
   vi) Drought
   vii) Extreme Temps
   viii) Tornadoes
   ix) High winds
   x) Snow and Blizzards
   xi) Ice storms
   xii) Earthquakes
   xiii) Landslides
   xiv) Future Potential Development Areas

e) Review Plan Goals and Objectives- see over

f) Discuss Public Involvement and Outreach
   i) Identify local stakeholders
   ii) Schedule first public meeting
g) Identify draft priority projects and funding for update

Project Overview MAPC is working with Essex to update its plan to mitigate potential damages of natural hazards such as floods, winter storms, hurricanes, earthquakes and wild fires, before such hazards occur. The federal *Disaster Mitigation Act of 2000* requires that all municipalities adopt a *Pre-Disaster Mitigation Plan* for natural hazards in order to remain eligible for FEMA Disaster Mitigation Grants.

This FEMA planning program is separate from ongoing homeland security initiatives, and is focused solely on addressing natural hazards, although some of the data collected for this plan may be useful for other aspects of emergency planning as well.

Recommended goals to align with MA State Hazard Mitigation Plan and FEMA Guidelines:

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

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

3. Increase cooperation and coordination among private entities, Town officials and Boards, State agencies and Federal agencies.

4. Increase awareness of the benefits of hazard mitigation through outreach and education.

Meeting of Essex, MA Conservation Commission
Tuesday July 10, 2018 7:30 PM EDT

Town Hall - Stage Conference Room (2nd Floor)
30 Martin Street, Essex, MA 01929
This meeting replaces the July 3, 2018 meeting.

The Conservation Commission will hold a public meeting under the Massachusetts Wetlands Protection Act, M.G.L. Chapter 131, Section 40 at 7:30 pm on Tuesday, July 10, 2018 at the Essex Town Hall - 30 Martin Street.
Michael Burke, Chairman
Draft Agenda
7:35 pm Public hearing on a Notice of Intent filed by Richard Denton to raze and rebuild an existing, single family house at 34A Robbins Island Road.
Conservation Commission legal notices are published: (1) in print in the Gloucester Daily Times (www.gloucestertimes.com); (2) on the newspaper's website, if it has one; and (3) on the Massachusetts Newspaper Publishers Associations' website (http://masspublicnotices.org)
8:00 pm Public meeting to present Hazard Mitigation Plan
Business:
*Review Certificate of Compliance Requests (if any)
*Sign documents for hearings closed at the last meeting (if any). -120 Western Ave
*Approve minutes from the meeting of June 5, 2018.
*Distribute minutes from last meeting. *Review mail/emails.
*Sign payroll and expense sheets. *Items that could not be reasonably anticipated by the Chairman within 48 hours of the meeting.
Please be advised that the Commission may vote on any item on this agenda. Next meeting: July 24, 2018 (Note change in meeting date)

Meeting of Essex, MA Conservation Commission
Tuesday November 20, 2018 7:30 PM EST

Town Hall - Stage Conference Room (2nd Floor)
30 Martin Street, Essex, MA 01929

The Conservation Commission will hold a public meeting under the Massachusetts Wetlands Protection Act, M.G.L. Chapter 131, Section 40 at 7:30 pm on Tuesday, November 20, 2018 at the Essex Town Hall - 30 Martin Street.
Michael Burke, Chairman
Agenda
7:35 pm Public hearing on a Notice of Intent filed by Tim Palermo to construct a dwelling, walkway, installation of a foundation drain, utilities and grading at 19 Turtleback Road
7:45 pm Public hearing on status of Hazard Mitigation Plan
Conservation Commission legal notices are published: (1) in print in the Gloucester Daily Times (www.gloucestertimes.com); (2) on the newspaper's website, if it has one; and (3) on the Massachusetts Newspaper Publishers Associations' website (http://masspublicnotices.org) Business:
*Review request for minor modification to Order of Conditions DEP #021-0553 for Lot 11W Turtleback Road (see Assessors Map 147, Lot 13).
*Review Certificate of Compliance Requests (if any).
*Review Certificates of Revocation.
*Sign documents for hearings closed at the last meeting (if any).
*Approve minutes from the meeting of October 23, 2018.
*Distribute minutes from last meeting. *Review mail/emails.
*Sign payroll and expense sheets. *Items that could not be reasonably anticipated by the Chairman within 48 hours of the meeting.
Please be advised that the Commission may vote on any item on this agenda. Next meeting: December 4, 2018

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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: https://mapc-org.sharefile.com/d-s67316042bae47d48

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: Development – This map shows potential future developments, and critical infrastructure sites. MAPC consulted with Town staff to determine areas that were likely to be developed or redeveloped in the future. The map also depicts current land use.

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 Essex 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 Essex 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.

