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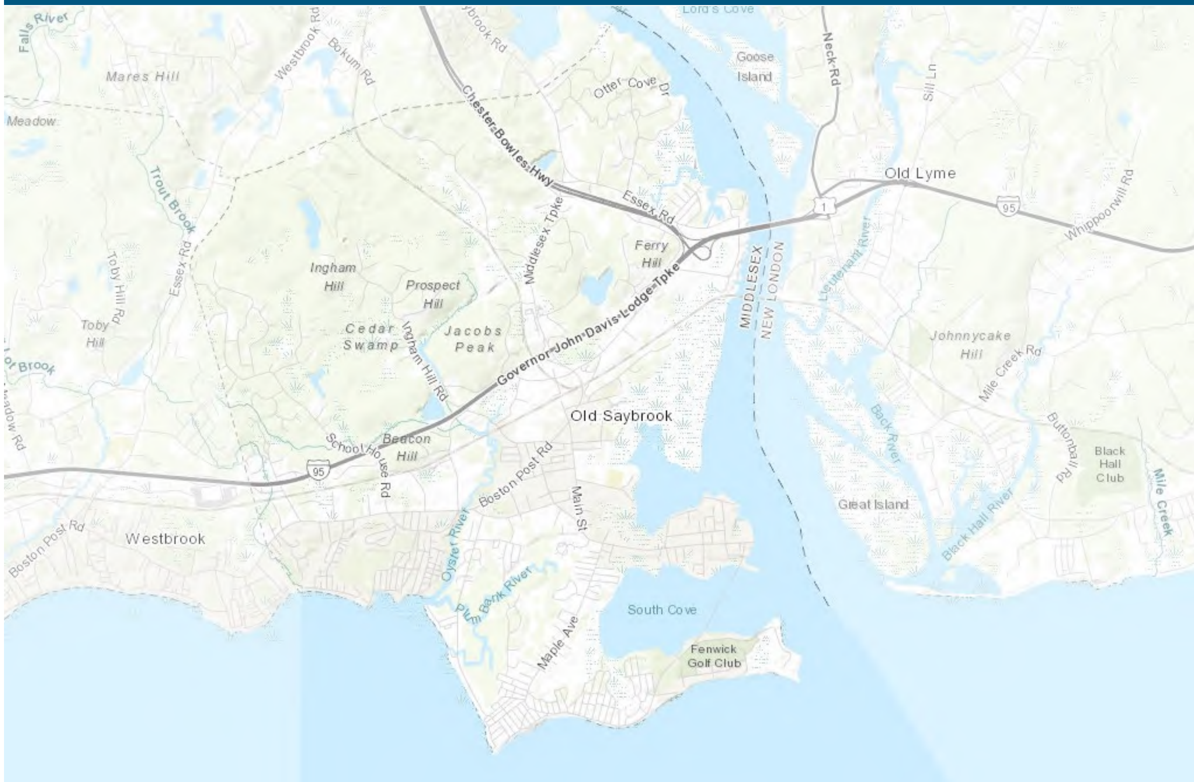


Town of Old Saybrook and Borough of Fenwick Natural Hazard Mitigation Plan Update

Old Saybrook and Fenwick, Connecticut

Draft for Review

Local Natural Hazard Mitigation Plan Update

Prepared in accordance with the requirements presented in the 44 Code of Federal Regulations (CFR) Part 201.6, FEMA Local Mitigation Plan Review Guide and the Local Mitigation Handbook

Prepared by:
GZA GeoEnvironmental, Inc.

Prepared For:
Town of Old Saybrook, Connecticut
Land Use Department and
Borough of Fenwick, Connecticut
Building and Land Use Department

June 2019

GZA GeoEnvironmental, Inc.

Table of Contents

Board of Selectmen

Town Hall
302 Main Street
Old Saybrook, CT
06475
(860) 395-3125

Certificate of Adoption Resolution

Town of Old Saybrook, Connecticut

BOARD OF SELECTMEN

A RESOLUTION ADOPTING THE *OLD SAYBROOK MULTI-HAZARD MITIGATION PLAN*

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

WHEREAS, the Town of Old Saybrook established a Local Planning Team to prepare the Hazard Mitigation Plan; and

WHEREAS, Town of Old Saybrook has prepared a multi-hazard mitigation plan, hereby known as the *OLD SAYBROOK AND FENWICK MULTI-HAZARD MITIGATION PLAN* dated ADD DATE, 2018 in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS, the *OLD SAYBROOK MULTI-HAZARD MITIGATION PLAN* dated ADD DATE, 2019 identifies mitigation goals and several potential future projects to mitigate impacts from natural hazards including climate-related hazards in the Town of Old Saybrook; and

WHEREAS, a duly-noticed public meeting was held by the Town of Old Saybrook on June 19, 2019 for the public and municipality to review prior to consideration of this resolution; and

WHEREAS adoption by the BOARD OF SELECTMEN demonstrates their commitment to the hazard mitigation and achieving the goals outlined in the OLD SAYBROOK *MULTI-HAZARD MITIGATION* PLAN dated ADD DATE; 2019 and

WHEREAS, the Town of Old Saybrook authorizes responsible departments to execute their responsibilities demonstrated in the plan; and

NOW, THEREFORE, BE IT RESOLVED that the Town of Old Saybrook BOARD OF SELECTMEN, formally approves and adopts the *MULTI-HAZARD MITIGATION PLAN,* in accordance with M.G.L. c. 40.

ADOPTED AND SIGNED this ADD day of ADD MONTH 2019.

OLD SAYBROOK BOARD OF SELECTMEN

By: ______________________

Carl P. Fortuna, First Selectman

By: ______________________

Scott Giegerich, Selectman

By: ______________________

Carol Conklin, Selectman

The Borough of Fenwick Connecticut

Board of Warden & Burgesses

580 Maple Avenue
Old Saybrook, CT
06475
(860) 388-3499

Certificate of Adoption Resolution

Borough of Fenwick, Connecticut

BOARD OF WARDEN & BURGESSES

A RESOLUTION ADOPTING THE *OLD SAYBROOK & FENWICK MULTI-HAZARD MITIGATION PLAN*

WHEREAS, the Borough of Fenwick recognizes the threat that natural hazards pose to people and property within the Borough of Fenwick; and

WHEREAS, the Borough of Fenwick established a Local Planning Team to prepare the Hazard Mitigation Plan; and

WHEREAS, Borough of Fenwick has prepared a multi-hazard mitigation plan, hereby known as the *OLD SAYBROOK AND FENWICK MULTI-HAZARD MITIGATION PLAN* dated ADD DATE, 2018 in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS, the *OLD SAYBROOK AND FENWICK MULTI-HAZARD MITIGATION PLAN* dated ADD DATE, 2019 identifies mitigation goals and several potential future projects to mitigate impacts from natural hazards including climate-related hazards in the Borough of Fenwick; and

WHEREAS, a duly-noticed public meeting was held by the Borough of Fenwick on June 19, 2019 for the public and municipality to review prior to consideration of this resolution; and

WHEREAS adoption by the BOARD OF WARDEN & BURGESSES demonstrates their commitment to the hazard mitigation and achieving the goals outlined in the OLD SAYBROOK & FENWICK *MULTI-HAZARD MITIGATION* PLAN dated ADD DATE; 2019 and

WHEREAS, the Borough of Fenwick authorizes responsible departments to execute their responsibilities demonstrated in the plan; and

NOW, THEREFORE, BE IT RESOLVED that the Borough of Fenwick BOARD OF WARDEN & BURGESSES, formally approves and adopts the *MULTI-HAZARD MITIGATION PLAN,* in accordance with M.G.L. c. 40.

ADOPTED AND SIGNED this ADD day of ADD MONTH 2019.

FENWICK BOARD OF WARDEN & BURGESSES

By: ______________________

Newton C. Brainard, Warden

By: ______________________

Pamela Christensen, Burgess

By: ______________________

Jonathan Gengras, Burgess

Add FEMA formal approval letter here

QUICK PLAN REFERENCE GUIDE

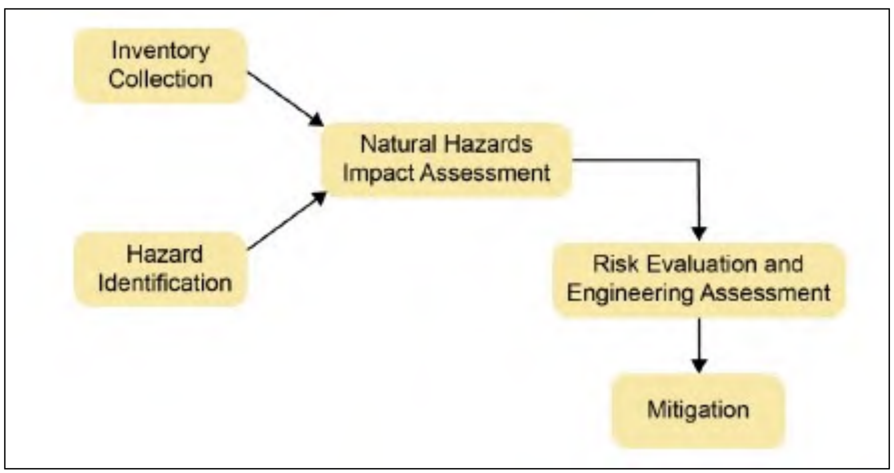
The following provides a Quick Reference Guide to the Town of Old Saybrook and Borough of Fenwick Natural Hazard Mitigation Plan Update:

STEP 1: UNDERSTAND THE PLANNING PROCESS

Section 2 - Planning Process describes the planning process and identifies the members of the Local Planning Team (LPT) that participated in the Plan development. **Attachment 6** presents public meeting documentation for the two public meetings.

STEP 2: INVENTORY TOWN ASSETS (COMMUNITY PROFILE)

Section 3 - Community Profile presents a brief overview of the Town assets. **Attachment 1** provides a detailed description of these assets, including the Town population, and an inventory of Essential and Lifeline Systems, High Potential Loss Facilities, Transportation Infrastructure, and Town Facilities and Zoning Districts and General Building Stock.



Conceptual Steps in Assessing and Mitigating Losses due to Natural Hazards (FEMA)

STEP 3: IDENTIFY NATURAL HAZARDS

Section 4 - Natural Hazard Risk identifies and summarizes the natural hazards applicable to the Town. **Attachment 2** provides the detailed description of relevant natural hazards. The hazards are characterized including past hazard events and expected probability of occurrence. Future climate-related changes to severe weather and climate-related hazards are also presented based on the current available science.

STEP 4: ASSESS NATURAL HAZARD IMPACTS AND RISK

Section 4 - Natural Hazard Risk also presents the results of an assessment of the vulnerability of the Town to the natural hazards. **Attachment 3** provides a detailed hazard vulnerability assessment. FEMA HAZUS-MH simulations were performed for Hurricane (probabilistic) and flood (1% and 0.2% Annual Exceedance Probability [AEP] floods). The simulation results are presented in **Attachment 4**.

STEP 5: MITIGATION PLAN AND IMPLEMENTATION

Sections 5, 6 and 7 present mitigation strategies and actions, regional and intercommunity considerations and plan implementation details. **Attachment 3** provides the basis for ranking natural hazard priorities. **Attachment 5** presents state and federal hazard mitigation and response grant funding sources. References and resources, and key contacts are presented in **Attachments 7** and **8.**

UNDERSTANDING NATURAL HAZARD RISK

This Natural Hazard Mitigation Plan Update is intended to provide the Town of Old Saybrook and Borough of Fenwick with a risk-based approach to making planning decisions. In simple terms...

Risk = the Probability of an event occurring x the Consequences of that event

Risk can be assessed qualitatively or quantitatively. The evaluation of the risks associated with the Old Saybrook and Fenwick natural hazards required: 1) identifying the type of natural hazard (s) applicable to Old Saybrook vicinity; 2) evaluating their probability of occurrence; and 3) evaluating their consequences. For example, a coastal flood could impact Old Saybrook and the Borough resulting in damage to property, injury or death and/or other economic or natural resource impacts. Different coastal flood conditions (water level, limit of flooding, wave height, etc.) are associated with different probabilities of occurrence and different degrees of consequences. By characterizing the hazard, evaluating its probability and evaluating the consequences, the likelihood that these consequences will be experienced is determined. Once the consequences are understood in this way, value and risk-based planning decisions can be made.

Quantitative Risk Assessment

Quantitative assessment of natural hazard risk typically defines hazard probability in terms of Annual Exceedance Probabilities (AEP). The AEP refers to the probability that an event (e.g., a specific flood water level) will be experienced or exceeded in any given year. For example, the 1% AEP event has a 1 in 100 chance of being met or exceeded in any given year. This probability is often described in terms of a recurrence interval. The recurrence interval is also a statistical indication of the probability of an event and can be considered as the “expected” frequency of an event, on average and over a long period of time. The 100-year recurrence interval is consistent with a 1% AEP. Estimates of AEP are typically presented as “mean” values and have uncertainty represented by lower and upper bounds.

Quantitative estimates of natural hazard probabilities, to be statistically meaningful, require long periods of record of actual historical hazard data or use of other statistical methods. Certain natural hazards such as coastal flooding and earthquakes have been defined quantitatively by the federal government (FEMA, USGS and/or the US Army Corps of Engineers), and these values have been used for this Plan. For other natural hazards (e.g., hail), this Plan has used limited historical data to extrapolate probabilities. While not statistically valid, the extrapolated estimates are useful in categorizing likelihood of occurrence (e.g., high to very low). Even though these “quantitative” values are presented in the Plan, the reader should be aware that they are not statistically meaningful due to the limited period of record of historical data.

Evaluating Consequences

This Plan Update evaluates the consequences associated with natural hazards in several different ways. The FEMA HAZUS-MH software is used to calculate losses (e.g. building damage) associated with Hurricanes (high winds), Coastal Flooding and Earthquakes. For the other natural hazards, the consequences were extrapolated from available historical data. Similar to the estimated probabilities for these hazards, this approach is not statistically valid; however, it is useful for categorizing the consequences (minor to catastrophic).

Risk Over Time

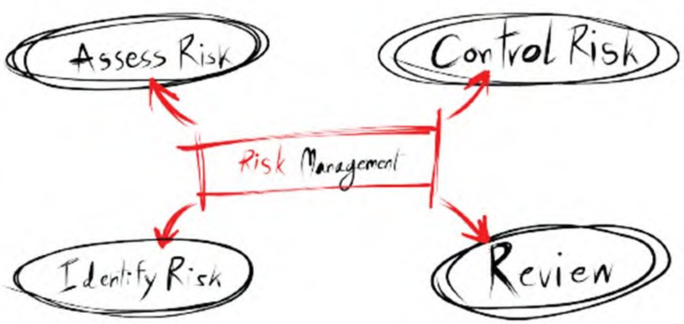
While AEPs and recurrence intervals define the annual risk (i.e., risk in any given year), the risk of experiencing that same hazard event at least once will increase when longer periods of time are considered. For example, the 1% AEP flood has a 1 in 4 chance (25%) of occurring at least once over a 30-year period.

Climate Change

Climate change can effect the risk of severe weather and climate-related hazards. For example, a flood level that has a 1% AEP today may have a much higher probability of occurrence in the future due to sea level rise.

Low Probability is not the Same as Impossible

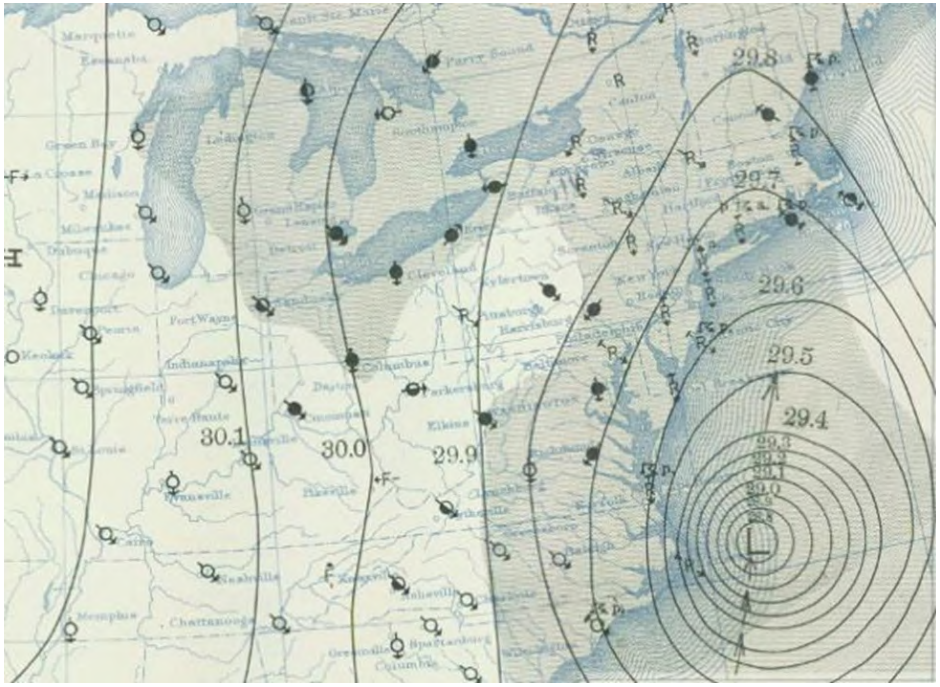
Even though a hazard is predicted to have a low probability of occurrence, that does not mean it cannot happen. For example, a major tornado is unlikely to occur at Old Saybrook and Fenwick based on the available historical data, but it could happen - it is just predicted to be a low probability for planning purposes.



Risk Management Planning Process

Section 1: Plan Introduction

SECTION 1- INTRODUCTION



Historical Surface Weather Map of the Hurricane of 1938 on September 9, 1938

PURPOSE OF PLAN UPDATE

The following presents the Natural Hazard Mitigation Plan (NHMP) Update for the Town of Old Saybrook and Borough of Fenwick, Connecticut. Both the Town and Borough are coastal waterfront municipalities that together are home to about 10,200 residents, located in southeastern Connecticut on Long Island Sound. Old Saybrook is 34 miles east of New Haven and 22 miles west of New London. The Borough of Fenwick is located entirely within Old Saybrook in the southeastern portion of Town. The Town's and Borough's eastern borders are located on the west bank of the Connecticut River.

As a coastal New England town and borough, Old Saybrook and Fenwick are vulnerable to coastal storms, intense rainfall and extreme wind. The Town and Borough are also vulnerable to other severe weather hazards, climate-related hazards (e.g., extreme heat and cold) and geologic hazards (e.g., earthquakes). Both the Town and Borough have developed this NHMP Update to update the risks and vulnerabilities associated with natural disasters and to develop near and long-term strategies for protecting people and property from future hazard events. Ultimately, the goal of the Plan is to enable action to reduce loss of life and property by lessening the impact of natural disasters.

The development of the Plan enables the Town and Borough to:

- Increase education and awareness about the Town's and Borough's vulnerability to natural hazards;
- Build partnerships for risk reduction involving government, organizations, businesses, and the public;
- Identify long-term, broadly-supported strategies for risk reduction;
- Align risk reduction with other state, regional, tribal, or community objectives;
- Identify implementation approaches that focus resources on the greatest risks and vulnerabilities; and
- Communicate priorities to potential sources of funding.

PLAN REQUIREMENT

In addition, FEMA requires state, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects. Jurisdictions must update their hazard mitigation plans and re-submit them for FEMA approval every five years to maintain eligibility.

The State of Connecticut encourages local municipalities to take ownership of the multi-hazard mitigation planning process by pursuing and developing local multi-hazard mitigation plans (MHMP).

NATURAL HAZARD MITIGATION GOALS

The Old Saybrook and Fenwick Local Planning Team (LPT) endorsed the following five goals for this NHMP Update.

1. Promote implementation of sound floodplain management and other natural hazard mitigation principles on a local and regional level
2. Implement effective hazard mitigation projects on a local and regional level.
3. Increase research and planning activities for the mitigation of natural hazards on a local and regional level.
4. Develop a resiliency strategy for historic resources
5. Increase and promote response preparedness

Section 2: Planning Process

SECTION 2 - PLANNING PROCESS

The FEMA planning process includes the following steps:

1. Organize the Planning Process and Resources

At the start, focus on assembling the resources needed for a successful mitigation planning process. This includes securing technical expertise, defining the planning area, and identifying key individuals, agencies, neighboring jurisdictions, businesses, and/or other stakeholders to participate in the process. The planning process for local and tribal governments must include opportunities for the public to comment on the plan.

2. Assess Natural Hazard Risks

Identify the characteristics and potential consequences of hazards. It is important to understand what geographic areas each hazard might impact and what people, property, or other assets might be vulnerable.

3. Develop Mitigation Strategies

Develop long-term strategies for avoiding or minimizing the undesired effects of disasters. The mitigation strategy addresses how the mitigation actions will be implemented and administered.

4. Adopt and Implement the Plan

Once FEMA has received the adoption from the governing body and approved the plan, the state, tribe, or local government can bring the mitigation plan to life in a variety of ways, ranging from implementing specific mitigation projects to changing aspects of day-to-day organizational operations. To ensure success, the plan must remain a relevant, living document through routine maintenance. The state, tribe, or local government needs to conduct periodic evaluations to assess changing risks and priorities and make revisions as needed.

The Town of Old Saybrook and Borough of Fenwick followed this process, including:

- Organizing a diverse local planning team.
- Retaining GZA to provide technical and planning expertise.
- Providing opportunities for the public to comment on drafts of the plan prior to final plan approval.
- Providing opportunities for neighboring communities and local and regional agencies involved in natural hazard mitigation activities that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process.
- Reviewing and incorporating applicable existing plans, studies, reports, and technical information into the plan.

Figure credit FEMA/Jenny Burmester – Aug 21, 2017

The Town assembled a Local Planning Team (LPT) with critical Town, Borough, State and Academic leadership responsibilities. The LPT was tasked with providing oversight and guidance in developing the Plan.

LOCAL PLANNING TEAM MEMBERS

Town of Old Saybrook

- Land Use Department, Christine Nelson, Director
- Board of Selectmen, Carl P. Fortuna, Jr., First Selectman
- Fire Department– Joseph Johnson, Chief
- Police Department– Michael Spera, Chief
- Public Works—Larry Bonin, Director
- Building Department, Tom Makowicki, Building Inspector
- Economic Development, Susan Beckman, Director

LOCAL PLANNING TEAM MEMBERS (Cont.)

Town of Old Saybrook (cont.)

- Parks and Recreation, Raymond Allen, Director
- Water Pollution Control Authority (WPCA), Steve Mongillo, Program Manager
- Land Use Department, Chris Costa, Zoning Enforcement Officer
- WPCA, Robbie Marshall, Project Coordinator

Borough of Fenwick

- Building and Land Use, Marilyn Ozols, Zoning Enforcement Officer
- General Manager, Jeffrey Champion
- Warden, Newton Brainard

Connecticut River Area Health District (CRHAD)

- Director, Scott Martinson

Lower Connecticut River Valley Council of Governments (RiverCOG)

- Executive Director, Sam Gold
- Environmental Planner, Margot Burns

Estuary Transit

- Executive Director, Joseph Comerford

State of Connecticut Department of Energy and Environmental Protection (DEEP)

- Water Permitting Enforcement Division, Joe Wettemann, Senior Sanitary Engineer
- Bureau of Water Protection and Land Reuse, David Kozak, Senior Coastal Planner
- Municipal Facilities Section, Carlos Esguerra, Sanitary Engineer

State of Connecticut Department of Housing

- National Disaster Resilience and Rebuild by Design, Rebecca French, Director

University of Connecticut

- Center for Land Use Education and Research (CLEAR), Bruce Hyde, Director
- CLEAR, Juliana Barrett, Coastal Habitat Specialist
- CLEAR, Amanda Ryan, Municipal Stormwater Educator

SECTION 2 - PLANNING PROCESS cont.

The Local Planning Team (LPT) conducted four working group meetings to provide input and guidance in developing the plan throughout the planning process. The meetings were held on 10/25/2018, 01/10/2019 and **ADD DATE**. The purpose each working group meeting is summarized below:

- Working Group Meeting No. 1: Reviewed, discussed and finalized the inventory of Town assets as presented in Section 3 and **Attachment 1**. LPT members also provided details on previous natural hazard occurrences that impacted the Town.
- Working Group Meeting No. 2: Reviewed and discussed natural and climate change related hazard characterizations and risk assessment results with respect to Old Saybrook as presented in Section 4 and **Attachment 2 and 3**. The LPT also discussed and prepared new goals for the town's hazard mitigation strategy that are consistent with the State of 2019 Connecticut's Natural Hazards Mitigation Plan Update
- Working Group Meeting No. 3: LPT members provided input on final revisions based on reviews of the Draft Plan. GZA documented the revisions for inclusion in the Final Draft Plan for submission to DEMHS. The LPT provided input to GZA on the approach to facilitating the second public meeting on **ADD DATE**.

The Town and Borough conducted three public meetings that provided residents, community stakeholders, business, neighboring communities, state agencies, regional planning authorities, and Town officials, including the LPT members the opportunity to participate during the planning process. The purpose of these meetings was to solicit input during the planning process for consideration and integration into the development of the Plan. The meetings were held at the Town Hall and publicized on the Town's website and through a formal press release. At the first public meeting, a presentation was given to provide background on Hazard Mitigation Planning and to describe the Town's assets inventory, hazards characterization, and risk assessment. The list of participants who attended the public meetings is included in **Attachment 6**. The Town hosted the meetings on the following dates: December 5, 2018, April 17, 2019 and June 19, 2019.

EXISTING PLAN REVIEW

Several existing plans, reports and regulatory programs were reviewed by GZA and relevant details (e.g. future development areas as outlined in the Old Saybrook and Fenwick Master Plan) were incorporated as part of this Natural Hazard Mitigation Plan, including:

- State of Connecticut Natural Hazard Mitigation Plan Update (January 2019)
- Community Wastewater System Desktop Evaluation (January 2019)
- Local Natural Hazard Mitigation Plan Update (2014)
- Coastal Resilience and Adaptation Study (March 2018)
- Sea Level Rise Climate Adaptation Report of Findings (SLRCC, 2015)
- Adapting to Coastal Storms and Flooding Report (2014, Nature Conservancy)
- A Salt Marsh Advancement Zone Assessment of Old Saybrook (2013, Nature Conservancy)
- Local Development Program: Municipal Coastal Program Report (1982)
- Local Plan of Conservation and Development
- Coastal Zone Management Act
- Federal and state flood regulations
- Local floodplain ordinances (Old Saybrook Chapter 128)
- Old Saybrook Zoning Regulations, March 1, 2019
- Fenwick Zoning Regulations, September 1, 2018
- Federal Coastal Barriers Act
- National Flood Insurance Program
- State and federal permits related to natural hazard mitigation, resilience and adaptation measures

A brief overview of relevant town details is also provided in **Section 3** and **Attachment 1.**

Section 3: Community Profile

SECTION 3 - COMMUNITY PROFILE OVERVIEW

Location: Old Saybrook and Fenwick are located within Middlesex County in south-central Connecticut on a peninsula along the northern shore of Long Island Sound. Old Saybrook is bounded to the south by Long Island Sound, to the east by the Lower Connecticut River, to the west by the town of Westbrook and to the north by the town of Old Essex. The Borough of Fenwick is located entirely within Old Saybrook in the southeastern portion of Town with Long Island Sound to the south; the Lower Connecticut River to the east; South Cove to the north; and Old Saybrook to the west.

Characteristics: Old Saybrook has the typical physical characteristics of a Long Island Sound coastal town, with uplands bordered by low-lying areas, tidal wetlands, salt marshes, tidal flats, and beaches. Old Saybrook has over 23 linear miles of shoreline abutting Long Island Sound (6 miles) and the Connecticut River (17 miles). The total area of Old Saybrook (excluding the North and South Cove coastal embayments) is about 15.2 square miles. The areas to the south of Interstate 95 (I-95) are low-lying, consisting mostly of tidal marsh and coastal plain. The area to the north of I-95 consists of rolling hills of bedrock and glacial till, with a network of valley streams and inland wetlands.

Beaches: Old Saybrook's southern shoreline consists of a series of beaches. Moving from west to east, are Chalker Beach, BelAire Manor Beach, Saybrook Manor Beach, Indiantown Beach, Great Hammock Beach, Harvey Beach, Town Beach (Plum Bank), Cornfield Point Beaches and Knollwood Beach.

Harbors: There are several harbors and marinas, including Indiantown, a dredged channel and harbor with breakwaters; the Harbor One Marina located at the intersection of College Street and Bridge Street (Rt. 154); and five marinas located to the north of the Amtrak railway on the Connecticut River (Island Cove, Brewer's Oak Leaf, Between the Bridges and Ragged Rock Marinas). A mooring field is also located in the North Cove.

The Borough is governed by a seven-member Board of Burgesses (Warden). The Town is governed by a three-member Board of Selectmen (First Selectman) and traditional New England Open Town Meeting. The Town is also one of seventeen member towns within the Lower Connecticut River Valley Council of Governments (RiverCOG), supporting regional land use, transportation, economic and natural resource management planning.

Attachment 1 provides a detailed description of the Town's and Borough's community profile including population, land use, essential facilities, lifeline systems, support, high occupancy and vulnerable populations, historic properties and natural resources. The following pages provide a brief overview.

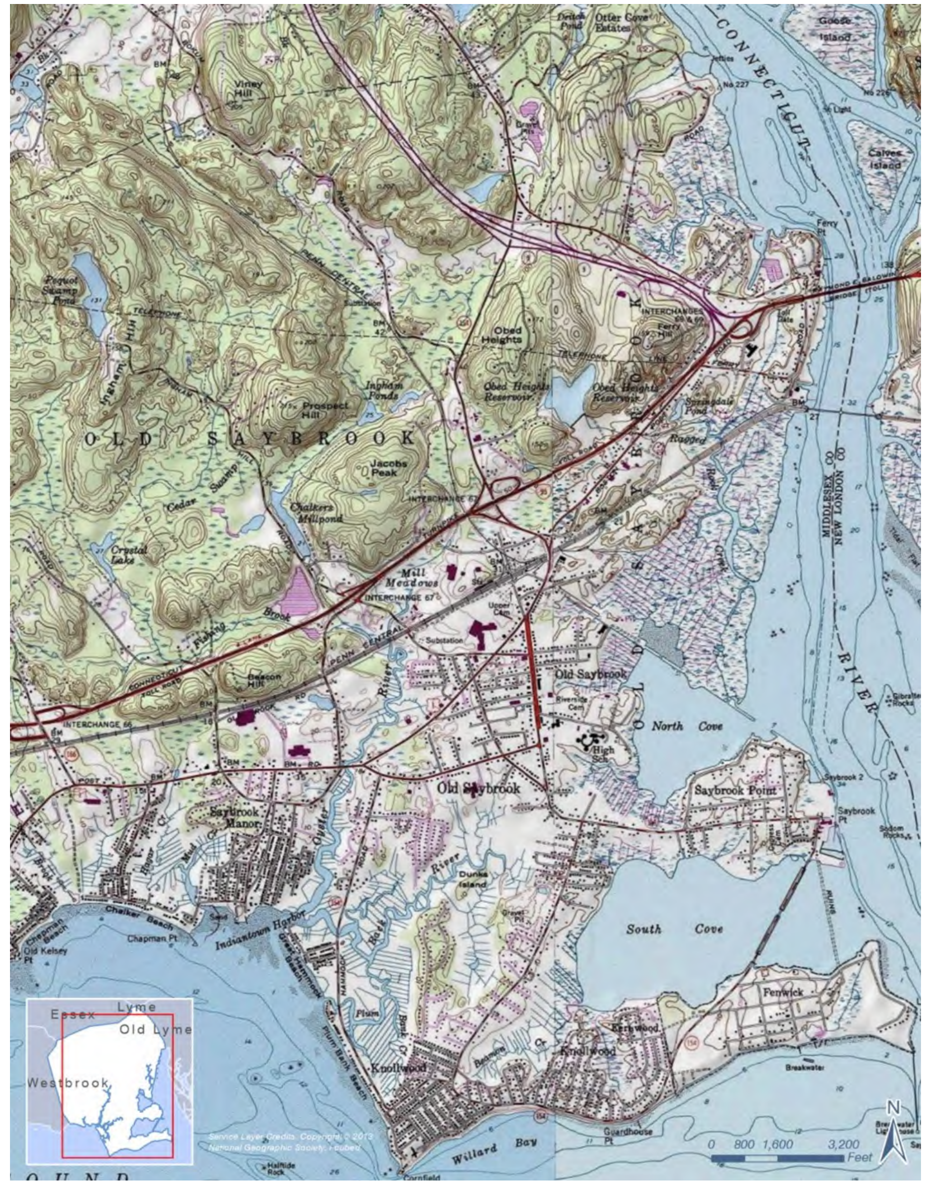


Figure 1: Old Saybrook & Fenwick Site Locus & Town & Borough Limits

Community Profile Snapshot:

Per the 2010 United States Census and 2013-2017 American Community Survey (ACS) (https://www.census.gov/quickfacts/oldsaybrooktownmiddlesexcountyconnecticut):

Age and Sex:

Population:	10,242
Population change since 2000:	-1.1%
Percent female/male:	52.6%/47.4%
Age:	
persons <5 years:	369
persons <18 years:	2,033
persons ≥ 65 years:	2,594

Race:

White alone:	90%
Black or African Amer. alone:	1.1%
American Indian and Alaska Native	0%
Asian alone:	4.3%
Two or more races:	3.1%
Hispanic or Latino:	5.5%

Health:

With disability, under 65 years:	7.9%
Persons w/o health insurance, under 65 years:	7.6%

Education:

High school graduate or higher, greater 25 years:	94.2%
Bachelor's degree or higher, greater 25 years:	42.6%

Economy:

In civilian labor force, total, greater 16 years+:	62.6%
In civilian labor force, female, greater 16 years:	56.9%

Income and Poverty:

Median household income:	$74,185
Per capita income:	$44,026
Persons in poverty:	4.8%

Family and Living Arrangements:

Households (ACS 2013 to 2017):	4,255
Persons per Household:	2.36
Language spoken at home other than English, greater than 5 years:	12.6%

Housing:

Median house cost:	$373,200
Median gross rent:	$1,529/month
Percent owner-occupied:	79%

Population Density: 680.8sq. mile

Social Vulnerability Index:

Old Saybrook's Overall Social Vulnerability: medium; Social Vulnerability Flags only include mobile home estimates. For this category Old Saybrook ranks in the upper 94th percentile of all U.S. census tracts.

Community Profile Snapshot:

Building Stock: 6,196 Buildings

- 72.4% Residential (building exposure: $1.49B)
- 24.2% Commercial/Industrial (building exposure: $497.6M)
- 3.4% Agricultural/Religion/Government/Education (building exposure: $67.4M)
- Total building exposure: $2.1B (see **Attachment 4** for more details)

Support, High Occupancy and Vulnerable Population Facilities:

- 60 Facilities including but not limited to Daycare, Assisted Living, Nursing Homes, Schools, Community Centers, Religious Institutions, Primary Care, Gas Stations, Hotels, Town Administration Buildings

Land Use:

- 42 % Residential
- 13 % Commercial/Industrial
- 20 % Open Space
- 3 % Transportation
- 22 % Undeveloped Land

Zoning & Districts:

- Residential: AAA, AA-1, AA-2, AA-3, A, B, C (Conservation District)
- Central Business B-1
- Shopping Center Business B-2
- Restricted Business B-3
- Gateway Business B-4
- Marine Commercial MC
- Saybrook Point SP-1, SP-2, SP-3
- Industrial District I-1

Future Development:

- 2 key development/redevelopment areas identified

Historic Districts:

- 3 historic districts (North Cove, South Green and Fenwick) and 17 properties on National Register of Historic Places
- 76 properties on the State Register of Historic Properties

Transportation Infrastructure:

- 47 miles of State Roads
- 88 miles of Town Roads
- 22 Bridges
- Regional and Amtrak Rail

Essential Facilities:

- 1 Emergency Management Facility
- 3 Healthcare Facilities
- 2 Police Facilities
- 5 Fire and Rescue Facilities
- 1 Designated Shelter
- 1 Public Works Garage

Lifeline Systems:

- Town Water Supply System (Connecticut Water Company, Guilford Water System (wells and reservoirs), Individual wells)
- Sanitary Wastewater Treatment (Decentralized Wastewater Management District and On-Site Septic)
- Electricity (Eversource
- Natural Gas (Mid-State Mechanical)
- Telecommunications (Comcast and Verizon)
- Separate Stormwater and Sanitary Infrastructure

Hazardous Materials:

- 26 HazMat Category IV Facilities

High Potential Loss Facilities:

- 11 Dams

Natural Resources:

- Two regional watersheds (Long Island Sound and the Lower Connecticut River)
- Five Wildlife Areas (Plum Bank Marsh, Ragged Rock Creek, Hagar Creek March, Ferry Point Marsh, and South Cove)
- Natural Heritage and Endangered Species (MA NHESP)

Section 4: Natural Hazard Risk Overview

SECTION 4 - NATURAL HAZARD RISK OVERVIEW

A Natural Hazard Risk Assessment was conducted by GZA to evaluate the potential consequences of natural hazards to the people, economy, and built and natural environments of the Town of Old Saybrook and Borough of Fenwick. The FEMA Multi-Hazard HAZUS-MH program was used to evaluate economic losses due to seismic, flood and hurricane hazards. The HAZUS-MH simulation results are presented in **Attachment 4**. The hazards were ranked (on a scale with 1 being the top ranking and 9 the lowest) using a scoring system based on the likelihood/frequency, severity/magnitude, and potential impact area (see **Table 1**). Each hazard category was provided a score based on the criteria shown in **Attachment 3**. For each hazard, the product of the points from each category was determined and the hazards ranked from highest value to lowest. The details of the risk assessment and how the hazards were ranked are presented in **Attachments 2 and 3.** The top ranked hazards include:

- Flooding due to Coastal Storm Surge

  The extent of coastal storm surge impacts a large area of shoreline and low-lying areas of Town south of Interstate 95, it is the top-ranked hazard due to: 1) flood inundation impacts to the Town's Essential Facilities; 2) impacts to transportation infrastructure, including Routes 1 and 154, and bridges with lower deck elevations such as the South Cove Causeway, Great Hammock Road over Back River, Plum Bank Road over Plum Bank Creek; 3) impacts to the lifeline systems decentralized wastewater management system 4) impacts to Beach Communities, Town Center, Saybrook Point, Roadway; and 5) natural resources including marshes and beaches. Extensive damage to the Transportation Infrastructure and Essential Facilities would result in significant impacts to residents due to loss of access to key roadways and loss of emergency response services (at least temporarily). It would also result in economic impact including effecting the Town's municipal bond rating.

- Sea Level Rise

  Sea level rise is the 2nd ranked hazard due to the increasing extent and depth of flooding, as well as the worsening effects of waves resulting principally to rising sea levels. This will in turn result in greater impacts to even larger extents of shoreline and increasing the vulnerability of major transportation, essential facilities, lifeline systems, residential and commercial properties as well as increasing the size of regularly flooded marshes while further eroding the beaches.

- Hurricanes/Tropical Storms/Nor'easters

  Severe wind, and related damages during hurricanes is ranked third due to its relatively high probability of occurrence, its coincidence with coastal flooding and its potential for wide-spread damage. In particular, a hurricane strike at or near Old Saybrook and Fenwick with a 1% probability of occurrence (100-year recurrence interval) would be catastrophic (similar to the 1938 and 1954 hurricanes). In addition to high winds, hurricanes will also create large storm surges and waves and heavy rainfall.

Table 1: Old Saybrook and Fenwick Natural Hazard Ranking based on the hazard frequency of occurrence, severity and extent of impact area.

Severe Weather Hazards:	**Rank**
Severe Wind:	
Hurricanes/Tropical Storms/Nor'easters	**3**
Thunderstorms	6
Tornadoes	5
Lightning	8
Intense Rainfall	6
Hail	7
Flood:	
Storm Surge	**1**
Sea Level Rise	**2**
Urban Drainage Flooding	5
Severe Winter Weather:	
Snowfall	4
Ice Storms	6
Climate-Related Hazards:	
Extreme Temperature:	
Heat	8
Cold	8
Drought	7
Wildfire	9
Geologic Hazards:	
Earthquake	7
Landslides	0
Tsunami	0
Secondary Hazard:	
Dam Failure	4

SECTION 4 - NATURAL HAZARD RISK OVERVIEW

Table 2 presents a summary of the predicted hazard likelihood of occurrence/frequency, severity/magnitude and impact area for each natural hazard that is relevant to Old Saybrook and Fenwick. The hazard probability of occurrence (frequency) is characterized as:

Frequency:

Very Low: Events that occur less frequently than once in 1,000 years (less than 0.1% per year).

Low: Events that occur from once in 100 years to once in 1,000 years (0.1% to 1% per year)

Medium: Events that occur from once in 10 years to once in 100 years (1% to 10% per year).

High: Events that occur more frequently than once in 10 years (greater than 10% per year).

The hazard impact in part is characterized as follows:

Severity:

Minor: Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e., 1 or 2 communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.

Serious: Scattered major property damage (more than 50% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services are briefly interrupted; some injuries and/or fatalities.

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

Catastrophic: Property and public infrastructure destroyed; essential services stopped, thousands of injuries and fatalities.

Climate change will have an effect on Severe Weather Hazards and Climate-Related Hazards. **Table 3** compares key components of Old Saybrook and Fenwick's climate today to changes predicted by the year 2050. The impact of certain climate change effects on the Town such as sea level rise and coastal flooding are predictable. The impact of other effects such as the increase in the frequency and duration of heat waves are less predictable. However, these Climate-Related hazards are predicted to become a high priority for Old Saybrook and Fenwick over the next decade.

Natural Hazard	Likelihood/Frequency	Severity/Magnitude	Impact Area
SEVERE WEATHER HAZARDS			
Severe Wind:			
Hurricanes/Tropical Storms/ Nor'easters	• High Wind Warning (>40mph): +/- 100% AEP (1-year recurrence interval); **High** • Hurricane Wind Warning (>74mph): 1% AEP (100-year recurrence interval); **Medium to Low** • Extreme Wind Warning (>115 mph) <0.2% AEP (>500-year recurrence interval); **Very Low**	Minor Extensive Catastrophic	Town-wide Borough-wide
Thunderstorms (wind >58 mph)	• Within Middlesex County: 56% AEP or minimum of 1-year to 2-year recurrence interval (29 years with 1 or more events over 52 years); Probability of occurrence within Old Saybrook and Fenwick is likely lower; **Medium to High**	Minor	Town-wide or portions of Town Borough-wide or portions of Borough
Tornadoes	• Tornadoes within Middlesex County: 12% AEP or 8-year recurrence interval (8 years with 1 or more events over 68 years); **Medium** • Major tornado within Middlesex County: 1.5% AEP or 70-year recurrence interval; **Low** • Based on the proportional land area, the Old Saybrook and Fenwick tornado AEP is about 0.2% and the Old Saybrook and Fenwick major tornado AEP is very low (less than 0.2%). **Very Low**	Serious to Catastrophic	Town-wide or portions of Town Borough-wide or portions of Borough
Lightning	• Events resulting in fatality, injury and/or damage within Middlesex County: 38% AEP or 3-year recurrence interval; **High** • Within Old Saybrook and Fenwick: 5% AEP or 20-year recurrence interval); **Medium to High**	Minor (fatality risk is very low)	Town-wide or portions of Town Borough-wide or portions of Borough
Intense Rainfall	• 4% AEP or 25-year recurrence; **High**	Minor Major (potential impacts to 3	Town-wide or portions of Town
Hail (≥ 3/4 inch)	• 31% AEP or 3-year recurrence interval (17 years with 1 or more events over 55 years); Probability of occurrence within Old Saybrook and Fenwick is likely lower; **Medium to High**	Minor to Serious	Town-wide or portions of Town

Table 2: Old Saybrook and Fenwick Natural Hazard Overview

Natural Hazard	Likelihood/Frequency	Severity/Magnitude	Impact Area
SEVERE WEATHER HAZARDS			
Flooding:			
Coastal Flooding	• Stillwater elevation (SWEL) = 5.5 feet NAVD88: 10% AEP (10-year recurrence interval); **Medium**	Minor to Serious	Portions of Town and Borough
	• Stillwater elevation (SWEL) = 7.7 feet NAVD88: 2% AEP (50-year recurrence interval); **Medium to Low**	Serious	Town-wide south of I-95 & Borough-wide
	• Stillwater elevation (SWEL) = 9.2 feet NAVD88: 1% AEP (100-year recurrence interval); **Low**	Serious to Catastrophic (15% of buildings and 27% of roadways)	Town-wide south of I-95 & Borough-wide
	• Stillwater elevation (SWEL) = 15.3 feet NAVD88: 0.2% AEP (500-year recurrence interval); **Very Low**	Catastrophic (42% of buildings including the Fire Station, 50% of roadways, 1000s of on-site septic systems)	
Urban Flooding	• 4% AEP or 25-year recurrence; **High**	Minor to Serious	Town-wide or portions of Town Borough-wide or portions of Borough

Town impact due to coastal flooding:

- 910 buildings are predicted to be impacted during to the 1% AEP flood. This number represents 15% of the total number of Old Saybrook and Fenwick buildings.
- 2624 buildings are predicted to be impacted during to the 0.2% AEP flood. This number represents 42% of the total number of Old Saybrook and Fenwick buildings.
- No Lifeline Systems are predicted to be impacted during to the 1% AEP flood.
- 6 Lifeline Systems (1 Fire and Police Station, and 4 Schools) are predicted to be impacted during to the .2% AEP flood.
- 10 miles of Town/State Roads impacted. Sections of Routes 154 and 1 during floods of <10% AEP (>10-year recurrence interval).
- 22 of Town/State Roads impacted. Large Sections of Routes 154 and 1 during floods of <1% AEP (>100-year recurrence interval).
- Several Town Commercial/Industrial districts and neighborhoods impacted during to the 1% AEP and 0.2% AEP flood including Saybrook Point SP1– 3 Districts, Shopping Center B-2 along Boston Post Road, Low Beach Communities, Saybrook Point, and Town Center.
- Widespread impacts to on-site septic systems during to the 1% AEP and 0.2% AEP flood.