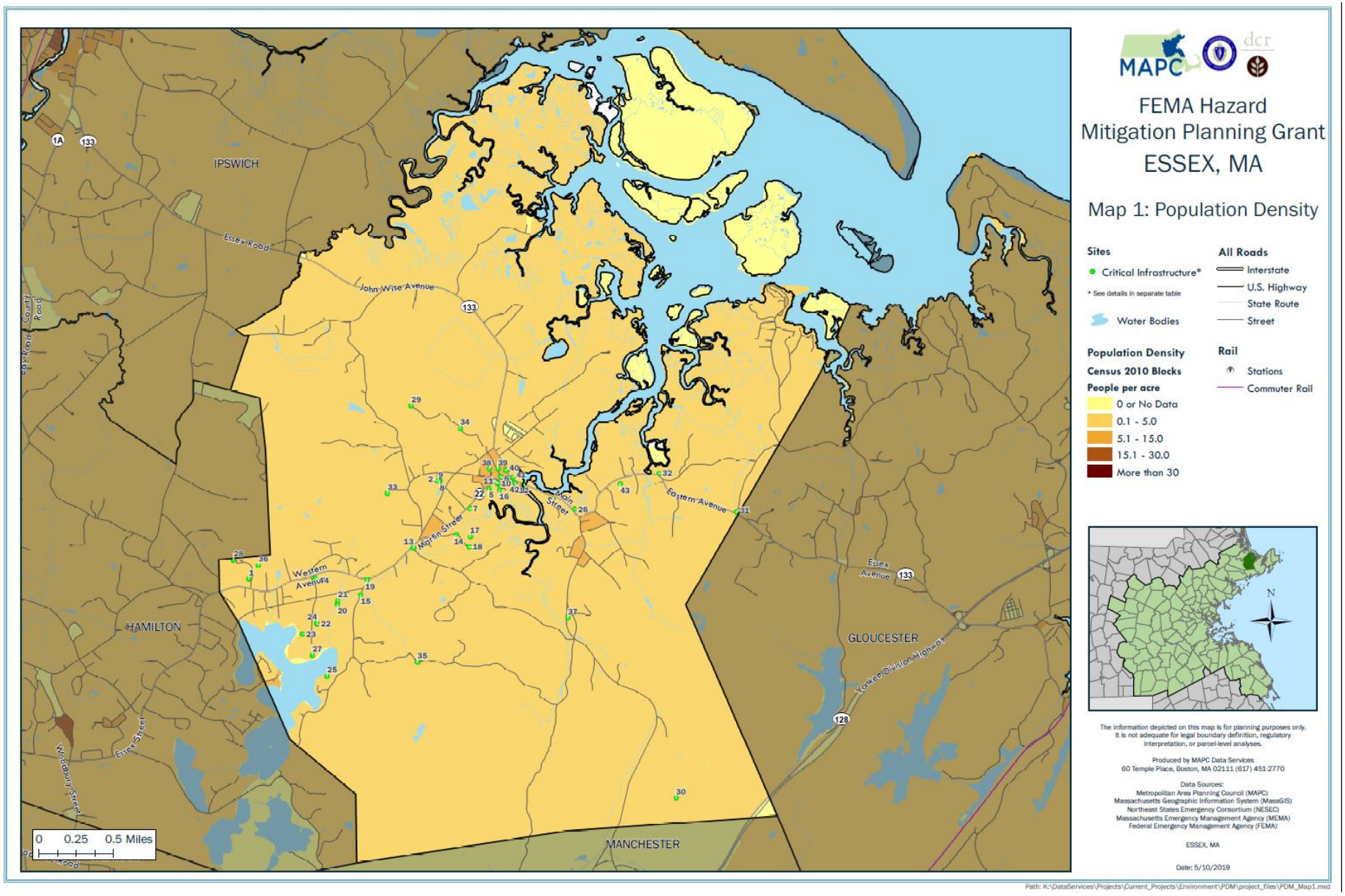
The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to http://pubs.usgs.gov/pp/p1183/pp1183.html.

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 – For each community, locally identified hazard areas are overlaid on an aerial photograph dated April, 2010. The critical infrastructure sites are also shown. The source of the aerial photograph is Mass GIS.


MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
ESSEX, MA
Map 1: Population Density
Sites
Critical Infrastructure*
* See details in separate table
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Population Density
Census 2010 Blocks
People per acre
0 or No Data
0.1 - 5.0
5.1 - 15.0
15.1 - 30.0
More than 30
Rail
Stations
Commuter Rail
IPSWICH
HAMILTON
GLOUCESTER
MANCHESTER
Essex Road
John Wise Avenue
Main Street
Eastern Avenue
Western Avenue
Essex Avenue
Yankee Division Highway
Essex Street
Woodbury Street
0 0.25 0.5 Miles
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)
ESSEX, MA
Date: 5/10/2019
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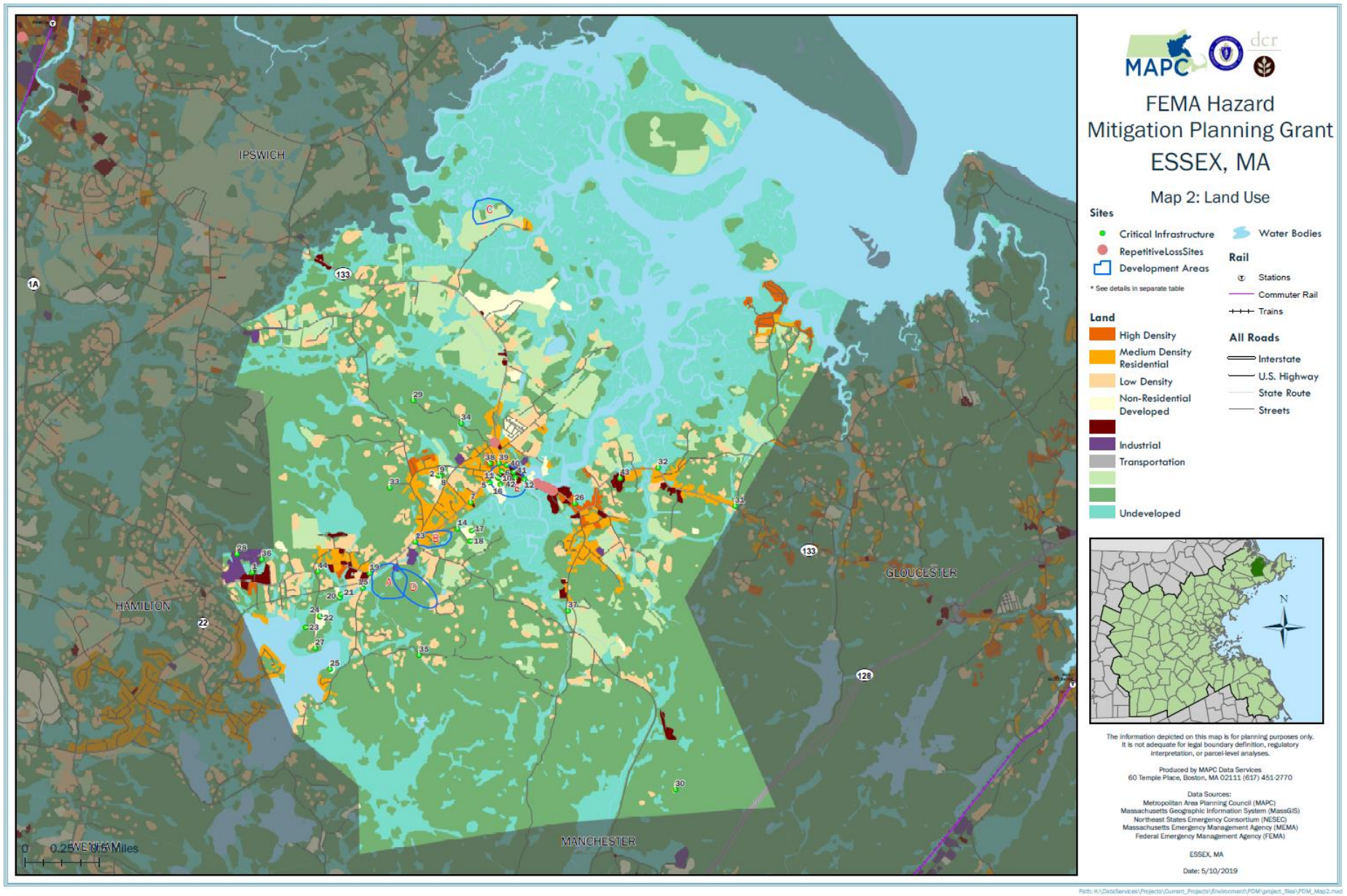
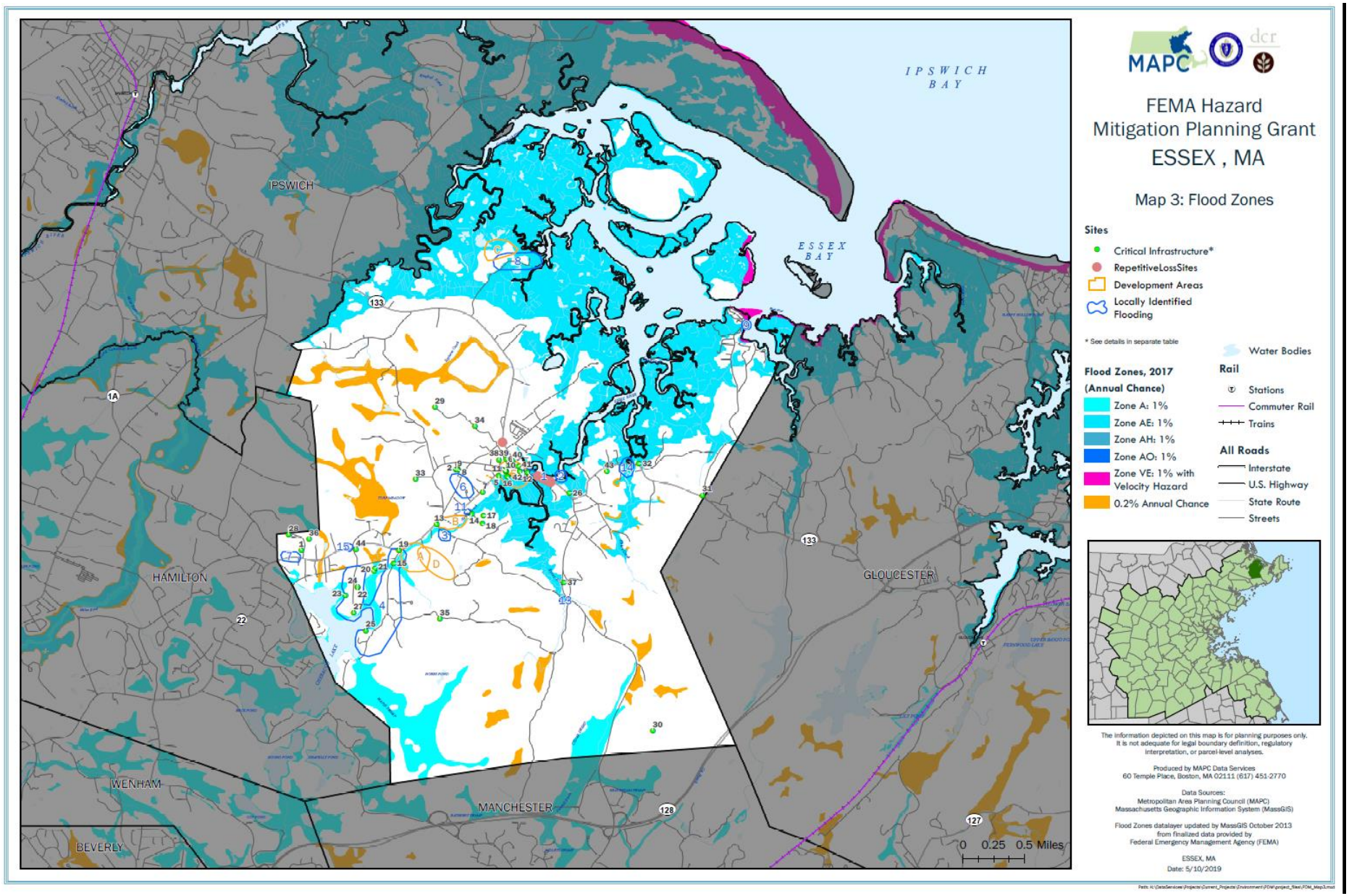
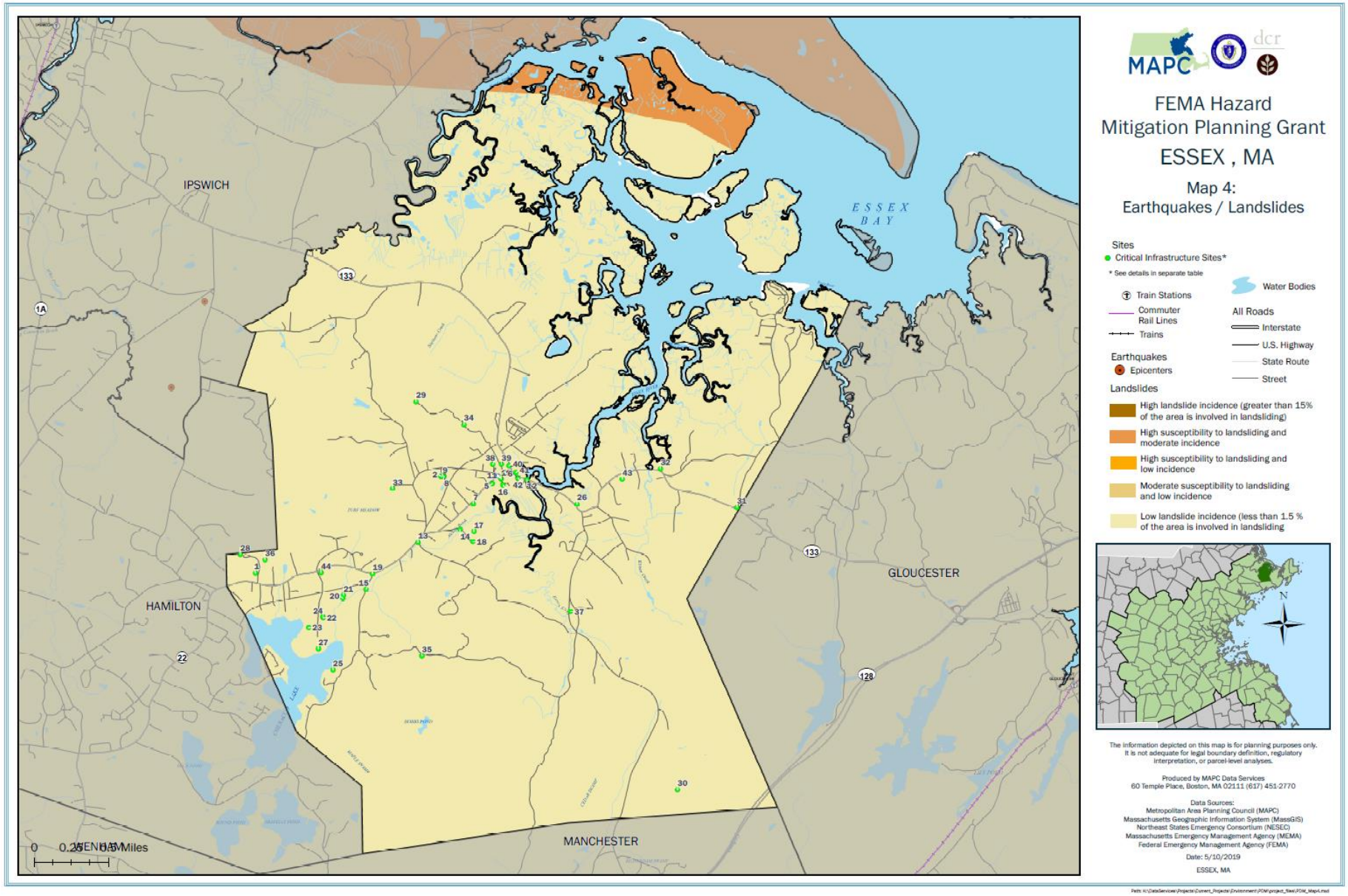
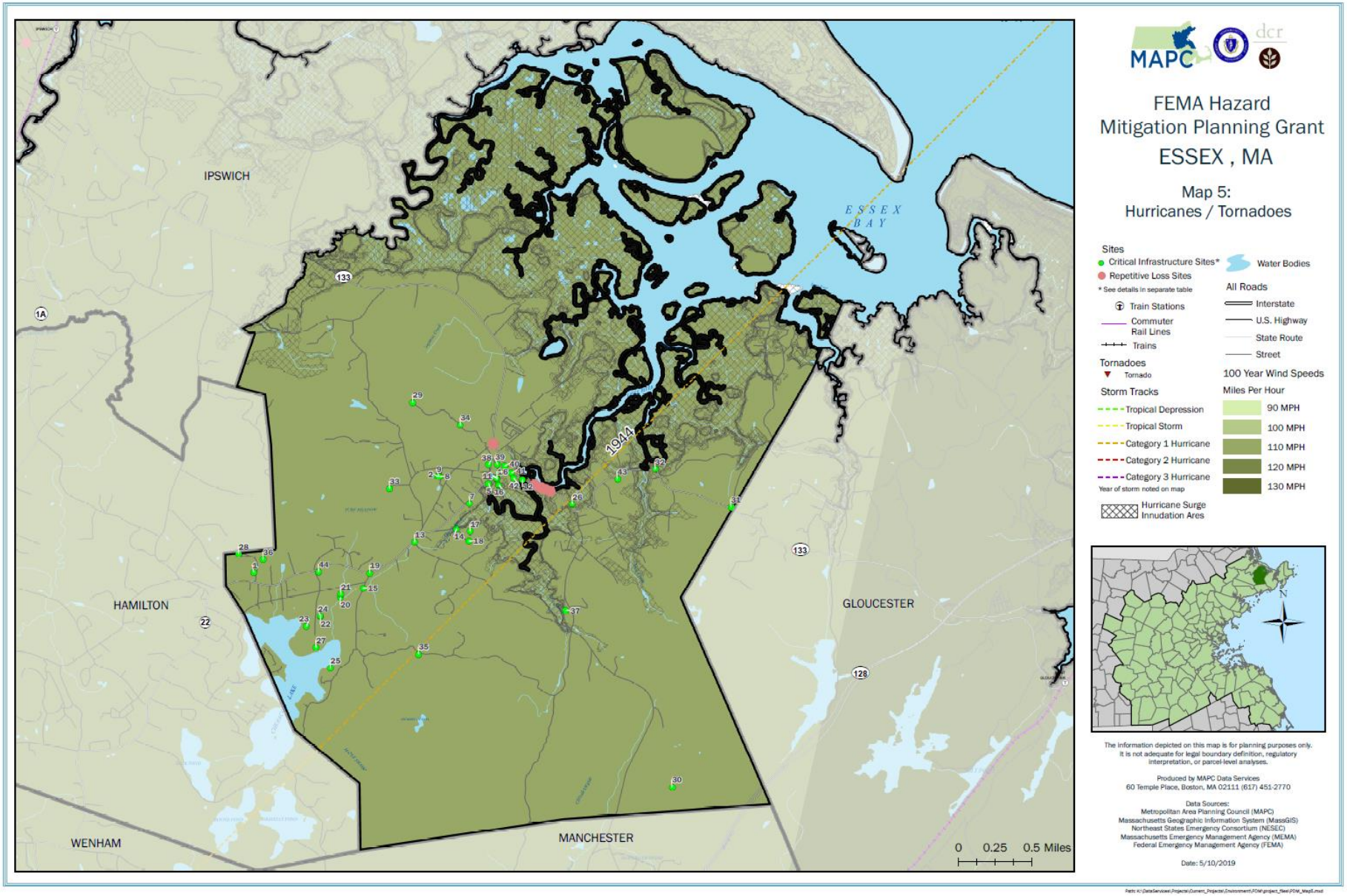