Table 2 cont.: Old Saybrook and Fenwick Natural Hazard Overview

Natural Hazard	Likelihood/Frequency	Severity/Magnitude	Impact Area
SEVERE WEATHER HAZARDS			
Severe Winter Weather:			
Snowfall	• 86% AEP or 1-year recurrence interval Heavy Snowfall; **High**	Minor to serious	Town-wide Borough-wide
Ice Storms	• The data indicate that the probability of Ice Storms at and near Old Saybrook and Fenwick (Groton) is low. Available data is insufficient to estimate probabilities. **Medium to Low**	Minor to serious	Town-wide or portions of Town Borough-wide or portions of Borough

Town snowfall estimates (upper bound monthly snowfall estimates inferred from Boston area):

- 8 to 10 snow days per year
- Average annual snowfall of 23 inches
- 90% AEP or 1 year recurrence interval Heavy Snowfall (19 years with 1 or more events over 22 year record)
- Reasonable estimate of average monthly snowfall: 6 to 8 inches
- Reasonably conservative monthly snowfall upper bound: 40 inches (maximum monthly upper bound of 60 inches)

Table 2 cont.: Old Saybrook and Fenwick Natural Hazard Overview

Natural Hazard	Likelihood/Frequency	Severity/Magnitude	Impact Area
CLIMATE-RELATED HAZARDS			
Extreme Temperatures:			
Heat	• Excessive Heat (multi-day period with higher than normal Heat Index) near Old Saybrook and Fenwick (Middlesex County): 30% AEP or 1 event every 3 years. **Medium**	Minor to Serious (in particular for more vulnerable populations)	Town-wide
Cold	• Available data is insufficient to estimate probabilities. **Assumed Medium**	Minor	Town-wide
Drought	• Drought Warnings are expected in the Connecticut Drought Southeast Region which includes Old Saybrook and Fenwick 5% to 10% AEP or 15 to 20-year recurrence interval; **Low** to **Medium** • Connecticut experiences extended, multi-year droughts about every 25 years; **Low** to **Medium**	Minor (due to limited agricultural economy in Town; could be Serious if affects Town Water Supply)	Town-wide
Wildfire	• The historical data indicates that the probability of wildfire within Old Saybrook and Fenwick is low. Quantitative probabilities of occurrence are not available. **Low**	Minor	20% of Town area is open space and forest

Town climate considerations:

Periods of colder temperatures occur at Old Saybrook and Fenwick and can cause wind chill conditions. Wind chill conditions example:

- 0° F and 25 mph sustained wind speeds, 30-minute exposure
- 5° F and 55 mph sustained wind speeds, 30-minute exposure

The severity and magnitude of extreme heat events at Old Saybrook and Fenwick is, in part, dependent upon: 1) demographics; and 2) the capability of residents to get cool (e.g. air conditioners in homes). Old Saybrook and Fenwick's demographic data indicates that about 34% of the population may be at a greater than average vulnerability.

- 25% of Old Saybrook and 81% of Fenwick's population is older than 65 years
- 4% of Old Saybrook and 0% of Fenwick's population is less than 5 years
- 5% of Old Saybrook and Fenwick's population is at the poverty level

Table 2 cont.: Old Saybrook and Fenwick Natural Hazard Overview

Natural Hazard	Likelihood/Frequency	Severity/Magnitude	Impact Area
GEOLOGIC HAZARDS			
Earthquake	• 2% in 50 years PGA (2,500-year recurrence interval; Maximum Considered Earthquake) in the vicinity of Old Saybrook and Fenwick is 0.13g **Very Low**	Serious	Town-wide
	• 10% in 50 years PGA (500-year recurrence interval) in the vicinity of Old Saybrook and Fenwick is 0.03g **Very Low**	Minor	Town-wide
Landslide	Landslide conditions do not exist within the Town. Local areas of shoreline bluff may experience sloughing or slope stability failure due to coastal erosion. **Low to Medium (only local shoreline bluff failures)**	Minor	Town-wide
Tsunami	The probability of a significant tsunami affecting Old Saybrook and Fenwick is **Very Low.***	Minor to Catastrophic	Town-wide
SECONDARY HAZARDS			
Dam Failure			
Obed Heights Reservoir Dam	• Available data is insufficient to estimate probabilities for each of the three dams.	Minor to Serious	portions of Town
Chalkers Millpond Dam		Minor to Serious	portions of Town
Turnpike Pond Dam		Minor to Serious	portions of Town

*2019 Connecticut Natural Hazards Mitigation Plan Update excluded Tsunami from the State's list of natural hazards due to their low probability of occurrence.

About earthquakes and tsunamis at Old Saybrook and Fenwick:

1. The direct earthquake risk to Old Saybrook and Fenwick is due to the ground motion that results during the earthquake. The Seismic Design Category for the majority of Old Saybrook and Fenwick is A or B indicating a low seismic hazard. The 10% in 50 years (500-year recurrence interval) ground motion would be experienced as light to moderate perceived shaking and none to very light damage. The 2% in 50 years (2,500-year recurrence interval) ground motion would be experienced as very strong perceived shaking and moderate damage. Based on HAZUS-MH simulations of Old Saybrook and Fenwick, Add# buildings are predicted to experience damage, ranging from slight to complete, from the 2,500-year (2% in 50 years) recurrence interval earthquake. The estimated economic losses are about $Add# million for the 2,500-year event.

2. Given its coastal setting, there is some risk of a tsunami reaching Old Saybrook and Fenwick. However, the risk of a significant tsunami is generally believed to be very low. There are two primary tsunami sources that could affect the Southern New England coast: 1) a tsunami generated by an earthquake along the Puerto Rican trench (located in the Caribbean); and 2) a slope failure of the continental shelf off of New England (likely to an earthquake). A landslide of the Cumbre Viejo in the Azores is also a potential New England tsunami source. If these occurred, and a tsunami reached Long Island Sound area, it would have to propagate as a tidal bore within Long Island Sound to reach Old Saybrook and Fenwick, further reducing Old Saybrook and Fenwick's risk.

Table 2 cont.: Old Saybrook and Fenwick Natural Hazard Overview

Climate Change and Old Saybrook and Fenwick

Old Saybrook and Fenwick Climate Today	Old Saybrook and Fenwick Climate 2050
Temperature: The average temperature is about 60°F. • The average low temperature in Winter (December, January and February) ranges from 22°F to 32°F, with the coldest temperature occurring during January. • The average high temperature in Summer (July and August) ranges from 77°F to 81°F, with the coldest temperature occurring during January. • Days above 90°F (based on state-wide data): 7 days • Heat Index above 105°F (based on state-wide data): 5 to 8 (lower in Old Saybrook and Fenwick - about 1 event every 3 years)	Temperature: The average temperature could be between 2°F and 8°F higher than today. • Average Summer temperature (based on state-wide data): could be between 2°F and 8°F higher than today. • Days above 90°F (based on state-wide data): 20 to 40 days • Heat Index above 105°F (based on state-wide data): 14 (lower in Old Saybrook and Fenwick, but still expected to increase relative to today to at least 1 event per year) • Spring will arrive sooner, summers will grow hotter, and the weather will becoming more extreme with swings between above-average winter temperatures to extreme cold with large snowfall events.
Intense Precipitation: • The 25-year recurrence interval, 24-hour rainfall at Old Saybrook and Fenwick: 6.35 inches	Intense Precipitation: Within the Northeast U.S., from 1996 to 2014, the amount on intense rainfall (heaviest 1% of all daily events) was about 50% higher than the period of 1901 to 1995. The frequency and intensity of intense rainfall is expected to increase.
Sea Levels and Coastal Flooding: • 10% AEP Flood Stillwater Elevation: 5.5 feet NAVD88 • 2% AEP Flood Stillwater Elevation: 7.7 feet NAVD88 • 1% AEP Flood Stillwater Elevation: 9.2 feet NAVD88 • 0.2% AEP Flood Stillwater Elevation: 15.3 feet NAVD88	Sea Levels and Coastal Flooding: There is very high confidence that sea levels near Old Saybrook and Fenwick will increase by about 1 foot by the year 2050 (relative to the year 2000). A reasonable mid-range planning bound is 1.7 feet (relative to the year 2000). Assuming 1.7 feet increase: • 10% AEP Flood Stillwater Elevation: 7.2 feet NAVD88 • 2% AEP Flood Stillwater Elevation: 9.4 feet NAVD88 • 1% AEP Flood Stillwater Elevation: 10.9 feet NAVD88 • 0.2% AEP Flood Stillwater Elevation: 17 feet NAVD88

Table 3: Climate Change Old Saybrook and Fenwick

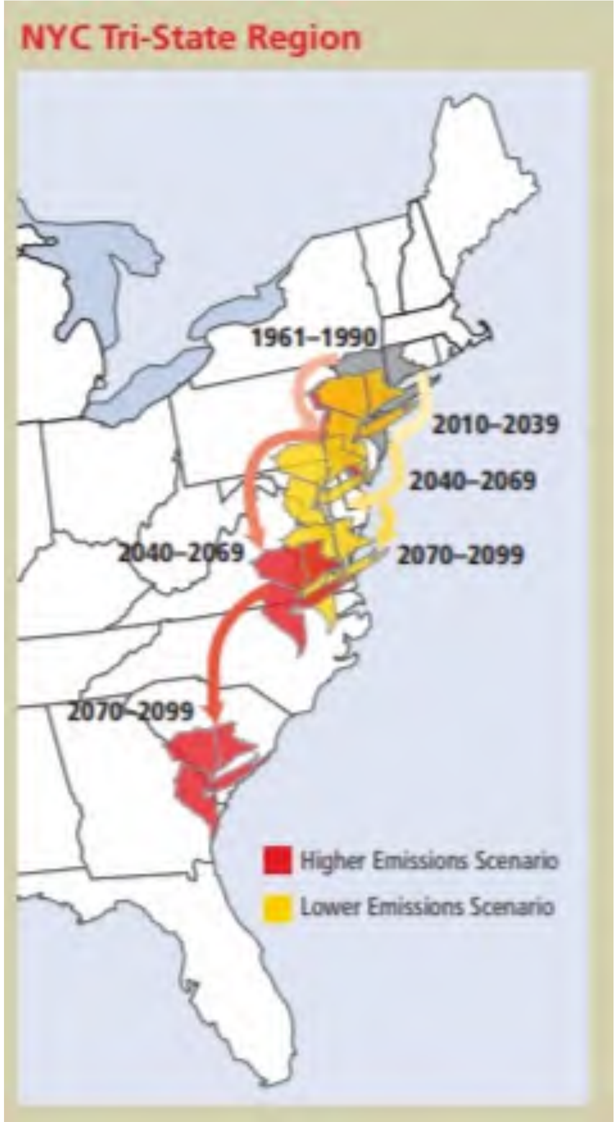


Figure 2: Latitudinal Changes in Regional Climate (source Union of Concerned Scientists)

Section 5: Natural Hazard Mitigation Strategies

SECTION 5 - NATURAL HAZARD MITIGATION STRATEGY

The Old Saybrook and Fenwick Local Planning Team (LPT) prepared an updated mitigation strategy to reduce the potential losses identified in the risk assessment (see **Section 4** and **Attachment 3**) based on the town's and borough's existing mitigation capabilities and community's ability to improve these capabilities in the future. This updated strategy serves as a roadmap for the next 5 years that builds upon the extensive mitigation and climate adaptation work carried out over the last five years based on the 2014 HMP Update. This strategy includes the following four elements as per 44 Code of Federal Regulations (CFR) part 201.6:

1. Hazard Risk Mitigation Goals
2. Hazard Mitigation Implementation and Progress
3. Existing Hazard Mitigation Capabilities
4. Hazard Risk Mitigation Measures/Actions

In the 2014 HMP Update existing capabilities and actions included in elements 3 and 4 above were combined into a single comprehensive table (Table 17). To better differentiate between these complimentary elements, this Plan Update present elements 3 and 4 as separate tables relative to the type of natural and climate related hazard. It is important to note that a majority of the new measures and actions outlined in this HMP Update focus on the highest ranked hazards due to the potential impacts these hazards may have on the Town and Borough. Many of the new actions focus on the top 2 flooding hazards (i.e. storm surge and sea-level-rise) based on the results presented in Old Saybrook's 2018 Coastal Community Resilience and Climate Adaptation Study.

1. HAZARD RISK MITIGATION GOALS

The Old Saybrook and Fenwick Local Planning Team (LPT) met on January 10, 2019 to review proposed hazard mitigation goals. In consideration of the State of Connecticut's 2019 Plan Update and feedback provided by the LPT and Planning Commission, the LPT endorsed the following five goals for this Plan Update.

Mitigation Goals

1. Promote implementation of sound floodplain management and other natural hazard mitigation principles on a local and regional level
2. Implement effective hazard mitigation projects on a local and regional level.
3. Increase research and planning activities for the mitigation of natural hazards on a local and regional level.
4. Develop a resiliency strategy for historic resources
5. Increase and promote response preparedness

2. HAZARD MITIGATION IMPLEMENTATION AND PROGRESS

The Old Saybrook and Fenwick Local Planning Team (LPT) met on October 25, 2018 to document the progress made by the Town and Borough over the last 5 years based on the actions outlined in the 2014 HMP Update. Based on the input provided by team members the LPT identified the following progress based on the Table 17 outlined in the 2014 HMP Update. It is important to note that many of the following items continue to be ongoing activities which are included as existing capabilities presented in **Table 4** and as measures/actions in **Table 5.**

Natural Hazard Mitigation Plan Implementation, Maintenance & Review

ANNUAL REVIEW OF MITIGATION EFFORTS & PLAN IMPLEMENTATION: The Town's lead agencies report on implementation of the Plan throughout its annual report. In 2015, the Conservation Commission's Sea Level Rise Climate Adaptation Committee issued a Report of Findings.

5-YEAR REVIEW & UPDATE NATURAL HAZARD MITIGATION PLAN: The Town started the update process in August of 2018.

CAPITAL IMPROVEMENT PROGRAM: Participated in annual updates to the 5-year capital improvement programs at the State, Regional and municipal levels that resulted in funding hazard mitigation actions;

GRANTS: Successfully secured a $125k grant to conduct a Community Coastal Resilience Study from the Connecticut Department of Housing's CDBG-DR funds from Superstorm Sandy funds.

Planning & Regulatory Standards

FLOOD ENFORCEMENT: Enforced flood standards through existing codes based on the revised State Building, State Fire Safety and State Fire Prevention Codes (10/1/18)

STORMWATER MANAGEMENT: The Town narrowed the pavement width in reconstructing Bokum Road; installed a rain garden in the Main Street parking lot; continues to limit non-residential development to a maximum impervious coverage per lot.

STORMWATER MANAGEMENT: Completed an inventory of stormwater catch basins, basins, and outfall (2017).

STORMWATER MANAGEMENT: Maintained Stormwater Infrastructure (Annually)

MANDATORY WIND CODE COMPLIANCE: Ensured all building permit applicants construct their projects to meet 110 mile per hour wind load standard per the State Building Code.

HAZARD MITIGATION IIMPLEMENTATION AND PROGRESS (cont.)

PUBLIC TRANSIT FUNDING: The Town maintains membership support for Estuary Transit District's Nine Town Transit system's fixed route with 3/4 mile on-call per ADA.

SEA LEVEL RISE CLIMATE ADAPTATION COMMITTEE (SLRCAC): Established a Local Sea Level Rise Climate Adaptation Committee to research medium and long-range impacts to coastal areas from SLR, to investigate possible mitigation actions and to assess legal, financial and policy implications.

SLRCAC: The Local Sea Level Rise Climate Adaptation Committee issued its Report of Findings in 2015.

DESIGN STANDARDS: The Historic District Commission adopted a policy to allow for specific substitute materials to be utilized when conducting repairs or maintenance on a structure within the local historic district without the necessity of a Certificate of Appropriateness.

Information Systems, Data Management & Analysis

GEOGRAPHIC INFORMATION SYSTEM: Updated the information for risk assessment in the Community Coastal Resilience Study (2018)

RESEARCH SEA LEVEL RISE IMPACTS: Updated coastal flood hazard risk based on the risk assessment results outlined in the Community Coastal Resilience Study (2018)

DAM INVENTORY: Updated the Dam & Assets Inventories with the Coastal Community Resilience Study & Infrastructure Evaluation (2018 Resilience Study)

RISK ASSESSMENT: Updated the information for risk assessment in the Community Coastal Resilience Study (2018).

STORMWATER INFRASTRUCTURE INVENTORY: The Town completed its inventory of storm water basins, catch basins and outfalls (2017).

PAPER RECORDS PRESERVATION: The Town is installed the MapGeo "Docs" digital file storage system to enable geo-enabled organization and access (2018).

ELECTRONIC RECORDS PRESERVATION: Maintained electronic records backups at multiple levels. Replicated key datacenter servers (Veeam Server Backup) to an offsite dark datacenter daily to enable restoration of service in the event of a catastrophic datacenter event.

STRUCTURAL REPORTS: Required structural engineering reports for expansion or alteration of buildings within the V zone from 2014 to 2019.

FIREFIGHTING INFRASTRUCTURE ANALYSIS: Updated the information for risk assessment in the Community Coastal Resilience Study (2018)

Physical & Infrastructure Improvements

STORMWATER INFRASTRUCUTURE: The Town cleaned the catch basins on an annual basis

ROAD EVALUATION: Updated roadways evaluation completed (2018 Community Coastal Resilience Study)

ELM STREET UNDERPASS: Completed engineering and design

OFF-STREET PARKING: The Town reconstructed North Main Street surface, drainage and sidewalks to streamline travel within higher-intensity transit node of Saybrook Junction.

NORTH MAIN STREET: CT-DOT Rails purchased land and constructed a 199-space surface parking lot.

SEQUASSEN AVENUE: Raised roadway west of Crab Creek to reduce flooding .

HEPBURN FAMILY PRESERVE: Implementing living shoreline project to minimize flooding.

TOWN DAM EVALUATION: In 2014, the Town received from CT-DEEP a Certificate of Registration (no. 201206994) for a small, Class B (significant hazard) dam at Chalkers Millpond, Ingham Hill Road; in 2018, the Town submitted to CT-DEEP an Emergency Action Plan for the dam.

STORMWATER MANAGEMENT: Continued to use best management practices (BMPs) as described in the Connecticut DEEP Stormwater Management Guidelines on a site-by-site basis as advised by a professional engineer.

Public Information and Outreach

PREPAREDNESS WEBPAGE: On a monthly basis the Town updated the Preparedness Webpage with preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters.

RECOVERY WEBPAGE: Posted on Town website information about recovery assistance following NH events.

HAZARD MITIGATION IIMPLEMENTATION AND PROGRESS (cont.)

HOTLINE: The Town participates in Connecticut's CT Alert ENS (Emergency Notification System), which is contracted through Everbridge.

DROUGHT EDUCATION: As part of its Water Supply Plan, the Connecticut Water Company has notified customers, municipalities and regulatory agencies through drought advisories in 2016-2018 when its reservoirs reach certain points.

OUTREACH: The Historic District Commission adopted a policy to allow for specific substitute materials to be utilized when conducting repairs or maintenance on a structure within the local historic district without the necessity of a Certificate of Appropriateness. The Commission hosted a workshop about funding rehabilitation of historic structures via tax credits.

REPETITIVE LOSS ELEVATION FUNDING: The Town provided one-on-one guidance during the permitting process to encourage repetitive loss property owners to obtain assistance from DEEP and FEMA to acquire hazard mitigation funds to elevate structures where appropriate.

NEIGHBORHOOD MITIGATION: The Town engaged Beach, Neighborhood and Condominiums Associations during outreach efforts for the Coastal Community Resilience Study (2018). Each of these associations were active participants during several workshops conducted to support the preparation of the Community Resilience Study (2018).

INCIDENT NOTIFICATION SYSTEM: The Town promoted voluntary sign-up for Connecticut's CT Alert ENS (Emergency Notification System), which is contracted through Everbridge.

Actions to Reduce Risk and Minimize Impacts During NH Events

NATURAL HAZARD MITIGATION TRAINING: The Town continued to rain and educate emergency responders about mitigating NHs.

LAND ACQUISITION: The Town advanced an assertive land acquisition plan to reserve vacant land subject to NHs that included the acquisition of the following properties:

Town: Coulter St (49/6-1), 9 ac. (2018)

Town: 40 Old Post Rd (28/62), 0.25 (2016)

Old Saybrook Land Trust (OSLT): Dunk Island (15/24), 4.6 ac. (2016)

OSLT: Maple Ave (16/73-4), 5 ac. (2016)

LAND ACQUISITION: (cont.)

OSLT: Plum Bank Rd (6/37), 9.5 ac. (2016)

OSLT: Rocky Pt Rd (59/85-6), 0.95 ac. (2015)

CT/Town/TNC: Bokum Rd (61/18), 28.17 ac. (2015)

CT/Town/The Nature Conservancy (TNC): Ingham Hill Rd, 849 ac. (2015)

CT/Town/TNC: Bokum Rd (61/18), 28.17 ac. (2015)

CT/Town/TNC: Bokum Rd (61/15), 10 ac. (2015)

Town: Fox Hill Rd, (51/25), 0.14 ac.(2015)

OSLT: Ingham Hill Rd (55/2), 12.60 ac. (2015)

OSLT: Meadowood Ln (19/56), 3.2 ac. (2015)

OSLT: Ingham Hill Rd (35/15), 6.14 ac. (2014)

STREET TREE PROGRAM: Implemented a tree hazard management program on a regular basis to encourage appropriate planting and maintenance practices to minimize future storm damage to buildings, utilities and streets.

HISTORIC PROPERTIES: The Historic Commission hosted a workshop on funding rehabilitation of historic structures via tax credits

DUNE RESTORATION: Design of hybrid living shoreline protection for the Fenwick Hepburn Dune (2018-19)

DROUGHT STUDY: Connecticut's State Water Plan (2018) provides data and guidance to manage water as a public trust.

UNDERGROUND UTILITIES: Undergrounding utilities is an ongoing design goal for new development through the land use permitting process; the BOS solicited estimates from Eversource in 2017 for retrofitting areas of town--College St. near Saybrook Pt., Boston Post Rd, or Main St.; and North Main Street.

3. EXISITING HAZARD MITIGATION CAPABILITIES

Old Saybrook and Fenwick have an organization structure in-place to plan for and respond to natural disasters (see Key Contacts in **Attachment 8**). **Table 4** presented on the following pages summarizes an updated overview of the existing natural hazard mitigation capabilities already in place in Old Saybrook and Fenwick. In addition to the mitigation capabilities outlined in the 2014 Plan Update, **Table 4** includes additional capabilities developed by the Town and Borough since the last update. Because of the number of existing public and private entities involved in natural hazard mitigation, the LPT used this list as a catalyst for preparing a more comprehensive inventory of future mitigation capabilities over the next five years.

EXISTING MITIGATION CAPABILITIES	STATUS	SCHEDULE	COSTS	PRIORITY	RESPONSIBLE AGENCIES	POSSIBLE FUNDING SOURCE
GENERAL MULTIPLE HAZARDS						
Design Standards (i.e. Enforcement of State Building and Fire Codes): Continue to implement State Building/Fire Code and local Flood Code for construction that minimizes loss of life and property damage due to Natural and Climate-related hazards. The 2018 Connecticut State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood resistant design, flood-proofing and snow loads.	Reviewed annually, changes made as necessary	Daily;	Low	High	Old Saybrook (OSB) Board of Selectmen and Finance (BOS/BOF), Planning Commission (PC), Zoning Commission (ZC), Land Use Department (LUD), Department of Public Works (DPW), Town Engineer (TE), Building Official (BO) Fenwick (FEN) Warden & Burgesses (W&B), Planning & Zoning Commission (P&Z) and BO	OSB and FEN Operating Budgets (OBs) and Other Programs (OP)
Local Emergency Operations Plan: Every community in Connecticut is required to have a Local Emergency Operations Plan (LEOP) as per Connecticut General Statutes Section 28-7 (a). These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain information on flooding, dam failures and winter storms. Also, these plans include details on the Town's and Borough's mutual aid agreements with other communities as well as the Regional Emergency Support Plan (RESP) and State Response Framework (SRF). Therefore, the LEOP is a mitigation capability that applies to many hazards discussed in this plan. The LEOP is available online through secure access for town personnel.	Reviewed annually, changes made as necessary	Daily	Low	High	OSB Police Department (PD), Fire Department (PD) and Emergency Management (EM)	Old Saybrook and Fenwick OBs and OPs FEMA Emergency Management Grant Program (EMPG) Connecticut Department of Emergency Management & Homeland Security (DEMHS)
Land Use Regulations: Subdivision and Zoning Regulations: Site Plan Review. Town permitting agencies and public officials should assist businesses, through the site plan review process, to plan for, adapt to and mitigate against future SLR and climate change impacts.	Reviewed annually, changes made as necessary	Daily	Low	High	OSB BOS/BOF, PC , ZC, LUD, DPW, TE FEN W&B and P&Z	Old Saybrook and Fenwick OBs OPs
Preparedness and Recovery Webpages: Maintain Town website updated with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per Natural Hazard event and locations of shelters. Maintain Town website information about recovery assistance following NH events.	Reviewed & updated before/after major hazard events.	As needed	Low	High	OSB PD, FD, EM and LUD	Old Saybrook and Fenwick OBs and Capital Improvement Programs (CIPs)

Table 4: Existing Hazard Mitigation Capabilities

EXISTING MITIGATION CAPABILITIES	STATUS	SCHEDULE	COSTS	PRIORITY	RESPONSIBLE AGENCIES	POSSIBLE FUNDING SOURCE
GENERAL MULTIPLE HAZARDS (cont.)						
Centralized Public Safety Dispatch/CT Alert Emergency Notification System (ENS): Utilizes joint communications and dispatch for public safety. Participates in Connecticut's CT Alert ENS (Emergency Notification System), which is contracted through Everbridge.	Active	Daily	Low	High	OSB PD, FD and OEM	OSB and FEN OBs FEMA EMPG DEMHS
Emergency Generators: The Town has invested in backup emergency generators for its public safety facilities. These generators give the town the ability to sustain operations during the event of an emergency.	On-site at public safety facilities	As needed during power outages ; tested monthly	Low	High	OSB PD, FD and OEM	OSB and FEN OBs FEMA EMPG DEMHS
Public Transit Funding: Support regional transportation district (RTD) to facilitate movement of people without means of transportation prior to NH events.	Town currently contributed to 9TT System funding	Ongoing	Low to Medium	High	OSB BOS/BOF, DPW, OEM, CREMPO	OSB CIP Regional Transportation Program (RTP) Statewide Transportation Improvement Project (STIP)
Portable Water Pumps: Rivers and ponds in town are available to be tapped into if necessary for fire-fighting support.		As needed	Low	Medium	OSB PD, FD and OEM	OSB and FEN OBs FEMA EMPG DEMHS
FEMA Resources: A tanker task force is available through State Fire mobilization. FEMA has 8-12 tankers that can be deployed anywhere in the US within 72 hours.		As needed	Low	High	OSB BOS/BOF, PC , ZC, LUD, DPW, FEN W&B and P&Z	DEMHS FEMA
Group Homes Permitting: Future permitting of these facilities shall include the requirement for the preparation of a disaster plan tailored to the needs of the specific clientele, or location of these facilities shall be discouraged in areas of known natural hazards.	Reviewed annually, changes made as necessary	Daily;	Low	Medium	OSB ZC	OSB OB
Geographic Information System: Maintain a comprehensive GIS Database of Town assets to assist in assessing the natural and climate related hazard risks in the Town.	Ongoing	Updated in the 2019 Plan Update	Low	Medium to High	OSB BOS and all Town Departments FEN W&B and all Borough Departments	OSB and FEN OBs
Electronic and Paper Records Preservation: Maintain electronic database and multiple back-up servers for preserving electronic files. Convert remaining paper records into electronic format consistent with state recommendations	Ongoing		Low	Medium	OSB BOS and all Town Departments FEN W&B and all Borough Departments	OSB and FEN OBs

Table 4: Existing Hazard Mitigation Capabilities

EXISTING MITIGATION CAPABILITIES	STATUS	SCHEDULE	COSTS	PRIORITY	RESPONSIBLE AGENCIES	POSSIBLE FUNDING SOURCE
SEVERE WEATHER HAZARDS: FLOOD RELATED HAZARDS						
Participation in the National Flood Insurance Program (NFIP): Old Saybrook and Fenwick participate in the National Flood Insurance Program. The NFIP aims to reduce the impact of flooding on private and public structures. It does so by providing affordable insurance to property owners, renters and businesses and by encouraging communities to adopt and enforce floodplain management regulations. These efforts help mitigate the effects of flooding on new and improved structures. Overall, the program reduces the socio-economic impact of disasters by promoting the purchase and retention of general risk insurance, but also of flood insurance, specifically. The NFIP provides grant funding to reduce &/or eliminate impacts from flood hazards.	NFIP Participating community.	Daily	Low	High	OSB PC and BOS Fenwick W&B and P&Z	Old Saybrook and Fenwick OBs
Emergency Action Plan(s) (EAP): Emergency Action Plans (EAPs) are required for High Hazard Class "C" and Significant Hazard Class "B" dams. The three dams in Old Saybrook that must meet this requirement includes 1) Chalkers Millpond Dam, 2)Obed Heights Reservoir Dam, and 3) Turnpike Pond Dam In essence an EAP establishes the guidelines and procedures for addressing emergency conditions identified at the dam in time to take mitigative action such as notifying the appropriate emergency management officials of potential, impending, or active failing of the dam. The Chalker Millpond Dam and Obed Heights Reservoir Dam EAPS are currently under review by the Water Planning and Management Division within the Connecticut Department of Energy and Environmental Protection. The Turnpike Pond Dam is currently out of compliance and has not sent an updated EAP for review. .	EAP Updates in process. As of 01/2019 Inspections required for Chalker Millpond Dam	Inspections required every 5 years	Low to Medium	High	OSB BOS	OSB OB and CIP
Design Standards (Flood Regulatory Enforcement): Enforce, through existing zoning, building and flood permitting processes, construction standards to minimize flood risks. Continue to require structural engineering reports for expansion or alteration of buildings within the V zone.	enforced through existing standards	Daily	Low	High	OSB BOS/BOF ZC, TE, BO, Fenwick W&B, BO and P&Z	Old Saybrook and Fenwick OBs

Table 4: Existing Hazard Mitigation Capabilities

EXISTING MITIGATION CAPABILITIES	STATUS	SCHEDULE	COSTS	PRIORITY	RESPONSIBLE AGENCIES	POSSIBLE FUNDING SOURCE
SEVERE WEATHER HAZARDS: Flood Related Hazards Cont.						
Structural Reports: Continue to require structural engineering reports for expansion or alteration of buildings within the VE Zone.	Currently Required	Performed on a project by project basis	Low	Medium	OSB BOS/BOF ZC, TE, BO, Fenwick W&B, BO and P&Z	OSB and FEN OBs, OPs
Stormwater Management: Provide for annual maintenance of stormwater infrastructure, including catch basins, detention basins and outfalls. Continue 1) to implement the actions prescribed by the Town's Stormwater Management Plan (2018) including routine inspections and cleaning of catch basins; and 2) land use permitting that encourages storm water retention within new and redeveloping areas (rain gardens, curbless roads, etc.).	Ongoing	Catch Basins cleaned annually	Low	High	OSB BOS/BOF, DPW and all OSB & FEN responsible permitting related agencies	OSB CIP
Water Quality Monitoring: Continue to meet the requirements of the NPDES and the Connecticut Public Health Code. Monitor water quality from stormwater runoff at public beaches in the town following flooding or heavy rain events.	Ongoing	Conducted following flooding events	Low	High	OSB BOS/BOF, DPW	OSB CIP
Street Sweeping and Leaf Removal: The Old Saybrook Department of Public Works conducts street sweeping annually that typically begins in April and takes four (4) to five (5) weeks.	Ongoing	Begins in April taking 4-5 weeks	Low	High	OSB BOS/BOF, DPW	OSB CIP
Local Sea Level Rise Committee: BOS established this committee to guide research medium and long-range impacts to coastal areas from sea-level-rise (SLR), and to investigate possible mitigation and climate adaptation options to assess legal, financial and policy implications of SLR.	Reviewed annually, changes made as necessary	Established for the 2015 SLRCAC Report; Convenes as needed	Low	High	OSB BOS/BOF, PC, LUD, BO, TE	OSB and FEN OPs
SEVERE WEATHER HAZARDS: Severe Wind, Lightening						
Roadway Treatments: The Town uses a salt/sand mix to treat the roads when needed for winter storms.	Ongoing	As neeed-for winter storms	Medium	High	OSB BOS/BOF, DPW	OSB OB, CIP
Mandatory Wind Code Compliance: Ensure all building permit applicants construct their projects to meet 110 mile per hour wind load standard per state building code.	Reviewed annually, changes made as necessary	Daily	Low	High	OSB BOS/BOF, PC, ZC, LUD, DPW, TE FEN W&B, BO and P&Z	Old Saybrook and Fenwick OBs OPs

Table 4: Existing Hazard Mitigation Capabilities

EXISTING MITIGATION CAPABILITIES	STATUS	SCHEDULE	COSTS	PRIORITY	RESPONSIBLE AGENCIES	POSSIBLE FUNDING SOURCE
SEVERE WEATHER HAZARDS: Severe Wind, Lightening						
Tree Trimming: The Old Saybrook Tree Warden, Fenwick Park Commission and local electric company, Eversource (formerly the Connecticut Power & Light Company), conducts regular tree trimming. The town and borough respond to downed tree limbs caused by winds, lightning strike reports	Ongoing	Performed on an annual basis, as needed	Low to Medium	High	OSB BOS/BOF, DPW Eversource FEN W&B, BO and P&Z	OSB and FEN OBs, CIPs Eversource
CLIMATE RELATED HAZARDS: Fire Related Hazards						
Permits Required for Outdoor Burning: The Town of Old Saybrook requires a certificate of open burning for outdoor burning. The property-owner must come into the Fire Station and fill out a form to receive a certificate from the Open Burning Official.	Reviewed annually, changes made as necessary	Open burning from 10am to 5pm on sunny/ partly sunny days	Low	High	OSB Open Burning Official, Fire Marshal, PD	OSB and FEN OBs, OPs
Fire Hydrant Regulations: The Old Saybrook ADD DEPARTMENT regulates that fire hydrants be installed at all new developments at the expense of the developer. Hydrants are spaced / located as directed by the Old Saybrook Fire Department. CONFIRM IF THIS IS ACCURATE	Reviewed annually, changes made as necessary	Performed daily on a project by project basis	Low	High	OSB BOS/BOF, PC	OSB OBs and OPs
Subdivision Review: The Old Saybrook Fire and Building Departments are 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.	Reviewed annually, changes made as necessary	Daily	Low	High	OSB BOS/BOF, PC , ZC, LUD, DPW, TE	OSB and FEN OBs OPs

Table 4: Existing Hazard Mitigation Capabilities

4. HAZARD RISK MITIGATION MEASURES

Development Approach

The LPT used a two-phased approach to developing hazard risk mitigation measures for this Plan Update. First, the LPT and planning consultant identified mitigation actions for inclusion for either ongoing actions or actions as yet to be implemented actions outlined in the 2014 Plan Update. The LPT and planning consultant then organized these mitigation actions by the type of natural hazard as presented in **Table 1** of **Section 4**. Second, the LPT and planning consultant focused the development of the new mitigation actions on the highest ranked hazards due to the potential impacts these hazards may have on the Town and Borough in the future. The LPT and planning consultant integrated the results of Old Saybrook's 2018 Coastal Community Resilience and Climate Adaptation Study (2018 Resilience Study) as new actions in this Plan Update. In preparing the new mitigation actions, the LPT and planning consultant integrated similar and complimentary mitigation actions outlined in the 2014 HMP Update with new actions. The purpose of this approach was to reduce redundancies and enhance previously developed actions based on recent studies (e.g. 2018 Resilience Study) prepared after the 2014 HMP Update.

Prioritization

Upon identification of the mitigation actions for inclusion, the LPT and planning consultant prioritized mitigation measures based on a benefit/cost review process predicated on local knowledge of the hazard areas, cost information, timeline estimate for implementation and an assessment of benefits and costs.

The LPT evaluated various approaches for prioritizing local mitigation actions including those outlined in FEMA's March 2013 *Local Mitigation Planning* Handbook, other local plans and FEMA's STAPLEE method. The LPT developed an approach based on FEMA's March 2013 *Local Mitigation Planning Handbook (*that includes elements derived from the City of Portland Oregon's 2016 Mitigation Action Plan).

This approach utilizes a qualitative benefit/cost analysis (although less detailed than used for FEMA's Hazard Mitigation Assistance Grants Programs). The approach qualitatively rates benefit and costs in terms of: high, medium and low, as follows:

Benefits

- **High:** Action will support compliance with a legal mandate or, once completed, will have an immediate impact on the reduction of risk exposure to life and property.
- **Medium:** Once completed, action will have a long-term impact on the reduction of risk exposure to life and property, has a substantial life safety component, or project will provide an immediate reduction in the risk exposure to property.

Costs

- **High:** Would require an increase in revenue via an alternative source (i.e., municipal bonds, grants, fee increases) to implement. Existing funding levels are not adequate to cover the costs of the proposed project.
- **Medium:** Could budget for under existing capital budget but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low:** Possible to fund under existing budget. Project is or can be part of an existing ongoing program or would not require substantial effort to initiate or appropriate funds.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly. To support the benefit/cost review, the LPT also estimated the length of time and project costs for each mitigation action as follows:

Estimated Timeline

For actions where funding is already available the action or strategy is identified as "ongoing." Since most of the actions were identified as a part of preparing this initial plan, most do not currently have funding. Therefore, length of time for implementation of each mitigation action are based on the amount of time it would take upon receiving funding. The estimated timeframes included:

- 1-2 years,
- 3-5 years,
- 5+ years, and
- ongoing.

Estimated Cost

To support the benefit/cost review the LPT used the following estimated cost categories:

Low: Less than $50,000

Medium: Between $50,000 - $100,000

High: Over $100,000

Note: The estimated costs vary from the "Costs" included in the benefit/cost analysis in that the costs provide preliminary cost estimates in dollars of each action to assist the town and borough for future planning and budgeting purposes.

MITIGATION ACTION PRIORITIZATION

Based on an evaluation of the results of the benefit/cost review, the LPT prioritized each mitigation action and strategy using the following qualitative rating system of high, medium and low.

High Priority: An action that has benefits that exceed cost, has funding secured or is an ongoing project. High priority actions can be completed in the short-term or mid-term (1 to 5 years) or are projects that are long-term projects that can be initiated in the short-term and will have large positive impacts once completed.

Medium Priority: An action that has benefits that exceed costs, and for which funding has not yet been secured, but is eligible for funding. Actions can be completed in the short- or mid-term, once funding is secured, or are projects that are long-term projects that can be initiated in the short-term and will have large positive impacts once completed.

Low Priority: An action that will mitigate the risk of a hazard that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for grant funding, and for which the time line for completion is long-term or uncertain. Low priority actions may be eligible for grant funding from other programs that have not yet been identified. Financing is unknown, and they can be completed over the long term.

The LPT prioritized the mitigation action plan based on the results of the benefit/cost review of the proposed actions as presented in **Table 5** on the next five pages. In addition to the benefit/cost review results based on the elements outlined above, **Table 5** provides details for each action relative to the agencies responsible for leading and coordinating the implementation of each action and potential funding sources.