IPSWICH
HAMILTON
GLOUCESTER
MANCHESTER
0 0.25 0.5 1 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
ESSEX, MA
Map 2: Land Use
Sites
Critical Infrastructure
RepetitiveLossSites
Development Areas
* See details in separate table
Land
High Density
Medium Density Residential
Low Density
Non-Residential Developed
Industrial
Transportation
Undeveloped
Water Bodies
Rail
Stations
Commuter Rail
Trains
All Roads
Interstate
U.S. Highway
State Route
Streets
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)
ESSEX, MA
Date: 5/10/2019


IPSWICH BAY
ESSEX BAY
IPSWICH
HAMILTON
WENHAM
BEVERLY
MANCHESTER
GLOUCESTER
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
ESSEX , MA
Map 3: Flood Zones
Sites
Critical Infrastructure*
RepetitiveLossSites
Development Areas
Locally Identified Flooding
* See details in separate table
Flood Zones, 2017 (Annual Chance)
Zone A: 1%
Zone AE: 1%
Zone AH: 1%
Zone AO: 1%
Zone VE: 1% with Velocity Hazard
0.2% Annual Chance
Water Bodies
Rail
Stations
Commuter Rail
Trains
All Roads
Interstate
U.S. Highway
State Route
Streets
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)
ESSEX, MA
Date: 5/10/2019


IPSWICH
ESSEX BAY
HAMILTON
GLOUCESTER
MANCHESTER
133
1A
22
128
0 0.25 0.5 1 Miles
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
ESSEX , MA
Map 4:
Earthquakes / Landslides
Sites
Critical Infrastructure Sites*
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Earthquakes
Epicenters
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
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)
Date: 5/10/2019
ESSEX, MA


IPSWICH
HAMILTON
WENHAM
MANCHESTER
GLOUCESTER
ESSEX BAY
1944
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
ESSEX , MA
Map 5:
Hurricanes / Tornadoes
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
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 Ares
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
100 Year Wind Speeds
Miles Per Hour
90 MPH
100 MPH
110 MPH
120 MPH
130 MPH
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.
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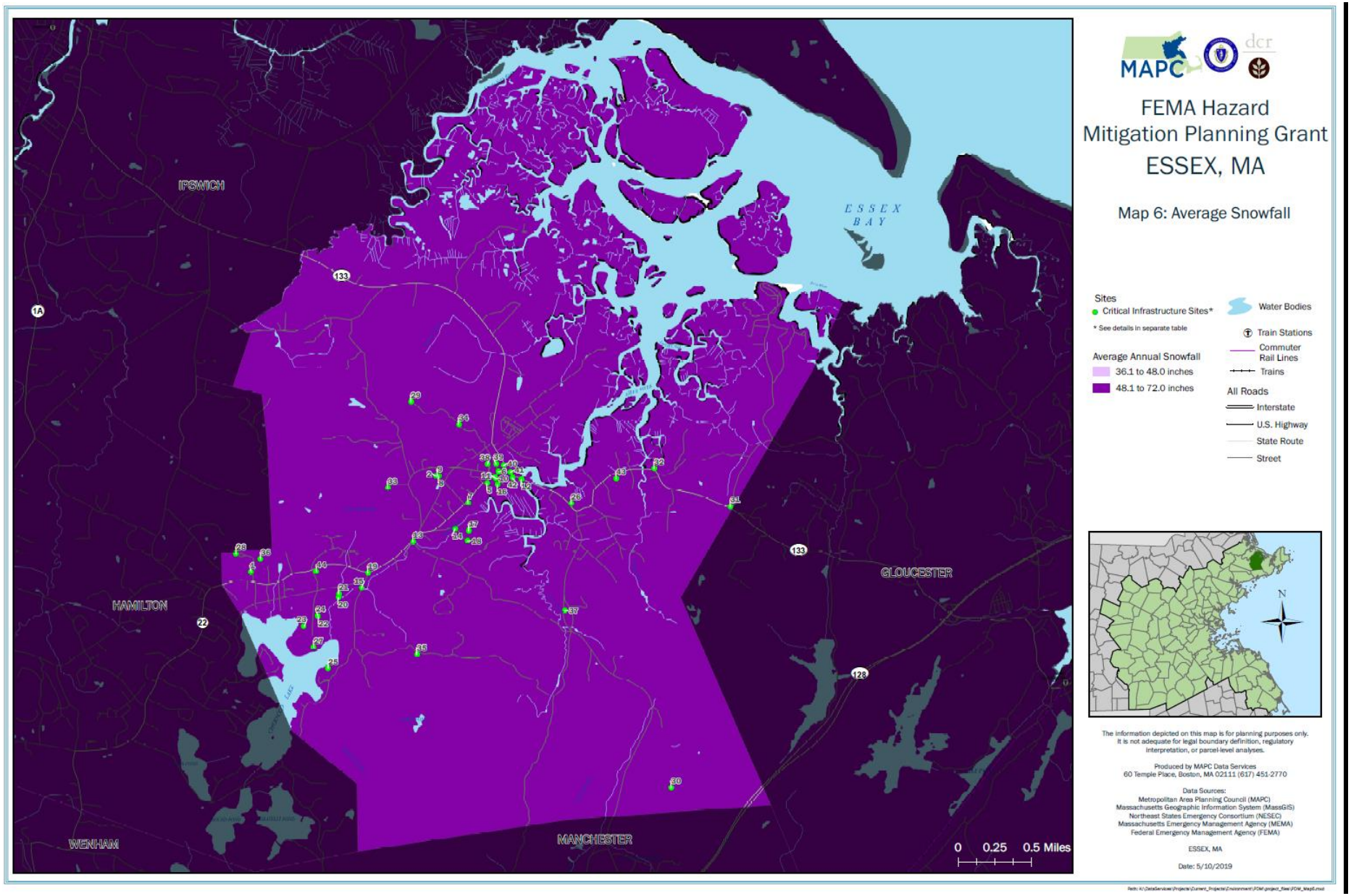
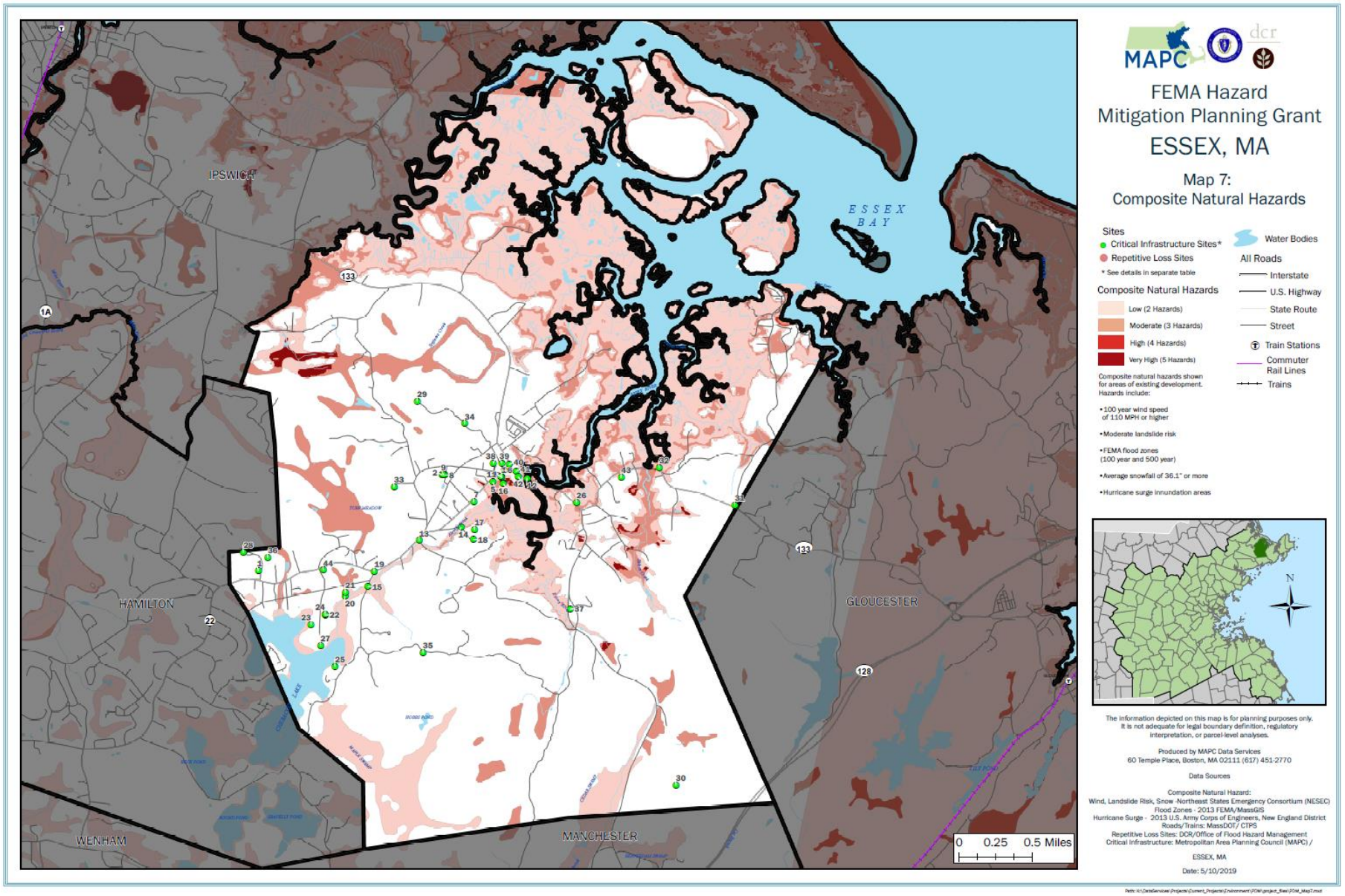
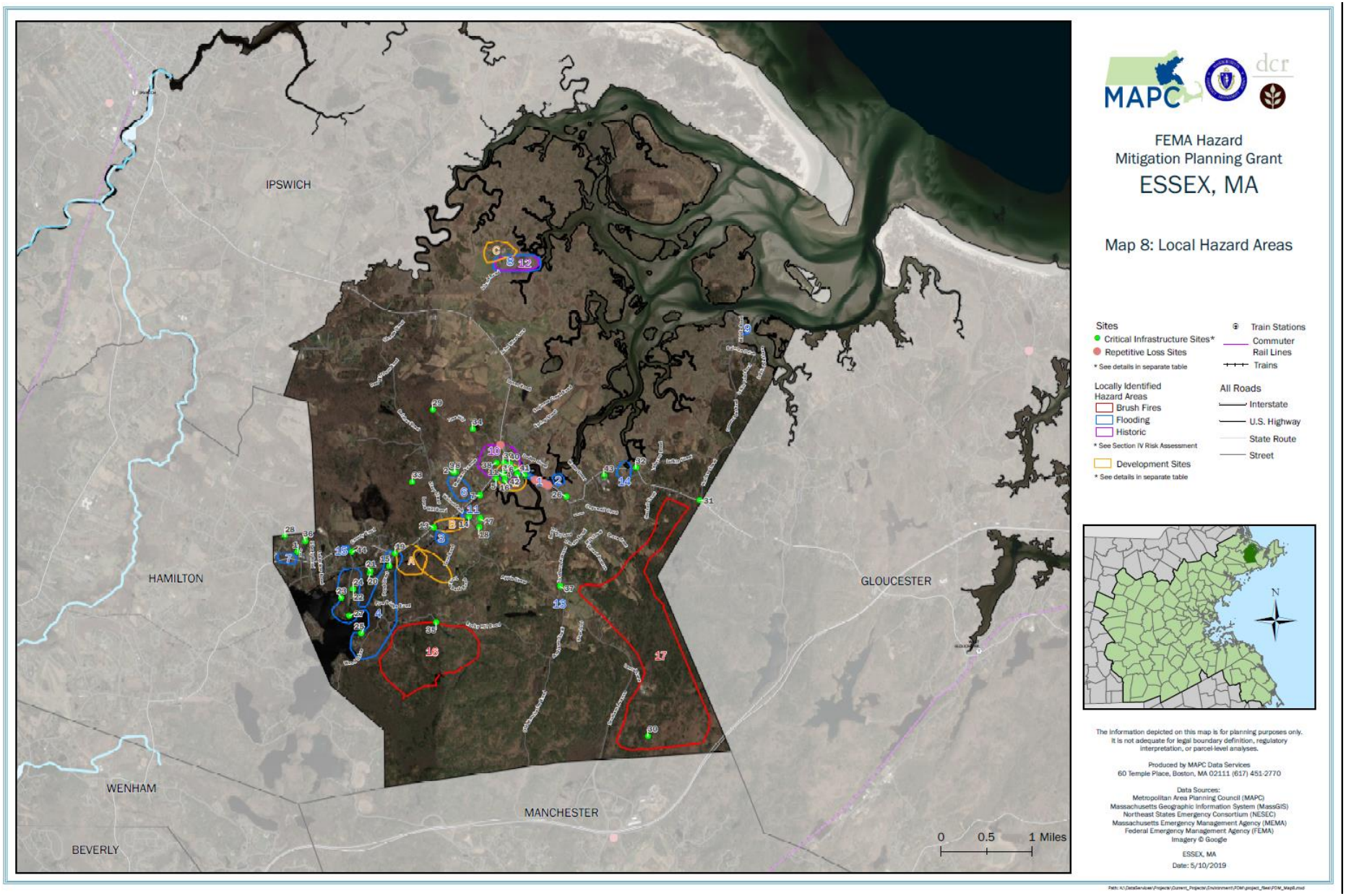
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Date: 5/10/2019