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
MULTIPLE HAZARDS							
Action 1. **Local Hazard Mitigation Plan**. The BOS/BOF will monitor and evaluate progress in implementing action items in this Plan and include those accomplishments in its annual report to the Town.	High	Low	2019 to 2024	Low	High	Old Saybrook (OSB) Planning Commission (PC) and Land Use Department (LUD) Fenwick (FEN) Warden & Burgesses (W&B) and Planning & Zoning Commission (P&Z)	Old Saybrook (OSB) and Borough of Fenwick FEN) Operating Budgets (OB), Other Programs (OP)
Action 2. **Capital Improvement Program (CIP).** Set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.	High	Low	2019 to 2024	Low	High	OSB Board of Selectmen and Finance (BOS/BOF) FEN W&B	OSB & FEN Operating Budgets (OB), Other Programs (OP) Federal Emergency Management Agency (FEMA)
Action 3. **Grants. Grant Application Plan (GAP).** Prepare detailed application plan for grant opportunities, including FEMA Hazard Mitigation Grant, USACE, NOAA, HUD, CIRCA, DOT, DECD and EPA programs. Initiate grant applications. Based on the GAP, apply for grants to fund mitigation tasks identified in this plan including a benefit-cost analysis for each opportunity including the three FEMA Hazard Mitigation Assistance (HMA) grant programs: HMGP, PDM and FMA.	High	Low	2019—2021	Low to Medium	High	OSB BOS/BOF, All Departments FEN W&B, All Departments	FEMA, USACE, NOAA, HUD, EPA, CIRCA, CT DOT, DECD OSB OP, CIP FEN OP, CIP
Action 4. **5-Year Review & Update of Natural Hazard Mitigation Plan**. The Planning Commission will reconvene its multi-agency Committee every 5 years to update the Plan.	High	Low	2023 to 2024	Low	High	OSB PD, BOS and LUD FEN W&B and P&Z	FEMA Pre-Disaster Mitigation (PDM) Grant, CT DEPT of Emergency Management and Public Safety (DEMHS)
Action 6. Purchase and install a **generator** for back-up power for the **Public Works Garage** and **Transfer Station.**	Medium	Medium	2019 to 2021	Medium to High	Medium	OSB BOS/BOF, Police Department (PD), Fire Department (FD), Department of Public Works (DPW), Office of Emergency Management (OEM)	DEMHS FEMA OSB OP, CIP

Table 5: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
MULTIPLE HAZARDS Cont.							
Action 6. **Maintain and upgrade as necessary all facility mechanicals**, such as generators, in municipal and other critical facilities.	High	Low	2019 to 2024	Low to High	High	OSB all departments, BOS /BOF FEN W&B and P&Z	FEMA HMGP and PDM DEMHS
Action 7. **Update town-wide evacuation plan** (Including vulnerable populations and that includes a plan for evacuation public housing, assisted-living facilities, schools). See State Evacuation Plan.	Medium	Low	2019—2022	Low	Medium	BOS, OEM, PD, FD	DEMHS FEMA OSB & FEN OBs, CIPs
Action 8. **Telecommunication Tower Generators (Private)**. Evaluate whether generators are needed for back-up power at telecommunications facilities.	Medium	Low	2019—2022	Low	Medium	BOS, OEM	DEMHS FEMA Old Saybrook and Fenwick CIPs
Action 9. Review and Update Current **Mutual Aid agreements**.	Medium	Low	2019—2022	Low	Medium	BOS, OEM, PD, FD	DEMHS FEMA OSB & FEN OBs
Action 10: **Keep up-to-date inventory of town assets** in the Town's and Borough's comprehensive GIS database including asset categories outlined in this 2019 NHMP Update.	High	Low	ongoing	Low	High	BOS/BOF and all Town and Borough Departments	Old Saybrook and Fenwick Operating CIPs FEMA PDM or HMGP
Action 11: **Conduct a Comprehensive Land Use Audit** to identify/consider what changes may be advisable to guide development away from areas that are at risk to impacts from natural and climate-related hazards. Focus on promoting new development in non-vulnerable areas of Town.	High	Low to Medium	2019—2022	Low	Medium	LUD, W&B, P&Z, DPW, PC	Old Saybrook and Fenwick OBs/CIPs CIRCA
Action 12: Encourage **privately owned gas stations** to install and maintain **emergency back-up generators**.		Low	2019—2022	Low	Medium	BOS, OEM	FEMA HMGP, PDM Old Saybrook and Fenwick CIPs

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
MULTIPLE HAZARDS Cont.							
Action 13. **Neighborhood Mitigation**: Establish a neighborhood working group to organize beach and neighborhood associations to engage these stakeholders in) Long-term retreat from very high vulnerability areas, including the beaches; 2) Land acquisition for: a) future relocation; b) expansion of tidal marsh; c) conservation land, including beach-front property; 3) Process for developing perimeter flood protection berms, including easements or land acquisitions, and responsibility for maintenance & operation during flooding; 4) the possibility of using perimeter flood protection berms as public greenways. **Attachment 7** of the 2018 Resilience Study presents a detailed discussion on land acquisition.	High	Low	2019—2022	Low	High	BOS/BOF and all Departments	Old Saybrook and Fenwick OBs, CIPs
Action 14: **Education and Outreach to residents and community stakeholders** to 1) promote owner participation in mitigation efforts to protect their property; 2) educate public on how the Town uses conservation planning, regulations to mitigation natural and climate related hazards; 3) educate residents and community stakeholders at high risk to impacts from natural hazards on the hazards relative to where they live.	High	Low	Annually	Low	High	BOS/BOF, LUD, Building Official, Economic Development Commission (EDC)	Old Saybrook and Fenwick OBs, CIPs
Action 15: **Incident Notification System**: Enlist public participation through public workshops to develop methods for emergency notifications of hazard events.	High	Low to Medium	Bi-Annually	Low to Medium	Medium	BOS/BOF, OEM	FEMA EMPG
Action 16: **Recovery and Reconstruction Plan**: Prepare a post-disaster recovery and reconstruction plan to re-establish infrastructure and public services, etc. damaged or destroyed by a NH event. Include in this plan a section dedicated to establishing an approach to working with group homes and community based organizations to prepare stand-alone disaster plans, if such plans do not already exist.	High	Low to Medium	2019—2022	Low to Medium	High	BOS/BOF,	FEMA HMGP, FMA, PDM CIRCA Resilience Grants

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
MULTIPLE HAZARDS Cont.							
Action 17: **Establish a Disaster Recovery and Reconstruction Rainy Day Fund** in case federal disaster assistance funding is not sufficient or delayed.	High	Medium to High	Ongoing	Medium to High	High	BOS/BOF,	OSB & FEN CIPs
Action 18: Conduct **Landlord Incentives Study** to identify what incentives would motivate property owners to make investments to reduce future damages to their properties resulting from NH events.	High	Medium	2019 to 2022	Low to Medium	Medium	BOS/BOF LUD	OSB & FEM CIPs FEMA HMGP, PDM, FMA
Action 19: **Cooperative Agreements for Shelters** : Prepare supporting documentation and encourage the BOS to establish agreement for shelters that can provide specialized services through out the region. Shelters with the capacity to provide for companion pets and medical equipment needs for individuals with disabilities are two examples of such specializations. Support changes in the laws that require every town to provide facilities capable of serving the most severe of handicapped individuals such that towns could pool their resources to better serve these individuals and their families by giving them the option to go to a regional shelter better equipped to handle theirs, and their family's, needs.	High	Low	Ongoing	Low	High	OSB BOS/BOF, PD, FD, OEM	FEMA EMGP OSB OP, CIP
Action 20: **Local Social Resources Impacts Analysis.** Identify local resources to assist with those populations (i.e. elderly, disabled, non-English speakers, who may frequent, reside, or work) in Old Saybrook. Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Old Saybrook will be affected by natural hazards.	High	Medium	2019—2023	Low to Medium	Medium	OSB PC, ZC, LUD	HUD FEMA OSB OP,CIP
Action 21: **Temporary Housing Assessment**. Evaluate the need for post disaster housing for residents displaced by flood or other natural disaster.	M	Medium	2019—2023	Low to Medium	Medium	OSB PC, ZC, LUD	HUD FEMA OSB OP,CIP

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
MULTIPLE HAZARDS Cont.							
Action 22: **Boats**: Identify areas where boats can be stored during flooding and hurricane events.	M	Low	2019—2022	Low	Medium	OSB PC, ZC, Harbor Commission (HC)	OSB OP
Action 23: **Immobile Evacuees Planning**: Review annually the program to evacuate persons without means of transportation, including registration and house numbering.	High	Low	2019—2021	Low	Medium	OSB BOS/BOF, OEM	OSB OP
Action 24: **Refugees of Last Resort Analysis**. Identify refugees of last resort that are unable to reach a designated shelter.	Medium	Low	2019-2012	Low	Medium	OSB BOS/BOF, OEM	OSB OP
Action 25: **Animal Shelter**: Expand the Animal shelter to increase the shelter's capacity to shelter more animals/pets and participate as a regional pet sheltering center.	Medium	Medium	2019—2023	Medium to High	Medium	OSB BOS/BOF, OEM	OSB OP, CIP
Action 26: Conduct **Natural Hazard Mitigation Training** on an annual basis.	High	Low to Medium	2019—2024	Low to Medium	High	OSB BOS/BOF, OEM	OSB OP, CIP
Action 27: **Tenant Notification**: Develop a mechanism for tenants to register for disaster notifications.	High	Low	2019—2021	Low to Medium	High	OSB BOS, OEM	OSB OP
Action 28: **Street Tree Program**: Implement a tree hazard management program to encourage appropriate planting and maintenance practices to minimize future storm damage to buildings, utilities and streets.	High	Low to Medium	Ongoing	Low to Medium	High	OSB BOS/BOF, DPW, Tree Warden (TW)	OSB OP
Action 26: **Municipal Buildings Capabilities Assessment**. Identify buildings for future investment for renovation or new construction to ensure the candidate buildings are in compliance with standards for use as a shelter.	High	Medium to High	2019—2023	High	Medium	OSB BOS/BOF	OSB CIP

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Departments	Potential Funding Sources
FLOOD HAZARDS							
Action 27. Develop an **Emergency Operations Plan** regarding potential coastal flooding.	Medium	High	2-3 years	Medium	Medium	Highway Dept., Police and Fire Departments, Planning Dept.	OSB & FEN OBs and CIP DEMHS FEMA EMPG
Action 28. **Evaluate publicly owned and managed stormwater outfalls and o**utlets along the shoreline of Old Saybrook and Fenwick to identify infrastructure that would benefit from the installation of backflow prevention (e.g. tide gates, check valve).	Medium	Low	1 year	Low	Medium	OSB BOS/BOF, DPW	OSB & FEN OB, OP and CIP
Action 29. Continue to participate in **National Flood Insurance Program (NFIP)** (or other) training offered by the State and/or FEMA that addresses flood hazard planning and management.	High	Low	Ongoing	Low	High	BOS/BOF; LUD	FEMA DEMHS DEEP Old Saybrook
Action 30. Incorporate the procedures for tracking **high water marks** following a flood into emergency response plans.	Medium	Low	Ongoing	Low	Medium	OSB DPW; PD; FD; LUD FEN	FEMA Silver Jackets (USACE) Old Saybrook and Fenwick
Action 31. Enhance communication with neighboring municipalities on **shared water resources** across Town borders.	Medium	Low	Ongoing	Low	Low	OSB BOS/BOF	OSB FEN Westbrook RiverCOG
Action 32. Participate in reviews of regulatory **floodplain maps updates** and revisions.	High	Medium to High	Ongoing	Low	High	BOS/BOF; LUD;	FEMA
Action 33: **Drinking Water Cache**: Install drinking water tanks with a supply of bleach for private well water purification.	High	Medium	2019—2022	Medium	Medium	OSB PC, ZC FEN P&ZC	OSB and FEN OPs

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
FLOOD HAZARDS (cont.)							
Action 34. **Land Acquisition** (Near-term): Identify and prioritize areas for the purchase of wetlands and other flood prone open space to enhance natural resources while improving coastal resiliency and flood retention.	High	Medium/ High	Ongoing	High	Medium	OSB: BOS/BOF, LUD, PC FEN: W&B, P&Z	FEMA HMGP, PDM and FMA OSB CIP
Action 35: Evaluate the possibility of participating in FEMA's **Community Rating System (CRS)** program that would result in reducing the cost of NFIP premiums while improving coastal flood resiliency. The Town has identified programs, higher standards and resilience activities for inclusion as a part of a future CRS application. If in the future resources become available to support a CRS program, it is recommended the Town apply for a Level 9 status.	MED	Medium	2019—2022	Low	Low	OSB: BOS/BOF, LUD, PC FEN: W&B, P&Z	FEMA FMA OSB CIP
Action 36. Evaluate **"green infrastructure"** program to link, manage, and expand existing parks, preserves, greenways, etc. **Update Open Space Criteria** to consider adding sea level rise as a factor for preserving areas that are vulnerable as open space.	MED	Medium	3-5 years	Low to Medium	Low	OSB Conservation Commission (CC), DPW	EPA, CT DEEP OSB and FEN OPs, CIPs
Action 37: Encourage Repetitive Loss Property Owners to **pursue flood mitigation funding** for actions such as elevation or acquisition of structures where appropriate on a voluntary basis.	High	Medium to High	Ongoing	Low	High	OSB BOS/BOF, ZC, BO, TE FEN W&B, P&Z,	FEMA HMA grants OBS OP, OB, CIP
Action 38: **Dune Restoration**: Implement dune restoration and marshland protection techniques for flood storage and surge protection based on the results outlined in the 2018 Coastal Community Resilience and Climate Adaptation Study.	High	Medium	2019—2024	High	High	OSB BOS/BOF, CC, LAC, DPW, DEEP FEN W&B, P&Z	OSB CIP DEEP
Action 39: Conduct a **Parking Emergency Access & Evacuation Planning Study** based on parking areas noted in the 2014 HMP Update to evaluate 1) siting and construction of off-street parking lot to deter on-street parking near A) North Main Street, B) Sheffield/Main Street C) High Density/Intensity Areas; 2) better organize on-street parking.	High	Medium	2019—2023	Medium	Medium	OSB BOS/BOF, DPW, TE FEN W&B, P&Z ConnDOT Amtrak	FHWA, Amtrak ConnDOT Statewide Transportation Improvement Project (STIP) Regional Transportation Program (RTP) OSB CIP

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
FLOOD HAZARDS (Cont.)							
Action 40: **Conduct a Drinking Water and Supplies Caches Assessment** to identify the amount and location for placing supplies and water in areas of town during a major flooding event.	High	Medium	2019—2023	Low to Medium	Medium	OSB BOS/BOF, DPW, TE FEN W&B, P&Z	EPA CT DEEP OSB CIP
Action 41: **Road Evaluation**: Evaluate roads at least annually to develop plans for improvement or elevation for emergency access and evacuation. Use results for **Attachment 7** in the 2018 Coastal Community Resilience Study (2018 CCR Study) as a guide for near and long term implementation and planning. **Develop conceptual plans and prioritization** for pursuing engineering, design and construction funding **of roadways** identified in the 2014 HMP Update. Roadways should include: 1) Banbury Crossing; 2) South Cove Causeway; 3) South Cove Causeway; 4) Plum Bank RD and Salt Meadow RD near Cornfield Pt.; 5) Shetucket Trail; 6) Fourth & Sunset Avenues; 7) Old Post RD (eastern end); 8) Shetucket Trail-to-Bellaire DR; 9) Owenco, Obed & Nehantic Trails; 10) Mohican & Red Bird Trails; 11) Bokum-to-Barley Hill Road; 12) Dwayne to Kitteridge Hill RD; 13) Rock Ridge DR to Dibble RD; 13) Niabang Ave. at Route 154; 14) Sequassen Ave; and 15) Day DR to Acorn Dr (Westbrook).	High	Medium	2019—2023	Medium to High	High	OSB BOS/BOF, DPW, TE FEN W&B, P&Z ConnDOT	FHWA ConnDOT Statewide Transportation Improvement Project (STIP) Regional Transportation Program (RTP) OSB CIP
Action 42: Per **Attachment 7** of the 2018 Resilience Study pursue grant funding for engineering, design, construction (as needed) for Near-Term Roadway Improvement Candidates including: 1) Elm Street underpass and roadway toward culvert over Oyster River; 2) Main and College Streets in the low-lying areas b/w Maple Ave. and Saybrook Point; 3) Sections of Rt. 1/ Boston Post Road at lower elevations near and adjacent to the Oyster River; 4) Sequassen Ave.; and 5) sections of Maple Ave.	High	Medium to High	2019—2024	Medium to High	High	OSB BOS/BOF, DPW, TE FEN W&B, P&Z ConnDOT	FHWA ConnDOT STIP RTP OSB and FEN CIPs
Action 43: **South Cove**: Evaluate to develop plans for 1) improving emergency access and evacuation; 2) options for potential dredging to improve flood storage; and 3) to evaluate the potential for creating a harbor of refuge.	High	Medium	2019—2022	Medium	Medium	OSB BOS/BOF, DPW, CC, TE FEN W&B, P&Z	and FEN CIPs

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
FLOOD HAZARDS (Cont.)							
Action 44: **Designate the Board of Selectmen (BOS) and Board of Warden & Burgesses (W&B) as the Town Resiliency Program Lead**. Task the BOS with annually requesting Town Departments/Staff to report on policies/plans/projects to ensure integration of coastal resiliency/climate change for the future.	High	Low	Ongoing	Low	High	OSB BOS/BOF, PC	OSB OP,
Action 45: Establish the BOS as the **Flood and Erosion Control Board (FECB)** for the Town of Old Saybrook per Section 25-85 Establishment of flood or erosion control system. The FECB may be the BOS in municipalities with a population not exceeding 50,000. FECB projects will require political support, funding and engineering. The BOS could create ad-hoc committees or use the Town Engineer to investigate these projects as they arise on a case by case basis similar to how the Town has made repairs to sea walls and other public improvement projects.	High	Low	2019—2021	Low to Medium	High	OSB BOS/BOF, PC, LUD FEN W&B and P&Z	OSB OP, CIP FEN OP, CIP
Action 46: **Repetitive Loss Area Analysis (RLAA).** Many repetitive loss (RL) structures have been demolished and rebuilt or elevated to higher standards than minimum FEMA requirements. Based on this extensive and successful effort by the Town and residents, it is recommended to perform a formal RLAA to identify the impact to Town's NFIP insurance rate due to repetitive loss. The results from the RLLA will help further support Town and property owner resilience and mitigation activities, including acquiring, relocating and/or flood mitigation of RL properties.	Medium	Low	2019—2021	Low to Medium	High	OSB BOS/BOF, LUD, DPW FEN W&B and P&Z	CT DEEP, OSB & FEN OP, CIP
Action 47: **Integrate findings and resilience strategies** presented in the Old Saybrook Coastal Resilience and Adaptation Study into the **Plan of Conservation and Development**.	High	Low	2019—2021	Low	High	OSB PC, LUD Economic Development (ED)	OSB OP
Action 48: **NATIONAL FLOOD INSURANCE PROGRAM (NFIP)**. Implement a survey and monitoring program to readily **document pre- and post-storm conditions** to make efficient and optimize opportunities for fed-	High	Low to Medium	2019—2022	Medium	High	OSB BOS/BOF, OEM DPW FEN W&B and P&Z	FEMA DEMHS OSB CIP

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
FLOOD HAZARDS (Cont.)							
Action 49: **NFIP.** Until FEMA changes their mapping guidelines to address sea level rise, provide residents with **Town-specific flood hazard maps** reflecting sea level rise projections for 2050 and 2100, in line with the State of Connecticut. The analyses performed in this study and presented in **Attachment 2** of the 2018 OSB Coastal Resilience Study provide a start in developing these planning maps.	High	Medium	2019—2021	Low to Medium	High	OSB BOS/BOF, LUD	FEMA FMA, PDM, HMGP DEMHS OSB OP, CIP
Action 50: INGRESS AND EGRESS: Roads. Develop a **roadway improvement plan** to identify specific projects, project costs and funding mechanisms. It is recommended that the plan include a strategy of improving only the portions of key roads that are subject to chronic and high probability floods in the near-term about 4 to 10 miles of road, excluding the causeway. Hold formal meetings with ConnDOT regarding improvement and resilience of State roads and bridges located within the Town limits.	High	Medium	2019—2024	Medium	High	OSB BOS/BOF, PC, DPW FEN W&B and P&Z	Federal Highway Administration (FHWA) CT DOT OSB CIP FEN CIP
Action 51: PUBLIC SAFETY: **Emergency Response**. Develop alternative emergency response capabilities such as amphibious emergency vehicles for use when roads are flooded. See example: https://www.dvidshub.net/news/252966/west-virginiaswift- water-rescue-team-attains-fema-level-2-status-prepares-future-disasters.	High	Medium to High	2019—2024	Medium to High	High	OSB BOS/BOF, FD, PD, OEM	FEMA EMPG DEMHS
Action 52: PUBLIC SAFETY: **Evacuation Planning**. Establish and communicate evacuation guidance and protocols. **Attachment 4** of the 2018 OSB Coastal Resilience Study provides roadway flood details for evacuation planning and predicted shelter requirements.	High	Medium	2019—2022	Low to Medium	High	OSB BOS/BOF, FD, PD, OEM FEN	FEMA EMPG DEMHS
Action 53: PUBLIC SAFETY: **Flood Protection**. Provide flood protection for at-risk Essential and Lifeline Facilities. **Attachment 4** and **Attachment 7** of the 2018 Resilience Study provides flood risk details and recommendations for the Essential and Lifeline Facilities.	High	High	2019—2024	High	High	OSB BOS/BOF, PC	FEMA HMGP, PDM and FMA

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
FLOOD HAZARDS (Cont.)							
Action 54: **PROTECTION OF PRIVATE PROPERTY**. Protect homes, on an individual property basis, using methods available under the existing flood regulations and ordinances (such as elevating houses). Evaluate the use of community-wide standards for elevating buildings to: 1) provide community aesthetic consistency; and 2) reduce the challenges of elevating roads (i.e., multiple, differing entry elevations.) Review and modify the Town's Floodplain Management Ordinance to incorporate coastal resilience and adaptation, including adoption of a Town Design Flood Elevation (DFE). Based on the results of the evaluation provide guidance to homeowners on floor elevations considering sea level rise.	High	Medium	2019—2024	Medium	High	OSB BOS/BOF, PC, BD, Beach Associations FEN W&B and P&Z	FEMA HMGP, PDM and FMA HUD CDBG-DR NOAA OSB and FEN OP, CIP
Action 55: Employ **living shoreline solutions** for select areas including low wave energy environments such as tidal marsh borders and river mouths.	High	Medium	2019—2024	Medium to High	Medium	OSB BOS/BOF, PC, LUD, DPW, Beach Associations FEN W&B and P&Z	FEMA HMGP, PDM and FMA CIRCA
Action 56: Develop program to **maintain existing groins and sea walls**.	H	Medium	2019–2022		High	OSB BOS/BOF, DPW, Beach Associations FEN W&B and P&Z	FEMA HMGP, PDM and FMA CIRCA USACE
Action 57: Develop a Town-wide and regional **beach nourishment plan**. Include an evaluation the technical feasibility of constructing dunes and berms into the plan.	High	Medium	2019—2022	Low to Medium	High	OSB, FEN, Beach Associations, Regional Committee to be formed.	FEMA OSB OP, CIP FEN OP, CIP
Action 58: Create a **re-development plan for Saybrook Point** that requires measures to achieve compliance with flood regulations as well as addresses sea level rise.	High	Medium	2019—2024	Medium	High	OSB BOS/BOF, PC Coastal Resilience Management Team (CRMT)	FEMA FMA OSB OP, CIP FEN OP, CIP
Action 59: **Coordinate with USACE** relative to proposed, **future dredge projects** and re-use of dredge materials for Town beach nourishment, salt marsh maintenance and restoration projects.	High	Low	2019—2024	Low	High	OSB BOS/BOF, PC, DPW, CRMT FEN W&B and P&Z	USACE OSB OP, CIP FEN OP, CIP

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
FLOOD HAZARDS (Cont.)							
Action 60: STORMWATER. **Analyze the existing stormwater infrastructure** under precipitation only and combined coastal flood-precipitation events. This data is necessary to comprehensively characterize the Town's flood risk and to identify the need for additional catch basins/pump stations/additional tide gates/green infrastructure.	High	Medium	2019—2022	Medium	High	OSB BOS, PC, CRMT FEN W&B and P&Z	EPA CT DEEP OSB OP, CIP FEN OP, CIP
Action 61: Every 10-years, update future coastal **flood risk overlay maps** and sea level rise projections.	High	Medium	2019—2028	Low to Medium	High	OSB BOS/BOF, PC, CRMT	FEMA, NOAA, USACE OSB OP, CIP FEN OP, CIP
Action 62: Develop an **operations plan** for stormwater structures including tide gates and culverts for pre- and post-flood recovery operations, to promote post-flood drainage. Maintenance activities are covered under the Town's MS4 General Stormwater Permit.	High	Low to Medium	2019—2023	Low to Medium	Medium	OSB BOS/BOF, DPW, TE	EPA CT DEEP OSB OP, CIP
Action 63: **HISTORIC PROPERTIES**. Provide **flood mitigation guidance** to property owners that is consistent with Historic District Regulations. **Attachment 7** of the 2018 Coastal Resilience Study recommends a flood mitigation approach for historic properties.	High	Medium	2019—2022	Low to Medium	High	OSB LUD, Historic District Commission (HDC) FEN P&Z	HUD CT Department of Economic & Community Development (DECD) OSB OP, CIP
Action 64: Request the **USACE** to perform a **feasibility study** under **Section 103** Hurricane and Storm Damage Protection, to support future USACE grants.	MED	Low	2019–2023	Low	Medium	OSB BOS/BOF, LUD, PC, Beach Associations FEN W&B and P&Z	USACE CT DEEP OSB OP, CIP FEN OP, CIP
Action 65: Evaluate Coastal Flood, Sea-Level-Rise and Climate Change Effects on **Municipal Bond Rating.**	High	Low	2019—2023	Low	Medium	OSB BOS/BOF	OSB OP, CIP

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
CLIMATE RELATED HAZARDS: DROUGHT, WILDFIRE & EXTREME TEMPERATURES							
Action 66. Conduct a town-wide study of **ground and surface water capacity** as it relates to planning for droughts.	High	Medium	2019—2023	Low to Medium	High	OSB BOS/BOF, FD, Fire Marshall (FM), CT Water Company (CWC)	CWC OSB OP, CIP
Action 67. Coordinate with the CWC on public **education** and **public service announcements** in anticipation of and during times of drought.	High	Low	2019—2021	Low	High	OSB BOS/BOF, FD, FM, CWC	CWC OSB OP, CIP
Action 68. **Wildfire Education**: Conduct public education and outreach to the public on potential wildfire hazards caused by camp fires & open air burning.	High	Low to Medium	Annually	Low	Medium	OSB BOS/BOF, FD, Fire Marshal (FM)	FEMA EMPG, HMGP, PDM OSB OP, CIP
Action 69. **Firefighting Infrastructure Analysis**: Evaluate existing firefighting infrastructure to identify needs for improvement to cover gaps in availability.	High	Low	HMP Update	Low	High	OSB BOS/BOF, FD, FM, PC	FEMA EMPG, HMGP, PDM OSB OP, CIP
Action 70. **Protect Vulnerable Populations** by: 1) Organize outreach to vulnerable populations to educate citizens on the dangers of extreme heat & cold, and the steps they can take to protect themselves when extreme temperatures occur.	High	Medium	2019—2022	Medium	Medium	OSB BOS/BOF, PD, FD, OEM	FEMA, CT DEEP DEMHS OSB and FEN OPs,
SEVERE WINTER WEATHER HAZARDS							
Action 71. Maintain adequate supply of sand, salt and other **road treatment** materials.	High	Low	Annually	Low	High	OSB DPW FEN	OSB OP, OB

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

MITIGATION ACTIONS	Benefits	Costs	Timeline	Estimated Project Costs	Priority	Responsible Agencies	Potential Funding Sources
SECONDARY HAZARDS: DAM FAILURE							
Action 72. Review and update annually **Emergency Action Plans (EAP)** and Maintenance and Operations Plans for the 3 High Hazard Dams to ensure the plans are up to date & have protocols in place to maintain safe operations of the Dams.	High	Low	2019—2021	Low	High	OSB BOS/BOF, DPW CT DEEP Dam Safety Section	CT DEEP OSB OP, CIP
Action 73. **Town Dam Evaluation**: Inspect Chalker Dam repairs (i.e. minor repairs including brush clearing and repair of gates) as identified in the EAP and Phase 1 Report (see **Attachment 3**).	High	Medium	2019—2024	Low to Medium	High	OSB BOS/BOF; DPW	CT DEEP OSB OP, CIP
Action 74. **Private Dam Evaluation**: Evaluate remaining privately-owned dams (including Cranberry Pond Dam); work with DPW and State DEEP for repairs as needed.	High	Medium	Annually	Low	High	OSB BOS/BOF, DPW, DEEP Private Dam Owners	CT DEEP
Action 75. **Obed Heights Dam Evaluation**: Evaluate Obed Heights Reservoir Dam; work with property-owners and State DEEP for repairs as needed.	High	Medium	2019—2022	Low to Medium	High	OSB BOS/BOF, DPW, DEEP	CT DEEP

Table 5 cont.: Natural Hazard Mitigation Action Matrix & Prioritization

Section 6: Regional and Inter-community Relationships

SECTION 6 - REGIONAL AND INTERCOMMUNITY 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.

The Old Saybrook Planning Commission is the primary Town agency responsible for long-range planning of land development in town. The Fenwick Planning and Zoning Commission is the primary Borough agency responsible for regulating development in Fenwick. Feedback to the Old Saybrook Planning Commission and Fenwick Planning and Zoning Commission was ensured through the participation of the Old Saybrook Director of the Land Use Department and the Zoning Enforcement Officers from both Old Saybrook and Fenwick on the Local Planning Team (LPT). In addition the public meetings were held during official Old Saybrook Planning Commission meetings that included the participation of the Planning Commission members. As a part of developing this new natural hazards mitigation plan, the Town coordinated with the Connecticut Department of Energy and Environmental Protection (DEEP) to update pertinent repetitive loss property and NFIP claims related details for the Town. The LPT also included the participation of other key local, regional and state entities. Neighboring communities and other regional and state entities were provided an opportunity to participate and provide input at the two public meetings held in December of 2018 and April of 2019. The Town and Borough will continue to collaborate with local, regional and state agencies as a part of the implementation of actions outlined in this plan. Below is an overview of the regional partners and facilities, and intercommunity considerations for this plan.

REGIONAL PARTNERS

In many communities, mitigating natural hazards, particularly flooding, is more than a local issue. The drainage systems and shoreline protection structures that serve these communities are a complex system of storm drains, outfalls, roadway drainage structures, on-site septic systems, revetments, sea walls, groins and other facilities owned and operated by a wide array of agencies including but not limited to the Town of Old Saybrook, Borough of Fenwick, Beach Associations, Connecticut DEEP, Connecticut Department of Transportation (DOT), and the U.S. Army Corps of Engineers. The planning, construction, operations and maintenance of these structures are integral to the flood hazard mitigation efforts of communities. These agencies must be considered as 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. **Section 5** of the Plan Update includes several mitigation actions where several of these agencies will participate in moving hazard mitigation efforts forward in collaboration with the Town and Borough. Implementation of these actions will require that all parties work together to develop solutions.

REGIONAL FACILITIES WITHIN OLD SAYBROOK & FENWICK

Major facilities owned, operated and maintained by federal, state, regional or private entities in Old Saybrook and Fenwick include: I-95 (Connecticut Turnpike), and State Routes 1 (Boston Post Road), 9 (Chester Bowles Highway), 154 (Main Street and College Street; Bridge Street and Maple Avenue; Indianola Drive; Plum Bank Road and Great Hammock Road; South Cove Causeway) and 166 (Spencer Plain Road) (CTDOT), Connecticut River Area Health District, Middlesex Hospital Urgent Care, Middlesex Hospital Primary Care, Gladeview Rehabilitation & Healthcare Facility, Apple Rehab Saybrook, lighthouses, and Eversource substations located in Old Saybrook.

INTERCOMMUNITY CONSIDERATIONS

Old Saybrook and Fenwick, as well as its surrounding communities are close to build-out, but some parcels may undergo significant re-development in the future. To avoid impacts from any residential and commercial development, communication between Old Saybrook, Fenwick and the surrounding communities, including input in the review processes, is vital.

Section 7: Plan Adoption and Implementation

SECTION 7- PLAN ADOPTION AND IMPLEMENTATION

Adopting, implementing, monitoring, evaluating, and updating the Town's and Borough's Local Natural Hazard Mitigation Plan Update are necessary steps to sustaining a viable plan that will assist the community in becoming more resilient to natural hazards long into the future. An overview of how the Town will carry out each of these tasks is outlined in the following sections.

PLAN ADOPTION

The Draft Plan was provided to the Town and Borough on May 10, 2019 for review and distribution to the public, and local, regional and state stakeholders. The Town and Borough provided input to the planning consultant on May 29, 2019. A Revised Draft Plan was provided to the Town and Borough on June 5, 2019. The Town and Borough posted the Draft Plan on the Town and Borough websites on June 6, 2019 for public review and input. A public meeting was held on **June** 19, 2019 at Old Saybrook Town Hall to: 1) present the Draft Plan and 2) solicit input and feedback on the Draft Plan from the public. Based on feedback provided at the public meeting and received from the public online, the Draft Plan was revised on **ADD MONTH XX, 2019**. The Town and Borough then submitted the Draft Plan Update to the Connecticut Department of Emergency Management Agency and Homeland Security (DEMHS) and the Federal Emergency Management Agency (FEMA) for review. Upon receiving conditional approval of the plan by FEMA, the plan was presented and approved by the Old Saybrook Board of Selectmen on **ADD MONTH XX, 2019** and Fenwick Board of Warden & Burgesses on **ADD MONTH XX, 2019**. A copy of both plan adoption letters are included in the front of this plan.

PLAN IMPLEMENTATION

The implementation of the Plan commences upon its formal adoption by the Board of Selectmen, Board of Warden & Burgesses and official approval by DEMHS and FEMA. Section 5 details the mitigation strategy that prioritizes the various actions identified to reduce the impacts from future natural hazards. A local hazard mitigation working group (including the LPT) will be responsible for overseeing the implementation of the plan.

In addition, the Local Planning Team (LPT), that includes Town and Borough officials as presented in Section 2, will identify existing planning documents and regulations where relevant policies and actions outlined in this Plan Update may be incorporated to improve the potential for the implementation of mitigation actions across related programs and agencies. Relevant programs, policies, and/or regulations may include updates to existing polices and regulations such as the following:

- Updates to the Local Building Code based on changes that occur to the Connecticut State Building Code
- Old Saybrook Plan of Conservation and Development Update (ongoing)
- Old Saybrook Chalker Dam Emergency Action Plan Update (forthcoming in 2019)
- Old Saybrook Zoning Regulations, March 1, 2019, including Section 10.11 Floodplain Compliance
- Old Saybrook Zoning Regulations, March 1, 2019, including Section 37 Saybrook Point District
- Old Saybrook Zoning Regulations, March 1, 2019, including Section 32 Shopping Center Business B-2 District
- Old Saybrook Zoning Regulations, March 1, 2019, including Section 59 Coastal Area Management (CAM) Zone
- Old Saybrook Town Ordinances, Chapter 128 local floodplain ordinance
- Fenwick Zoning Regulations, September 1, 2018, including Section 7.2 Sedimentation and Erosion Control
- Fenwick Zoning Regulations, September 1, 2018, including Section 7.3 Flood Plain Construction Requirements
- Fenwick Borough Ordinances, Flood Plain Management Regulations, February 15, 2019.
- Fenwick Plan of Conservation and Development (2017)

PLAN MONITORING AND EVALUATION

On an annual basis, the LPT led by the Old Saybrook First Selectman and Fenwick Warren, will coordinate a meeting to review the Plan progress over the last year. This Plan review will include an evaluation of hazard mitigation activities such as ongoing projects, changes in developing new mitigation actions resulting from a natural disaster event, changes in local, State and federal regulations that may impact the implementation of future projects, and modification of existing actions. As a part of this process, the working group will evaluate and assess the effectiveness of the action items outlined in the plan have been in achieving the plan goals and objectives. The results of this evaluation will be posted to the Town and Borough websites to gather public input on the progress of the Plan as well as to provide the public with the opportunity to provide additional mitigation activities for the working group's consideration.

A review and evaluation of the Town's and Borough's HMP Update will be conducted on a 5-year basis in compliance with the 2000 Disaster Mitigation Act and Part 201.6 of 44 Code of Federal Regulations (CFR). In the event of a major disaster event impacting the Town of Old Saybrook and Borough of Fenwick, the Town and/or Borough may update the plan at that time with actions to address unexpected impacts resulting from the damages to the community, if needed.

FEDERAL AND STATE FUNDING SOURCES

Several of the proposed hazard mitigation projects and actions may be eligible activities for funding under the three FEMA Hazard Mitigation Assistance (HMA) Grant Programs. The FEMA HMA Grant Programs include two non-disaster mitigation grant programs that include the Pre-Disaster Mitigation and Flood Mitigation Assistance grant programs, and one disaster mitigation grant program that is the Hazard Mitigation Grant Program (HMGP). State and federal Funding source details are presented in **Attachment 5.**

Attachment 1: Community Profile

Community Profile Overview

This section of the Plan presents details about the Town assets which categorically include:

- People
- Support, High Occupancy and Vulnerable Population facilities;
- Essential Facilities including emergency response, police, fire, hospitals, etc.;
- Lifeline Systems including water, wastewater, electrical power, etc.;
- High Potential Loss Facilities, including high hazard dams; and
- Transportation Infrastructure.

Demographic Overview

Per the 2010 United States Census and 2013-2017 American Community Survey:

Age and Sex:

Population:	10,242
Population change since 2000:	+/- 1.1%
Percent female/male:	52.6%/47.4%
Age:	
persons <5 years:	3.6%
persons <18 years:	19.8%
persons ≥ 65 years:	25.3%

Race:

White alone:	90%
Black or African Amer. alone:	1.1%
Amer. Indian or Alaska Native alone:	0
Asian alone:	4.3%
Two or more races:	3.1%
Hispanic or Latino:	5.5%

Health:

With disability, under 65 years:	7.9%
Persons w/o health insurance, under 65 years:	7.6%

Education:

High school graduate or higher, greater 25 years:	94.2%
Bachelor's degree or higher, greater 25 years:	42.6%

Economy:

In civilian labor force, total, greater 16 years:	62.6%
In civilian labor force, female, greater 16 years:	56.9%

Income and Poverty:

Median household income (2017$):	$74,185
Per capita income (2017$):	$44,026
Persons in poverty:	4.8%

Family and Living Arrangements:

Households :	4,255
Persons per Household:	2.36
Language spoken at home other than English, greater than 5 years:	12.6%
Median house cost:	$373,200
Percent owner-occupied:	79%

Population Density: 680.6/sq. mile

The Town and Borough combined have a total area of 21.6 square miles that includes 15 square miles of land and 6.6 square miles of water. Old Saybrook has the typical physical characteristics of a Long Island Sound coastal town, with uplands bordered by low-lying areas, tidal wetlands, salt marshes, tidal flats, and beaches. Old Saybrook has over 23 linear miles of shoreline abutting Long Island Sound (6 miles) and the Connecticut River (17 miles). The areas to the south of Interstate 95 (I-95) are low-lying, consisting mostly of tidal marsh and coastal plain. The area to the north of I-95 consists of rolling hills of bedrock and glacial till, with a network of valley streams and inland wetlands.

Demographics

Based on the 2010 U.S. Census, the population per square mile is 680.8, which is lower than the average for Connecticut as a whole (738.1), but higher than Middlesex County (448.6). (**Figure 1-1**)

The number of residents has decreased from 10,367 in the 2000 US Census to 10,242 in 2010. Old Saybrook and Fenwick include a largely white population, representing about 90% of all residents. Hispanics or Latinos make up the largest single minority group at 8.8% of all residents.

The population includes 19.4% of residents under the age of 18, 3.4% between the ages of 20 to 24, 16.4% between the ages of 25 to 44, 33.5% between the ages of 45 to 64, and 25.3% who are 65 years or older.

There are 4,255 households, with an average household size of 2.36.

The median household income in Old Saybrook was $74,185, which is slightly above the median averages of $73,781 for the State and lower than $81,673 for Middlesex County. Poverty is at 4.8% which is lower than the State and County rates of 10.1% and 6.8%, respectively.

Housing costs are $373,200 for the median value, owner-occupied housing unit compared to the State at $270,100 and Middlesex County at $283,700. Seventy-nine (79) % of the housing units are owner-occupied compared to

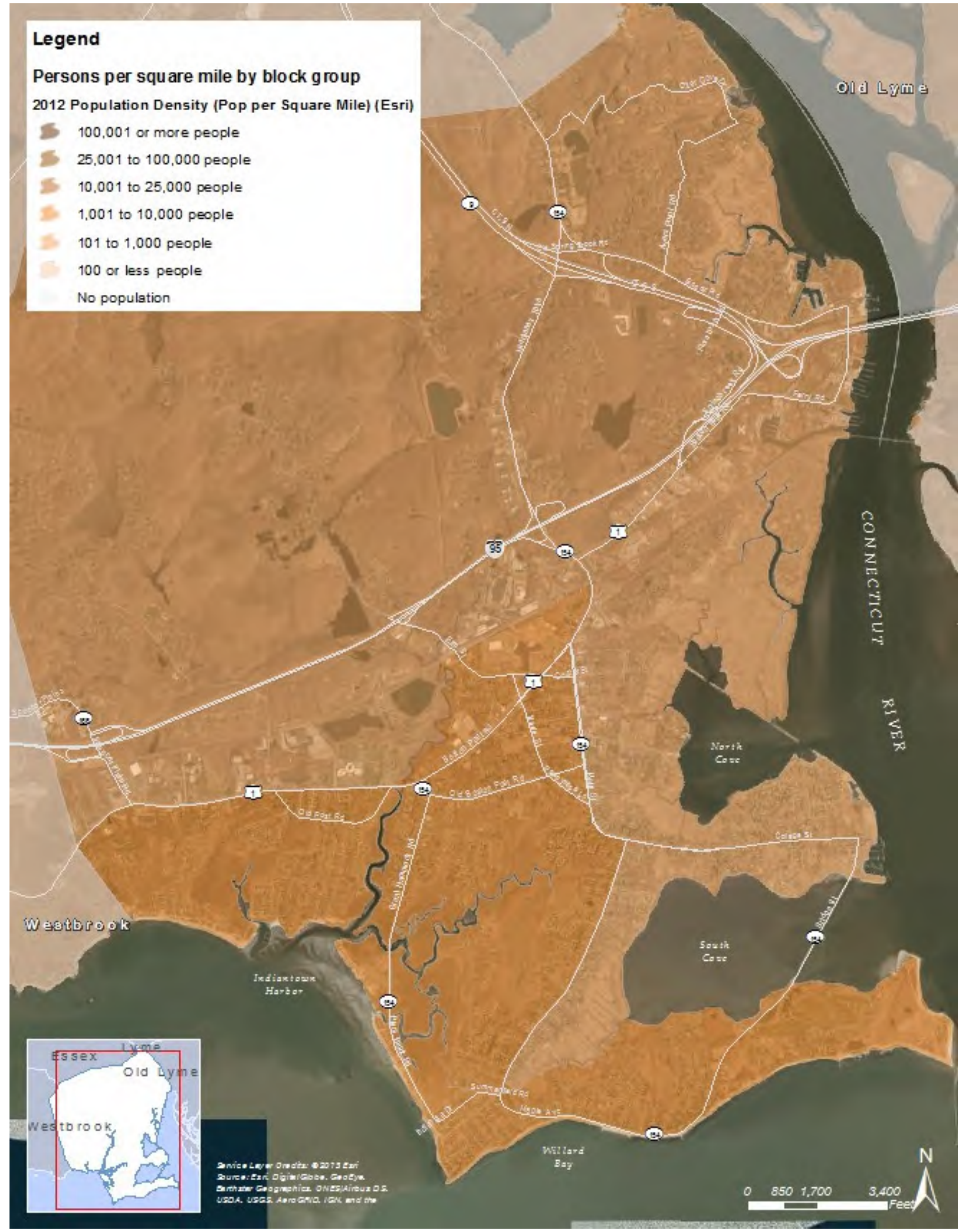


Figure 1-1: Population Density

Social Vulnerability

The term Social Vulnerability describes how resilient a community is to external stresses, such as natural hazards, on human health. The Social Vulnerability Index (SVI) employs U.S. Census Bureau variables to identify neighborhoods that may need additional support in preparing for hazards or recovering from disasters, and is a useful tool for emergency response planners and public health officials. U.S. Census Bureau data to determine the social vulnerability of every census tract (census tracts are subdivisions of counties for which the Census Bureau collects statistical data). The SVI ranks each tract on 15 social factors, including poverty, lack of vehicle access, and crowded housing, and groups them into four related themes: 1) Socioeconomic; 2) Household Composition/Disability; 3) Each tract receives a separate ranking for each of the four themes, as well as an overall ranking.

The SOVI for the Town is categorized as Medium for the entire Town based on the results of two US Census tracts, and as shown in **Figure 1-2**.

A detailed risk profile, by census tract within the Town was performed using the ATSDR SVI Dashboard https://svi.cdc.gov/map.aspx. The results are presented in **Table 1-1**.

This analysis identified only one Social Vulnerability Index flag in each of the two tracts: Household Composition - Persons aged 65 and older. For this category, Old Saybrook ranks in the top 91st to 98th percentile of all US Tracts, with approximately 26.9% of Old Saybrook's population meeting this category. Old Saybrook's overall vulnerability ranks between the 28th percentile (southern tract) to 35th percentile (northern tract) among all US Tracts.

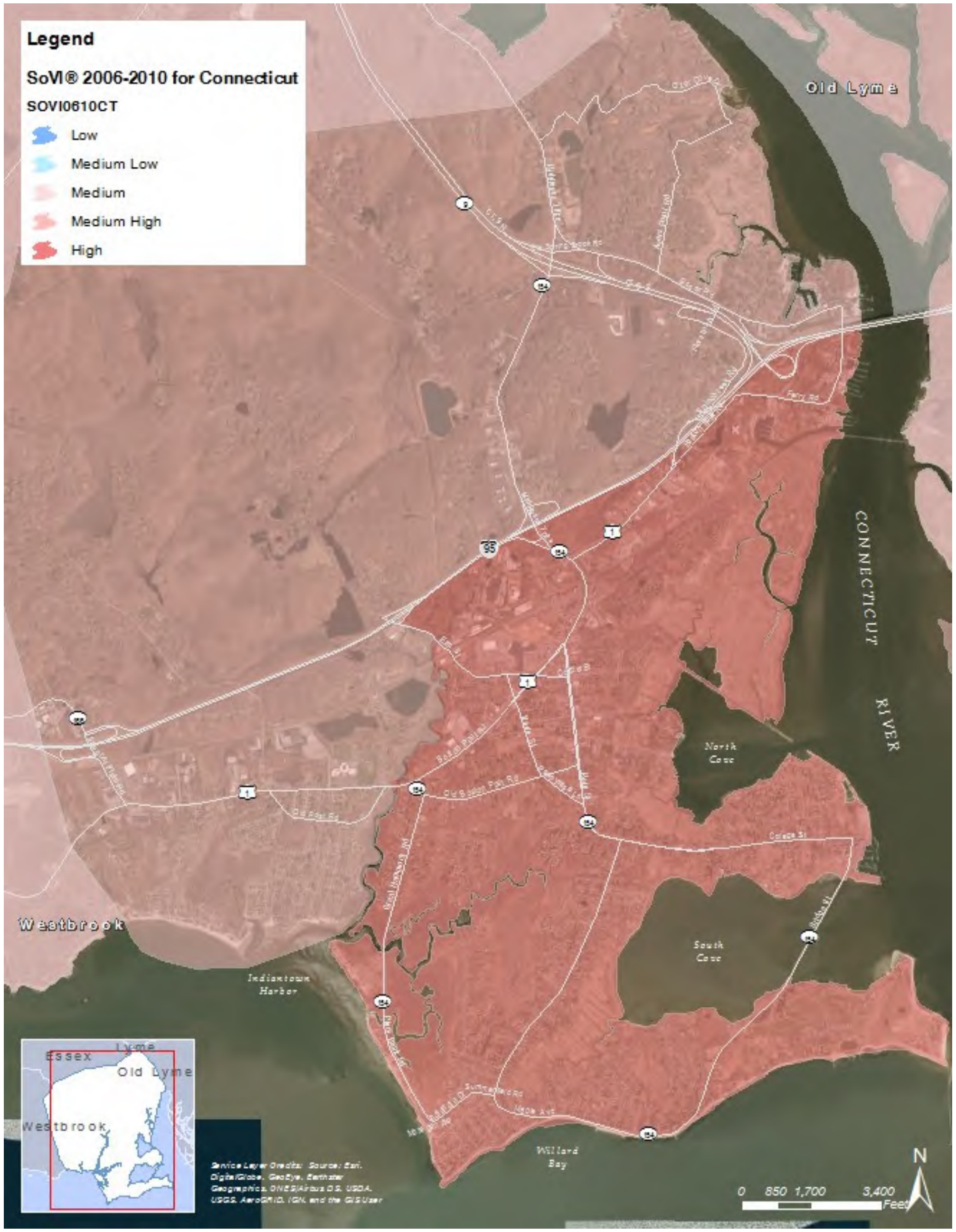
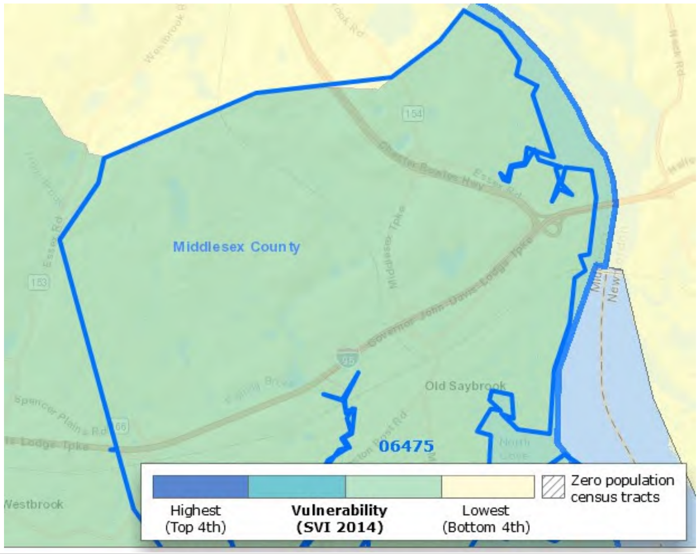


Figure 1-2: Social Vulnerability Index

Attachment 1: Community Profile

US Census Tract 670100



Additional Data	Number	Number MOE	Percentage	Percentage MOE
Uninsured in the total civilian noninstitutionalized population estimate, 2010-2014 ACS	204	95	4.3%	1.9%
Estimated daytime population, LandScan 2012	3771			

Additional data: 203 individuals within census tract 670100 are predicted to be uninsured. (4.3% of tract popula-

Socioeconomic Theme						
Measure	**Number**	**Number MOE**	**Percentage**	**Percentage MOE**	**Percentile Rank (among all CT tracts)**	**SVI Flags**
Persons below poverty estimate, 2010-2014 ACS	120	68	2.5%	1.4%	13th	No
Civilian (age 16+) unemployed estimate, 2010-2014 ACS	97	70	4.0%	2.7%	5th	No
Per capita income estimate, 2010-2014 ACS*	$43,787	$4,769			28th	No
Persons (age 25+) with no high school diploma estimate MOE, 2010-2014 ACS	308	102	8.7%	2.8%	53rd	No
SOCIOECONOMIC DOMAIN SUMMARY					20th	0

* Per capita income is the average income per person in each tract. Unlike the other variables for which a high percentage indicates potentially higher social vulnerability, a higher per capita income is associated with lower social vulnerability.