IPSWICH
ESSEX BAY
HAMILTON
GLOUCESTER
WENHAM
MANCHESTER
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
ESSEX, 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
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)
ESSEX, MA
Date: 5/10/2019


IPSWICH
ESSEX BAY
HAMILTON
WENHAM
MANCHESTER
GLOUCESTER
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
ESSEX, MA
Map 7: Composite Natural Hazards
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
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 innundation areas
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Train Stations
Commuter Rail Lines
Trains
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) /
ESSEX, MA
Date: 5/10/2019


IPSWICH
HAMILTON
WENHAM
BEVERLY
MANCHESTER
GLOUCESTER
0 0.5 1 Miles
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
ESSEX, 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
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.
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Data Sources:
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Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google
ESSEX, MA
Date: 5/10/2019

APPENDIX C
DOCUMENTATION OF PUBLIC PARTICIPATION

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

CALENDAR LISTING / MEDIA ADVISORY

ESSEX NATURAL HAZARDS PLAN UPDATE IS FOCUS OF JULY 10 PUBLIC MEETING

Meeting to present an overview of the update of Essex's Natural Hazards Mitigation Plan and solicit public comments

Who: Essex 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 Essex Emergency Management Team (EMT) will hold a public meeting to present an overview of the pending update of the Town of Essex's Natural Hazards Mitigation Plan. 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 Essex adopted its first Hazard Mitigation Plan in 2012, which was approved by the Federal Emergency Management Agency (FEMA). The plan identifies natural hazards affecting Essex 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 an updated plan.

When: July 10, 2018, 7:00 PM

Where: Essex Town Hall, 30 Martin Street

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.

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

CALENDAR LISTING / MEDIA ADVISORY

ESSEX'S DRAFT HAZARD MITIGATION PLAN TO BE PRESENTED AT NOVEMBER 29 PUBLIC MEETING

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

Who: Essex 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 Essex Planning Board and Emergency Management Team (EMT) will hold a public meeting to present an overview of the draft Essex Hazard Mitigation Plan Update. 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 Essex adopted its first Hazard Mitigation Plan in 2012, which was approved by the Federal Emergency Management Agency (FEMA). The plan identifies natural hazards affecting Essex 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 an updated plan.

When: November 20, 2018, 7:00 PM

Where: Essex Town Hall, 30 Martin Street

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.

ESSEX HAZARD MITIGATION PLAN UPDATE – NEIGHBORING COMMUNITIES OF ESSEX, MA

Notification / Email

Gloucester –gcademartori@gloucester-ma.gov

Hamilton- Patrick Reffett preffett@hamiltonma.gov

Ipswich- Ethan Parsons ethanp@ipswichma.gov

Manchester-Sue Brown browns@manchester.ma.us

Additional Organizations:

Cape Chamber of Commerce

Essex Planning Board

Essex Department Directors – DPW, PUBLIC BUILDINGS, FIRE, POLICE, TOWN CLERK, RECREATION AND BOARD OF HEALTH.

Gloucester Daily Times

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Smart Growth & Regional Collaboration

What is the Hazard Mitigation Plan Update?
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.

Why is this plan important?
The Federal Disaster Mitigation Act of 2000 requires that a city or town have an approved hazard mitigation plan in order to qualify for federal funding from the following grant programs:

- Pre-Disaster Mitigation Competitive (PDM-C)
- Hazard Mitigation Grant Program (HMGP)
- Flood Mitigation Assistance (FMA)

Additionally, the plan provides a municipality the opportunity to review potential vulnerabilities to natural hazards and develop measures that can reduce or mitigate these vulnerabilities and be included in the local planning process.

What goes into a hazard mitigation plan?
A hazard mitigation plan assesses the municipality's risks and vulnerabilities to natural hazard events such as flooding, hurricanes, winter storms, and earthquakes. MAPC uses statewide data and information directly from the community to make this assessment.

The plan includes a set of goals related to the overall goal of hazard mitigation planning, an assessment of existing mitigation measures, and a set of new mitigation measures that will serve to advance the plan goals. The plan update will also look at implementation progress that has been made on mitigation measures from the previous plan.

What is the Local Hazard Mitigation Committee?
The Local Hazard Mitigation Committee includes and coordinates with representatives from a number of different Town departments including Public Works, Engineering, Health, Community Development, Emergency Management and Fire. This committee provides the local on-the-ground knowledge necessary to write this plan including information on local hazard areas and current mitigation measures. This committee also identifies and prioritizes mitigation measures to be included in the plan.