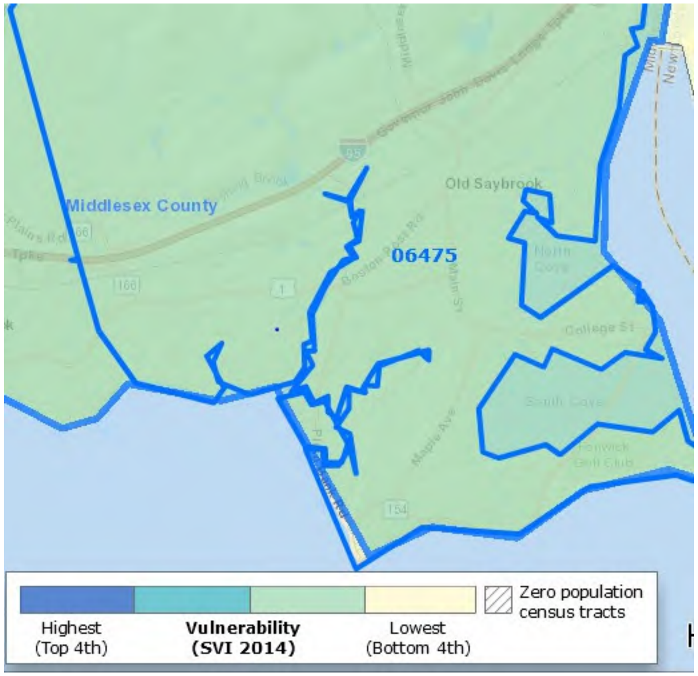
Household Composition/Disability Theme						
Measure	**Number**	**Number MOE**	**Percentage**	**Percentage MOE**	**Percentile Rank (among all CT tracts)**	**SVI Flags**
Persons aged 65 and older estimate, 2010-2014 ACS	1,099	135	22.5%	2.4%	91st	Yes
Persons aged 17 and younger estimate, 2010-2014 ACS	1,129	123	23.1%	123.0%	60th	No
Civilian noninstitutionalized population with a disability estimate, 2010-	500	121	10.5%	2.4%	50th	No
Single parent household with children under 18 estimate, 2010-2014 ACS	107	47	5.9%	2.6%	38th	No
HOUSEHOLD COMPOSITION/DISABILITY DOMAIN SUMMARY						

Minority Status/Language Theme						
Measure	**Number**	**Number MOE**	**Percentage**	**Percentage MOE**	**Percentile Rank (among all CT tracts)**	**SVI Flags**
Minority (all persons except white, non-Hispanic) estimate, 2010-2014 ACS	355	498	7.3%	10.2%	13th	No
Persons (age 5+) who speak English "less than well" estimate, 2010-2014 ACS	88	81	1.9%	1.7%	50th	No
MINORITY STATUS/LANGUAGE DOMAIN SUMMARY					30th	0

Housing/Transportation Theme						
Measure	**Number**	**Number MOE**	**Percentage**	**Percentage MOE**	**Percentile Rank (among all CT tracts)**	**SVI Flags**
Housing in structures with 10 or more units estimate, 2010-2014 ACS	14	27	0.6%	1.1%	18th	No
Mobile homes estimate, 2010-2014 ACS	0	12	0.0%	1.3%	0th	No
ACS	25	29	1.4%	1.6%	58th	No
Households with no vehicle available estimate, 2010-2014 ACS	31	25	1.7%	1.4%	16th	No
Persons in institutionalized group quarters estimate, 2010-2014 ACS	105	42	2.2%	0.8%	74th	No
HOUSING/TRANSPORTATION DOMAIN SUMMARY					33rd	0

Table 1-1: Old Saybrook and Fenwick Social Vulnerability Profile Analysis
https://svi.cdc.gov/map.aspx

US Census Tract 670200



Additional Data	Number	Number MOE	Percentage	Percentage MOE
Uninsured in the total civilian noninstitutionalized population estimate, 2010-2014 ACS	179	104	3.4%	2.0%
Estimated daytime population, LandScan 2012	9210			

Additional data: 179 individuals within census tract 64401 are predicted to be uninsured. (3.4% of tract population)

Socioeconomic Theme						
Measure	**Number**	**Number MOE**	**Percentage**	**Percentage MOE**	**Percentile Rank (among all CT tracts)**	**SVI Flags**
Persons below poverty estimate, 2010-2014 ACS	294	209	5.5%	3.9%	40th	No
Civilian (age 16+) unemployed estimate, 2010-2014 ACS	153	108	5.8%	3.9%	20th	No
Per capita income estimate, 2010-2014 ACS*	$44,675	$8,326			26th	No
Persons (age 25+) with no high school diploma estimate MOE, 2010-2014 ACS	152	78	3.7%	1.9%	17th	No
SOCIOECONOMIC DOMAIN SUMMARY					22nd	0

* Per capita income is the average income per person in each tract. Unlike the other variables for which a high percentage indicates potentially higher social vulnerability, a higher per capita income is associated with lower social vulnerability.

Household Composition/Disability Theme						
Measure	**Number**	**Number MOE**	**Percentage**	**Percentage MOE**	**Percentile Rank (among all CT tracts)**	**SVI Flags**
Persons aged 65 and older estimate, 2010-2014 ACS	1,654	210	31.0%	4.1%	98th	Yes
Persons aged 17 and younger estimate, 2010-2014 ACS	1,025	204	19.2%	204.0%	26th	No
Civilian noninstitutionalized population with a disability estimate, 2010-	709	196	13.3%	3.8%	75th	No
Single parent household with children under 18 estimate, 2010-2014 ACS	130	105	5.4%	4.4%	34th	No
HOUSEHOLD COMPOSITION/DISABILITY DOMAIN SUMMARY						

Minority Status/Language Theme						
Measure	**Number**	**Number MOE**	**Percentage**	**Percentage MOE**	**Percentile Rank (among all CT tracts)**	**SVI Flags**
Minority (all persons except white, non-Hispanic) estimate, 2010-2014 ACS	398	483	7.5%	9.0%	14th	No
Persons (age 5+) who speak English "less than well" estimate, 2010-2014 ACS	3	64	0.1%	1.3%	8th	No
MINORITY STATUS/LANGUAGE DOMAIN SUMMARY					8th	0

Housing/Transportation Theme						
Measure	**Number**	**Number MOE**	**Percentage**	**Percentage MOE**	**Percentile Rank (among all CT tracts)**	**SVI Flags**
Housing in structures with 10 or more units estimate, 2010-2014 ACS	16	29	0.5%	0.9%	17th	No
Mobile homes estimate, 2010-2014 ACS	4	7	0.1%	0.2%	76th	No
ACS	0	24	0.0%	1.0%	0th	No
Households with no vehicle available estimate, 2010-2014 ACS	40	37	1.7%	1.5%	16th	No
Persons in institutionalized group quarters estimate, 2010-2014 ACS	38	61	0.7%	1.1%	56th	No
HOUSING/TRANSPORTATION DOMAIN SUMMARY					32nd	0

Table 1-1 cont.: Old Saybrook and Fenwick Social Vulnerability Profile Analysis
https://svi.cdc.gov/map.aspx

Figure 1-3: Support, High Occupancy and Vulnerable Population Facilities

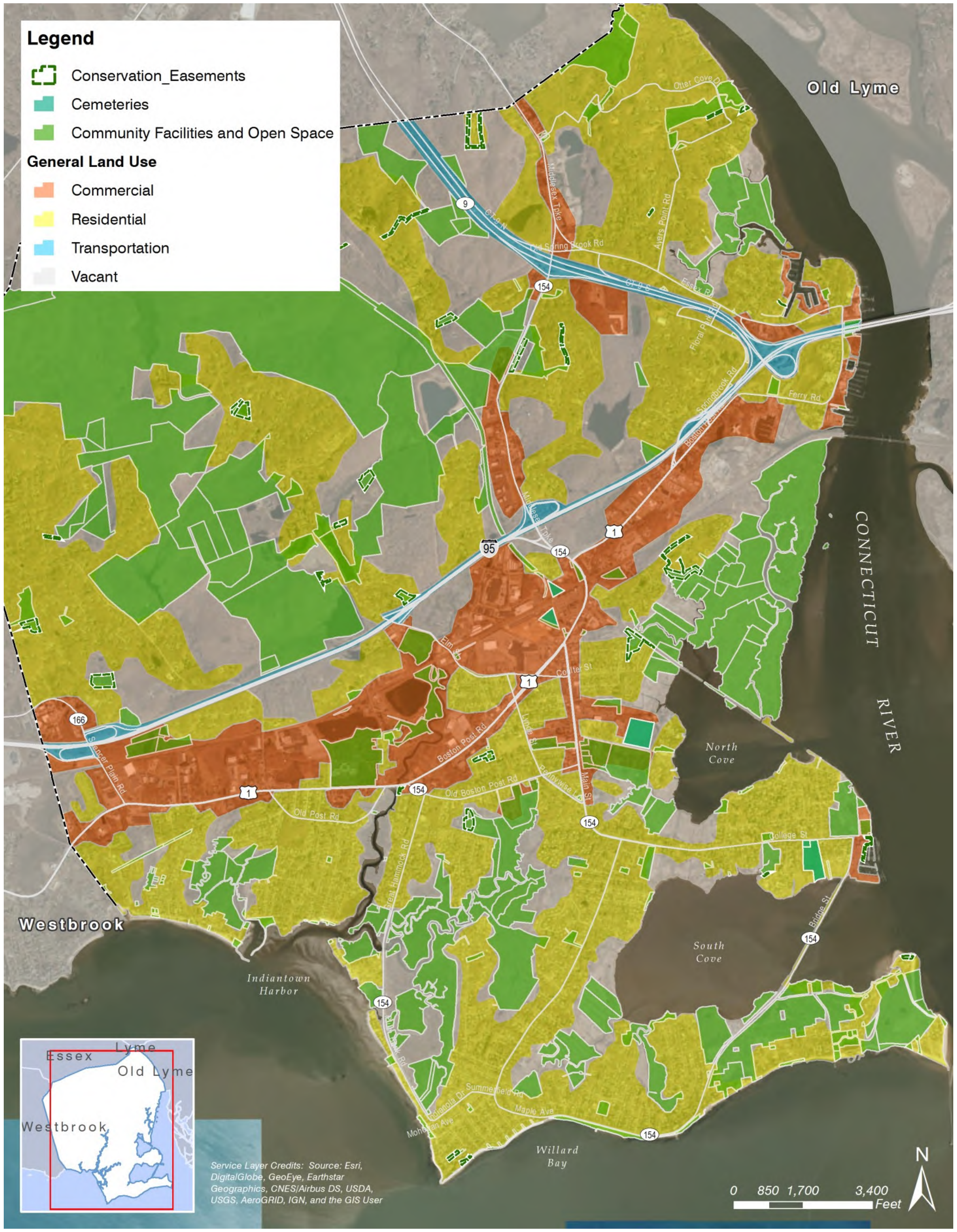
Support, High Occupancy and Vulnerable Populations

Support, High Occupancy, and Vulnerable Populations in Old Saybrook and Fenwick are shown on **Figure 1-3**. These include:

- Long-term Care Facilities,
- Schools,
- Pre-schools and Children's care facilities,
- Town Administration Buildings
- Grocery & Supply Stores
- Theaters
- Religious Institutions
- Museums and Galleries,
- Community Centers & Other Recreational Facilities
- Athletic Fields
- Hotels and Inns

Image of Old Saybrook Town Hall at 302 Main Street

Figure 1-4: Existing General Land Use



Land Use (Existing)

Land area, broken down by general land use category is shown in **Table 1-2** and presented in **Figure 1-4**. Land use trends show that residential development continues to make up the largest area of developed land in the Town at 42% of the total area. It is important to note that most of the land south of Interstate 95 is close to built out which includes most of the Town's commercial and industrial land uses. Since the Town relaxed the process for converting seasonal residential properties to year-round properties in 2011, the Town has seen an increase in conversion of these properties. Of the remaining developed land, about 13% is commercial and 3 % transportation (i.e. roadway right of ways). Overall, the two changes of note in the distribution of land use since the 2014 Plan update with were the increase of 2.5 % of residential land areas and a decrease of just over 2% of Commercial/Industrial land area.

Land Use	Acres Total (2016)	Acres (%) (2016)
Residential:	4,370	44.7
Commercial/Industrial	1,014	10.4
Transportation	293	3
Open Space	1999*	20.4
Vacant Land:	2,139*	21.9
TOTAL	9,766	100.0%

*based on 2011 numbers

Table 1-2 Land Use by Parcel Type

Open Space and Undeveloped Land: Approximately 20% of land in Old Saybrook is open space owned by several public, private and non-profit entities.

Old Saybrook has a legacy of conserving open space because conservation of open space significantly contributes to the overall preservation of the town's character by tempering the impact of development. Therefore, the preservation of open space has been and continues to be an important goal dating back to the 1969 Old Saybrook POCD and 1986 Fenwick POCD. Since the adoption of the 2014 Plan Update continued this tradition continued through the acquisition of close to 940 acres of land from 2015 to 2018.

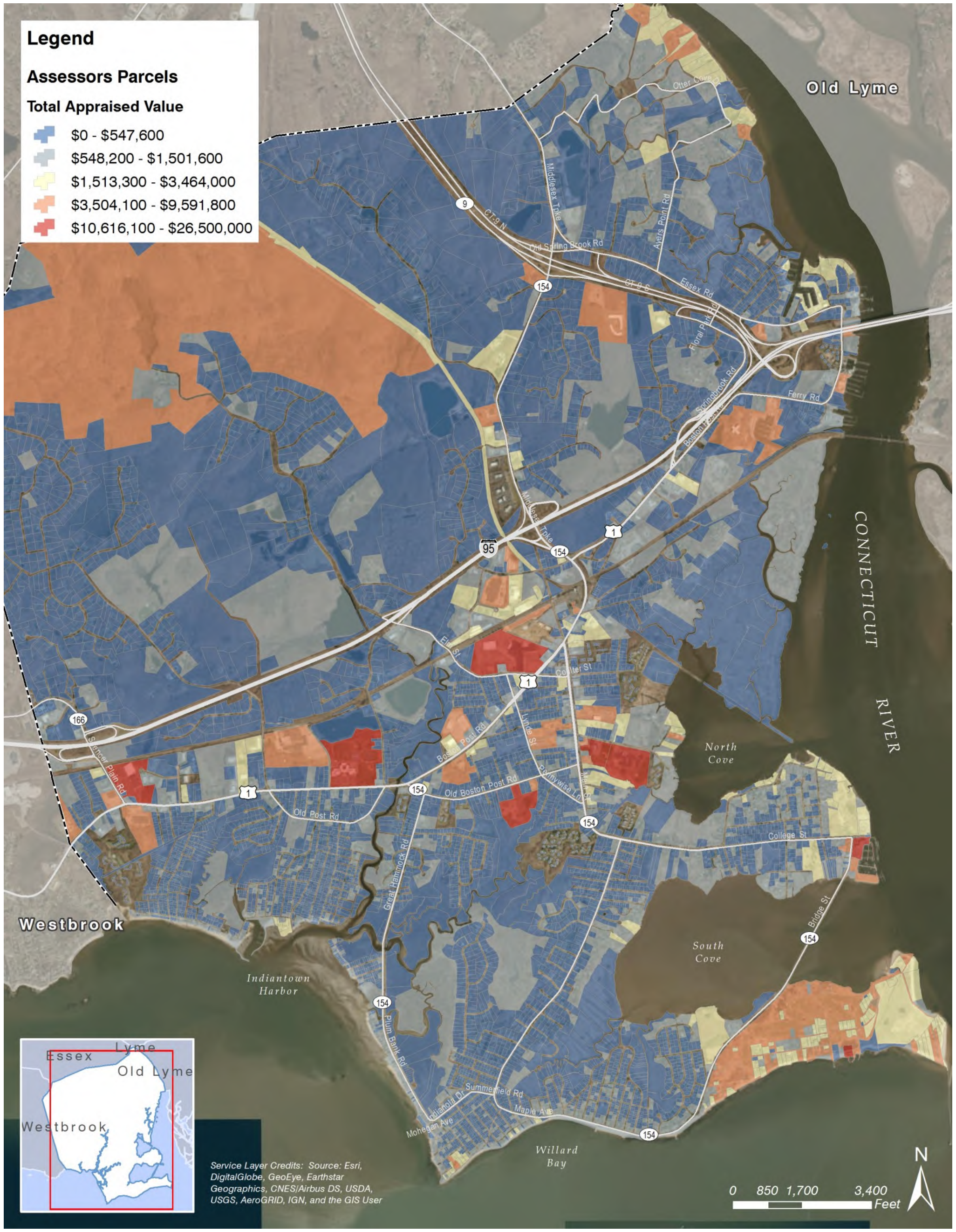


Figure 1-5: Assessed Property Values

Current Asset Value

According to the Town's 2018 Annual Report (2018 AR), Old Saybrook has 5,753 residential dwellings (which accounts for over 92% of structures) and 467 Commercial/Industrial Dwellings. Based on the 2018 AR there are an estimated 6,220 buildings in the Town of Old Saybrook and Borough of Fenwick. The 2018 AR also indicated that there are 12,441 motor vehicles. The 2018 AR noted that permit activity for FY 2017-2018 included 1,127 permits taken out with a construction cost of over $17.5 Million. The report highlighted that commercial construction has been very active and overall construction remained steady.

Figure 1-5 shows the total assessed values through out both the Town and Borough based on the August 2016 Assessment Data provided by the Old Saybrook Tax Assessor.

The total building replacement value (excluding contents) of 1,444 million dollars and 7025 parcels of land with an assessed value of $1,109 million dollars based on August 2016 Town Assessment Data. This indicates that the total real estate assessed property increased by 220 million dollars from the 2014 Plan Update to a total of $2,553 million dollars from $2,333 million dollars. Approximately 92% of the buildings (and 72.45% of the building value) are associated with residential housing. Commercial and Industrial buildings account for 24.2% of the total building value.

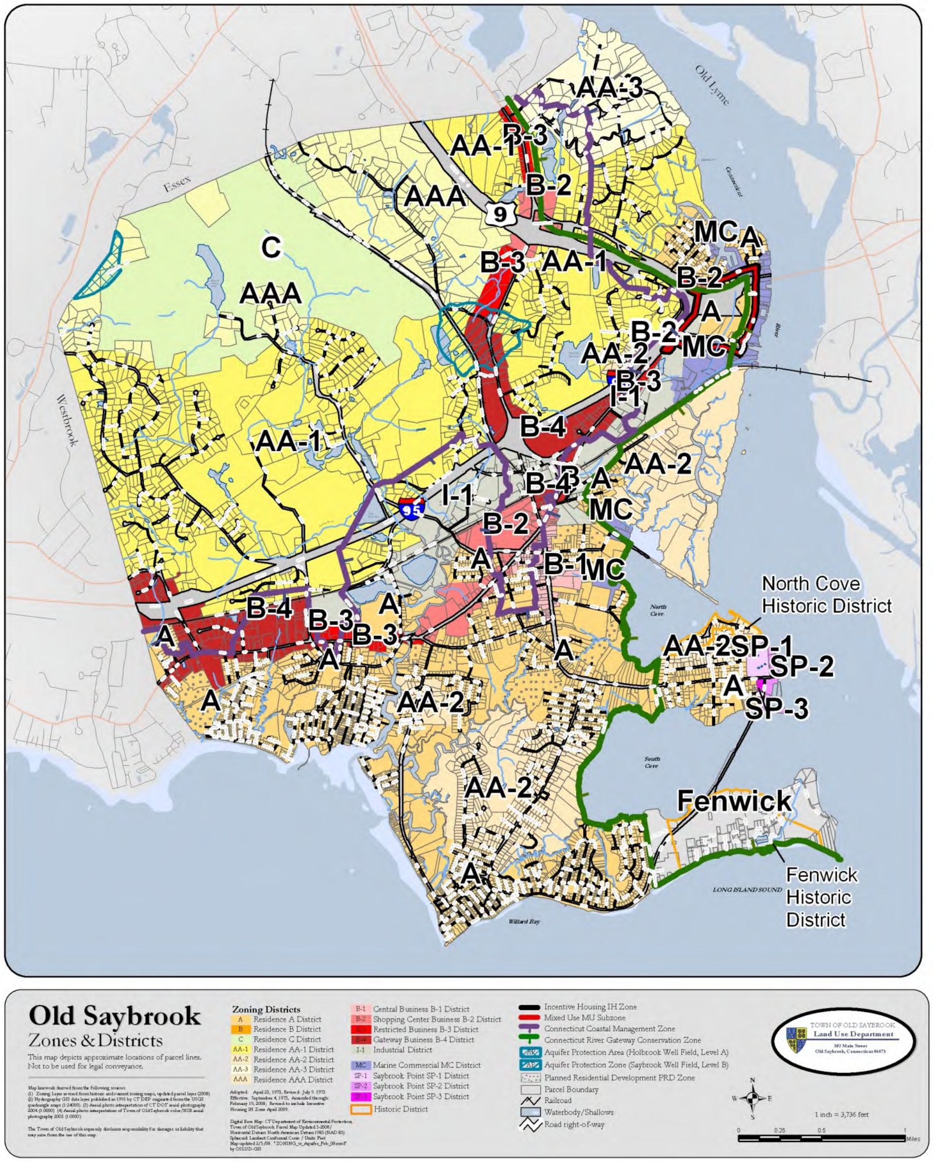


Figure 1-6: Zoning Map

Zoning

The Town of Old Saybrook is divided into seventeen zoning districts as shown on **Figure 1-6**. Zoning Districts include:

- Residential: A, B, C (Conservation District)
- Residential: AA-1, AA-2, AA-3
- Residential: AAA
- Central Business B-1
- Shopping Center Business B-2
- Restricted Business B-3
- Gateway Business B-4
- Marine Commercial MC
- Saybrook Point SP-1, SP-2, SP-3
- Industrial District I-1
- Historic Districts

The Borough of Fenwick has one zoning district that is Residential A.

Land Use (Future)

Future Development Opportunities: The 2006 Old Saybrook Plan of Conservation and Development (POCD) and 2019 Mariner's Way District Plan (2019 MWD Plan) identifies opportunities for economic development, new housing, redevelopment and revitalization. The 2006 POCD identified the following economic development goals as a vision for maintaining the Town's "small town character" through future development that enhances the unique historic and natural setting.

Goals

- To promote the small-town character and unique natural resources of the town as a marketable economic commodity, providing an exceptional quality-of-life for residents and a quality experience for visitors.
- To encourage development of commercial and industrial sites that is consistent with Old Saybrook's small-town character with respect to scale, appearance, and design and with special regard for landscape and other site amenities, traffic safety and convenience, and functional and visual linkages with adjacent areas.
- To periodically review and maintain or revise existing commercial development area boundaries, avoiding intrusions on established residential, civic or environmentally sensitive areas.

To support these goals both the 2006 Old Saybrook POCD and 2019 MWD Plans identified Ferry Point and Mariner's Way as two key areas to prepare and implement plans to redevelop and revitalize both areas. It's important to note that both these areas include structures and land located in the FEMA Special Flood Hazard Area (SFHA).

Future Development Areas:

Area 1: Mariner's Way

The recently adopted 2019 MMWD Plan created the Mariner's Way Tax Increment Financing District (TIF District) and vision for revitalizing the Route 1 East Connector between Saybrook Junction's Town Center and Ferry Point's Marina. The TIF District establishes a dedicated funding mechanism to assist in the implementation of the goals and objectives of the 2019 MWD Plan including: Branding, Economics, Zoning, Transportation, Landscape, Building Patterns, Transition to Town Center, and Transition to the Marina District. Proposed future development areas for Mariner's Way are presented on **Figure 1-7.**

Area 2: Ferry Point

The Ferry Point area (see **Figure 1-8**) of Old Saybrook is located along the Connecticut River in the area of the Baldwin Bridge (I-95). The Ferry Point area has experienced a variety of changes in land uses where restaurants and commercial activities have struggled to take root. Based on these changing land uses the Town identified this area as an opportunity for future redevelopment. The Town led a planning concepts workshop in June 2005 that resulted in the identification of 2 planning concepts for Ferry point. Both concepts included programs for new development that would combine with enhancing the marine elements of the area.

Figure 1-7: Map of three areas proposed for redevelopment: Mariner's Way East, West and Central

Figure 1-8: Overview of the Ferry Point Area in Old Saybrook

Transportation Infrastructure

The Town and Borough are served by major highways (Interstate 95 and Route 9), major arterials such as U.S. Route 1, CT Route 154 and Route 166, and a network of smaller roads that provide access throughout the Town and serve as collectors for the major arterials and highways. The Town is also served by several bus routes of the 9 Town Transit District, as well as a train station which offers a stop on both Amtrak's Northeast Regional service and the Shore Line East Railroad. The Town's piers, dock and marinas, while not formally part of the Town's transportation system, are available to provide water access and egress.

An overview of the roadways, bridges and culverts, by jurisdiction, is presented below and is followed by a detailed list of each road and bridge included for analysis for this evaluation. **Figure 1-9** shows the locations of the major transportation infrastructure.

Roads

The State roads make up approximately 47 miles of total roadway within Old Saybrook. The four (4) key State roads include:

- Interstate I-95 (Connecticut Turnpike)
- Route 9 (Chester Bowles Highway)
- Route 1 (Boston Post Road)
- Route 154 (Main Street and College Street; Bridge Street and Maple Avenue; Indianola Drive; Plum Bank Road and Great Hammock Road; South Cove Causeway)
- Route 166 (Spencer Plain Road)

Municipal roads make up approximately 88 miles of total roadway within Old Saybrook. "Key" roads (including both municipal and State roads) are the main arteries serving Old Saybrook and also provide Town ingress and egress (to State highways). These roads are also essential for providing emergency response services and for evacuation. In addition to the State roads, key municipal roads include the following:

- Essex Road
- Ferry Road
- Springbrook Road
- Elm Street
- Lynde Street
- Pennywise Lane
- Sheffield Street
- Old Boston Post Road
- Chalker Beach Road
- Baum Avenue
- Sea Lane

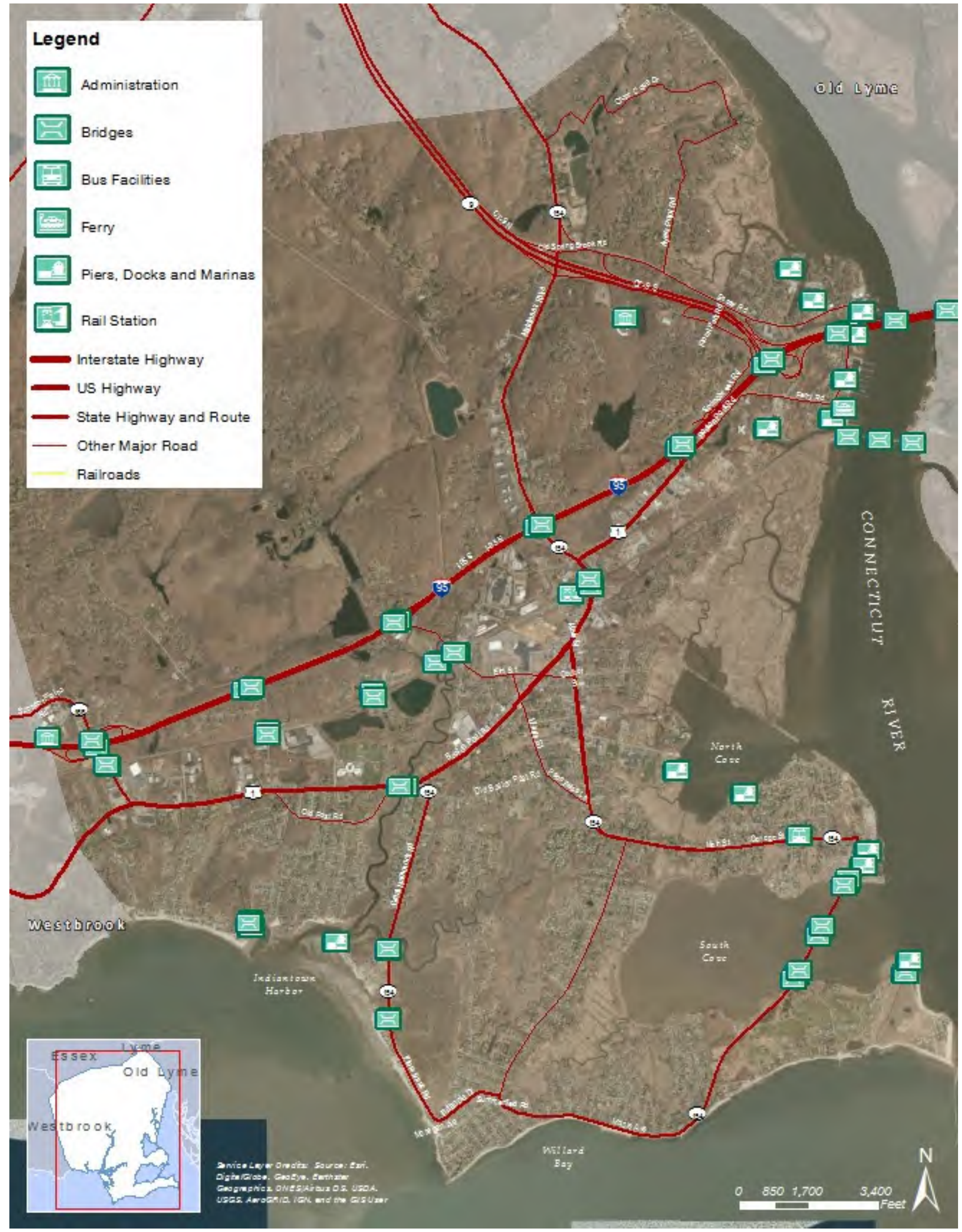


Figure 1-9: Transportation Infrastructure

Transportation Infrastructure (cont.)

Bridges

There are 22 bridges in Old Saybrook and Fenwick, including bridges where I-95 (Connecticut Turnpike) overpasses Town and State roads, Amtrak rail bridges overpassing Town and State roads, culverts supporting roadways at rivers, and the South Cove Causeway. **Figure 1-10** presents the transportation infrastructure including culverts.

Six (6) I-95 (Connecticut Turnpike) bridges located within the Town limits:

- I-95 Bridge over School House Road
- I-95 Bridge over Elm Street
- I-95 Bridge over Middlesex Turnpike
- I-95 Bridge over Springbrook Road
- I-95 Bridge over Essex Road
- I-95 Bridge over Route 9

Three (3) Amtrak Rail bridges:

- Amtrak Rail Bridge over the Connecticut and Oyster Rivers
- Amtrak Bridge over Elm Street

Five (5) State bridges, including three bridge structures that are part of the South Cove Causeway:

- Raymond E. Baldwin Bridge over the Connecticut River
- Route 1 Bridge over the Oyster River
- Causeway Middle Bridge over South Cove (Route 154)
- Causeway North Bridge over South Cove (Route 154)
- Causeway South Bridge over South Cove (Route 154)

Eight (8) Town bridges:

- Great Hammock Road Bridge over Back River
- Ingham Hill Road Bridge over Amtrak
- Nehantic Trail Bridge over Hager Creek
- Plum Bank Road Bridge over Plum Bank Creek
- School House Road Bridge over Amtrak
- Sequassen Avenue Bridge over Crab Creek (in Borough of Fenwick)
- Spencer Plain Rd Bridge over I-95
- Spencer Plain Road Bridge over Amtrak

Culverts: There are 111 culverts within Old Saybrook, most of which are used to support road waterway crossings.

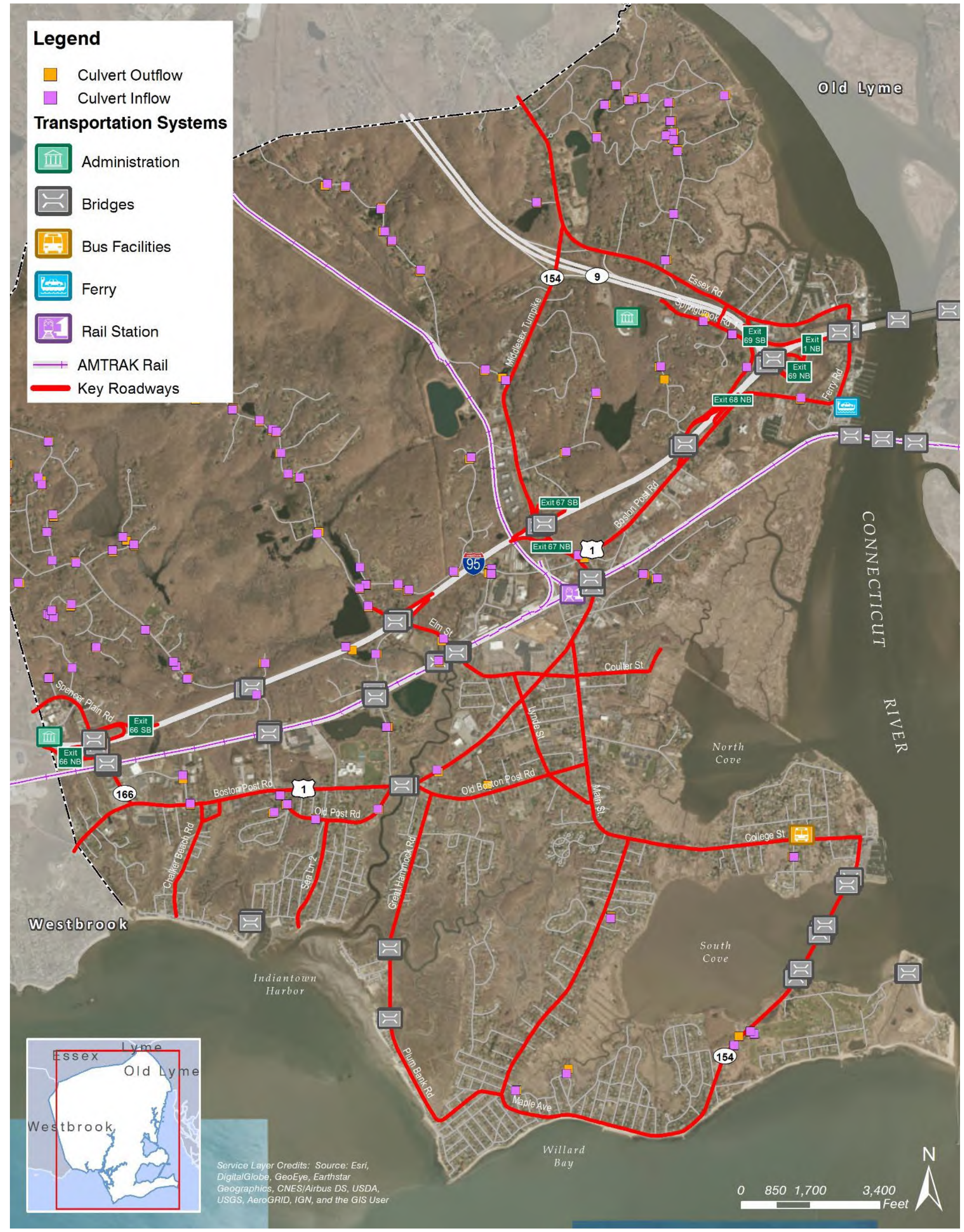


Figure 1-10: Transportation Infrastructure including Culverts

Essential Facilities and Lifeline Systems

Essential Facilities and Lifeline Systems in Old Saybrook and Borough of Fenwick are presented in **Figure 1-11**. Essential facilities include facilities that provide critical services including public safety (e.g. police, fire, emergency shelters), health care, and town and regional services necessary for response during and after natural disasters. More information about these services are described below. Lifeline Systems include power generation and transmission, communication systems, potable water supply and sanitary wastewater treatment.

Public Safety and Health Care

Public safety within the Town of Old Saybrook and Borough of Fenwick is the responsibility of the local Old Saybrook Police Department, Fire Department, Office of Emergency Management, and Department of Public Works. The Old Saybrook Police Department is located at 36 Lynde Street and the Fire Department Headquarters is located at 310 Main Street in Old Saybrook. The Town's Office of Emergency Management is located at 302 Main Street.

The Police Department consists of 21 full-time police officers , who are also assisted by 6 reserve police officers. All officers are supported by 5 full-time and 2 part-time public safety dispatchers, 3 part-time marine patrol officers, a full-time and 3 part-time records staff and 3 part-time community service officers. The Department is engaged in several mutual aid agreements with other municipalities and entities. Some of these agreements allow the Department to rapidly supplement the Old Saybrook and Borough of Fenwick patrol force in the case of a large- scale emergency.

The Fire Department includes 13 officers. The full-time fire officers include the Fire Chief, Deputy Fire Chief, 1st and 2nd Assistant Chiefs, 1 Captain of Apparatus, 1 Captain of Training, 5 Lieutenants and 2 Training Lieutenants. The Fire Department also includes numerous Firefighter/Paramedics and Firefighter/EMT's. The Department is tasked with providing fire protection (fire prevention and fire extinguishing), emergency medical response, search and rescue, fire education and a host of other services. The station has 3 fire trucks, 2 ladder trucks, 2 rescue vehicles, 1 bush truck, 5 SUVS, and 2 rescue boats.

The Office of Emergency Management, located at 302 Main Street. Police Chief Michael Spera serves as the Emergency Management Director and is responsible for developing, organizing, directing and coordinating the Town's Emergency Management Program with the goal of saving lives and protecting property by maintaining emergency operational capabilities that mitigate, prepare for, respond to, and recover from any emergency or disaster.

The Town's designate emergency shelter is located the Old Saybrook Senior High School at 1111 Boston Post Road.

The three healthcare facilities include:

- Middlesex Hospital Urgent Care at 1687 Boston Post Road;
- Middlesex Hospital Primary Care at 154 Main Street; and
- Connecticut Area River Health District (CRAHD) at 455 Boston Post Road.

Figure 1-11: Essential Facilities

The two Middlesex healthcare facilities include walk-in care for non-emergency medical service, laboratory services and X-rays (at the Urgent Care Facility).

Utilities

Electrical service for the Town and Borough is provided by Eversource (formerly the Connecticut Power & Light Company) and distributed via overhead transmission lines and two electrical substations located at: 1) Bokum Road; and 2) Elm Street. No public power generation occurs within the limits of Old Saybrook and power generation facilities are located outside of the Town limits. Eversource has an on-going program of system resilience and hardening to minimize outages, in particular focused on tree maintenance (>90% of outages are due to falling limbs on power lines) and electrical system hardening.

Gas service is provided by Southern Connecticut Gas. Xfinity and Frontier provide cable and telecommunications services, respectively. **Figure 1-12** shows the lifeline systems located in Old Saybrook and Fenwick.

Water Supply

The following description is based on the description of Old Saybrook's and Westbrook's water supply from the 2006 POCD.

The Connecticut Water Company (the "CWC") supplies drinking water in Old Saybrook by a central public water supply system. The CWC Guilford-Chester Division, a State regulated public utility, provides service to the portion of town generally south of I-95 or the railroad, but also extends north to include Floral Park, Middlesex Turnpike to the area just south of Route 9**,** and the Spencer Plain Road area. Houses and buildings in the remainder of town, where most new residential development is occurring, rely on private, on-site wells.

The central water system in Old Saybrook is the eastern leg of an inverted "T" that takes water from a surface supply reservoir in Killingworth. Water feeds southerly to the Kelseytown distribution reservoir in Clinton and down to the Route 1 area, where transmission mains feed west to Guilford and east to Old Saybrook. Wells in several locations supplement the reservoir supply. Pumps raise water to the Obed Heights storage tank (1.09 million gallons of useable storage volume) for reserve supply and water pressure at an approximate elevation of one hundred forty feet above mean sea level (140' AMSL).

The Bokum Road well pumps as needed between May and October. The CWC estimates a safe yield of 290,000 gallons per day. The CWC is seeking permits to expand the capacity of its Killingworth Reservoir by raising the dam height to increase the impoundment area. If permits are not forthcoming, the governing entities will require the CWC to expand its water supply wells within the region.

Figure 1-12: Lifeline Facilities in Old Saybrook and Fenwick

Wastewater Management Districts

Town residents and businesses are currently serviced exclusively by on-site septic systems. The Town established a Decentralized Wastewater Management District (WWMD) in August, 2009 for the purpose of protecting the public health and the environment through improvements to the treatment of wastewater (per Article II of Chapter 173). Enhancing the existing on-site wastewater systems through the use of a Decentralized Wastewater Management Program (DWMP) proactively upgrades certain on-site systems and increases the extent of management of these systems. The Town adopted: 1) WWMD boundaries that include approximately 1900 lots located within 15 neighborhood focus areas; and 2) Upgrade Program Standards for improvements. The areas were selected primarily based on physical characteristics such as density of houses, proximity to water bodies and marshes and shallow depth to groundwater.

The Upgrade Program Standards specify the types of improvements required for existing septic systems as part of the DWMP. The Town has applied a phased approach to the implementation of improvements to existing on-site septic upgrades with an estimated nine-year expected build-out. The 15 neighborhood focus areas located within the WWMD include:

- Chalker Beach
- Cornfield Point
- Cornfield Point Park
- Fenwood
- Great Hammock Beach
- Indiantown
- Ingham Hill
- Maple Avenue North
- Meadowood
- Oyster River East
- Plum Bank
- Saybrook Acres
- Saybrook Manor
- Saybrook Point
- Thompson

A majority of the land area within the 15 neighborhood focus areas is located within the FEMA Special Flood Hazard Area making these areas highly vulnerable to coastal flooding today.

Figure 1-13: Sanitary Wastewater Treatment

High Potential Loss Facilities: Dams

High potential loss are those facilities, such as dams, whose failure can result in catastrophic loss of human life. The Connecticut Department of Energy and Environmental Protection (DEEP) requires the registration of all dams over six feet in height. As of 2019, there were eleven such dams in Old Saybrook as shown on **Figure 1-14**. Three (3) of the eleven (11) dams in Old Saybrook are Class C High Hazard potential and Class B Significant Hazard potential dams that are required to prepare Emergency Action Plans (EAPs) under Section 22a-6b of the Connecticut General Statutes and Section 22a-6b-1 of the Regulations of Connecticut State Agencies. The Obed Heights Reservoir Dam is a Class C High Hazard Dam and the Chalkers Millpond and Turnpike Road Dams are Class B Significant Hazard Dams located in Old Saybrook. The following describes the flood conditions in the vicinity of the 3 Old Saybrook Class C and B dams.

Chalkers Millpond Dam: The Chalkers Millpond Dam, Class B, DEEP dam # 10606, is a low earthen dam located at the southern extent of the Chalkers Millpond. The spillway is located at the east end of the dam. Based on recent Lidar data, the crest elevation of the dam appears to be about Elevation 20 to 22 feet NAVD88. The pond behind the dam is approximately 10 acres in size. Its depth is unknown. The spillway discharges to a drainage swale that appears to be hydraulically connected to the Oyster River via several roadway drainage culverts. The area immediately downgradient from the dam is classified as a FEMA A zone. The Chalkers Millpond Dam Emergency Action Plan is currently under review by DEEP.

Obed Heights Reservoir Dam: Obed Heights Reservoir Dam, Class C, DEEP dam # 10601, is a privately owned earthen dam approximately 465 feet in length and 22 feet in height. It was constructed in 1880. The reservoir behind the dam is approximately 20 acres in size and under normal conditions impounds 175 acre feet of water. Its maximum storage capacity during a storm event is 250 acre feet. The Reservoir and Dam are located at a high ground elevation, approximately 60 feet NAVD88 and outside the limits of current and future coastal flooding. There is no emergency operations plan to go into effect in the event of a possible dam failure.

Turnpike Pond Dam: Turnpike Pond Dam, Class B, DEEP dam # 10602, is an earthen dam approximately 130 feet in length. The pond behind the dam is approximately 6 acres in size. Its depth is unknown. The Turnpike Dam is located at a high ground elevation, approximately 56 feet NAVD88 and outside the limits of current and future coastal flooding. The EAP for this dam is currently under development.

Figure 1-14: Location of Dams in Old Saybrook

Stormwater Management

Stormwater within Old Saybrook is primarily managed through a network of catch basins, manholes, underground piping, culverts and outfalls. Surface stormwater runoff also drains to the marshes and embayments. While much stormwater run-off is to adjacent marshes, green infrastructure is not presently utilized to provide on-site infiltration of stormwater.

The stormwater management infrastructure is owned and operated by the Town. The Town is in the process of mapping the town-wide stormwater management infrastructure. Currently, the Town has collected information on approximately sixty percent (%) of the town-wide system. While the data collected to-date is not complete, the data collected to-date includes:

- 108 Culvert Inflows
- 101 Culvert Outflows
- 2,217 storm water catch basins
- 204 outfalls
- 8 stormwater manholes

The most recently available mapping of the Town's catch basins, manholes, drainage pipes and outfalls is presented in **Figure 1-15.** Piped stormwater is discharged via gravity flow to drainage outfalls to the Connecticut River, Long Island Sound and local waterways. The Town also does not have any stormwater pump stations. Based on the available information, existing outfalls do not have tide gates or backflow preventers. (There are two tide gates in town that are used for control of tidal flow: one at Chalker Beach and another on the Oyster River just south of I-95 near Elm Street. The Chalker Beach tide gate is owned and managed by the Chalker Beach Association and Summerwood Condominiums. The Chalker Beach tide gate functions as a backflow reducer without manual controls. The Oyster River tide gate is owned and operated by the State of Connecticut and can be manually opened and closed.)

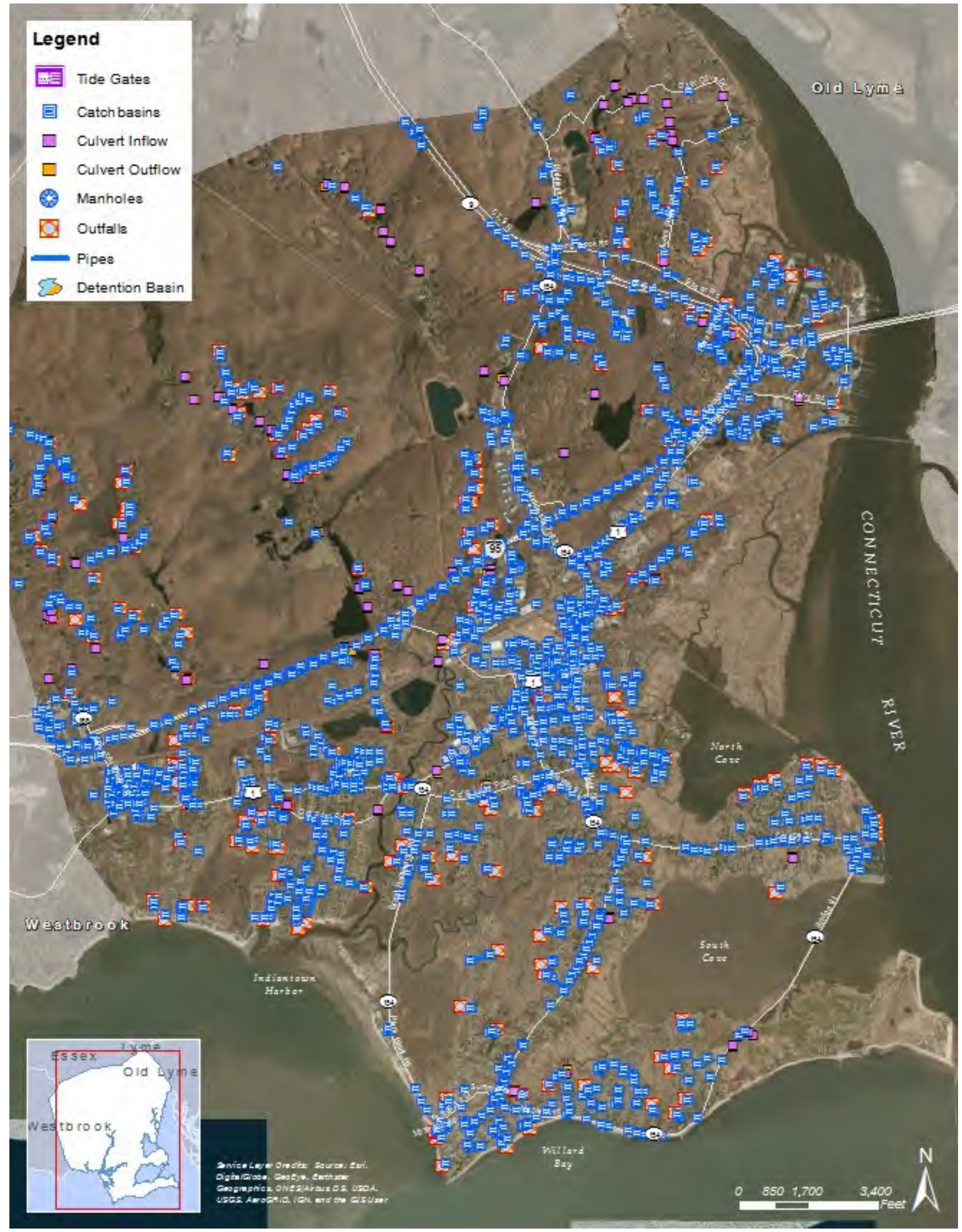


Figure 1-15: Stormwater Management System

Figure 1-16: Hazardous Materials Facilities and Landfills

Hazardous Materials Facilities and Landfills

Facilities regulated by DEEP and the EPA located in Old Saybrook are shown in **Figure 1-16.** There are 27 HazMat Category IV Facilities identified by the Environmental Protection Agency (EPA) within Old Saybrook. Animal shelters are included because these facilities are often repositories for hazardous waste.

Of the 27 waste facilities, 9are located within FEMA special flood hazard zones. These include:

- Opcon at 167 Elm Street (Research Parkway)
- Paragon Products at 175 Elm Street (Research Parkway)
- Ryther Purdy at 174 Elm Street (Research Parkway)
- M&J Bus Company at 130 Ingham Hill Road
- Essex Cabinets at 91 School House Road
- Target Custom Manufacturing at 164 Old Boston Post Road
- Design X at 83 Spencer Plain Road
- Vijon Studios at 97 Spencer Plain Road
- SSHC Inc. at 4 Custom Drive

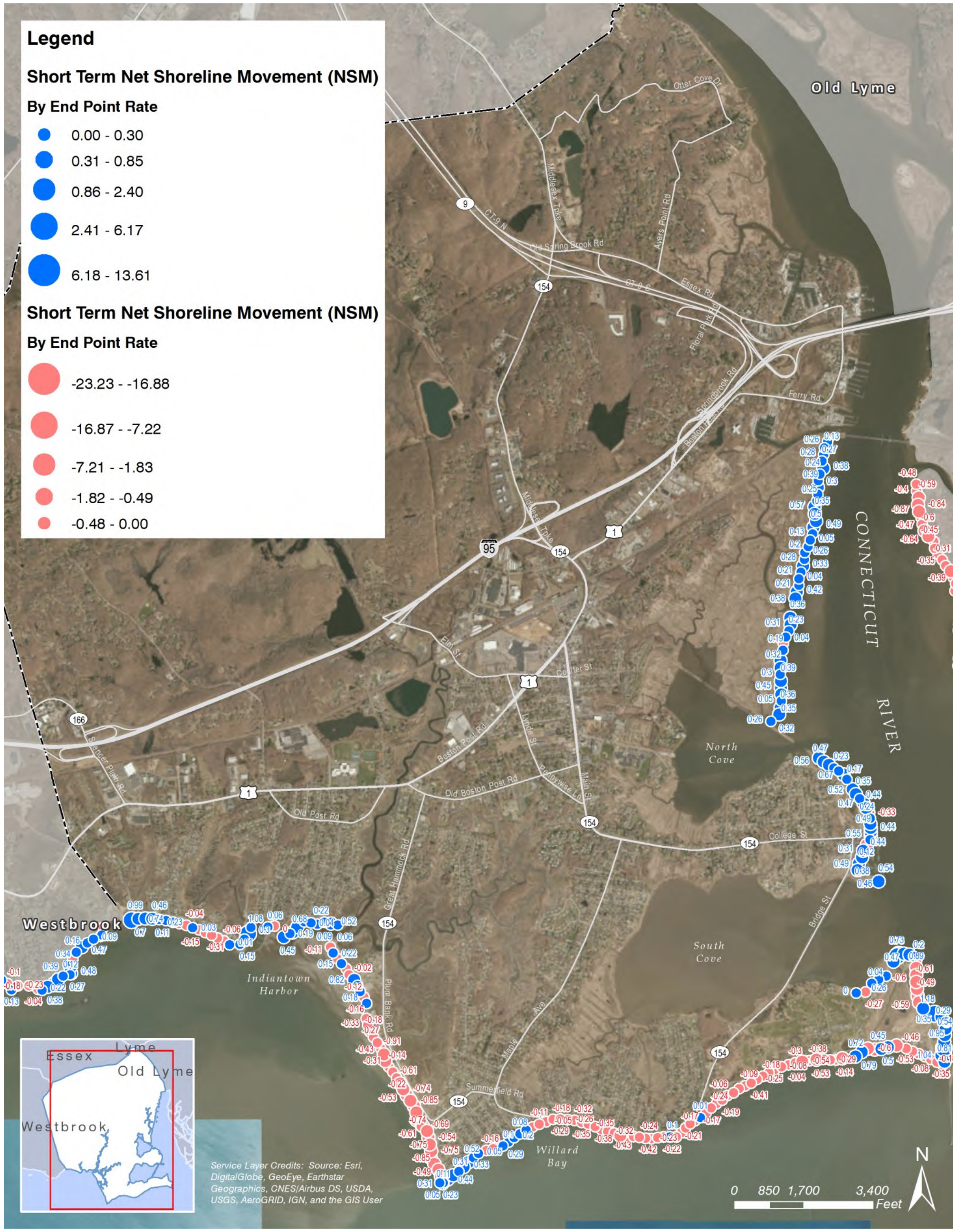


Figure 1-17: Observed net shoreline change (meters/yr.) from 1983 to 2006

Natural Resources—Beaches

Old Saybrook's southern shoreline including Fenwick includes 14 beaches. Typical of the Connecticut coast, Old Saybrook's beaches consist of barrier spits and pocket beaches. Beach shoreline protection in the form of groins and jetties have been constructed along most of the beaches in Old Saybrook. About 8 miles of the Old Saybrook shoreline is potentially erodible (including areas of Fenwick along Long Island Sound and the west bank of the Connecticut River), of which about 2 miles have been significantly affected by erosion. Areas that have been historically affected by shoreline erosion include: Chalker Beach, Chapman Beach, Westbrook, Plum Beach and Great Hammock Beach. The "Analysis of Shoreline Change in Connecticut", completed by University of Connecticut (CLEAR), Sea Grant and the Connecticut Department of Energy and Environmental Protection (DEEP), analyzed how the Connecticut shoreline has changed between the late 1800s and 2006 through loss (erosion) and gain (accretion) over time. Shoreline statistics include:

<u>Old Saybrook and Fenwick – Long Island Sound Beaches</u>

Short-Term (1983 to 2006):
- Net Shoreline Movement:
  - Minimum: -19.9 meters
  - Maximum: 23.8 meters
  - Average: -2.6 meters

End Point Rate (average): -0.12 meters/year

<u>Old Saybrook and Fenwick – Connecticut River Shoreline</u>

Short-Term (1983 to 2006):
- Net Shoreline Movement:
  - Minimum: -20.5 meters
  - Maximum: 2.8 meters
  - Average: 6.2 meters
- End Point Rate (average): 0.28 meter/year

The long term effects of sea level rise on the beaches will be increased erosion and migration of barrier beaches and spits landward in Old Saybrook and Fenwick. Over the past century, the sea level in Long Island Sound has risen approximately 10 inches. Landward beach migration can progress as long as there are glacial deposits available to replenish the sediment supply and infrastructure does not impede the natural movement of the beach. At Old Saybrook and Fenwick, sediment supply is limited, and the large number of coastal structures impedes natural sediment transport. By 2100, the barrier spits, in particular Plum Bank, may have disappeared entirely.

See **Attachment 4 of the 2018 Coastal Community Resilience Study** for a detailed description shoreline change along the Old Saybrook and Fenwick shoreline.

Natural Resources—Marshes and Critical Habitats

Tidal Marshes and Wetlands: Much of the Old Saybrook land area south of Interstate 95 consists of intertidal salt marshes and tidal wetlands. The largest intertidal marsh systems are: 1) the Plum Bank Marsh Wildlife Area (around the Plum Bank, Oyster and Back Rivers and abutting Long Island Sound); 2) Ragged Rock Creek Marsh Wildlife Area (located around the Ragged Rock Creek and abutting the Lower Connecticut River); 3) the Hager Creek Marsh Wildlife Area (located around Hager and Mud Creeks, abutting Long Island Sound); 4) the Ferry Point Marsh Wildlife Area (abutting the Lower Connecticut River); and 5) the South Cove Wildlife Area (around Beamon Creek and abutting the South Cove).

Lower Connecticut River: In the vicinity of Old Saybrook, the Lower Connecticut River is a tidal estuary and has extensive fresh and brackish tidal wetlands. It also has diverse and critical habitat and is recognized as containing "Wetlands of International Importance" under the intergovernmental Ramsar Convention. As a tidal estuary, with direct connection to Long Island Sound, the Lower Connecticut River shorelines experience water level fluctuations from both tides and coastal storm surges.

Brooks, Creeks and Rivers: The Old Saybrook tidal wetlands and marshes are fed and drained by brooks, creeks and rivers, which discharge into the Lower Connecticut River and Long Island Sound. These include Ragged Rock Creek (Lower Connecticut River), Beamon Creek (South Cove and the Lower Connecticut River), Plum Bank, Back, Hagar and Mud Creeks, Oyster River and Back River (Long Island Sound). Several of these waterways extend upland of the tidal marshes and wetlands, including Oyster River and Fishing Brook, which are hydraulically connected. Coastal flooding propagates inland up these rivers and connect to lakes and ponds (Crystal Lake, Chalkers Millpond and Ingham Ponds).

Marshes: The tidal salt marshes, located at the margin between land and water, are dynamic ecosystems that provide ecological and economic value. The marshes provide habitat for wildlife and fisheries and add to the quality of life and aesthetics of Town residents. The marshes provide some level of resilience to coastal flooding, primarily through wave attenuation and erosion control. The marshes also provide water quality benefits through surface runoff storage and infiltration and pollutant absorption. **Figure 1-18** presents the locations of existing tidal and inland wetlands, critical habitats, vernal pools, and places of coastal access for Old Saybrook and Fenwick.

Marshes are also some of the most susceptible ecosystems to climate change, in particular accelerated rates of sea level rise. Long-term changes to air and water temperature and precipitation may affect species composition and type of habitat. However, the most significant climate change impact to the marshes will be sea level rise. A climate change effect is the advancement of the marsh in response to sea level rise. Another key issue is the potential for chronic or episodic erosion of beaches that separate the marshes from Long Island Sound, which will increase due to the effects of climate change. Beach erosion is discussed in the next section.

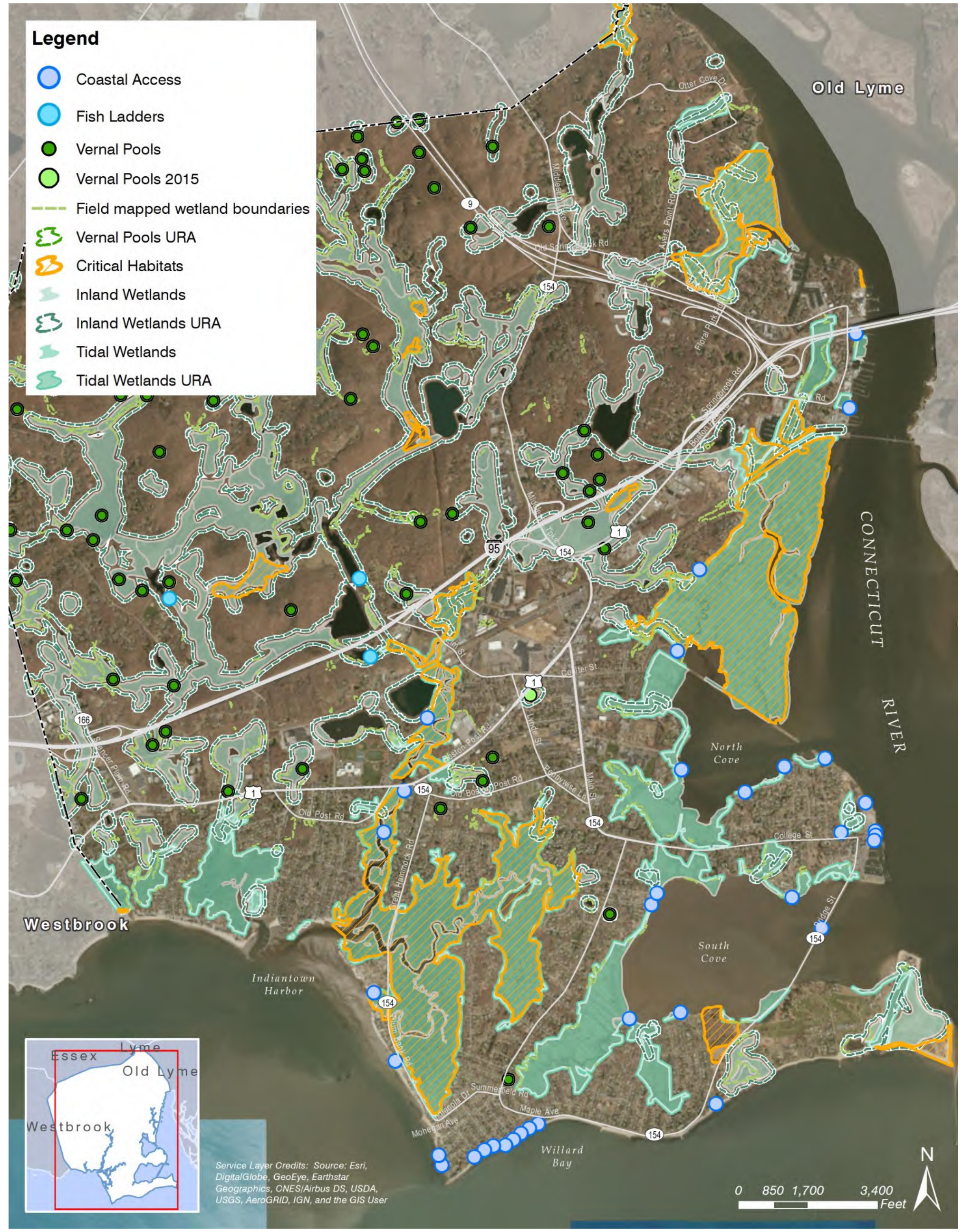


Figure 1-18: Tidal and Inland Wetlands and Critical Habitats

Cultural and Historic Sites

There are three historic districts and 335 historic properties located within Old Saybrook. The Historic Districts include: 1) the North Cove Historic District; 2) the South Green Historic District; and 3) the Fenwick Historic District.

North Cove Historic District:

The North Cove Historic District is 37-acres in extent and is located on Saybrook Point. The District was listed on the National Register of Historic Places in 1994. The District extends to the north and east along North Cove Road from just north of Church Street on the west to past Cromwell Place to the east. The District also includes a small area along Cromwell Place that extends south from the intersection with North Cove Road for approximately 330 feet. The District is of historical significance because it was the site of the first settlement of the Saybrook Colony(1645) and is an example of a small maritime development between 1645 and 1927. Most housing stock was built between 1700 and 1855. The District includes the Black Horse Tavern and the William Tully House, both separately listed on the National Register.

South Green Historic District:

The South Green Historic District is 20-acreshistoric district located around the intersection of Main Street and Old Boston Post Road. The District was listed on the National Register of Historic Places in 1976. The district encompasses the historic town green of Old Saybrook, which was founded in the 1630s. Most of the buildings located around the green were built between 1760 and 1900. Among the buildings in the district are the c. 1767 Gen. William Hart House and the c. 1785 Humphrey Pratt Tavern, which are individually listed on the National Register.

Fenwick Historic District:

The Fenwick historic district includes the entire Borough of Fenwick, with the exception of a small portion of the Borough located northwest of Maple Avenue. This Borough of Fenwick, surrounded on three sides by water, encompasses 225 acres of land, 146 acres of which are a park. Most of the buildings in the district are large late 19th- or early 20th-century wood-shingled summer cottages. The cottages are located on a peninsula surrounded by the waters of South Cove on the north and Long Island Sound on the east and south. The central part of the Fenwick Historic District consists of a small grid of streets lined with cottages set amid spacious lawns, north of which is the Fenwick Golf Course.

The 335 historic properties located within Old Saybrook include:

- 17 National Register Federal Historic Properties; and
- 76 State Register Historic Properties.

Figure 1-19 shows the 91 State and National Register historic properties located in Old Saybrook.

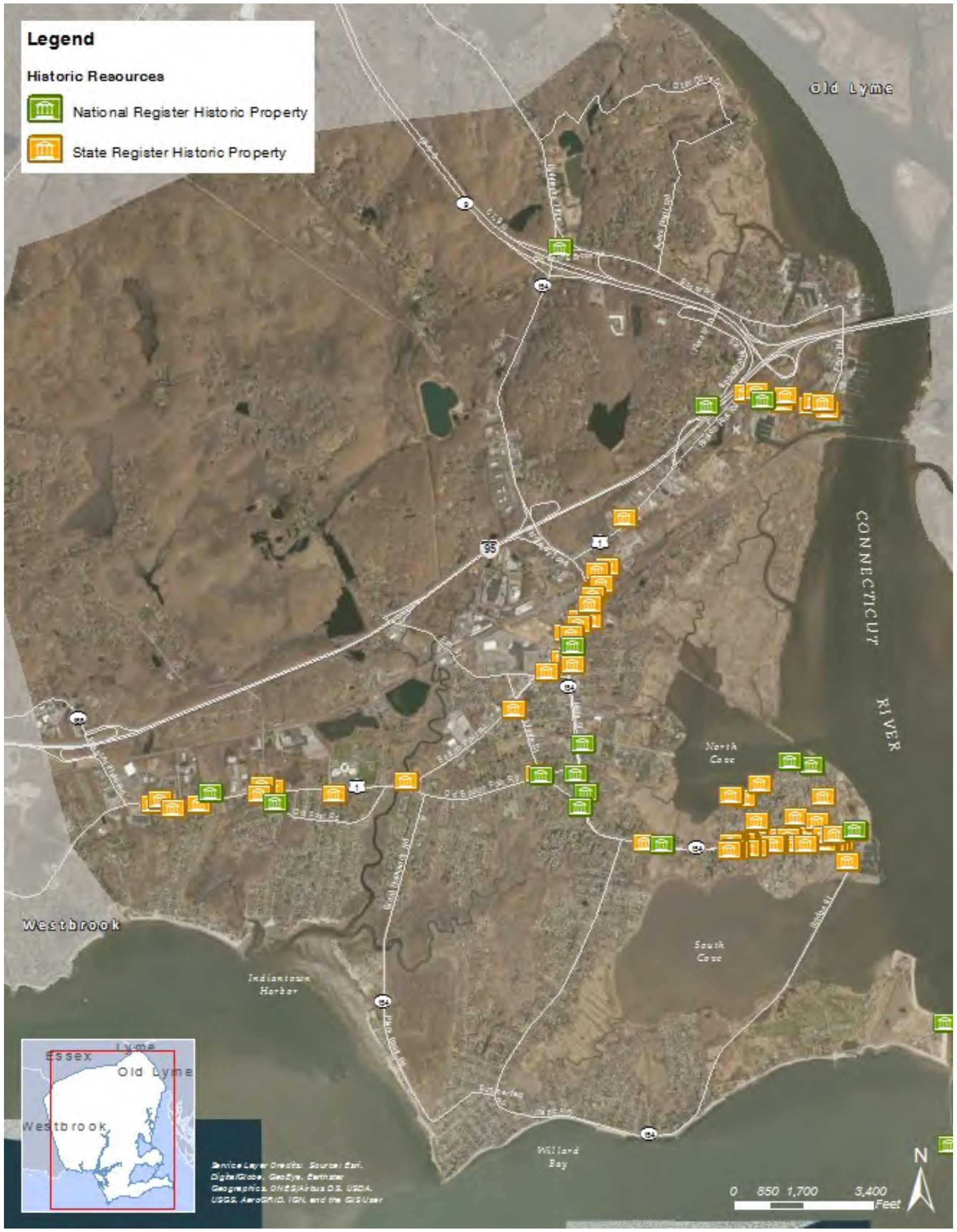


Figure 1-19: State and National Historic Properties

Attachment 2: Natural Hazards

Attachment 2: Natural Hazards

NATURAL HAZARDS OVERVIEW

Natural hazards are **natural events** that threaten lives, property, and other assets. Within Connecticut, natural hazards typically include:

- Severe Weather Hazards such as Hurricanes and Tropical Storms, Nor'easters, Lighting, Intense Rainfall, Hail, Heavy Snowfall and Ice Storms.
- Climate-Related Hazards such as extreme heat and cold, drought and wildfire.
- Geologic Hazards such as earthquakes, landslides and tsunamis.

Severe weather hazards, including hurricanes, tropical storms and nor'easters can result in coastal flooding (storm surge and waves). These flood events will become worse in the future due to climate-related changes to sea level rise and, perhaps, storm intensity. Coastal flooding can result in the secondary hazard of shoreline change. Severe weather hazards can also result in high winds, lightning, hail, intense rainfall and tornadoes.

Coastal Connecticut is also vulnerable to tsunamis, a geologic hazard; however, the likelihood of a significant tsunami impacting coastal Connecticut is considered very low.

Localized intense rainfall can result in urban flooding where existing stormwater management capacity is exceeded. It can also result in flash flooding of streams and rivers and exceedance of water reservoir dam capacity.

Hazard Probability

Natural hazards can often be predicted, including predicting their likelihood of occurrence. The probability of a specific natural hazard occurring is typically defined in terms of its annual exceedance probability (AEP). This refers to the probability that a hazard condition will be met or exceeded in any given year. In lieu of the AEP, the term recurrence interval (in years) is often used.

Climate Change

Climate change, a result of increased greenhouse gas emissions and secondary effects, will significantly impact certain natural hazards. There is high scientific consensus that coastal flooding in Connecticut will become worse due to sea level rise. Storm intensity may also increase, resulting in increased flood elevations. There is high scientific consensus that climate change will result in increased rainfall intensity within Connecticut as well as the frequency of extreme rainfall events. There is also scientific consensus that climate change will result in in extended periods of extreme heat (heat waves) and cold.

OLD SAYBROOK AND FEWNWICK NATURAL HAZARDS

GZA performed an analysis of multiple natural hazards and identified those hazards that are relevant to the Town and Borough. These are presented in **Table 2-1**. These hazards are characterized in detail in the following pages.

Severe Weather Hazards:
Severe Wind:
Hurricanes/Tropical Storms
Thunderstorms
Tornadoes
Lightning
Intense Rainfall
Hail
Flood:
Storm Surge
Sea Level Rise
Urban Drainage Flooding
Shoreline Change
Severe Winter Weather:
Snowfall
Ice Storms
Climate-Related Hazards:
Extreme Temperature:
Extreme Heat
Extreme Cold
Drought
Wildfire
Geologic Hazards:
Earthquake

Table 2-1: Natural Hazards applicable to Old Saybrook and Fenwick

Severe Weather Hazards: Severe Wind

SEVERE WIND

Severe wind (including high to extreme wind) will typically occur in the Town as a result of: 1) tropical storms and hurricanes; 2) extratropical nor'easters; 3) severe thunderstorms; and 4) tornadoes. Severe thunderstorms and tornadoes are convective weather events. Extreme "straight line" convective wind events include microbursts, macrobursts and derechos. Derechos are widespread, long-lived, and violent convectively-induced "straight-line" windstorms associated with a fast moving band of severe thunderstorms,. "Thunderstorm winds", arising from convection are winds with speeds greater than 58 mph or winds of any speed producing, damage, injury or fatality.

Severe wind poses a threat to life, building structures, and essential facilities (e.g., electrical utilities) due to the effects of wind loads, flying debris, and/or downed trees and power lines. Severe wind will typically cause the greatest damage to lightly-constructed structures, in particular manufactured homes. Downed tree limbs can also cause property and vehicle damage, impact roadways, and in rare instances, cause loss of life. These storms may be accompanied by lightning, which can spark fires. During hurricanes and tropical storms, high winds can also occur coincident with intense rainfall and during nor'easters, high winds can occur coincident with snow (blizzards), rain and a snow/rain mix.

Wind speeds are categorized by the National Weather Service based on potential for structure damage and public health risk, with a distinction between sustained (1-minute duration) wind speeds and gust (3 second duration) wind speeds:

- Wind Advisory: 1) sustained winds of 31 to 39 mph for an hour or more; and/or 2) wind gusts of 46 to 57 mph for any duration.
- High Wind Watch/Warning: 1) sustained winds of 40 mph for one hour or more; or 2) wind gusts of 58 mph or higher for any duration.
- Hurricane Warning: sustained winds of 74 mph or higher or frequent (for more than 2 hours) gusts of 74 mph or greater associated with a tropical cyclone.
- Extreme Wind: 1) surface winds of 115 mph or greater associated with a derecho or sustained hurricane winds.
- Severe Thunderstorm Watch/Warning: winds of 58 mph or higher and/or hail 1-inch in diameter or larger.

The Connecticut State Building Code (using ASCE 7-10) utilize wind gusts as the basis for structure design. The regulatory 3 second gust speeds applicable to Old Saybrook and Fenwick (**Table 2-2**). GZA performed an extreme value statistical analysis of historical wind data (sustained 1 minute, 10-meter wind speeds) at the nearby New London/Groton Airport. The results are presented in **Figure 2-1**.

Mean Recurrence Interval (yrs)	3-second Gust (mph)
10	79
25	89
50	98
100	107
300	122
700	132
1,700	143

Table 2-2: ASCE 7-10 Wind speed Mean Recurrence Intervals (3-second peak gust in mph)

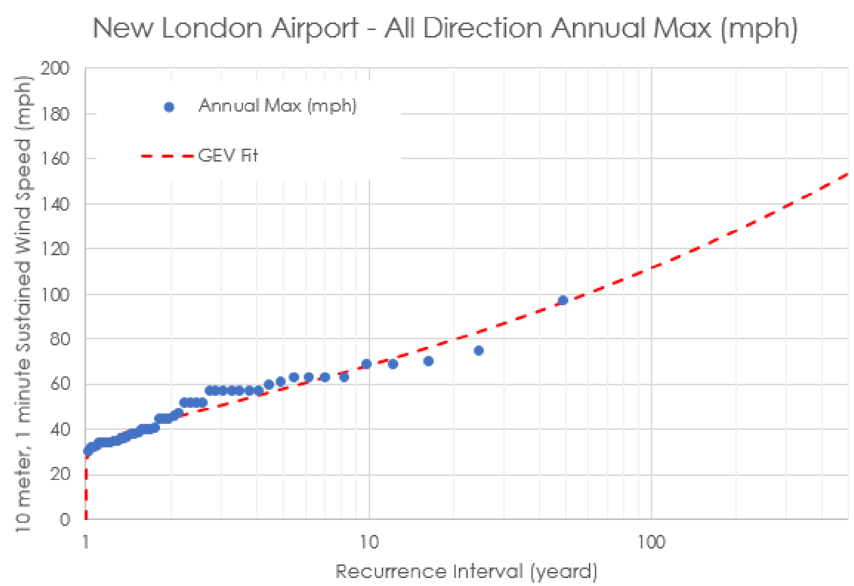


Figure 2-1: Mean 1-minute sustained wind speed based on GZA Extreme Value Analysis of New London/Groton Wind Data

SEVERE WIND cont.

Old Saybrook and Fenwick Design Wind Speeds for Buildings and Other Structures

The Connecticut State Building Code wind speed design requirements (in terms of 3-second gust) are:

- Risk Category I: 122 mph - 300 year recurrence interval;
- Risk Category II: 132 mph - 700 year recurrence interval; and
- Risk Categories III-IV: 143 mph - 1,700 year recurrence interval.

Risk categories are based on occupancy and use and are described in **Table 2-3**.

Historical Occurrence at Old Saybrook and Vicinity

During 1996 to 2018, Middlesex County experienced 17 days of High Wind events with estimated gusts of about 58 to 80 mph resulting in about $560,000 in property damage and no deaths. During 1950 and 2018, Middlesex County and surrounding areas had 60 days with Thunderstorm (convective) winds resulting in no deaths and $211,250 damage.

(Source: NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/)

Estimated Probability of Occurrence at and near Old Saybrook/Fenwick

The results indicate the following severe wind probabilities at and near Old Saybrook/Fenwick:

- High Winds: near 100% AEP or 1 year recurrence interval
- Hurricane wind speeds or greater: +/- 1.2% AEP or 80-year recurrence interval (about 1/80 in any given year). Note that the Hurricane of 1938 was not included in the airport data set, which would increase the chance of experiencing sustained Hurricane wind speeds or greater to about 2.5% AEP or 40-year recurrence interval
- Extreme Wind: less than 0.2% AEP or 500-year recurrence interval

TABLE 1604.5
RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES

RISK CATEGORY	NATURE OF OCCUPANCY
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities.
II	Buildings and other structures except those listed in Risk Categories I, III and IV
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing elementary school, secondary school or day care facilities with an occupant load greater than 250. • Buildings and other structures containing adult education facilities, such as colleges and universities, with an occupant load greater than 500. • Group I-2 occupancies with an occupant load of 50 or more resident care recipients but not having surgery or emergency treatment facilities. • Group I-3 occupancies. • Any other occupancy with an occupant load greater than 5,000 [a]. • Power-generating stations, water treatment facilities for potable water, waste water treatment facilities and other public utility facilities not included in Risk Category IV. • Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and Are sufficient to pose a threat to the public if released [b].
IV	Buildings and other structures designated as essential facilities, including but not limited to: • Group I-2 occupancies having surgery or emergency treatment facilities. • Fire, rescue, ambulance and police stations and emergency vehicle garages. • Designated earthquake, hurricane or other emergency shelters. • Designated emergency preparedness, communications and operations centers and other facilities required for emergency response. • Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures. • Buildings and other structures containing quantities of highly toxic materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and Are sufficient to pose a threat to the public if released [b]. • Aviation control towers, air traffic control centers and emergency aircraft hangars. • Buildings and other structures having critical national defense functions. • Water storage facilities and pump structures required to maintain water pressure for fire suppression.

Table 2-3: Building Code Risk Categories of Buildings and Other Structures
See Connecticut State Building Code for additional detail.

Climate Change Effects and Severe Wind Occurrence

The attribution of high wind events to climate change is uncertain. There is moderate scientific consensus, that the intensity and frequency of intense hurricanes could increase within southern New England due primarily to the increase in sea water temperature along the East Coast. There is lower confidence, and less understanding, in the attribution of increased extratropical nor'easters and thunderstorms frequency and intensity to climate change.

HURRICANES

Hurricanes, tropical storms and tropical depressions are tropical cyclones (rotating low pressure weather systems that have organized thunderstorms but no pressure fronts - a boundary separating two air masses of different densities). Tropical cyclones with maximum sustained surface winds of less than 39 miles per hour (mph) are called tropical depressions. Those with maximum sustained winds between 39 mph and 73 mph are tropical storms. Hurricanes are tropical cyclones with sustained wind speeds of 74 mph or higher.

East Coast hurricanes originate in the Atlantic basin, which includes the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. A six-year rotating list of names, updated and maintained by the World Meteorological Organization, is used to identify these storms. "Hurricane Season" begins on June 1 and ends on November 30, although hurricanes can, and have, occurred outside of this time frame (NOAA National Ocean Service).

The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating, or category, based on a hurricane's maximum sustained winds. The higher the category, the greater the hurricane's potential for property damage (NOAA National Ocean Service). A major hurricane (Categories 3, 4 and 5) has sustained wind speeds of 111 mph or higher on the Saffir-Simpson Hurricane Wind Scale.

Historic hurricane and tropical storm tracks which have passed within 100 nautical miles of Old Saybrook are presented in **Figure 2-2**. (source https://coast.noaa.gov/hurricanes/) Historic hurricane tracks which have passed within 100 nautical miles of Old Saybrook are presented in **Figure 2-3**. A distance of 100 nautical miles is a reasonable representation of hurricanes that have the potential to cause flooding within Long Island Sound.

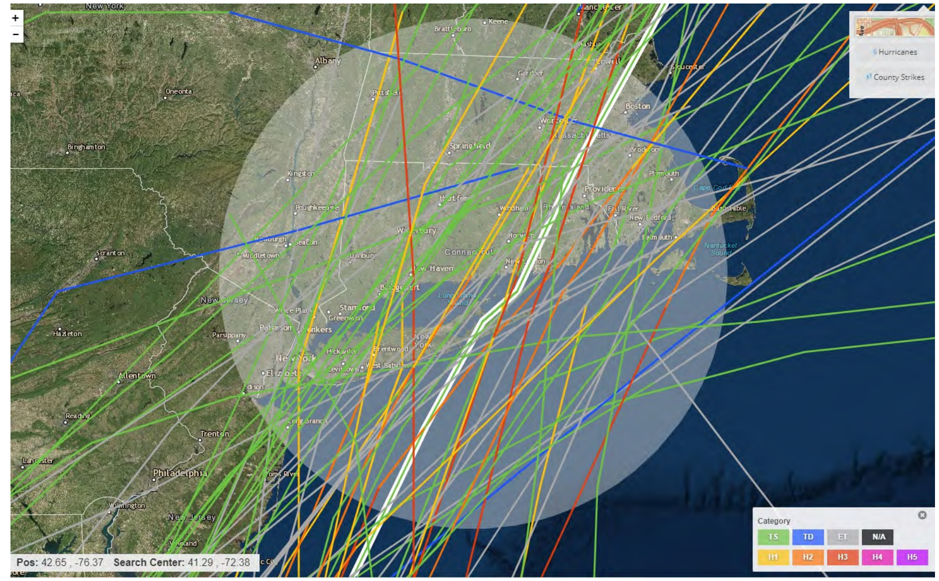


Figure 2-2: Hurricanes and Tropical Storms within 100 miles of Old Saybrook

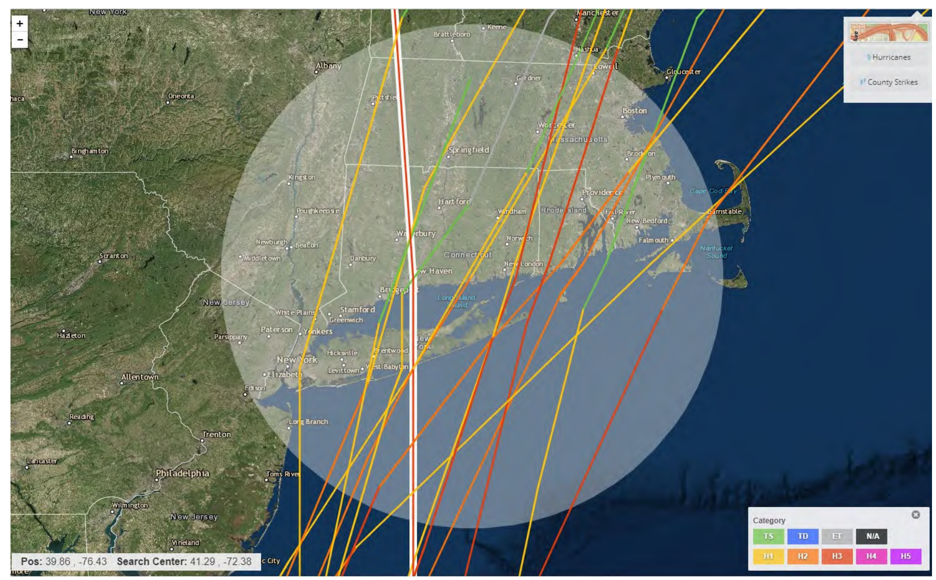


Figure 2-3: Hurricanes within 100 miles of Old Saybrook

HURRICANES

Fifteen hurricanes have tracked within 100 nautical miles during NOAA's period of record, including the following significant hurricane. The Hurricane of 1938 was a major hurricane (≥ Category 3) at landfall west of Old Saybrook.

Table 2-5 summarizes the top ten water levels at the NOAA New London and Bridgeport tide stations relative to MHHW. The highest observed water levels resulted from hurricanes, with the highest documented flood water level observed during the Hurricane of 1938. The top observed water levels at New London have resulted from six hurricanes, one tropical storm and three Nor'easters.

Name	Date	Category	Landfall (relative to Old Saybrook)
Gloria 1985	9/16 to 10/02/1985	H1 (Category 1)	West
Unnamed 1858	9/14 to 9/17/1858	H1 (Category 1)	East
Unnamed 1894	10/01 to 10/12/1894	H1 (Category 1)	West
Unnamed 1934	9/05 to 9/10/1934	H1 (Category 1)	West
Donna 1960	8/29 to 9/14/1960	H2 (Category 2)	At Old Saybook
Unnamed 1944	9/09 to 9/16/1944	H2 (Category 2)	East
Bob 1991	9/16 to 9/29/1991	H2 (Category 2)	East
Carol 1954	8/25 to 9/01/1954	H3 (Category 3)	East
Unnamed 1869	9/07 to 9/09/1869	H3 (Category 3)	East
Hurricane of '38	9/09 to 9/23/1938	H3 (Category 3)	West
Unnamed 1879	8/13 to 8/20/1879	H1 (Category 1)	East
Unnamed 1916	7/10 to 7/22/1916	H1 (Category 1)	East
Belle 1976	8/06 to 08/10/1976	H3 (Category 3)	West
Edna 1954	9/05 to 9/14/1954	H3 (Category 3)	East
Unnamed 1893	8/15 to 8/26/1893	H3 (Category 3)	West

Table 2-4: Hurricane tracks within 100 miles of Old Saybrook

Station	1	2	3	4	5
8461490 New London[1]	9/21/1938 7.53 feet	8/31/1954 6.53 feet	10/30/2012 4.89	11/25/1950 4.53 feet	9/14/1944 4.03 feet
	6	7	8	9	10
	9/12/1960 3.83 feet	11/7/1953 3.73 feet	10/31/1991 3.42 feet	8/28/2011 3.39 feet	11/12/1968 3.33 feet
	1	2	3	4	5
8467150 Bridgeport[2]	10/30/2012 5.72	8/28/2011 4.72	12/11/1992 4.72	10/31/1991 4.06	10/25/1980 3.67
	6	7	8	9	10
	3/29/1984 3.29	9/27/1985 3.27	10/19/1996 3.21	11/12/1968 3.20	4/16/2007 3.19

Table 2-5: NOAA Station Top Ten Water Levels (in feet above MHHW)

Hurricane recurrence intervals reflect the frequency at which hurricanes can be expected to occur within a given distance of a given location. The total number of hurricane strikes within Middlesex County during 1900 and 2010 is 5 (**Figure 2-4**). The total number of major hurricanes strikes within Middlesex County is 3. **Figures 2-5 and 2-6** shows hurricane recurrence intervals (aka return periods) for hurricanes passing within 50 miles of various locations. In the vicinity of Old Saybrook and Fenwick, the hurricane passing recurrence interval is about 17 to 18 years. In simpler terms, this means that a hurricane is likely to strike or pass near Old Saybrook and Fenwick, on average, about 6 to 8 times per 100 years. In the vicinity of Old Saybrook and Fenwick, the recurrence interval for major hurricanes striking or passing near (Cat 3 and above) is about 52 to 70 years. **Figure 2-7** shows the zones of origin and tracks for different months during the hurricane season. These figures depict average conditions. Hurricanes can originate in different locations and travel much different paths from the average. Regardless, they provide a good sense of the general pattern of hurricane tracks near Long Island Sound. The likelihood of a hurricane striking near Old Saybrook is much greater during the months of August through October.

Historical Occurrence at Old Saybrook and Vicinity

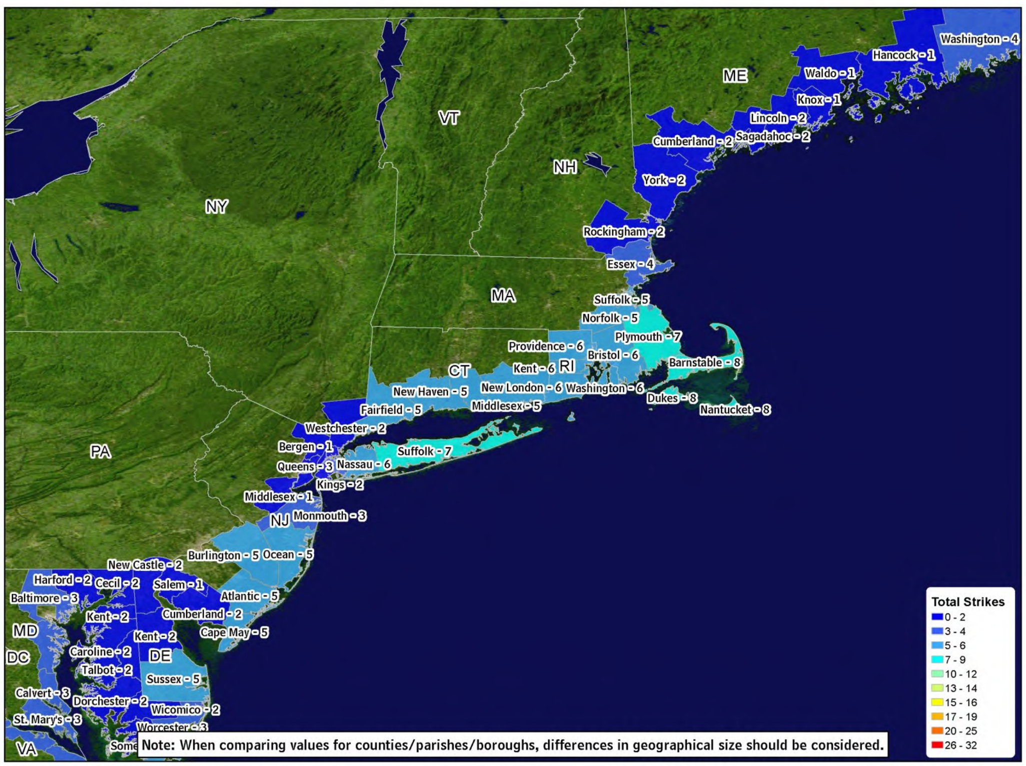
In the vicinity of Old Saybrook and Fenwick, the hurricane recurrence interval of the hurricane passing or striking in the vicinity of Old Saybrook and Fenwick is about 17 to 18 years. In the vicinity of Old Saybrook and Fenwick, the recurrence interval for major hurricanes (Cat 2 and above) is about 52 to 70 years.