How can the public become involved in the Hazard Mitigation planning process?
Public participation is very important to the hazard mitigation planning process. FEMA requires a minimum of two public meetings. When the first draft of the plan is developed, the Town will provide an online link where the plan can be viewed and comments may be provided by the public.

60 Temple Place, Boston, MA 02111 • 617 451 2770 • Fax 617 482 7185 • www.mapc.org

PUBLIC COMMENTS RECEIVED

Chebacco Lake & Watershed Association
P. O. Box 2344
South Hamilton, MA 01982

May 29, 2019

Brendhan Zubricki
Town Administrator
Town of Essex
30 Martin Street
Essex, MA 01929

Re: Comments on the draft Hazard Mitigation Plan of April 25, 2019

Dear Brendhan:

Congratulations on the impressive documentation of natural hazards in the town and the plan for mitigation. The lake association appreciates the opportunity to comment on the draft and there are several issues we'd like to raise in the categories of flooding, wind, and winter hazard.

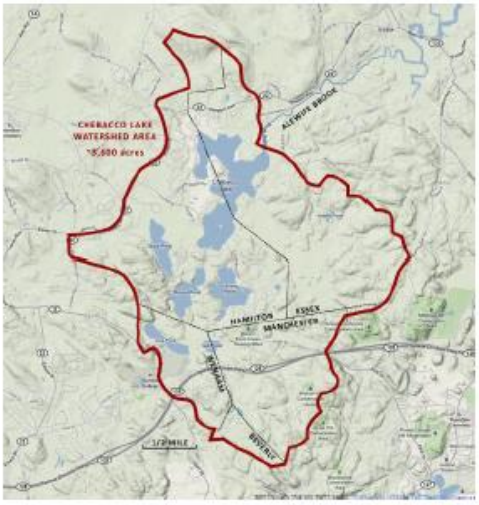
Background

Chebacco Lake and five tributary ponds comprise 10% of a sensitive 3,657-acre watershed area which overlaps portions of Hamilton (1,463 acres), Essex (1,097 acres), Manchester (658 acres), Wenham (329 acres), and Beverly (110 acres). Forested areas comprise 58% of the watershed area; wetlands comprise another 17%, and residential areas comprise approximately 11%. Routes 22 and 128 cross the watershed. The watershed is a completely natural system; there are no dams or control structures. The health of these ponds and their ecosystems are closely intertwined with land and water use practices in all five communities.

Hazards from a watershed ecosystem perspective

Major hazards in the watershed include the following:

- **Flooding** of homes, septic systems, and roads exacerbated by beaver dams and excessive siltation and vegetation in Alewife Brook;
- **Reduction of holding capacity** as well as erosion of shoreline caused by the elevated water level and wave action created by motorboats;
- **The danger of excessive water drawdown** for municipal use over time and impacts on the natural ecosystem and water reserves;
- **Fuel spills and chemical runoff**, including phosphates and herbicides in lawn treatments;
- **Invasive aquatic species**; and
- **Disruption of power and communications**, particularly during wind and winter storms.



Many of these issues intersect with the natural hazards covered by the Hazard Mitigation Plan and we recommend some greater attention be given to these points of intersection.

Watershed Priorities – page 23

The first paragraph on page 23 mixes erroneous information about Chebacco Lake with a broad note about wetlands and flooding through Essex. We recommend the first sentence be deleted and a new paragraph pertaining to the Chebacco Lake watershed be added. Here is possible language:

> Chebacco Lake and five tributary ponds comprise 10% of a sensitive 3,657-acre watershed area that experiences regular flooding and water levels that exceed historical levels as a result of beaver activity and excessive siltation and vegetation in the relatively flat, mile-long section of Alewife Brook between the lake and the Essex River. The elevated surface and ground water levels reduce the water holding capacity in the watershed, causing elevated flooding during storms and the shoreline to erode (in part due to the combination of high water levels and wave action created by motorboats). No significant clearing or deepening of Alewife Brook has been done in decades. Additional watershed hazards are fuel spills and chemical runoff, including phosphates and herbicides from lawn treatments and road salt and pollutants from surrounding roadways. Invasive aquatic species are present in the lake and present an ongoing threat to the health of the watershed. All these factors aggravate and undermine the migration and spawning of alewife populations that return to the lake and ponds each spring.

Wind and Winter Hazards – page 92

Neighborhoods around the lake seem to experience an inordinate number of power outages. Whether this problem can be mitigated by proactive tree and branch pruning, or whether other measures are needed, we recommended that the lake area be added to the mitigation plan with respect to power outages.

Climate Resilience/Adaptation – page 113-114

It was encouraging to see that climate change is receiving attention in the report and that Chebacco Lake watershed protection is included in Table 29.

* * *

In the near term, the ongoing beaver management program is essential to maintaining balance in the watershed. In the long term, a critical hazard mitigation would be the restoration of Alewife Brook to increase flow.

Very truly yours,

Dave Lash

Dave Lash
Board Member

APPENDIX D
DOCUMENTATION OF PLAN ADOPTION

ESSEX BOARD OF SELECTMEN
TOWN HALL • MARTIN STREET • ESSEX, MASSACHUSETTS 01929-1219
Telephone (978) 768-6531

CERTIFICATE OF ADOPTION
BOARD OF SELECTMEN
TOWN OF ESSEX, MASSACHUSETTS

A RESOLUTION ADOPTING THE
TOWN OF ESSEX HAZARD MITIGATION PLAN 2019 UPDATE

WHEREAS, the Town of Essex established a Committee to prepare the *Town of Essex Hazard Mitigation Plan 2019 Update*; and

WHEREAS, the *Town of Essex Hazard Mitigation Plan 2019 Update* contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Essex, and

WHEREAS, duly-noticed public meetings were held by the LOCAL HAZARD MITIGATION PLANNING TEAM on July 10, 2018 and November 20, 2018 and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Essex BOARD OF SELECTMEN adopts the *Town of Essex Hazard Mitigation Plan 2019 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Essex.

ADOPTED AND SIGNED this Date. July 15, 2019

Name(s)	Andrew C. Spinney	Peter D. Phippen	Ruth R. Pereen
Title(s)	Chairman	Selectman	Selectman
Signature(s)			