Estimated Probability of Occurrence at and near Old Saybrook and Fenwick

The results indicate the following conservative hurricane strike probability at and near Old Saybrook and Fenwick:

- All Hurricanes: 7% AEP or 15-year recurrence interval
- Major (≥ Cat 3) Hurricanes: 2% or 50-year recurrence period

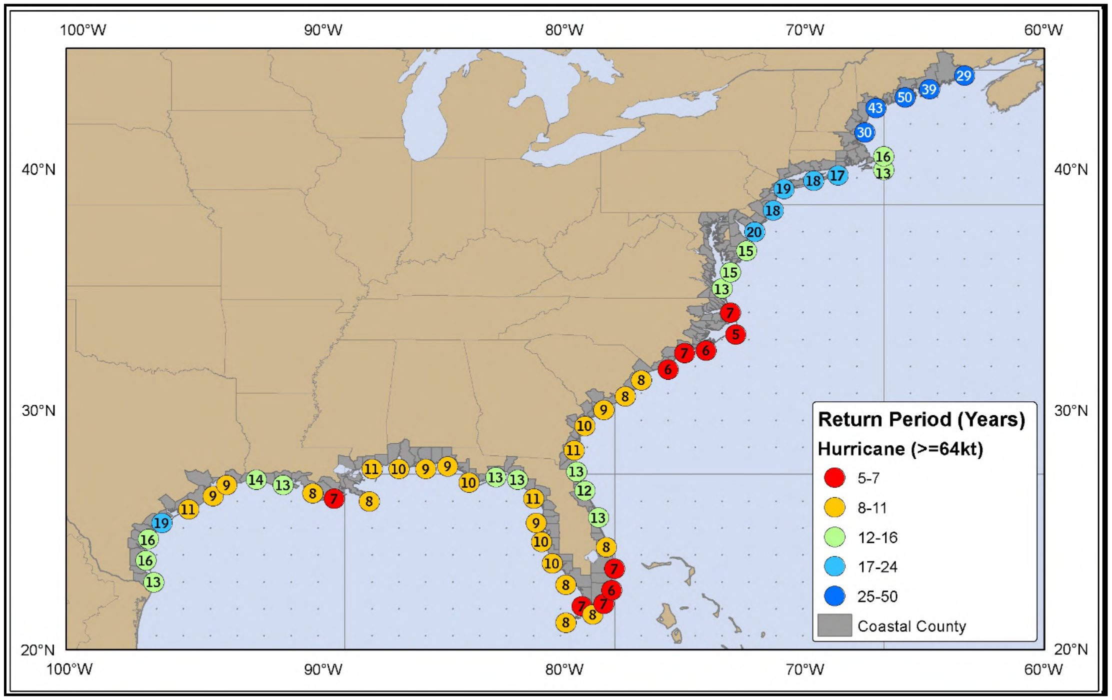
Hurricanes striking the vicinity of Old Saybrook will pass over Long Island, somewhat reducing their intensity.

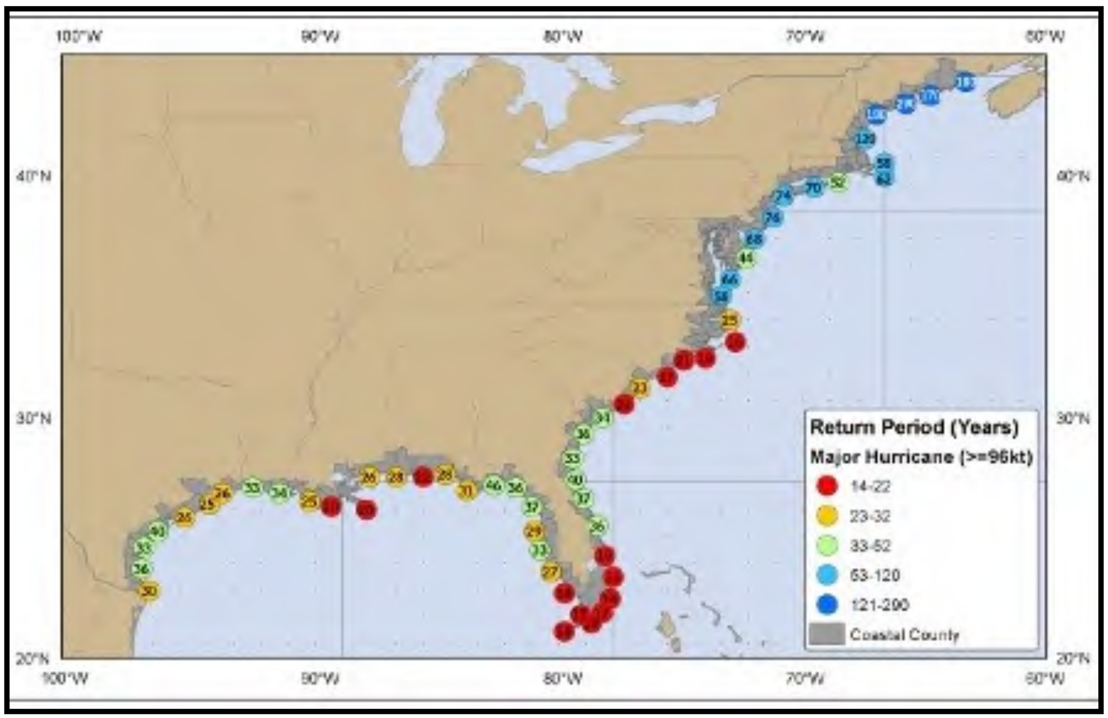


Total number of hurricane strikes by counties/parishes/boroughs, 1900-2010

Data from NWS NHC 46: Hurricane Experience Levels of Coastal County Populations from Texas to Maine. Jerry D. Jarrell, Paul J. Hebert, and Max Mayfield. August, 1992, with updates.

Figure 2-4: Hurricane Strikes (source - https://www.nhc.noaa.gov/climo/)





Figures 2-5 and 2-6: Hurricane Recurrence Interval (all hurricanes - top and major hurricanes - bottom)
(Source: (Source: https://www.nhc.noaa.gov/climo/#bac

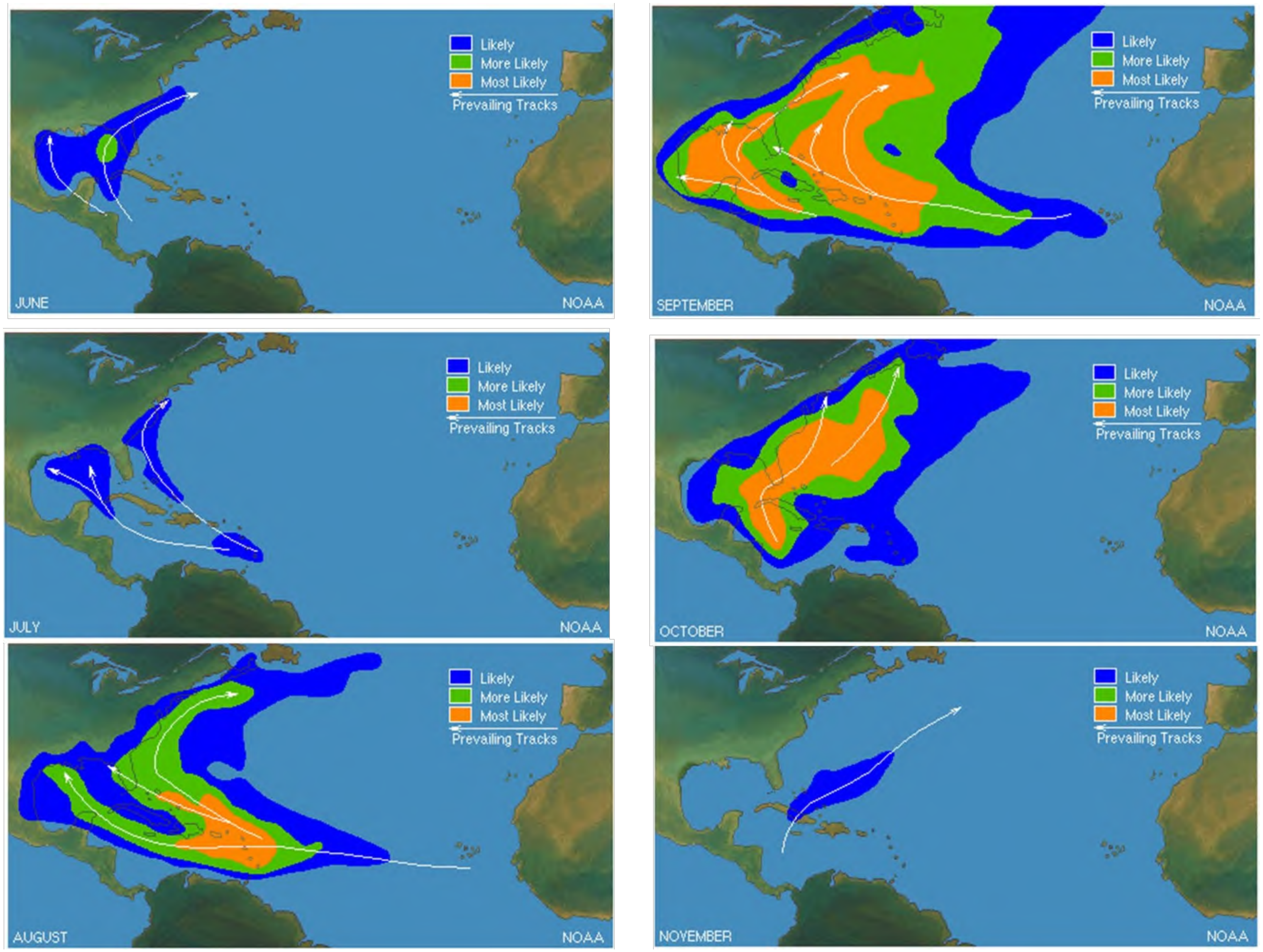


Figure 2-7: Hurricane Origin and Track Probability by Month

THUNDERSTORMS

A thunderstorm is characterized by lightning and thunder and usually produces gusty winds, heavy rain, and sometimes hail. Cumulonimbus clouds produce lightning, which locally heats the air to 50,000 degrees Celsius, which in turn produces an audible shock wave, known as thunder. Tornadoes can also be generated during these events. Three basic ingredients are required for a thunderstorm to form: moisture, rising unstable air (air that keeps rising when given a nudge), and a lifting mechanism. Every thunderstorm has an updraft (rising air) and a downdraft (sinking air). Sometimes strong downdrafts known as downbursts can cause tremendous wind damage, similar to that of a tornado. A small (< 2.5-mile path) downburst is known as a "microburst" and a larger downburst is called a "macroburst."

The peak season for severe thunderstorms in the Northeast U.S. is June through August, although thunderstorms also occur in the Spring and Fall, and thunder can occur during winter snow storms. Hazards from thunderstorms include high to extreme winds, lightning, torrential downpours, and hail. Thunderstorms can spawn tornadoes and cause flash floods, downed trees and power lines, power outages, and mudslides. Roads may become impassable due to flooding, downed trees, or a landslide. Power lines may be downed due to high winds, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury. Fatalities are uncommon, but can occur.

Figure 2-8 shows the average number of thunderstorm days throughout the U.S. Connecticut, including Middlesex County, experiences between 20 and 30 thunderstorm days each year.

An average thunderstorm is 15 miles across and lasts 30 minutes; severe thunderstorms can be much larger and longer. According to the National Weather Service:

- a severe thunderstorm is a thunderstorm that produces a tornado, winds of at least 58 mph (50 knots or ~93 km/h), and/or hail at least 1" in diameter; and
- An approaching severe thunderstorm is a thunderstorm with winds equal to or greater than 40 mph (35 knots or ~64 km/h) and/or hail of at least ½"

Observed structural wind damage may imply the occurrence of a severe thunderstorm. Hail of 1" or greater can damage property such as plants, roofs and vehicles. http://www.weather.gov/bgm/severedefinitions

Derechos: Based on climatology, Connecticut is located in a zone where derechos are predicted to occur about 1 every four years (typically during April to August).

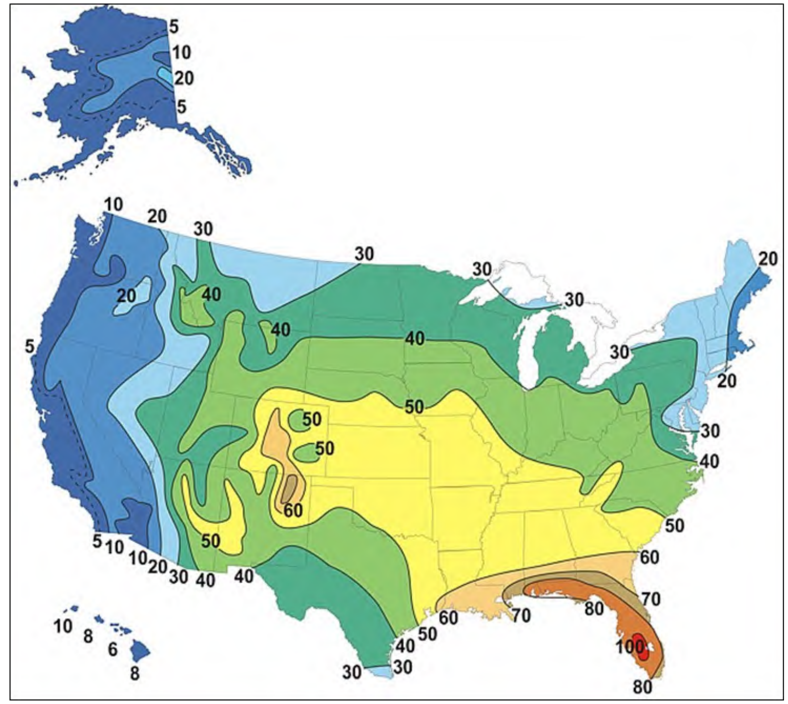


Figure 2-8: Average Annual Number of Thunderstorms in U.S.
(Source: http://www.srh.noaa.gov/jetstream/tstorms/tstorms_intro.html)

Historical Occurrence at Old Saybrook/Fenwick and Vicinity

90 thunderstorm wind events have occurred in Middlesex County from 1966 to 2017, resulting in about $211.25k in property damage (about $2,350 per event) and 0 deaths. 25 of these events resulted in damage and no event resulted in death or injury. Of these, 2 thunderstorm events impacted the Old Saybrook. The most severe thunderstorm, resulting in $1.5K in wind damages, occurred on May 27, 2010. Other severe thunderstorms were reported in Old Saybrook on _October 14, 1995. Ref. NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/ For this database, thunderstorm winds are defined as speeds of at least 58mph or of any speed producing a fatality, injury or damage.

Estimated Probability of Occurrence at and near Old Saybrook/Fenwick

The results indicate the following thunderstorm wind probability at and near Old Saybrook (within Middlesex County):

- Thunderstorm Winds within Middlesex County: +/- 56% AEP or minimum of 1-year to 2-year recurrence interval (29 years with 1 or more events over 52 years)
- Based on proportional land area, the estimated AEP at Old Saybrook is

TORNADOES

A tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud. The destruction caused by tornadoes ranges from light to catastrophic depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, including residential dwellings and particularly manufactured homes. Tornadoes are more likely to occur during the months of March through May and tend to form in the late afternoon and early evening.

Since 2007, tornadoes have been categorized according to the Enhanced Fujita scale:

Scale	Wind speed estimate		Potential damage
	mph	km/h	
EF0	65–85	105–137	Minor damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.
EF1	86–110	138–177	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111–135	178–217	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136–165	218–266	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations are badly damaged.
EF4	166–200	267–322	Devastating damage. Well-constructed and whole frame houses completely leveled; cars and other large objects thrown and small missiles generated.
EF5	>200	>322	Incredible damage. Strong-framed, well-built houses leveled off foundations are swept away; steel-reinforced concrete structures are critically damaged; tall buildings collapse or have severe structural deformations; some cars, trucks, and train cars can be thrown approximately 1 mile (1.6 km).

Table 2-5: Enhance Fujita Scale for Tornadoes

Prior to 2007, tornadoes were categorized according to the Fujita Tornado Intensity Scale:

Scale	Wind Speed Estimate (mph)	Potential Damage
Category F0:	Gale tornado (40-72 mph)	Light damage. Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage to sign boards.
Category F1	Moderate tornado (73-112 mph)	Moderate damage. The lower limit is the beginning of hurricane wind speed; peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads.
Category F2	Significant tornado (113-157 mph)	Considerable damage. roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
Category F3	Severe tornado (158-206 mph)	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.
Category F4	Devastating tornado (207-260 mph)	Devastating damage. Well-constructed houses leveled; structure with weak foundation blown off some distance; cars thrown and large missiles generated.
Category F5	Incredible tornado (261-318 mph)	Incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile sized missiles fly through the air in excess of 100 yards; trees debarked; incredible phenomena will occur.

Table 2-6: Original Fujita Tornado Intensity Scale

Tornadoes can occur anywhere in Connecticut, although relatively infrequently. Between 1950 and 2018, there were 97 tornado events within Connecticut (including 8 in Middlesex County), resulting in 4 fatalities, 709 injuries. The longest tornado path was 44 miles and the widest path was 1400 yards. The data for this period for the State is presented below (source: http://www.tornadohistoryproject.com/tornado/Connecticut/table)

Magnitude	Number of Events	No. of Injuries	No. of Deaths	Property Damage
F0/EF0	19	7	0	$500 to $20,500
F1/EF1	51	9	0	$676,000 to $6,762,502
F2/EF2	21	88	0	$10,687,000 to $106,870,000
F3/EF3	4	62	1	$5,105,000 to $51,050,000
F4/E4	2	540	3	$100M to $1B

Magnitude	Avg. No of Events/year	Avg. No. of Injuries/Event	Avg. No. of Deaths/Event	Avg. Property Damage/ Event
All	1.4	7.3	0.04	
F0/EF0	0.3	0.4	0	$26 to $107
F1/EF1	0.8	0.2	0	$13,255 to $132,598
F2/EF2	0.3	4.2	0	$508,905 to $5,089,048
F3/EF3	0.06	15.5	0.25	$1,276,250 to $12,762,500
F4/E4	0.03	270	1.5	$50M to $500

Table 2-7 Connecticut Tornado Data for the period of 1950 to 2018

Tornado risk is calculated from the destruction path that has occurred within 30 miles of the location. Details for Middlesex County are presented in **Table 2-8.** **Figure 2-9** shows the locations and tracks of Middlesex County tornadoes. These tornadoes ranged in severity from F0 to F3. These tornadoes occurred between the months of June and August. There have been 8 tornadoes in the last 68 years near (within Middlesex County) Old Saybrook/Fenwick.

Date	County, State	Fujita	Fatalities	Injuries	Damage ($)
8/1/1983	Middlesex, Connecticut	0	0	0	<$50
6/30/1998	Middlesex, Connecticut	0	0	0	-
7/19/1963	Middlesex, Connecticut	1	0	0	$500 to $5,000
7/21/1972	Middlesex, Connecticut	1	0	0	$500 to $5,000
6/27/1974	Middlesex, Connecticut	1	0	0	$50 to $500
6/30/1998	Middlesex, Connecticut	1	0	0	-
7/12/1950	Middlesex, Connecticut	2	0	0	$500 to $5,000
8/21/1951	Middlesex, Connecticut	3	0	0	$50,000 to $500,000

Table 2-8: Middlesex County, Connecticut Tornado Data for the period of 1950 to 2018

Historical Occurrence at Old Saybrook, Fenwick and Vicinity

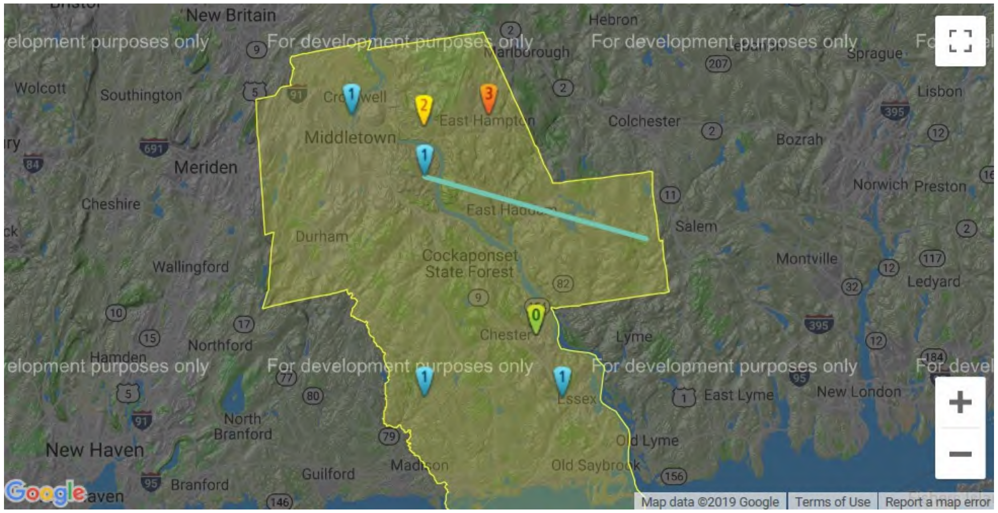
Of the 8 tornadoes in Middlesex County, the F3 tornado during August, 1951 resulted in the largest degree of damages at $50K to $500 M. The 7 other tornadoes combined accounted for less than $50,000 in total damages where most of the tornadoes ranged in severity from F0 to F2. Ref. NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/

Estimated Probability of Occurrence at and near Old Saybrook

The results indicate the following tornado probability at and near Old Saybrook and Fenwick (within Middlesex County):

- Tornadoes within Middlesex County: 12% AEP or 8-year recurrence interval (8 years with 1 or more events over 68 years)
- Major tornado within Middlesex County: 1.5% AEP or 70-year recurrence interval
- Based on the proportional land area, the Old Saybrook and Fenwick tornado AEP is about 0.2% and the Old Saybrook and Fenwick major tornado AEP is expected to be very low.

Figure 2-9: Location of Middlesex County Tornadoes
http://www.tornadohistoryproject.com/tornado/Connecticut /Middles/



THUNDERSTORMS - TORNADOES

During May 15, 2018 a squall line brought widespread high winds and wind damage to the Northeast. This happened one day after another squall line swept from Ohio to Virginia.

Beginning as a small broken line of thunderstorms around midday in northwest Pennsylvania, the line eventually congealed and raked across Pennsylvania, southern New York, Connecticut, Massachusetts, Rhode Island, northern Delaware and Maryland through the evening, producing well over 200 reports of high winds or wind damage.

Roughly 600,0000 people were without power at the time of peak outage in Pennsylvania, Connecticut, Virginia, New jersey and New York following the squall line.

Beginning as a small broken line of thunderstorms around midday in northwest Pennsylvania, the line eventually congealed and raked across Pennsylvania, southern New York, Connecticut, Massachusetts, Rhode Island, northern Delaware and Maryland through the evening, producing well over 200 reports of high winds or wind damage.

National Weather Service post-storm damage surveys and video confirmed 9 tornadoes touched down in Connecticut, New York, and Pennsylvania.

Two people died in Connecticut.

(Source The Weather Channel https://weather.com/storms/severe/news/2018-05-16-derechos-back-to-back-east-coast-may2018)

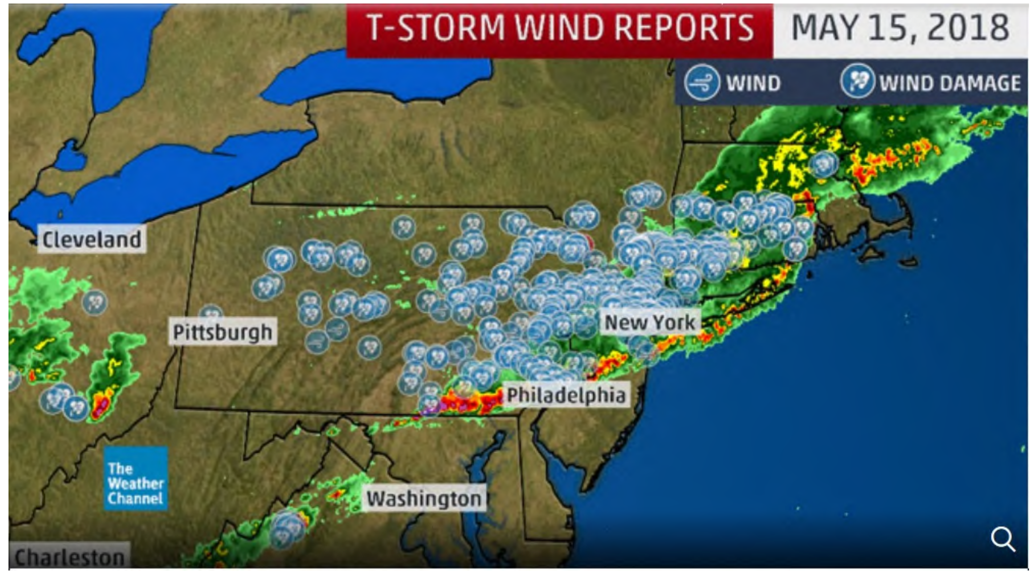


Figure 2-10: Radar and thunderstorm wind/wind damage reports (blue dots) from the derecho on May 15, 2018 from noon through 9 p.m. EDT.

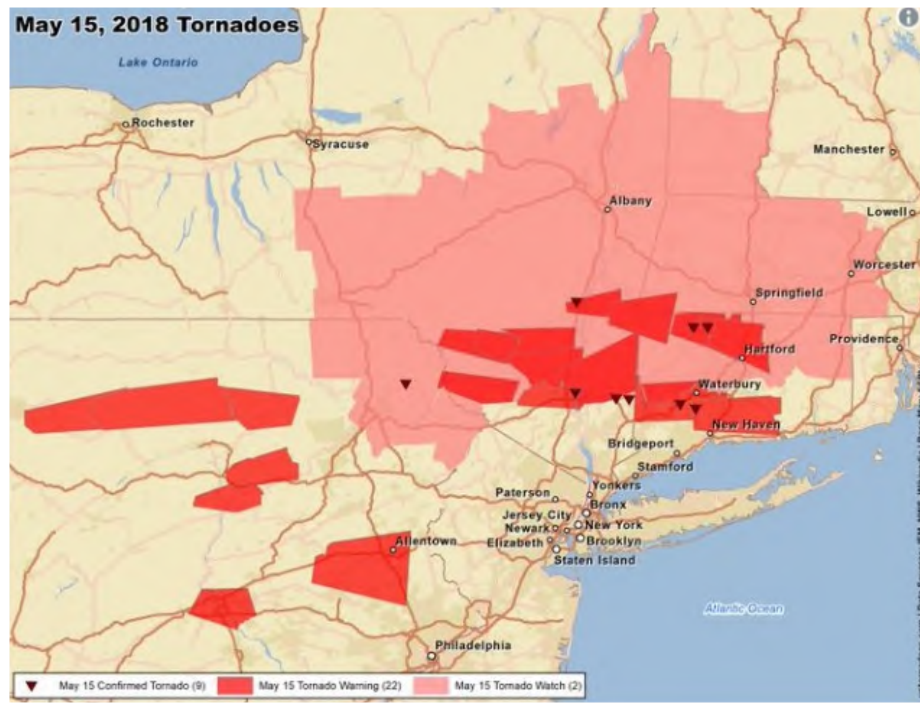


Figure 2-11: Confirmed Tornadoes, EFO0 to EF2 in strength. Four in Connecticut, four in New York and one in Pennsylvania.

Severe Weather Hazards: Lightning

LIGHTNING

Lightning strikes primarily occur during the summer months. There were 20 lightning deaths in the U.S. in 2018, none of which occurred in Connecticut (https://www.weather.gov/safety/lightning-fatalities18).

Lightning is the second most common storm-related killer in the United States. It causes several billion dollars in property damage each year and kills several dozen people. It is a frequent cause of wildfires and costs airlines billions of dollars per year in extra operating expenses.

Lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground. In the early stages of development, air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground. When the opposite charges builds up enough, this insulating capacity of the air breaks down and there is a rapid discharge of electricity that we know as lightning. The flash of lightning temporarily equalizes the charged regions in the atmosphere until the opposite charges build up again. Lightning can occur between opposite charges within the thunderstorm cloud (intra-cloud lightning) or between opposite charges in the cloud and on the ground (cloud-to-ground lightning).

Connecticut, including Middlesex County, has a moderate risk associated with Lightning strikes relative to other states. **Figures 2-12** and **2-13** show the number of fatalities and relative fatality rates by state. During the period of 2005 and 2014 (10 years), there have been 2 lightning fatalities in Connecticut (average of 0.2 per year).

Historical Occurrence at Old Saybrook and Vicinity

Since 1997, Middlesex County has experienced 16 Lightning events and 13 days with Lightning resulting in about $188k in property damage, 3 injuries and 1 death.

NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/

Estimated Probability of Occurrence at and near Old Saybrook/ Fenwick

The results indicate the following Lightning probability at and near Old Saybrook (within Middlesex County):

- Lightning Events resulting in fatality, injury and/or damage within Middlesex County: 38% AEP or 3-year recurrence interval (8 years with 1 or more events over 21 years)

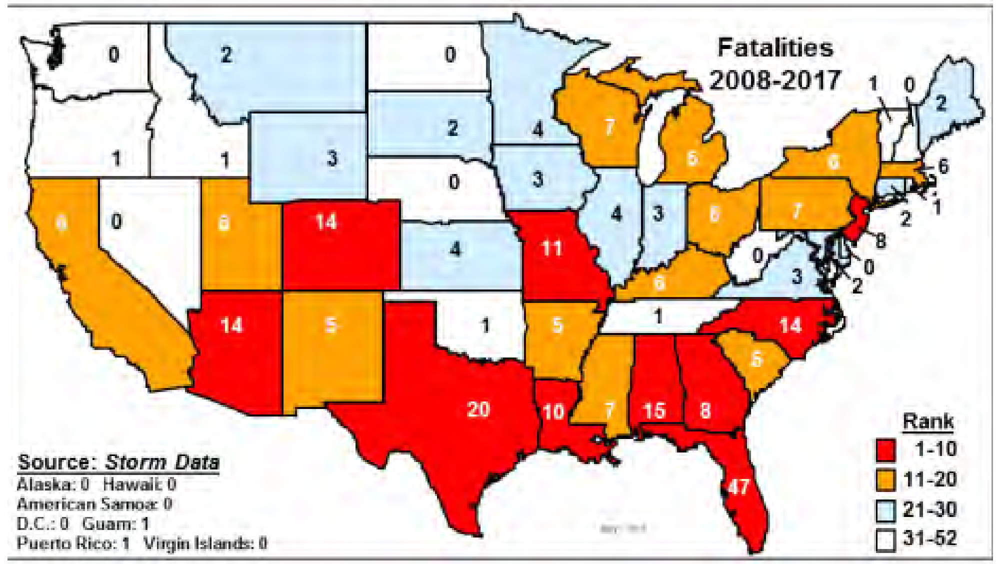


Figure 2-12: Lightning Fatalities by State, 2008-2017; (Source: Vaisala)

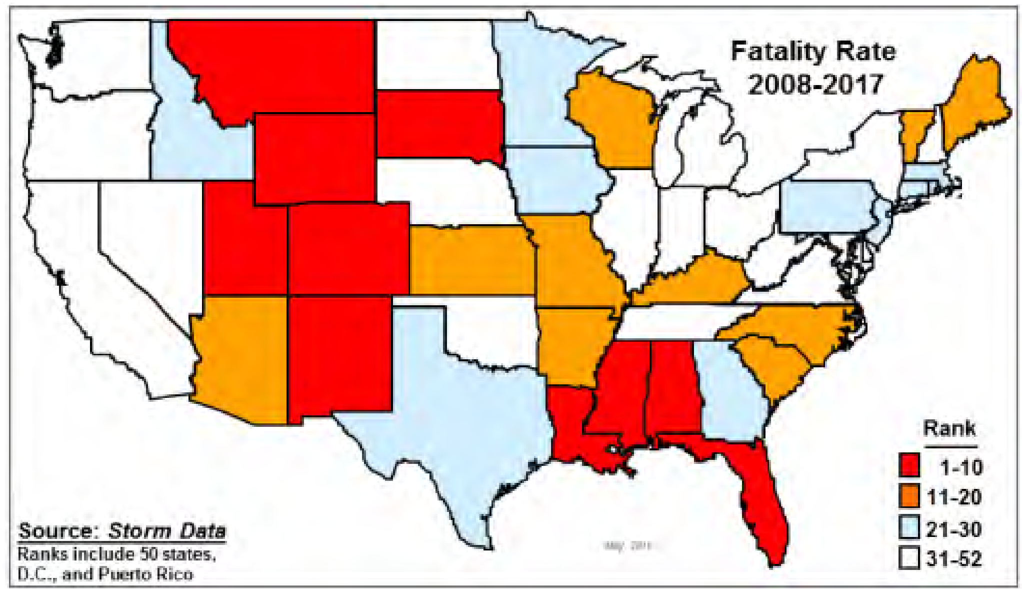


Figure 2-13: Lightning Fatalities Weighted by Population, 2008-2017; (Source: Vaisala)

Severe Weather Hazards: Intense Rainfall

INTENSE RAINFALL

Intense, heavy rainfall can result in localized flooding including flash flood events. Several factors contribute to intense precipitation flooding including rainfall intensity and duration. Other factors include the presence of streams and rivers, soil type, ground cover, drainage and the capacity of stormwater infrastructure. **Table 2-9** presents precipitation projections for the vicinity of Old Saybrook/Fenwick by the NOAA's National Weather Service (NOAA Atlas 14).

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.340 (0.259-0.442)	0.408 (0.311-0.530)	0.519 (0.394-0.676)	0.611 (0.462-0.798)	0.737 (0.542-0.997)	0.833 (0.601-1.14)	0.933 (0.657-1.32)	1.05 (0.700-1.50)	1.21 (0.782-1.77)	1.34 (0.849-2.00)
10-min	0.482 (0.367-0.626)	0.578 (0.440-0.751)	0.735 (0.558-0.958)	0.866 (0.654-1.13)	1.05 (0.768-1.41)	1.18 (0.852-1.62)	1.32 (0.930-1.87)	1.48 (0.991-2.12)	1.71 (1.11-2.51)	1.90 (1.20-2.83)
15-min	0.567 (0.432-0.736)	0.680 (0.518-0.884)	0.865 (0.657-1.13)	1.02 (0.770-1.33)	1.23 (0.903-1.66)	1.39 (1.00-1.91)	1.56 (1.09-2.20)	1.74 (1.17-2.49)	2.01 (1.30-2.95)	2.24 (1.42-3.33)
30-min	0.791 (0.603-1.03)	0.948 (0.723-1.23)	1.21 (0.917-1.57)	1.42 (1.07-1.86)	1.72 (1.26-2.32)	1.94 (1.40-2.66)	2.17 (1.53-3.06)	2.43 (1.63-3.48)	2.81 (1.82-4.12)	3.12 (1.97-4.64)
60-min	1.01 (0.774-1.32)	1.22 (0.928-1.58)	1.55 (1.18-2.02)	1.82 (1.38-2.38)	2.20 (1.62-2.98)	2.49 (1.79-3.41)	2.78 (1.96-3.93)	3.12 (2.09-4.46)	3.60 (2.33-5.28)	4.00 (2.53-5.95)
2-hr	1.32 (1.01-1.71)	1.59 (1.22-2.05)	2.02 (1.55-2.62)	2.38 (1.81-3.10)	2.88 (2.13-3.88)	3.25 (2.37-4.45)	3.65 (2.59-5.14)	4.11 (2.76-5.84)	4.79 (3.11-6.98)	5.37 (3.41-7.93)
3-hr	1.53 (1.18-1.97)	1.84 (1.42-2.37)	2.35 (1.80-3.03)	2.77 (2.11-3.58)	3.35 (2.48-4.49)	3.78 (2.75-5.15)	4.24 (3.02-5.96)	4.78 (3.22-6.76)	5.59 (3.63-8.11)	6.28 (4.00-9.24)
6-hr	1.95 (1.51-2.49)	2.35 (1.81-3.00)	2.99 (2.30-3.82)	3.52 (2.70-4.52)	4.25 (3.17-5.66)	4.79 (3.51-6.49)	5.37 (3.85-7.51)	6.07 (4.10-8.52)	7.11 (4.63-10.2)	7.99 (5.10-11.7)
12-hr	2.43 (1.89-3.08)	2.92 (2.27-3.70)	3.71 (2.87-4.72)	4.37 (3.37-5.58)	5.28 (3.95-6.98)	5.95 (4.38-8.00)	6.67 (4.80-9.24)	7.52 (5.11-10.5)	8.79 (5.75-12.6)	9.86 (6.31-14.3)
24-hr	2.85 (2.23-3.59)	3.45 (2.69-4.35)	4.42 (3.44-5.59)	5.23 (4.05-6.63)	6.34 (4.78-8.33)	7.16 (5.30-9.57)	8.05 (5.82-11.1)	9.11 (6.20-12.6)	10.7 (7.03-15.2)	12.1 (7.76-17.3)
2-day	3.18 (2.50-3.98)	3.89 (3.06-4.88)	5.06 (3.96-6.35)	6.02 (4.69-7.59)	7.35 (5.58-9.62)	8.33 (6.22-11.1)	9.40 (6.87-13.0)	10.7 (7.33-14.7)	12.8 (8.42-18.0)	14.6 (9.39-20.8)
3-day	3.45 (2.72-4.30)	4.22 (3.33-5.26)	5.47 (4.30-6.85)	6.52 (5.09-8.18)	7.95 (6.05-10.4)	9.01 (6.74-12.0)	10.2 (7.45-14.0)	11.6 (7.94-15.9)	13.8 (9.14-19.4)	15.8 (10.2-22.4)
4-day	3.71 (2.93-4.61)	4.51 (3.56-5.61)	5.82 (4.59-7.26)	6.91 (5.41-8.65)	8.41 (6.41-10.9)	9.51 (7.13-12.6)	10.7 (7.86-14.7)	12.2 (8.38-16.6)	14.5 (9.61-20.3)	16.5 (10.7-23.4)
7-day	4.43 (3.52-5.47)	5.29 (4.20-6.54)	6.70 (5.30-8.31)	7.87 (6.19-9.79)	9.48 (7.25-12.2)	10.7 (8.02-14.0)	12.0 (8.77-16.2)	13.5 (9.31-18.3)	15.9 (10.5-22.0)	17.9 (11.6-25.2)
10-day	5.13 (4.09-6.31)	6.02 (4.80-7.43)	7.49 (5.95-9.26)	8.71 (6.88-10.8)	10.4 (7.96-13.3)	11.6 (8.75-15.1)	13.0 (9.50-17.4)	14.5 (10.0-19.6)	16.9 (11.2-23.3)	18.9 (12.3-26.4)

Table 2-9: Predicted Rainfall Intensity by Duration and Recurrence Interval for Old Saybrook/Fenwick

While there is no specific, single set of criteria that defines "intense rainfall", the rainfall intensities associated with a 25-year recurrence interval are a reasonable benchmark (a 1 in 4 chance of being met or exceeded in any given year). This figure indicates short duration intensities (30 minutes and 1-hour) on the order of 3.4 and 2 inches per hour respectively and longer duration intensities (24 hours) on the order of an average 0.25 inch per hour (one day total rainfall amounts of about 6 inches).

Historical Occurrence at Old Saybrook/Fenwick and Vicinity

During the period between 1996 and 2005, Middlesex County experienced 22 days with Heavy Rain events, an average of about 2.4 event days per year, with no documented property damages, injuries or death. Ref. NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/

Estimated Probability of Occurrence at and near Old Saybrook and Fenwick

The results indicate the following intense rainfall probability at and near Old Saybrook (within Middlesex County):

- Intense Rainfall within Middlesex County: 4% AEP or approximately a 25-year recurrence

Severe Weather Hazards: Hail

HAIL

Hailstorms are a potentially damaging outgrowth of severe thunderstorms. Hailstorms frequently accompany thunderstorms, so their locations and spatial extents overlap. Large hail (greater than 1 inch in diameter) can be destructive. Hail can cause substantial damage to vehicles, roofs, landscaping, and other areas of the built environment. U.S. agriculture is typically the resource most affected by hail storms, which cause severe crop damage even during minor events. A recent risk, due to the widespread use of solar panels, is hail-related damage to solar panels.

Hail storms are not common in Connecticut, including Middlesex County. Connecticut hail data indicates between 1960 and 2015 Middlesex county experienced 24 days with hail events (an average of 0.4 events per year), with 0 injuries, 0 deaths, and $0k property damage. (source: NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/)

The Hail Risk Score (**Table 2-10**) provides a short-to-medium term view of future hail risk based on the last 10 years of ultra-high resolution radar data. The score is based on a scale of 1 to 10, with the lowest score of 1 representing Very Low hail risk (damaging hail unlikely in the next 5-10 years) and the highest score of 10 representing Extreme hail risk (damaging hail very likely every year).

The Hail Risk Score for the Old Saybrook area is 1 (reference: stormersite.com) .

Hail Risk Score	Hail Risk	Hail Risk Guidance
1	Very low	Damaging Hail unlikely in next 5-10 years
2	Very Low to Low	Damaging Hail likely every 5 years
3	Low	Damaging Hail likely every 2-4 years
4	Low to Moderate	Damaging Hail likely every 2-3 years
5	Moderate	Damaging Hail likely every other year
6	Moderate	Damaging Hail very likely every other year
7	Moderate to High	Damaging Hail likely every 1-2 years
8	High	Damaging Hail very likely every 1-2 years
9	Very High	Damaging Hail likely every year
10	Extreme	Damaging Hail very likely every year

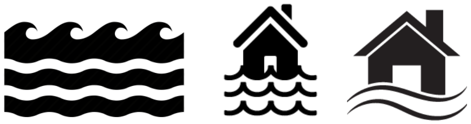
Table 2-10: Hail Risk Score Classifications

Estimated Probability of Occurrence at and near Old Saybrook/Fenwick

The results indicate the following hail probability at and near Old Saybrook (within Middlesex County):

- 31% AEP or approximately a 3 year recurrence interval (17 years with 1 or more events over 55 years)

Severe Weather Hazards: Flood



FLOOD

A flood is the partial or complete inundation of normally dry land. The various types of flooding include riverine flooding, coastal flooding, and shallow flooding. Common impacts of flooding include damage to personal property, buildings and infrastructure; bridge and road closures; service disruptions; and injuries or even fatalities.

The Town is vulnerable to:

- **Coastal storm surge.** Due to its low-lying coastal setting on Long Island Sound, the nearshore portions of Old Saybrook and Fenwick are vulnerable to coastal flooding including flood inundation and waves.
- **Rainfall events.** Inland (urban) flooding associated with large rainfall events, in particular within areas with impervious surfaces, poor drainage and inadequate stormwater management.
- **Nuisance flooding (aka coastal shallow water flooding)**. Coastal, frequent shallow water flooding due to astronomical high tides.
- **River Flooding**. The Site is vulnerable to riverine flooding from the Connecticut River and other smaller tributaries.

Coastal Flooding

Coastal floods in Connecticut are due to tropical cyclones (hurricanes and tropical storms) and extratropical nor'easters. The top ten highest water levels recorded at the NOAA tide stations (as of 1938 to May, 2019) located in the vicinity of Old Saybrook and Fenwick (the NOAA tide station at New London) are presented in **Table 2-11**.

More than ten major coastal flood events have occurred in Connecticut over the last 50 years. Several resulted in minimal-to-moderate damage to Middlesex County. Extreme flooding resulting from coastal storm surges at Old Saybrook result from two types of storms: Extra-tropical storms (Nor'easters) and tropical cyclones (Tropical Storms and Hurricanes).

The most intense hurricane of record in the vicinity of Old Saybrook is the Hurricane of 1938 . According to NOAA, this hurricane was a Category 3 intensity at landfall along the Connecticut coast. The approximate peak water levels at New London during the Hurricane of 1938 were Elevation 8.5 to 9 feet NAVD88. There were also several high intensity hurricanes during the 1800s and early 1900s that made landfall along Long Island, although details about their intensity are limited.

Hurricane Gloria in September 1985 arrived at low tide and resulted in storm surges of about 4 feet, which did not result in extensive damage to the coastline. Hurricane Bob in August 1991 made landfall over Block Island, RI and did not result in extensive damage to the coastline in Middlesex County. An unnamed coastal storm in October 1991 (aka the Perfect Storm) joined up with the remains of Hurricane Grace and resulted in the 7th highest floods near Old Saybrook. In August 2011, Hurricane Irene, weakened to a tropical storm, caused extensive damage throughout Middlesex County.

Hurricane Sandy, although its landfall was over 200 nautical miles south of Old Saybrook, was one of the most significant flood events in Connecticut. Sandy's storm surge when combined with tides, caused peak water levels to reach approximately Elevation 6.5 feet NAVD88 at Old Saybrook.

Table 2-11: Top Ten Coastal Floods near Old Saybrook and Fenwick
Note: Water levels are referenced to feet above MHHW with no adjustment for sea level rise.

Station	1	2	3	4	5
8461490 New London	Hurricane of 38 9/20/1938 8.74 feet	Hurricane Carol 8/30/1954 7.74 feet	Hurricane Sandy 10/30/2012 6.10	Great Appalachian Storm 11/24/1950 5.74 feet	Great Atlantic Hurricane 9/13/1944 5.24 feet
	6	7	8	9	10
	Hurricane Donna 9/11/1960 5.04 feet	Perfect Storm 11/6/1953 4.94 feet	Nor'easter 10/31/1991 4.63 feet	Hurricane Irene 08/29/2011 4.60 feet	Nor'easter 11/11/1968 4.54 feet

Coastal flooding at Old Saybrook and Fenwick occurs due to storm surge and waves within Long Island Sound and the Connecticut River. Coastal storm surges will also propagate up waterways that are hydraulically connected with Long Island Sound and the Connecticut River. An assessment of the coastal flood frequency (i.e. probability) applicable to the Town was performed based on the following data sources. Flood frequency is characterized in terms annual exceedance probability (also recurrence interval).

- The current FEMA FIRMs and Flood Insurance Studies (FIS). The current FEMA FIS is the Middlesex County, Connecticut (All Jurisdictions) study, revision date February 6, 2013, Flood Insurance Study Number 09007CV001B.
- The results of the Army Corps of Engineers (USACE) North Atlantic Coast Comprehensive Study (NAACS). The study provides nearshore storm surge and wave hazard data at several locations along the Old Saybrook and Fenwick shoreline.
- Statistical analysis of the NOAA New London tide station water level data

FEMA Flood Hazard Determination

Through FEMA's flood hazard mapping program, Risk Mapping, Assessment and Planning (MAP), FEMA identifies flood hazards, assesses flood risks and partners with states and communities to provide accurate flood hazard and risk data to guide them to mitigation actions. Flood hazard mapping is an important part of the National Flood Insurance Program (NFIP), as it is the basis of the NFIP regulations and flood insurance requirements. FEMA maintains and updates data through Flood Insurance Rate Maps (FIRMs) and risk assessments. FEMA coastal transects provide detailed flood data around Old Saybrook and Fenwick and are summarized in **Table 2-12**. Flood elevations are presented in **Table 2-12** for: 1) the stillwater elevation, which is the water level in the absence of waves; 2) the Total Water Level which includes the stillwater elevation and the effects of wave setup; and 3) the Base Flood Elevation (BFE). The BFE is the flood having a one percent chance of being equaled or exceeded in any given year. This is the regulatory standard also referred to as the "100-year flood" and includes the Total Water Level plus wave plus wave runup.

Transect	Stillwater Elevation (SWEL)				Total Water Level	FEMA Flood Zone	Base Flood Elevation
	10%	2%	1%	0.2%	1%		
33	5.4	7.7	9.3	15.6	10.7	VE AE	13-16 12-13
32	5.4	7.7	9.3	15.5	13.1	VE AE	15-20 13-15
31	5.4	7.7	9.3	15.4	10.3	VE AE	13 10-12
30	5.4	7.7	9.3	15.3	11.4	VE AE	14 11-13
29	5.4	7.7	9.3	15.3	12.5	VE AE	19 12-14
28	5.4	7.7	9.3	15.2	10.9	VE AE	13-24 11-13
27	5.4	7.7	9.3	15.2	11.6	VE AE	13-24 11-13
26	5.4	7.7	9.3	15.2	10.1	VE AE	13-24 11-13
25	5.4	7.7	9.3	15.1	13.2	VE AE	13-18 11-15
24	5.4	7.7	9.3	15.1	12.7	VE AE	13-18 11-15
23	5.4	7.7	9.3	15.1	11.7	VE AE	13-18 11-15
22	5.4	7.7	9.3	15.1	10.6	VE AE	13-18 11-15
21	5.4	7.7	9.3	15.1	11.5	VE AE	13-18 11-15
20	5.4	7.7	9.3	15.1	11.0	VE AE	13-18 11-15
19	5.4	7.7	9.3	15.1	11.6	VE AE	13-18 11-15

Table 2-12: FEMA Coastal Transect Data around Old Saybrook and Fenwick
Note: Water levels are referenced to feet, NAVD88

Coastal Flood Probability

As presented in the 2018 Coastal Community Resilience Study, Flood hazard mitigation planning requires characterizing flooding in terms of risk, specifically associating different flood levels with a probability of occurrence. Flood probabilities are typically described in terms of the annual chance of occurrence. For example, the 1% annual chance flood elevation has, in any given year, a 1/100 chance of being met or exceeded. This flood is also known as the 100-year return period flood. There are several publicly -available, industry-accepted sources of flood probability data for the vicinity of Old Saybrook. These include:

1. Statistical analysis of the NOAA New London tide station water level data: Statistical analysis of the NOAA New London tide station water level data provides an indication of the recurrence interval of flooding based on an approximately 80-year period of record. The gage at New London has too brief a period of record for extrapolating extreme water levels without significant uncertainty.

2. FEMA Flood Insurance Study and Rate Maps: FEMA has characterized the current flood hazard within Old Saybrook for the purposes of the National Flood Insurance Program (NFIP). FEMA uses the 1% annual chance (100-year return period) flood event to characterize flood risk, presented on Flood Insurance Rate Maps (FIRMs). FEMA also presents the 0.2% annual chance flood inundation limits in these maps. Figure B-11 presents the effective (i.e., currently applicable) FEMA Flood Insurance Rate Map (FIRM) flood limits and elevations, used to calculate flood insurance rates for Long Wharf.

3. The USACE North Atlantic Coast Comprehensive Study (NACCS): The USACE performed extensive regional coastal flood hazard analyses after Hurricane Sandy (the North Atlantic Coast Comprehensive Study). These analyses utilized interpretation of meteorological parameters, numerical computer modeling of storm surge and waves, and statistical analysis (e.g., Joint Probability Method-Optimum Sampling, Empirical Simulation Technique) to characterize regional flood hazards.

There is no exact prediction of flood probability; rather, there are a range of probabilities (and corresponding flood elevations) that reflect different prediction methods, error and uncertainty. The NOAA New London, CT tide gage data has significant uncertainty for predicting floods beyond 20 to 50-year recurrence interval floods due to the limited period of record and likely under-predicts the flood hazard. The FEMA stillwater flood projections for Old Saybrook, which were also developed using tide gage data, have similar uncertainty (stillwater elevation is the flood elevation that occurs in the absence of wave effects). The USACE NACCS utilized the “state-of-the-practice” methodology; however, there is significant statistical uncertainty and some model error.

Overall, the USACE NACCS currently presents the most robust analysis of coastal flood hazards in the vicinity of Old Saybrook.

Figure 2-14: Temporary USGS Tide Gage on South Cove Causeway, measuring water levels during Hurricanes Irene and Sandy

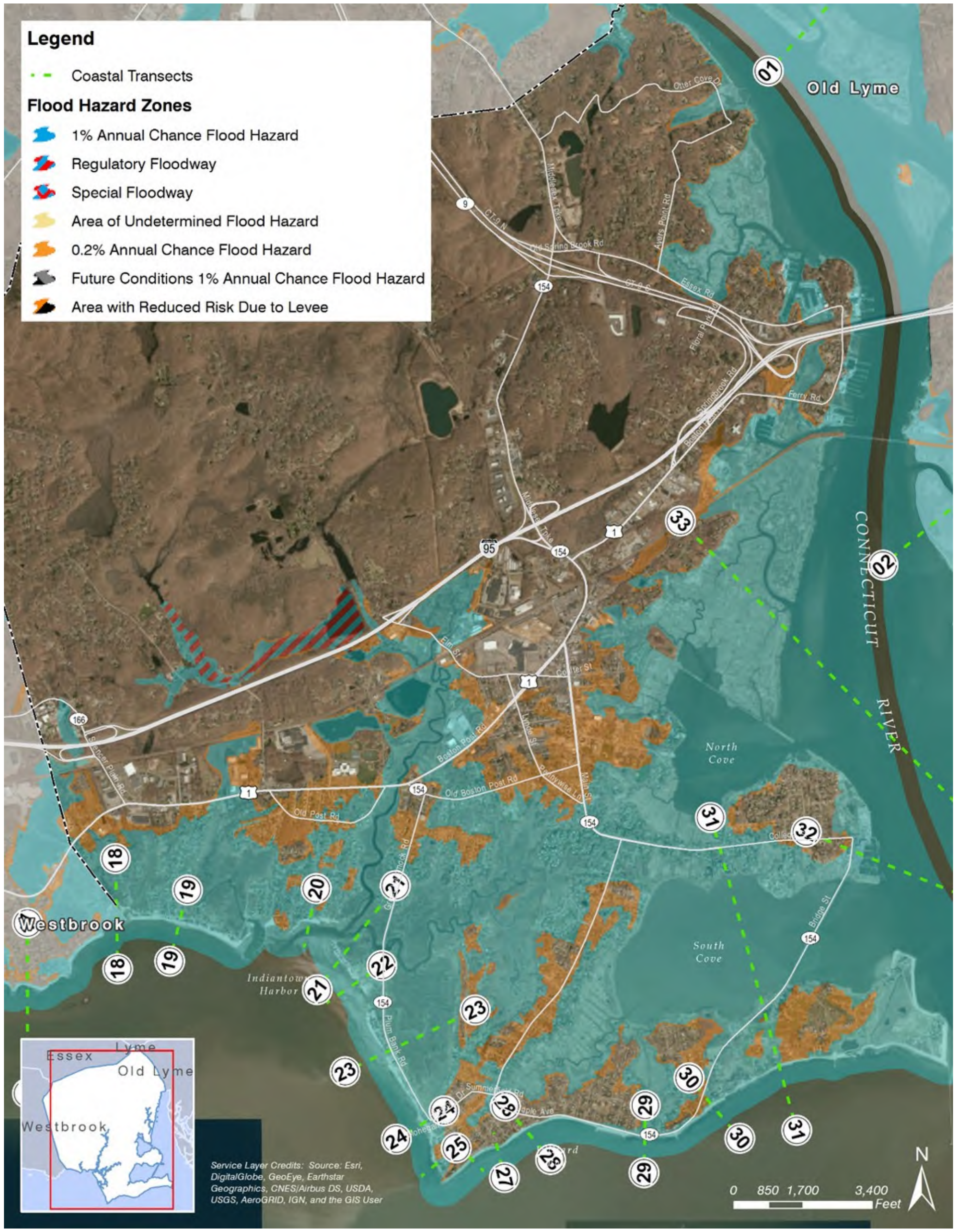
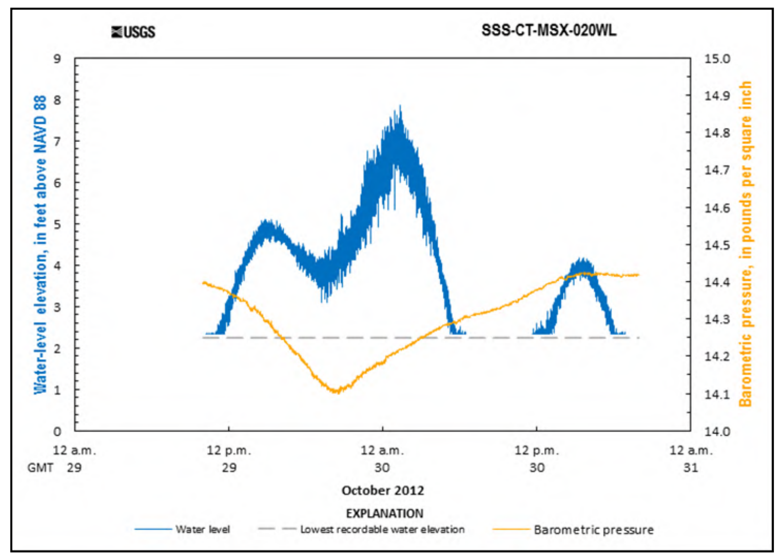


Figure 2-15: FEMA Flood Insurance Rate Map Flood Hazard Zones and Base Flood Elevations

South Cove Causeway during Irene showing wave overtopping bridge deck. The image above photo by Mara Lavitt won a first-place award in the Connecticut SPJ contest. “Thrill seekers on the causeway between Old Saybrook and Fenwick Point during Tropical Storm Irene, on Aug. 28, 2011.” The tide gage data USGS gage data indicated a peak water level during Irene of about Elevation 6.5 feet NAVD (about or slightly higher than the bridge deck elevation). In comparison, the same tide gage (shown below) measured a peak water level of about Elevation 8 feet NAVD during Sandy. The gage data likely includes some wave effects and the actual stillwater flood elevation during Sandy was lower.



NOAA Tide Station Water Level Analysis

NOAA statistically analyzed annual water level data at the NOAA Bridgeport and New London tide gages using the Generalized Extreme Value (GEV) probability distribution. The results are shown in **Figure 2-16** (in meters relative above MHHW). The 95% confidence intervals are also shown.

GZA independently performed similar statistical analyses with comparable results. The mean 1% annual exceedance stillwater elevation is estimated using this analysis and corrected for Old Saybrook) is at about Elevation 7.5 feet NAVD88.

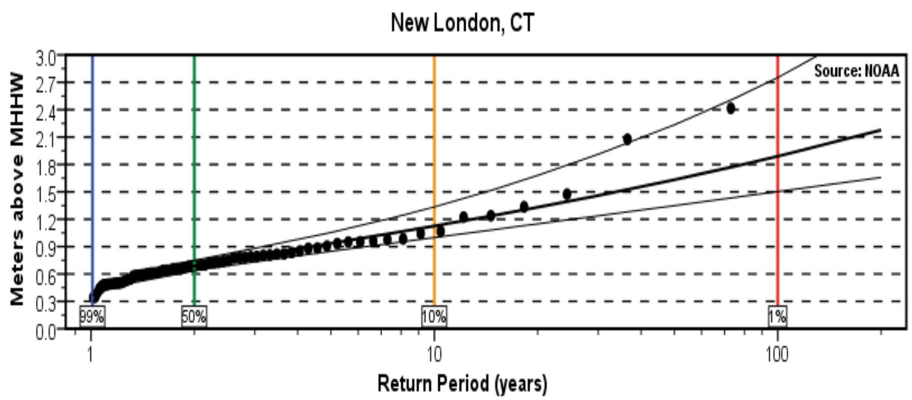


Figure 2-16: NOAA Annual Exceedance Probability Curve for the New London Station

USACE North Atlantic Coast Comprehensive Study

The results of the USACE NACCS are available at specific model "save point" locations. **Figure 2-17** shows the locations of "save points" along the Old Saybrook shoreline. USACE-predicted Total Water Level data, including the stillwater elevation plus wave setup, and wave heights are available at these locations.

Due to the updated methodology used by the USACE, the flood hazard data developed by the USACE NACCS are expected to be indicative of what future editions of the FEMA FIS and FIRMs will be for Old Saybrook.

Figure 2-17: USACE North Atlantic Coast Comprehensive Study Results Save Points

Summary of Predicted Summary of Predicted Flood Elevations and Probabilities

Table 2-13 summarizes the coastal, nearshore predicted flood stillwater elevations by annual exceedance probability (return period). The data presented in **Table 2.13** is relative to FEMA FIS Transect 29 and USACE NACCS Save Point 8244. Similar to tides, a reasonable estimation of the effects of RSLC on storm surge stillwater elevations can be developed by linear superposition of the predicted RSLR to the predicted stillwater elevation. **Figure 2-18** presents the flood-frequency curve (mean with uncertainty) for the USACE NACCS Save Point 8244.

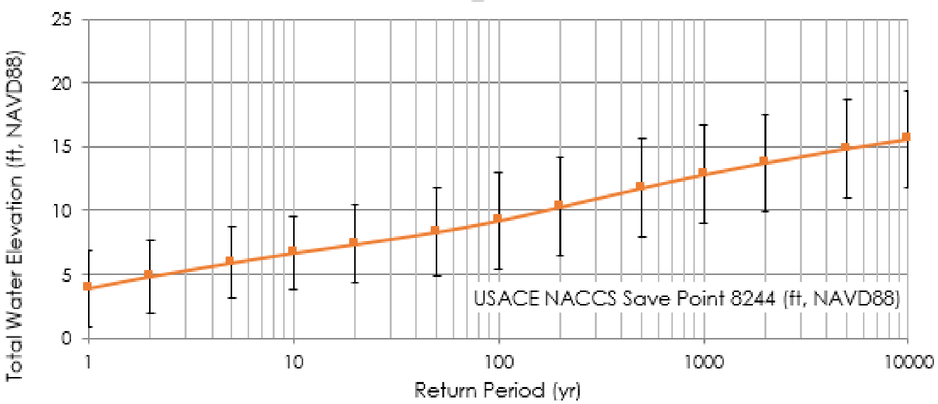


Figure 2-18: Flood Frequency Curve Base of USACE North Atlantic Coast Comprehensive Study along Old Saybrook Shoreline for the year 2017. Mean, upper and lower bounds shown.

Table 2-13: Summary of Predicted Flood Elevations and Probabilities for the Years 2017, 2041, 2066 and 2116; UB and LB indicate lower and upper bounds, respectively. In feet, NAVD88.

Recurrence Interval (years)	1	2	5	10	20	50	100	200	500	1,000
2017:										
NOAA MEAN	2.3	3.5	4.4	5.0	5.6	6.6	7.5	8.4		
NOAA UB	2.3	3.7	4.7	5.7	6.7	8.6	10.3	12.6		
NOAA LB	2.3	3.3	4.1	4.5	5.0	5.7	6.2	6.8		
FEMA				5.5		7.7	9.2		15.3	
USACE MEAN	3.9	4.8	5.9	6.7	7.4	8.3	9.2	10.3	11.8	12.8
USACE UB	6.9	7.7	8.7	9.6	10.4	11.8	12.9	14.1	15.6	16.6
USACE LB	0.9	2.0	3.1	3.7	4.3	4.9	5.5	6.4	7.9	9.0
2040:										
USACE MEAN (INT SLR)	4.2	5.1	6.2	7.0	7.7	8.6	9.5	10.6	12.1	13.1
USACE MEAN (HIGH SLR)	4.9	5.8	6.9	7.7	8.4	9.3	10.2	11.3	12.8	13.8
2070:										
USACE MEAN (INT SLR)	4.7	5.6	6.7	7.5	8.2	9.1	10.0	11.1	12.6	13.6
USACE MEAN (HIGH SLR)	6.2	7.1	8.2	9.0	9.7	10.6	11.5	12.6	14.1	15.1
2100:										
USACE MEAN (INT SLR)	5.9	6.8	7.9	8.7	9.4	10.3	11.2	12.3	13.8	14.8
USACE MEAN (HIGH SLR)	10.3	11.2	12.3	13.1	13.8	14.7	15.6	16.7	18.2	19.2

North Atlantic Coast Comprehensive Study

Table 2-14 presents flood stillwater levels and wave heights at representative save points, as predicted by the USACE NACCS study. Figure 2-13 shows the locations of the NACCS save points. The save point locations correspond to the FEMA transect locations in **Table 2-12**. The values presented below represent mean values. The range of uncertainty (95% confidence intervals) associated with the stillwater levels at the 1% and 0.2% floods is about 4 feet. The NACCS predicted values differ somewhat from FEMA due to the difference in methodologies used. Consistent with FEMA, the NACCS-predicted 1% wave heights indicate high velocity (VE) zones along Old Saybrook and Fenwick's shorelines.

Historical Occurrence at Old Saybrook/Fenwick and Vicinity

For the period of 1996 to 2018, there have been 7 coastal flood events in Middlesex County, including 5 days with property damage (resulting in $0k of damage), no injuries and no deaths. NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/

Estimated Probability of Occurrence at and near Old Saybrook

The results indicate the following coastal flood probability at and near Old Saybrook (within Middlesex County):

- See Tables 2-12 and 2-13.

NACCS Save Point	Mean Stillwater Elevation (SWEL)							Mean 1% Wave Height, ft.
	100%	50%	20%	10%	2%	1%	0.2%	
8272	2.6	3.6	4.8	6.5	7.6	8.4	9.3	3.3
8269	2.6	3.7	5	5.9	7.9	8.8	9.9	3.7
8270	2.6	3.8	5	5.9	8	8.8	9.9	3.7
8268	2.6	3.7	4.9	5.8	7.8	8.7	9.7	7.1
8267	2.7	3.8	5	5.9	7.9	8.8	9.8	4.7
8263	2.6	3.7	4.9	5.8	7.8	8.7	9.7	7.0
8245	2.6	3.7	4.9	5.8	7.7	8.7	9.8	6.9
8244	2.6	3.6	4.8	5.7	7.7	8.6	9.7	10.4
8243	2.6	3.7	4.9	5.8	7.7	8.7	9.8	9.6
8261	3	3.9	5.1	6	8.4	9.5	10.7	4.4
8240	2.6	3.7	5	5.9	7.9	8.9	10	7.7

Table 2-14: NACCS Save Point Data around Old Saybrook and Fenwick
Note: Water levels are referenced to meters, NAVD88

Sea Level Rise

Sea Level Rise (SLR) is the rise of global ocean waters. Relative SLR change (RLSC) is the drainage of sea level relative to the adjacent land mass and is unique to a given geographic location. RSLC is caused by several factors, including: 1) ground settlement due to post-glacial isostatic adjustment; 2) warming of ocean waters, resulting in volume expansion; 3) increase in ocean volumes due to melting Arctic and land ice; 4) ocean density gradients due to the infusion of lower density fresh water; and 5) changes to global ocean circulation patterns (e.g., the Gulf Stream and Labrador Current).

As shown in **Figure 2-18**, the observed RSLC at the NOAA New London station, over the last approximately 80 years, indicates a mean sea level rise trend of 2.56 millimeters (mm) per year (with a 95% confidence interval of +/- 0.21 mm per year) (2.65 mm/yr = 0.10 inch/year).

Compared to Global Sea Level Rise. Over the last century, sea levels along the New England coast have risen faster than the global mean rate (which is about 1.7 to 1.8 mm per year). In fact, the observed sea level rise along the Northeast coast (from Mid-Atlantic region to Boston) is experiencing some of the largest rates of sea level rise in the world. This has been due, in part, to post-glacial land subsidence (glacial isostatic adjustment). Consistent with global sea level rise, other factors include increases in the ocean volume (due to glacial ice melt) and thermal expansion (due to increasing sea temperatures). Recent studies (Geophysical Research Letters, 2013), however, attribute the recent significant increase in the rate of sea level rise along the New England coast to ocean dynamics, specifically the effects and movement of the Gulf Stream and its interaction with cold, less dense water flowing down from Greenland.

Sea Level Rise Uncertainty

While the sea level of Long Island Sound is clearly rising, predicting the future rate of sea level rise is complex, highly uncertain, and dependent on many unknown factors (such as future emissions of greenhouse gases, rate and amount of ice melt, etc.).

NOAA and the USACE have developed ranges of RSLC for use on federal projects in the United States. The 2013 USACE projections, used for the Study, range from Low to Intermediate to High. The USACE Low projections are generally consistent with the observed historical rates of RSLC. Observed RSLC over recent years indicate a trend of increased rates. As indicated in **Figure 2-20,** recent projections adopted by NOAA indicate the potential for even higher RSLC. The predicted sea level rise at New London between the years 2017 and 2116 (based on projections at NOAA tide station 8467150 at New London, CT and USACE 2013/NOAA2012 projections) are summarized in **Table 2-15** and **Figure 2-20** (facing) (in feet relative to the NAVD88 elevation datum). These projections were developed using the USACE Sea Level Change Curve Calculator (version 2017.42) and are based on USACE 2013/NOAA 2012 projections.

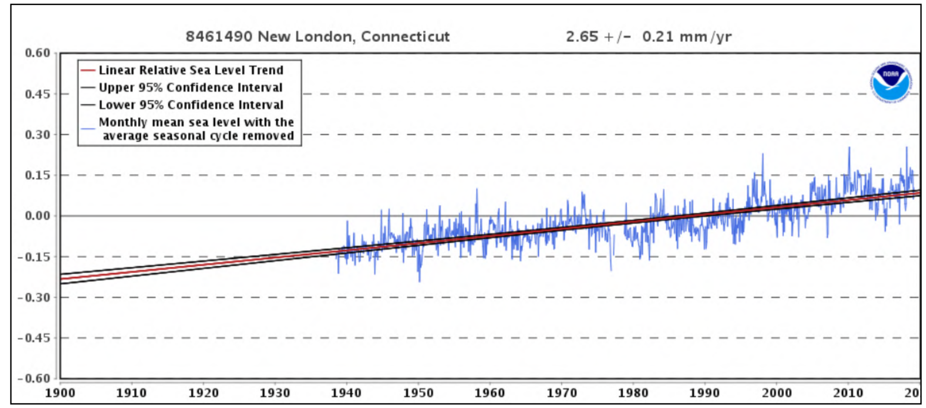


Figure 2-19: Observed Sea Level Rise at New London, Connecticut

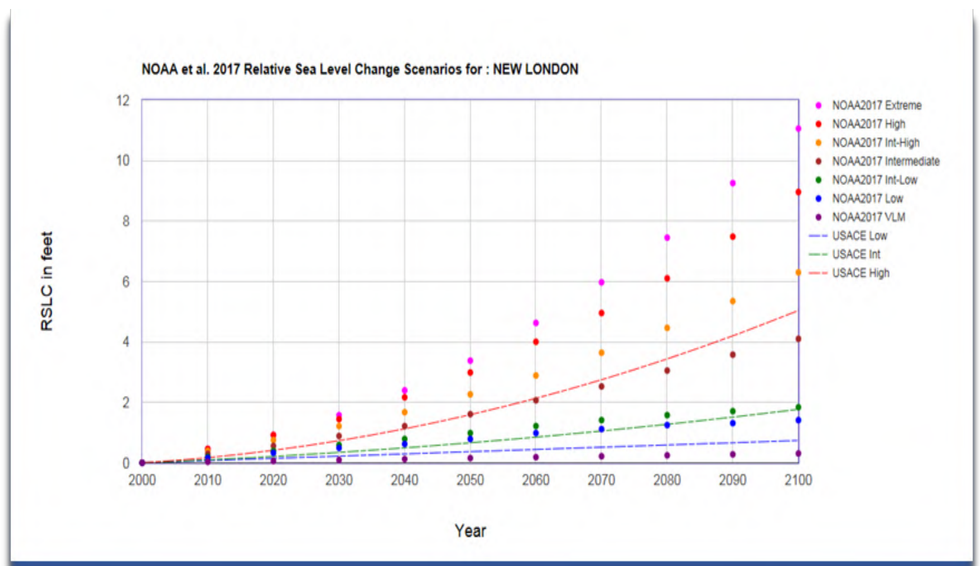


Figure 2-20: Sea Level Rise Projections (using the USACE Relative Sea Level Change Calculator for USACE2013/NOAA 2012 projections)

Year	NOAA (LOW)	USACE (LOW)	NOAA (INT-LOW)	USACE (INT)	NOAA (INT-HIGH)	USACE (HIGH)	NOAA (HIGH)
2017	-	-	-	-	-	-	-
2040	0.17	0.17	0.32	0.32	0.65	0.79	1.03
2050	0.13	0.13	0.43	0.43	1.09	1.38	1.85
2070	0.39	0.39	0.88	0.88	1.95	2.42	3.18
2100	0.61	0.61	1.59	1.59	3.77	4.71	6.25

Table 2-15: Sea Level Rise Projections (using the USACE Relative Sea Level Change Calculator for USACE 2013/NOAA 2012 projections; relative to the year 2017)

The NOAA sea level rise projections were revised subsequent to completion of GZA's analysis but prior to completion of the Study report. NOAA 2017 projections (mean values) are presented in **Figure 2-20** and **Table 2-16**. The USACE 2013 projections are shown for comparison. NOAA 2017 utilizes six descriptive categories: VLM (representing vertical land movement); Low; Intermediate-Low; Intermediate; Intermediate-High; High; and Extreme.

Year	NOAA (VLM)	NOAA (LOW)	NOAA (INT-LOW)	NOAA (INT)	NOAA (INT-HIGH)	NOAA (HIGH)	NOAA (Extreme)
2017	-	-	-	-	-	-	-
2040	0.06	0.29	0.46	0.88	1.34	1.84	2.07
2050	0.09	0.46	0.65	1.28	1.93	2.66	3.05
2070	0.16	0.79	1.08	2.20	3.31	4.62	5.64
2100	0.25	1.08	1.51	3.77	5.97	8.63	10.73

Table 2-16: Sea Level Rise Projections (using the USACE Relative Sea Level Change Calculator for NOAA et. al. 2017 projections; relative to the year 2017)

Table 2-16 presents the NOAA 2017 mean projections, interpolated from the year 2017. (These interpolations assume a RSLC of about 0.33 feet between the years 2000 and 2017.) **Table 2-17** presents estimated exceedance probabilities associated with the six NOAA 2017 projections (shown in Figure 2-5) for several possible future climate climate scenarios (Representative Concentration Pathways RCP 2.6, RCP 4.5, RCP 8.5) adopted by the Intergovernmental Panel on Climate Change (IPCC) for its fifth Assessment Report (AR5).

In general, the median "Intermediate-Low" is considered appropriate as an "analysis and planning lower bound" and either the median "Intermediate" or median "Intermediate-High" is appropriate as an "analysis and planning upper bound".

GMSL Rise Scenario	RCP 2.6	RCP 4.5	RCP 8.5
Low (0.3 m)	94%	98%	100%
Intermediate-Low (0.5 m)	49%	73%	96%
Intermediate (1.0 m)	2%	3%	17%
Intermediate-High (1.5 m)	0.4%	0.5%	1.3%
High (2.0 m)	0.1%	0.1%	0.3%
Extreme (2.5 m)	0.05%	0.05%	0.1%

Table 2-17: Probability of Exceeding Global Mean Sea Levels in 2100 for Several Representative Concentration Pathways (RCP) Scenarios (reproduced from "Global and Regional Sea Level Rise Scenarios for

The variance between the NOAA, 2017 projections increases significantly by mid-century. The NOAA 2017 Intermediate-Low projection has a high (possible to certain) likelihood of occurrence (49% to 96% by 2100). The NOAA 2017 Intermediate projection has low to moderate (possible to certain) likelihood of occurrence (2% to 17% by 2100). The NOAA 2017 Extreme GMSL scenario is a worst case scenario. For the New London area, the Extreme RSLC scenario for the year 2100 is about 11 feet. Note that the probabilities presented here are approximate; however, they are appropriate for use in understanding the risk of different sea level rise scenarios and planning.

The 2013 USACE projections, the latest projections available at the time of GZA's analyses, were used to model flooding for the Study. The exceedance probabilities associated with the USACE projections can be approximated using Table 2-5 as a guide along with the following: USACE 2100 RSLC High (lies between the NOAA 2017 Intermediate-High and Intermediate); USACE 2100 RSLC Intermediate (close to NOAA 2017 Intermediate-Low); USACE 2100 RSLC Low (between NOAA 2017 Low and VLM). At mid-century (2050) the USACE 2050 High RSLR is consistent with NOAA 2017 Intermediate; the 2050 USACE Intermediate is consistent with the NOAA 2017 Low. As an approximate guide, the 2100 USACE High RSLC projection has a very low to moderate chance of occurrence (exceedance probabilities of 0.4% to 17%) and the USACE Intermediate RLSC projection has a possible to certain chance of occurrence (exceedance probability of 49% to 100%).

The State of Connecticut, in PA 13-179, "An Act Concerning the Permitting of Certain Coastal Structures by the Department of Energy and Environmental Protection" references NOAA CPO-1 report (an earlier NOAA report, dated December, 2012) and requires that State and Municipal Plans of Conservation and Development, Civil Preparedness Plans and Municipal Hazard Mitigation Plans must "consider" the sea level change scenarios from the NOAA CPO-1 report. PA 13-179 also charged the University of Connecticut, Department of Marine Science to update the NOAA CPO-1 projections every 10 years based on local conditions and the state of the science.

Based on verbal communication with the University of Connecticut, we understand that forthcoming updates to the NOAA COP-1 projections will result in recommendations as follows: 1) for mid-range planning, assume that sea level will be 1.7 feet higher than the national tidal datum in Long Island Sound by the year 2050 (relative to the year 2000); 2) planners should be aware that the rate of sea level is expected to continue to increase, with a 3.25 feet rise in sea level by 2100; and 3) greenhouse gas emissions will be monitored and new assessments will be developed at decadal intervals. These recommended values are close to the NOAA 2017 Intermediate projections (see **Table 2-16**). They are also reasonably represented by the 2013 USACE High projections. See **Tables 2-15** and **2-16** for projections relative to the year 2017.

The report "Global and Regional Sea Level Rise Scenarios for the United States"; NOAA Technical Report NOS CO-OPS 083; January, 2017 (NOAA, 2017) presents general guidance about selection of projections for planning purposes. One planning approach is to: 1) use a scientifically plausible, but currently low expected likelihood of occurrence as a planning upper bound; and 2) define a mid-range scenario as a baseline for planning, such as adaptation plans covering the next three decades (2050). These projections would bound a planning "envelope".

In consideration of the information presented above, as well as State guidance, it is recommended that the USACE High RSLC Scenario, which was used for the Study, be considered as an appropriate projection for adaptation planning. It is also recommended that the USACE Intermediate RSLC Scenario be considered as having a very high (possible to near certain) likelihood of occurrence. However, projections representing greater rates of relative sea level rise should be considered on a case-by-case basis for design of costly or critical infrastructure.

Rising Tides

A reasonable estimate of the effects of RSLC on tides can be developed by linear superposition of the predicted RSLC to the current epoch tidal datums. **Table 2-17** presents the current and predicted changes to the tidal datums for Old Saybrook due to RSLC for the years 2040, 2070 and 2100, in feet NAVD88.

Figure 2-21 shows the predicted tidal inundation due to between 1 foot and 6 feet sea level rise, relative to MHHW. Assuming the 2013 USACE High RSLC scenario, RSLC amounts corresponding to future years are:

1 foot (MHHW = 2.5 feet NAVD88):	Years 2040 to 2045
2 feet (MHHW = 3.5 feet NAVD88):	Year 2060
3 feet (MHHW = 4.5 feet NAVD88):	Years 2075 to 2080
4 feet (MHHW = 5.5 feet NAVD88):	Year 2090
5 feet (MHHW = 6.5 feet NAVD88):	Year 2100

Except for areas along the beaches and near tidal wetlands, the effects of tidal flooding on the Town are currently minimal. The MHHW assuming the 2013 USACE High RSLC projection for the years 2080 to 2100 is very close to the water levels experienced during Hurricane Sandy peak flood. These conditions would result in flooding throughout the Town similar to that experienced during Sandy, but on a daily basis.

	Current	2040		2070		2100	
		USACE High SLR	USACE Int SLR	USACE High SLR	USACE Int SLR	USACE High SLR	USACE Int SLR
MSL	-0.28	0.51	0.04	2.14	0.60	4.43	1.31
MHW	1.14	2.12	1.54	4.14	2.23	6.98	3.11
MHHW	1.5	2.48	1.90	4.50	2.59	7.34	3.47
MLW	-2.06	-1.08	-1.66	0.96	-0.96	3.83	-0.07
MLLW	-2.3	-1.31	-1.90	0.73	-1.20	3.59	-0.31

Table 2-18: Projected Old Saybrook Tidal Datums Based on 2013 USACE High RSLC Projections

Attachment 2 of the 2018 Coastal Community Resilience Study presents the results of GZA's model simulations of MHW (mean high tide), and storm types associated with the 100-year and 500-year return period floods (1% and 0.2% annual chance) during the years 2041, 2066 and 2116, assuming the USACE Intermediate sea level rise projection which is considered to have a high likelihood of occurrence. These results were used to conduct the vulnerability assessment outlined in **Attachment 3** of this Plan Update.

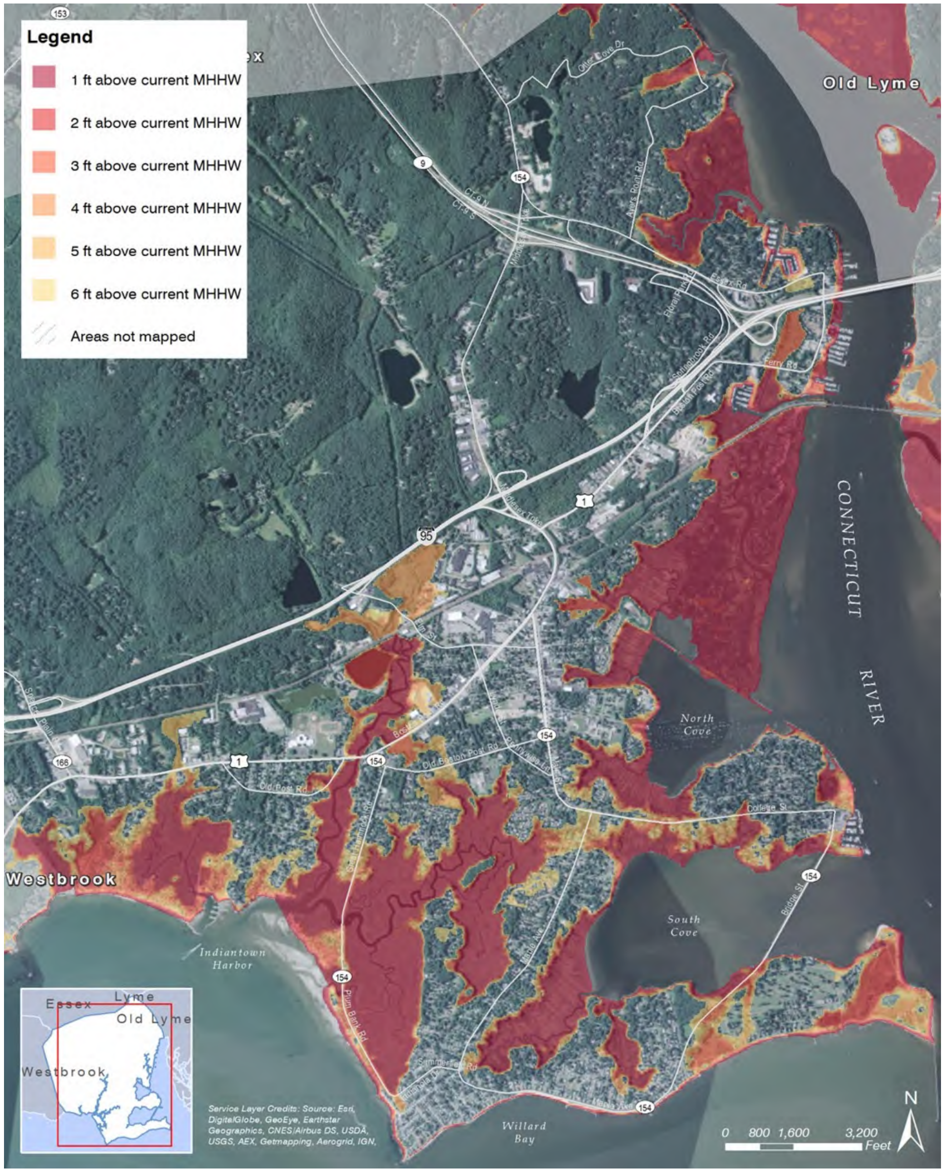


Figure 2-21: Limits of Flood Inundation due to Relative Sea Level Rise

Intense Rainfall and Urban Flooding

Intense, heavy rainfall can result in localized flooding including flash flood events. Risks due to intense rainfall is predominantly associated with flash flooding and are typically related to the capacity of the existing stormwater infrastructure to manage stormwater run-off. High velocity stormwater flow can also occur during these events. Damages can include localized flooding, damage to property and vehicles and potentially safety risk to the public.

Historical Occurrence at Old Saybrook and Vicinity

- During the period between 1996 and 2005, Middlesex County experienced 22 days with Heavy Rain events, an average of about 2 to 3 event days per year, with no documented property damages, injuries or death. Ref. NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/
- During the period between 1996 and 2018, Middlesex County experienced 17 days with Flash Flood events, an average of about 0 to 1 event day per year, with $250k in documented property damages, 0 injuries, and 0 deaths. Ref. NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/

Estimated Probability of Occurrence at and near Old Saybrook

The results indicate the following urban flooding probability at and near Old Saybrook and Fenwick (within Middlesex County):

- Urban Flooding due to Intense Rainfall within Middlesex County: 4% AEP or approximately a 25-year recurrence

Effects of Climate Change

The attribution of rainfall intensity and frequency has high confidence. Average annual precipitation in the Northeast increased 10 percent from 1895 to 2011, and precipitation from extremely heavy storms has increased 70 percent since 1958. During the this century, average annual precipitation and the frequency of heavy downpours are likely to keep rising. Average precipitation is likely to increase during winter and spring, but not change significantly during summer and fall.

Figure 2-15: Add Date Total Rainfall and area photographs during storm

Shoreline Change

Shoreline Change

Shoreline change along the Town's Long Island Sound shorelines is due to both: 1) long-term erosion (with localized areas of beach accretion); and 2) episodic erosion due to coastal storms (with combined flood and waves). Due to the increased storm and wave activity during the Fall and Winter, beach profiles may change seasonally from an eroded "winter" beach to a fuller "summer" beach; however, this seasonal effect is less prominent along Long Island Sound compared to beaches that are directly exposed to the Atlantic Ocean.

A 2014 cooperative effort between the Connecticut Department of Energy & Environmental Protection (DEEP), the Connecticut Sea Grant (CT Sea Grant) and the University of Connecticut Center for Land Use Education and Research (UCONN-CLEAR) conducted a time series analysis of the Connecticut shoreline from different time periods between 1880 and 2006 to establish Connecticut shoreline trends. Old Saybrook was included in this analysis

Historical Occurrence at Old Saybrook/Fenwick and Vicinity

Connecticut Shoreline Change analysis indicates that Old Saybrook lost 4.28 m of coastal shoreline between 1880 and 2006. Results from the analysis also indicate that Old Saybrook has gained 11.95 m of riverine shoreline along the Connecticut River between 1880 and 2006.

SHORELINE CHANGE STATISTICS

Shoreline "rate of change statistics" reflect a cumulative summary of the processes that altered the shoreline for the time period analyzed. **Figures 2-22 and 2--23** present the shoreline change statistics for the long-term and short term, respectively. The values calculated for Old Saybrook include:

<u>Old Saybrook – Long Island Sound Beaches</u>

Short-Term (1983 to 2006):

- Net Shoreline Movement:
  - Minimum: -19.9 meters
  - Maximum: 23.8 meters
  - Average: -2.6 meters
- End Point Rate (average): -0.12 meters/year

Long-Term (1880 to 2006):

- Net Shoreline Movement:
  - Minimum: -67.5 meters
  - Maximum: 212.9 meters
  - Average: -4.3 meters
- End Point Rate (average): -0.03 meter/year

<u>Old Saybrook – Connecticut River Shoreline</u>

Short-Term (1983 to 2006):

- Net Shoreline Movement:
  - Minimum: -20.5 meters
  - Maximum: 2.8 meters
  - Average: 6.2 meters
- End Point Rate (average): 0.28 meter/year

Long-Term (1880 to 2006):

- Net Shoreline Movement:
  - Minimum: -26.4 meter
  - Maximum: 258.3 meter
  - Average: 12.0 meter
- End Point Rate (average): 0.10 meter/year

Estimated Probability of Occurrence at and near Old Saybrook/Fenwick

Data is not currently available to develop quantitative estimates of shoreline change.

Considerations for Shoreline Change in Old Saybrook and Fenwick

Based on **Attachment 4** of the 2018 Coastal Resilience Study, conclusions and recommendations for shoreline change along Old Saybrook and Fenwick shoreline include:

1. Old Saybrook beaches include: 1) barrier spits, separating the marsh from Long Island Sound, from Chalker Beach to just north of Cornfield Point; and 2) pocket beaches between shoreline structures and natural promontories, from Cornfield Point to Old Saybrook Point. The shoreline has been heavily fortified by hard shoreline structures including groins, revetments and seawalls.
2. The net, long term effect for the Old Saybrook shoreline including Chalker Beach to just north of Cornfield Point is long term, moderate (1 to 2 feet per year) erosion of the beaches with highly impactful, episodic erosion associated with coastal storm flooding and wave action. Sea level rise will amplify and accelerate shoreline change. Inadequate sediment supply to replace alongshore and offshore transport will require beach nourishment to mitigate erosion. Major sections of shoreline are fortified with revetments. The average shoreline change rates indicate minor to moderate erosion and accretion (less than 0.5 foot per year to 1.5 feet per year).
3. The long-term effects of sea level rise on the beaches will be increased erosion and migration of barrier beaches and spits landward. The barrier beaches typically erode from the Long Island Sound side and will either: 1) wash overland and remain intact; or 2) break up and disappear (leaving open water and a shoreline at the current marsh boundary.
4. Climate change can also result in long term changes to prevailing wind direction and velocity, which in turn would affect shoreline change. In general, the beaches of Old Saybrook (consistent with almost all of Connecticut's beaches) are moving landward due to gradual sea level rise and the net effect of storms.

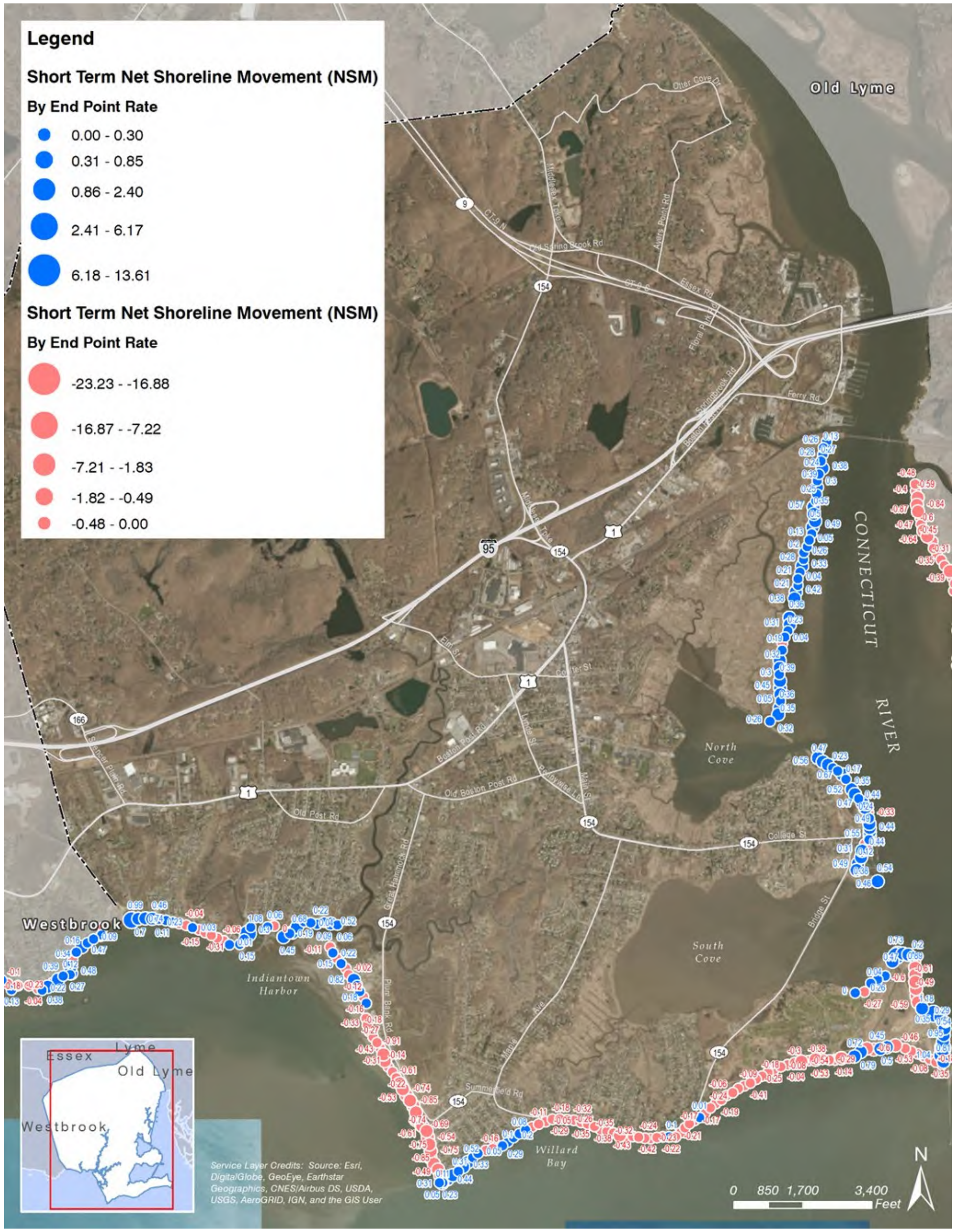


Figure 2-22: Short Term Shoreline Change

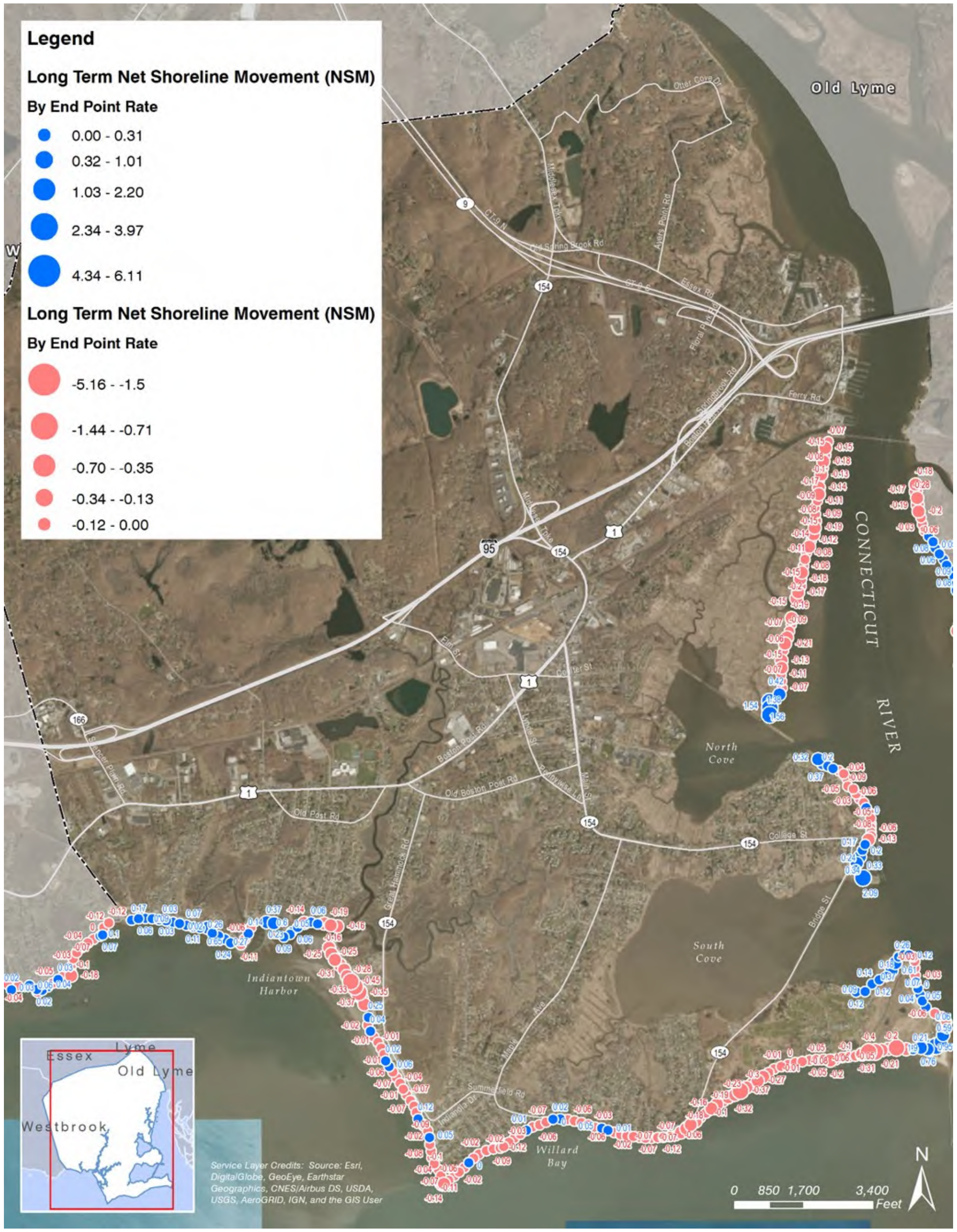
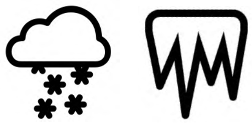


Figure 2-23: Long Term Shoreline Change

Severe Weather Hazards: Winter Weather



SEVERE WINTER WEATHER: SNOWFALL

Severe winter weather includes large snow events, blizzards and ice storms. As defined by the National Weather Service, a blizzard is a snowstorm with sustained winds or frequent gusts of 35 miles an hour or greater and considerable falling and/or blowing snow (i.e., reducing visibility frequently to less than a quarter of a mile) for a period of 3 hours or longer. NOAA's National Centers for Environmental Information produces the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two thirds of the U.S. The RSI ranks snowstorm impacts on a scale from 1 to 5, as shown in **Table 2-19**. RSI is based on the spatial extent of the storm, the amount of snowfall, and the juxtaposition of these elements with population density and societal impacts. Currently, the index uses population data based on the 2000 Census. A similar storm index is the Northeast Snowfall Impact Scale (NESIS), also shown below. Reference NOAA; https://www.ncdc.noaa.gov/snow-and-ice/rsi/

Severe winter weather in Connecticut is almost always associated with nor'easters. Table **2-20** presents Groton average snowfall distribution by month. **Table 2-21** summarizes the major nor'easters that occurred between the 1880's and now in the Northeast U.S. and includes RIS and NESI values (if available). Ref. https://gis.ncdc.noaa.gov/maps/ncei/rsi

Figure 2-24 indicates the average annual snowfall amounts for the Northeast U.S. The average snowfall per year near Old Saybrook/Fenwick is 25 to 50 inches, with generally lower snowfall rates in coastal Connecticut versus inland Connecticut. For the period between 1981 to 2010, the average annual snowfall rates at nearby Groton, Connecticut was 23.2 inches with average number snowfall days of 10.2 days per year.

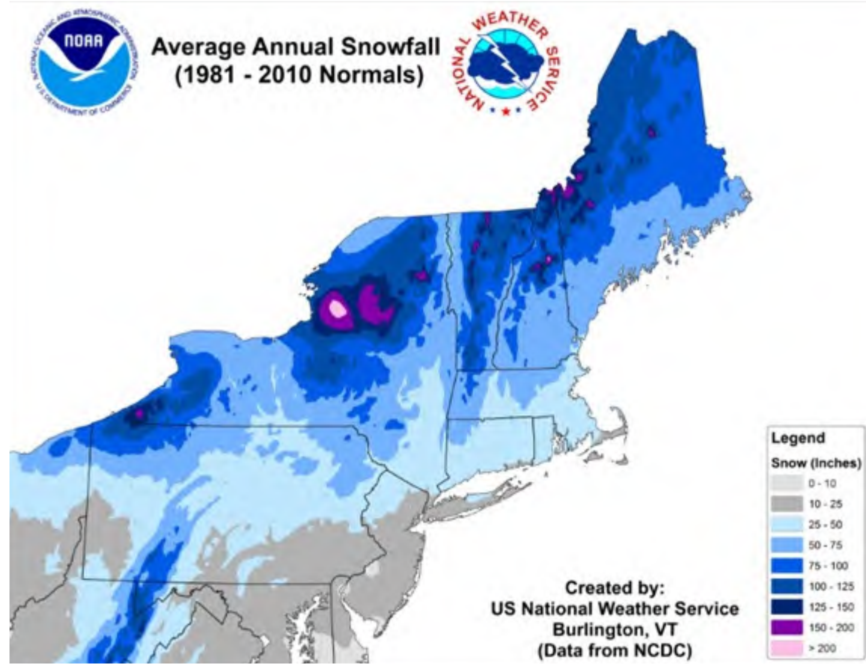


Figure 2-24: Average Annual Snowfall (http://www.weather.gov/btv/winter)

Category	RSI Value	Description	Category	NESIS Value	Description
1	1-3	Notable	1	1-2.5	Notable
2	3-6	Significant	2	2.5-4	Significant
3	6-10	Major	3	4-6	Major
4	10-18	Crippling	4	6-10	Crippling
5	18+	Extreme	5	10+	Extreme

Table 2-19: Regional Snowfall Index (RSI) and Northeast Snowfall Impact Scale

Month	Average Snowfall in inches (Groton, Ct.)
January	6
February	8
March	3
April	1
November	1
December	5
Year	23.2

Table 2-20: Average snowfall per month in inches (Groton)

Table 2-21: Major Historical Nor'easters in the New England Region (Bold indicates est. snowfall near Old Saybrook > 6" to12")

Event	Northeast Category/RSI Value	Date	Description
Great Blizzard of 1888	NA	March 11-14, 1888	One of the worst blizzards in U.S. history. Dropped 40–50 inches (100–130 cm) of snow, killed 400 people, mostly in New York.
Great Appalachian Storm of November 1950	4/14.5	November 24-30, 1950	A very severe storm that dumped more than 30 inches (76 cm) of snow in many major metropolitan areas along the eastern United States, record breaking temperatures, and hurricane-force winds. The storm killed 353 people.
The Blizzard of'58	**3/7.9**	February 16-17, 1958	This coastal storm brought heavy snow and strong winds to the Northeast and resulted in 19.4 inches of snow in Boston.
	0/0	March 3-5, 1960	This wind-driven snowstorm brought whirling snow from Virginia to New York, before blowing into New England. Left 19.8 inches of snow in Boston.
Ash Wednesday Storm of 1962	1/1.8	March 5-9, 1962	Caused severe tidal flooding and blizzard conditions from the Mid-Atlantic to New England, killed 40 people.
February Blizzard	**5/34.0**	February 24-27, 1969	This storm lasted several days and left 26.3 inches of snow in Boston.
Eastern Canadian Blizzard of March 1971	4/10.8	March 3-5, 1971	Dropped over 32 inches (81 cm) of snow over areas of eastern Canada, killed at least 30 people.
Groundhog Day Gale of 1976	NA	February 1-5, 1976	Caused blizzard conditions for much of New England and eastern Canada, dropping a maximum of 56 inches (140 cm) of snow.
January Blizzard	**2/5.4**	January 20-21, 1978	The January blizzard occurred just a couple of weeks before the infamous Blizzard of '78 and left 21.4 inches of snow in Boston.
Northeastern United States blizzard of 1978	**5/18.4**	February 5-7, 1978	A catastrophic storm, which dropped over 27 inches (69 cm) of snow in areas of New England, killed a total of 100 people, mainly people trapped in their cars on metropolitan Boston's inner beltway and in Rhode Island. $500M property damage in Massachusetts.
1991 Perfect Storm (the "Perfect Storm," combined Nor'easter/ hurricane)	0/0	October 28-November 2, 1991	Very unusual storm which evolved into a hurricane, tidal surge caused severe damage to coastal areas, especially Massachusetts, killed 13 people.
December 1992 nor'easter	2/4.7	December 10-12, 1992	A powerful storm which caused severe coastal flooding throughout much of the northeastern United States.
1993 Storm of the Century	5/22.1	March 12-15, 1993	A superstorm which affected the entire eastern U.S., parts of eastern Canada and Cuba. It caused 6.65 billion (2008 USD) in damage, and killed 310 people.
Christmas 1994 nor'easter	NA	December 22-26, 1994	An intense storm which affected the east coast of the U.S., and exhibited traits of a tropical cyclone.
North American Blizzard of 1996	**5/21.8**	January 6-10, 1996	Severe snowstorm which brought up to 4 feet (120 cm) of snow to areas of the mid-Atlantic and northeastern U.S.
April Fools Storm	2/4.7	March 31-April 1, 1997	This April Fools storm dropped more than 2 feet of snow in Boston.

Table 2-21: Major Historical Nor'easters in the New England Region cont. (Bold indicates est. snowfall near Old Saybrook > 6" to12")

Event	Northeast RSI/ NESIS Category	Date	Description
North American Blizzard of 2003	**4/14.7**	February 14-22, 2003	Dropped over 2 feet (61 cm) of snow in several major cities, including Boston, and New York City, affected large areas of the Northeastern and Mid-Atlantic U.S., and killed a total of 27 people.
North American Blizzard of 2005	**NA**	January 20-23, 2005	Brought blizzard conditions to southern New England and dropped over 40 inches (100 cm) of snow in areas of Massachusetts.
North American Blizzard of 2006	**2/5.0**	February 11-13, 2006	A powerful storm that developed a hurricane-like eye when off the coast of New Jersey. It brought over 30 inches (76 cm) of snow in some areas and killed 3 people.
April 2007 nor'easter	0/1.0	April 13-17, 2007	An unusually late storm that dumped heavy snow in parts of Northern New England and Canada and heavy rains elsewhere. The storm caused a total of 18 fatalities.
November 2009 nor'easter	0/0	November 11-17, 2009	Formed from the remnants of Hurricane Ida, produced moderate storm surge, strong winds and very heavy rainfall throughout the mid-Atlantic region. It caused US$300 million (2009) in damage, and killed six people.
December 2009 North American blizzard	**1/2.8**	December 16-20, 2009	A major blizzard which affected large metropolitan areas, including New York City, Philadelphia, Providence, and Boston. In some of these areas, the storm brought up to 2 feet (61 cm) of snow.
March 2010 nor'easter	0/0.3	March 12-16, 2010	A slow-moving nor'easter that devastated the Northeastern United States. Winds of up to 70 miles per hour (110 km/h) snapped trees and power lines, resulting in over 1 million homes and businesses left without electricity. The storm produced over 10 inches (25 cm) of rain in New England, causing widespread flooding of urban and low-lying areas. The storm also caused extensive coastal flooding
December 2010 North American blizzard	**2/3.4**	December 5, 2010-January 15, 2011	A severe and long-lasting blizzard which dropped up to 36 inches (91 cm) of snow throughout much of the eastern United States.
January 8–13, 2011 North American blizzard and January 25–27, 2011 North American blizzard	**2/3.4**	January 8-13 and January 25-27, 2011	In January 2011, two nor'easters struck the East Coast of the United States just two weeks apart and severely crippled New England and the Mid-Atlantic. During the first of the two storms, a record of 40 inches (100 cm) was recorded in Savoy, Massachusetts. Two people

Table 2-21: Major Historical Nor'easters in the New England Region cont. (Bold indicates est. snowfall near Old Saybrook > 6" to12")

Event	Northeast RSI/ NESIS Category	Date	Description
2011 Halloween nor'easter	1/2.6	October 28-November 1, 2011	A rare, historic nor'easter, which produced record breaking snowfall for October in many areas of the Northeastern U.S., especially New England. The storm produced a maximum of 32 inches (81 cm) of snow in Peru, Massachusetts, and killed 39 people. After the storm, the rest of the winter for New England remained very quiet, with much less than average snowfall and no other significant storms to
November 2012 nor'easter	0/0.3	November 7-10, 2012	A moderately strong nor'easter that struck the same regions that were impacted by Hurricane Sandy a week earlier. The storm exacerbated the problems left behind by Sandy, knocking down trees that were weakened by Sandy. It also left several residents in the Northeast without power again after their power was restored following Hurricane Sandy. Highest snowfall total from the storm was 13 inches (33 cm), recorded in Clintonville, Connecticut.
Late December 2012 North American storm complex	3/9.2	December 17-31, 2012	A major nor'easter that was known for its tornado outbreak across the Gulf Coast states on Christmas day as well as giving areas such as northeastern Texas a white Christmas. The low underwent secondary cyclogenesis near the coast of North Carolina and dumped a swath of heavy snow across northern New England and New York, caused blizzard conditions across the Ohio Valley, as well as an ice storm in the mountains of the Virginia and West Virginia.
Early February 2013 North American blizzard	**3/NA**	February 7-18, 2013	An extremely powerful and historic nor'easter that dumped heavy snow and unleashed hurricane-force wind gusts across New England. Many areas received well over 2 feet (61 cm) of snow, especially Connecticut, Rhode Island, and eastern Massachusetts. The highest amount recorded was 40 inches (100 cm) in Hamden, Connecticut, and Gorham, Maine, received a record 35.5 inches (90 cm). Over 700,000 people were left without power and travel in the region came to a complete standstill. The storm killed 18 people. Left 24.9 inches of snow in Boston and 22.8 inches in Providence.

Table 2-21: Major Historical Nor'easters in the New England Region cont. (Bold indicates est. snowfall near Old Saybrook > 6" to12")

Event	Northeast RSI/ NESIS Category	Date	Description
March 2013 nor'easter	1/1.6	March 1-21, 2013	A large and powerful nor'easter that ended up stalling along the eastern seaboard due to a blocking ridge of high pressure in Newfoundland and pivoted back heavy snow and strong winds into the Northeast United States for a period of 2 to 3 days. Many officials and residents were caught off guard as local weather stations predicted only a few inches (several centimeters) of snow with a change to mostly rain. Contrary to local forecasts, many areas received over one foot (30 cm) of snow, with the highest amount being 29 inches (74 cm) in Milton, Massachusetts. Several schools across the region, particularly in the Boston, Massachusetts, metropolitan area, remained in session during the height of the storm, not knowing the severity of the situation. Rough surf and rip currents were felt all the way southwards towards Florida's east coast.
January 2015 North American Blizzard	**3/6.2**	January 23-31, 2015	Unlike recent historical winter storms, there was no indication that a storm of this magnitude was coming until about 3 days in advance. The Blizzard began as an Alberta Clipper in the Midwestern States, which was forecast to transfer its energy to a new, secondary Low Pressure off the coast of the Mid Atlantic and move northeastward and pass to the south and east of New England. Several reports of over 30 inches (76 cm) across the State of Massachusetts, breaking many records. A maximum of 36 inches (91 cm) was recorded in at least four towns across Worcester County in Massachusetts and the city of Worcester itself received 34.5 inches (88 cm), marking the city's largest storm snowfall accumulation on record. The city of Boston recorded 24.6 inches (62 cm), making it the largest storm snowfall accumulation during the month of January and the city's sixth largest storm snowfall accumulation on record. On the coast of Massachusetts, Hurricane Force gusts up to around 80 mph (130 km/h) along with sustained winds between 50 and 55 mph (80 and 89 km/h) at times, were reported. The storm also caused severe coastal flooding and storm surge. The storm bottomed out to a central pressure of 970 mb (970 hPa). By January 28, the storm began to pull away from the area.
October 2015 North American storm complex	0/0	September 29-October 2, 2015	In early October, a low pressure system formed in the Atlantic, Tapping into moisture from Hurricane Joaquin, the storm dumped a huge amount of rain, mostly in South Carolina.

Table 2-21: Major Historical Nor'easters in the New England Area cont.

Event	Northeast RSI/ NESIS Category	Date	Description
January 2016 United States blizzard (also known as Winter Storm Jonas, Snowzilla, or The Blizzard of 2016 by media outlets)	4	January 19-29, 2016	This system dumped 2 to 3 feet (61 to 91 cm) of snow in the East Coast of the United States. States of Emergencies were declared in 12 States in advance of the storm as well as by the Mayor of Washington D.C. The blizzard also caused significant storm surge in New Jersey and Delaware that was equal to or worse than Hurricane Sandy. Sustained damaging winds over 50 mph (80 km/h) were recorded in many coastal communities, with a maximum gust to 85 mph (137 km/h) on Assateague Island, Virginia. A total of 55 people died due to the storm.
February 2017 United States blizzard (also known as Winter Storm Niko and The Blizzard of 2017 by media outlets)	**4.17.8**	February 6-11, 2017	Forming as an Alberta clipper in the northern United States on February 6, the system initially produced light snowfall from the Midwest to the Ohio Valley as it tracked southeastwards. It eventually reached the East Coast of the United States on February 9 and began to rapidly grow into a powerful nor'easter, dumping 1 to 2 feet (30 to 61 cm) across the Northeast Megapolis. The storm also produced prolific thunder and lightning across Southern New England. Prior to the blizzard, unprecedented and record-breaking warmth had enveloped the region, with record highs of above 60 °F (16 °C) recorded in several areas, including Central Park in New York City. Some were caught off guard by the warmth and had little time to prepare for the snowstorm.
October 2017 nor'easter	0/0	October 28-31, 2017	An extratropical storm absorbed the remnants of Tropical Storm Philippe. The combined systems became an extremely powerful nor'easter that wreaked havoc across the Northeastern United States and Eastern Canada. The storm produced sustained tropical storm force winds along with hurricane force wind gusts. The highest wind gust recorded was 93 mph (150 km/h) in Popponesset, Massachusetts. The storm caused over 1,400,000 power outages. Damage across New England, especially in Connecticut, Massachusetts, and Rhode Island, was extreme. This was due to the combination of the high winds, heavy rainfall, saturated ground, and most trees still being fully leaved. Some residents in Connecticut were without power for nearly a week following the storm. Heavy rain in Quebec and Eastern Ontario, with up to 98 mm (3.9 in) in the Canadian capital region of Ottawa, greatly interfered with transportation.

Table 2-21: Major Historical Nor'easters in the New England Region cont. (Bold indicates est. snowfall near Old Saybrook > 6" to12")

Event	Northeast RSI/ NESIS Category	Date	Description
January 2018 North American blizzard	**4/17.8**	January 2-6, 2018	A powerful blizzard that caused severe disruption along the East Coast of the United States and Canada. It dumped snow and ice in places that rarely receive wintry precipitation, even in the winter, such as Florida and Georgia, and produced snowfall accumulations of over 2 feet (61 cm) in the Mid-Atlantic states, New England, and Atlantic Canada. The storm originated on January 3 as an area of low pressure off the coast of the Southeast. Moving swiftly to the northeast, the storm explosively deepened while moving parallel to the Eastern Seaboard, causing significant snowfall accumulations. The storm received various unofficial names, such as Winter Storm Grayson, Blizzard of 2018 and Storm Brody. The storm was also dubbed a "historic bomb cyclone".
March 1-3, 2018 nor'easter (also known as Winter Storm Riley or False Tropical Storm Riley by media outlets)	2/4.4	March 1-5, 2018	A very powerful nor'easter that caused major impacts in the Northeastern, Mid-Atlantic and Southeastern United States. It originated as the northernmost low of a stationary front over the Midwest on March 1, which moved eastward into the Northeast later that night. A new low pressure system rapidly formed off the coast on March 2 as it slowly meandered near the coastline. It peaked later that day and began to gradually move out to sea by March 3. Producing over 2 feet (24 in) of snow in some areas, it was one of the most significant March snowstorms in many areas, particularly in Upstate New York. In other areas, it challenged storm surge records set by other significant storms, such as Hurricane Sandy. It also produced widespread damaging winds, with gusts well over Hurricane force strength in some areas across Eastern New England as well as on the back side in the Mid-Atlantic via a sting jet. Over 2.2 million customers were left without power.
March 6-8, 2018 nor'easter (also known as Winter Storm Quinn by media outlets)	1/2.2	March 2-9, 2018	A powerful nor'easter that affected the Northeast United States. It came just days after another nor'easter devastated much of the Northeast. Frequent cloud to ground Thundersnow as well as snowfall rates of up to 3 inches (7.6 cm) an hour were reported in areas around the Tri-State Area, signaling the rapid intensification of the storm. Late in the afternoon, an eye-like feature was spotted near the center of the storm. It dumped over 2 feet of snow in many areas across the Northeast, including many areas in New England where the predominant precipitation type was rain for the previous storm. Over 1 million power outages were reported at the height of the storm due to the weight of the heavy, wet snow on trees and power lines. Many people who lost power in the previous storm found themselves in the dark again.

Table 2-21: Major Historical Nor'easters in the New England Region cont. (Bold indicates est. snowfall near Old Saybrook > 6" to12")

Event	Northeast RSI/ NESIS Category	Date	Description
March 12-14, 2018 nor'easter (also known as Winter Storm Skylar by media outlets)	1/2.2	March 11-14, 2018	A powerful nor'easter that affected portions of the Northeast United States. The storm underwent rapid intensification with a central millibaric pressure dropping down from 1001 mb to 974 mb in just 24 hours. This was the third major storm to strike the area within a period of 11 days. The storm dumped over up 2 feet of snow and brought Hurricane force wind gusts to portions of Eastern New England. Hundreds of public school districts including, Boston, Hartford, and Providence were closed on Tuesday, March 13.
March 20–22, 2018 nor'easter (also known as Winter Storm Toby and Four'easter by media outlets)	1/1.6	March 20-22, 2018	A powerful nor'easter that became the fourth major nor'easter to affect the Northeast United States in a period of less than three weeks. It caused a severe weather outbreak over the Southern United States on March 19th before moving off of the North Carolina coast on March 20th and spreading freezing rain and snow into the Mid-Atlantic States after shortly dissipating later that night. A new low pressure center then formed off of Chesapeake Bay on March 21st and then became the primary nor'easter. Dry air prevented most of the precipitation from reaching the ground in areas in New England such as Boston, Hartford, and Providence, all of which received little to no accumulation, in contrast with what local forecasts had originally predicted. In Islip, New York at the height of the storm, snowfall rates of up to 5 inches per hour were reported. 8 inches was reported at Central Park and over 12 inches was reported in many locations on Long Island as well in and around New York City and in parts of New Jersey.

Historical Occurrence at Old Saybrook and Vicinity

Between 1996 and 2018, there were a total of 70 Heavy Snow events including 42 days in Middlesex County, 0 days with property damage and no injuries or fatalities. Heavy Snow in the NOAA database is defined as snow accumulation meeting or exceeding locally/regionally 12 and/or 24 hour warning criteria: typically 4, 6 or 8 inches or more within 12 hours or 6, 8 or 10 inches or more in 24 hours.

From December 2010 through February 2011, southern New England, including Middlesex County, saw a series of winter storms that led to record snowfall for the season. Hartford experienced a record 57 inches of snow. Heavy snow, combined with rain led to numerous flooding problems across the county, roof collapses, and downed trees and utility lines. NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/

Estimated Probability of Occurrence at and near Old Saybrook/Fenwick

The results indicate the following Snowfall probability at and near Old Saybrook/Fenwick (based on Groton):

- 8– 10 snow days per year
- Average annual snowfall of 23 inches
- 86% AEP or 1 year recurrence interval Heavy Snowfall (19 years with 1 or more events over 22 years)
- Reasonably conservative monthly snowfall upper bound: 40 inches (maximum monthly upper bound of 60 inches)

Effects of Climate Change

The attribution of Heavy Snowfall events to climate change and understanding is moderate. High sea surface temperatures, increased atmospheric moisture and polar vortex conditions may result in an increased frequency of Heavy Snowfall.

SEVERE WINTER WEATHER: ICE STORMS

Ice storms are an occasional component of severe winter weather. Rain that falls and freezes on contact with cold surfaces is called freezing rain, while sleet is precipitation that freezes in the air before hitting the ground in the form of ice pellets. Heavy accumulations of ice can bring down trees or tree branches that may damage utility wires, causing power and communications outages, which may take days to repair. Ice can increase the weight of branches by 30 times. A 1/2-inch accumulation on power lines can add 500 lbs. of weight. Even slight accumulations of ice result in slippery conditions for motorists and pedestrians.

The National Weather Service issues:

- an Ice Storm Warning for a quarter-inch or more of ice accumulation
- a Freezing Rain Advisory for ice accumulation of less than one quarter-inch

Ice storms are relatively rare events in Connecticut, including Old Saybrook/Fenwick.

Historical Occurrence at Old Saybrook and Vicinity

There was one ice storms recorded in the NOAA Storm Events Database for Middlesex County between 1950 and 2019. Between 1990 and 2018, there was a 1 day with ice storm events in Connecticut (an average of 0.04 event per year), resulting in 0 injury and $0 property damage.

Estimated Probability of Occurrence at and near Old Saybrook/Fenwick

The results indicate that the probability of Ice Storms at and near Old Saybrook is low. Quantitative probabilities are not available.

Effects of Climate Change

The attribution of Ice Storm events to climate change and understanding is low to moderate. High sea surface temperatures, increased atmospheric moisture and polar vortex conditions may result in an increased frequency of Ice Storms.

Extreme Winters

While the average annual snowfall at Old Saybrook/Fenwick is on the order of 23 inches, there are often years with much greater snowfall amounts. Extreme Connecticut storms events include:

- Blizzard of 1978 (+/- 40 inches)
- Snowstorm of February 2003 (+/- 15 to 30 inches)
- Ice Storm of November 2002
- Winter Storm of December 1996
- Blizzard of March 1993 (+/-15 to 24 inches)
- Great Blizzard of 1888 (+/- 50 inches)
- Great Snow of 1717 (+/- 50 to 60 inches with 16-foot drifts)
- Winter Storm Nemo of 2013 (+/- 40 inches; 4 to 5 inches per hour)
- Winter Storm Juno of 2015 (+/- 27 to 33 inches)

New Haven, CT, after the Blizzard of 1888 | Worst Snowstorms in New England History
Yankee archives/New Haven Colony Historical Society

Figure 2-25: Blizzard of 1888, New Haven, Connecticut

Example Winter Storm

Winter storms that impact Old Saybrook and Fenwick are almost always nor'easters and these can range from wintry mix of rain and snow to heavy snowfall blizzards. These storms typically also create storm surge and high winds. Winter Storm Nemo is representative of Connecticut winter nor'easters. Snow and rainfall began at 9 a.m. on February 8 across New England; by late that day, totals reached 8 in (200 mm) near Milton, Vermont. Later that evening, snow was falling at 2 to 3 inches (5 to 8 cm) per hour in coastal Massachusetts, and at an extreme rate of over 6 inches per hour in parts of Connecticut. Thunder and lightning along with small hail were reported within the heavy band of snow in Connecticut. When the snow stopped, the highest amount recorded was 40 inches (100 cm) in Hamden, Connecticut. Total snowfall near Old Saybrook/Fenwick was about 30 to 33 inches. (source: Wikipedia.org)

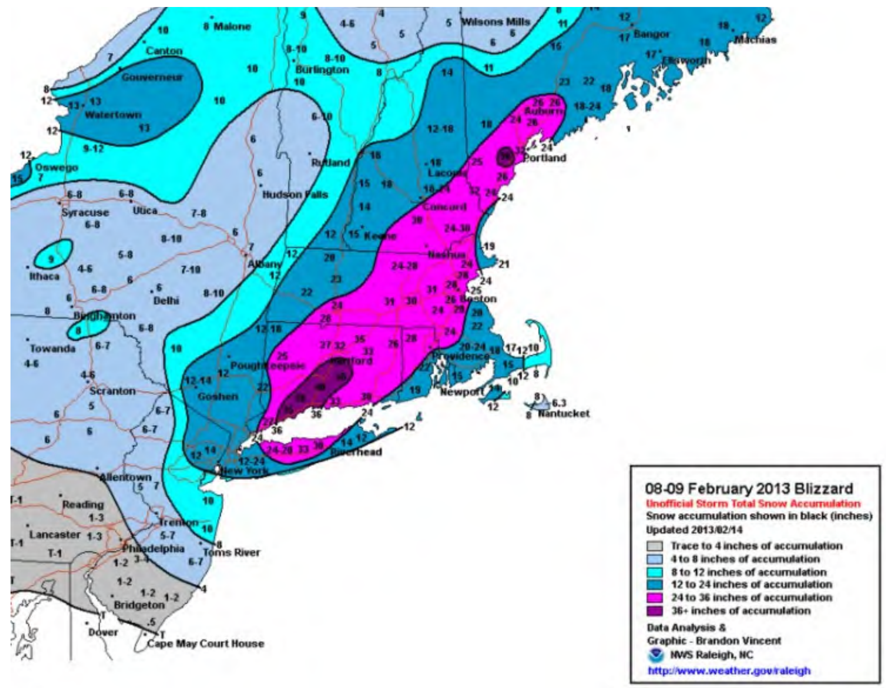
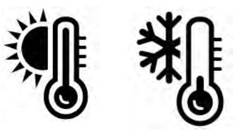


Figure 2-26: Observed Snowfall Winter Storm Nemo, February 2013

Extreme Temperatures



EXTREME TEMPERATURE: HEAT

The National Weather Service in Taunton issues:

- Excessive Heat Warnings when the daytime heat indices reach 105° F or greater for 2 or more hours
- A Heat Advisory is issued when the daytime heat indices reach 100-104°F for 2 or more hours
- A Heat Wave is defined as 3 or more days of temperatures of 90° F or above.

Heat Index

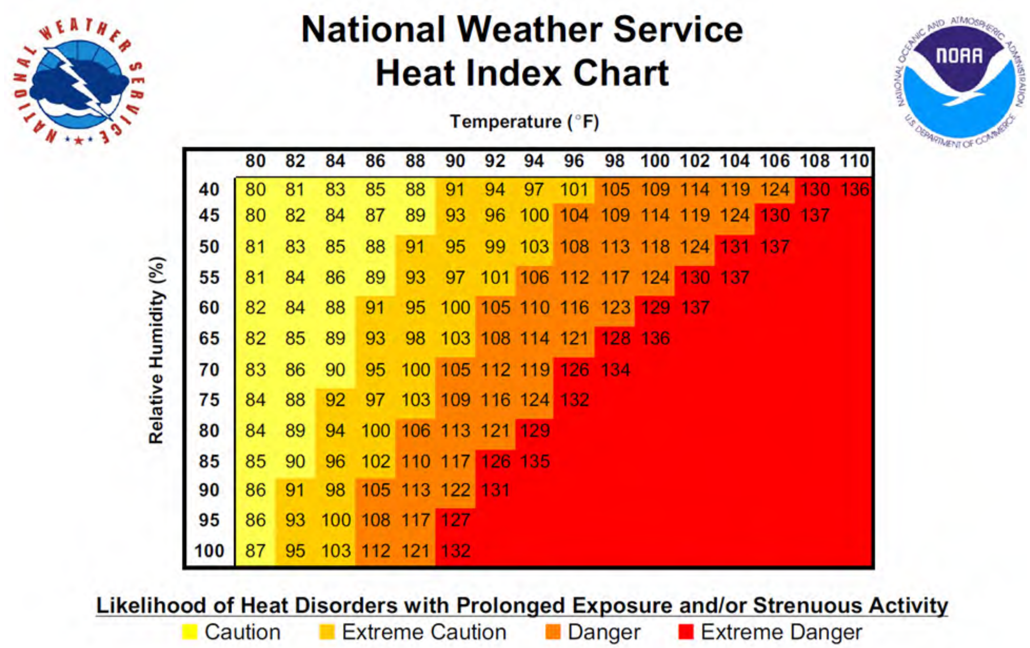
The Heat Index, also known as the Apparent Temperature, is a subjective measure of what it feels like to the human body when relative humidity is factored into the actual air temperature. Relative humidity is a measure of the amount of water in the air compared with the amount of water that air can hold at the current temperature. The body cools itself through the evaporation of perspiration or sweat. However, when the relative humidity is high, the increased moisture content in the air decreases the evaporation of perspiration or sweat. For example, a hot and very humid air mass with a temperature of 94 degrees and a relative humidity of 45 percent yields an apparent temperature of 100 degrees. Holding the temperature constant and increasing the relative humidity to 60 percent yields an apparent temperature of 110° F.

The National Weather Service will initiate alert procedures when the Heat Index is expected to exceed 104° F (depending on local climate). Under these conditions, sunstroke and heat exhaustion are likely, and physical activity or being outside for long periods is risky, potentially leading to heat stroke.

These dangerous heat days pose the greatest threat to kids and the elderly, and to people who don't have easy access to air conditioning. The Heat Index values were derived for shady, light wind conditions, and exposure to full sunshine can increase heat index values by up to 15°F. (http://www.nws.noaa.gov/om/heat/heat_index.shtml).

From 1979-2014, excessive heat exposure caused in excess of 8,000 deaths in the United States (EPA, May 2014). During this period, more people in this country died from extreme heat than from hurricanes, lightning, tornadoes, floods, and earthquakes combined.

The average high temperatures in Groton, Connecticut during July and August are 81 and 80 degrees F , respectively. The record hot temperature for Connecticut was 106°F on July 15, 1995 (in Danbury). Temperatures along the Connecticut coast, however, are generally moderated by the close proximity to the Atlantic Ocean, with warmer winters and longer frost-free seasons than inland areas.



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

Figure 2-27: Heat Index Chart

Historical Occurrence at Old Saybrook and Vicinity

Between 2010 and 2018, there were a total of 4 events with Excessive Heat, including 2 days with Excessive Heat events in Middlesex County and no fatalities or injuries. These included July 22, 2011 and July 1, 2018. Ref. NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/

Estimated Probability of Occurrence at and near Old Saybrook/Fenwick

The results indicate that the probability of Excessive Heat near Old Saybrook (Middlesex County) is:

- 30% AEP or 1 event every 3 years.

Additional Heat Effects

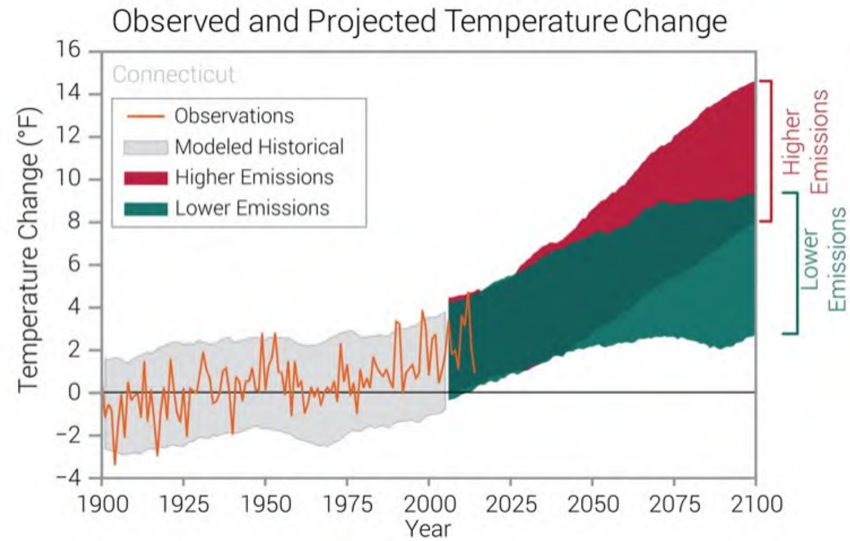
In addition to the Heat Index, air quality is a significant issue related to extreme temperature. Summers in the U.S. bring more than just searing, dangerously hot days. When the air is stagnant and there is little air circulation, hot weather can trigger high levels of air pollution that can have health consequences. High temperatures on sunny days make ground-level ozone (a major component of smog) form much more readily. An EPA study looking at more than 20 years of measurements across most of the rural areas in the eastern U.S. found that harmful ozone concentrations increased nearly linearly as temperatures increased and named the effect the "climate penalty on ozone."

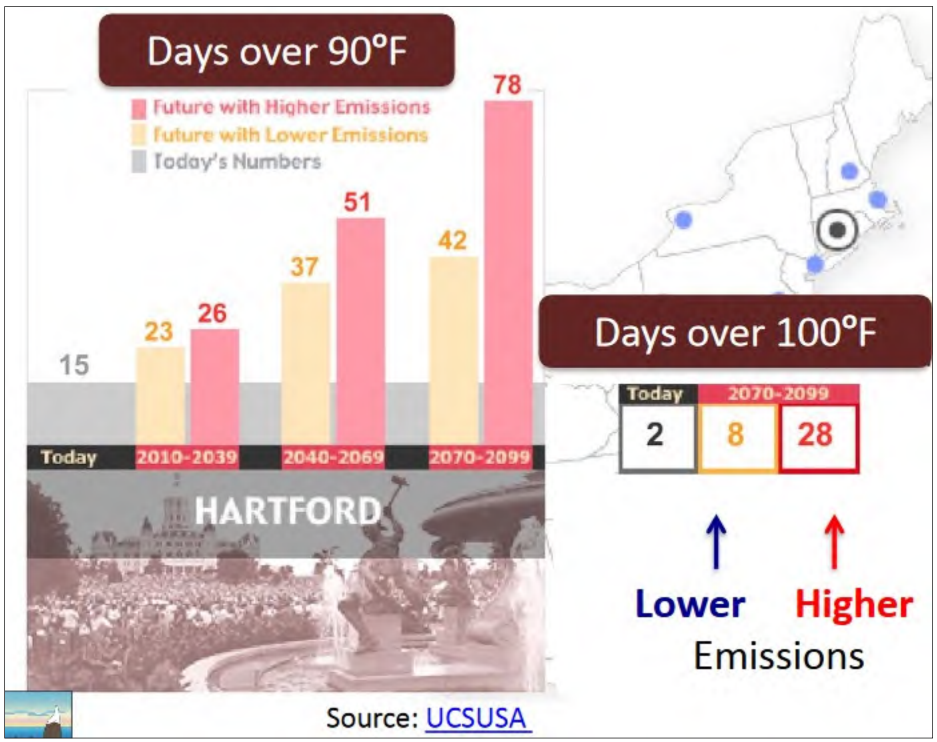
Effects of Climate Change

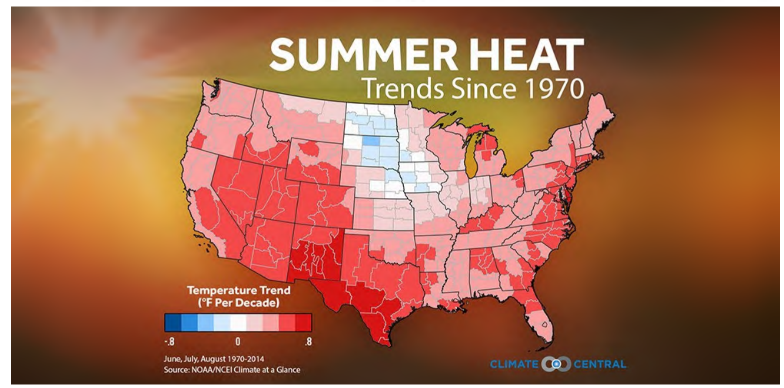
The confidence of attribution of Excessive Heat to climate change, and understanding, is high. Temperatures in Connecticut have increased about 3 degrees F since the beginning of the 20th Century as shown in **Figure 2-28**. The Hartford Metro area currently experiences 15 days a year over 90° F as shown in **Figure 2-29** below. Southeast Connecticut coastal communities are expected to fall below the predicted values for Hartford.

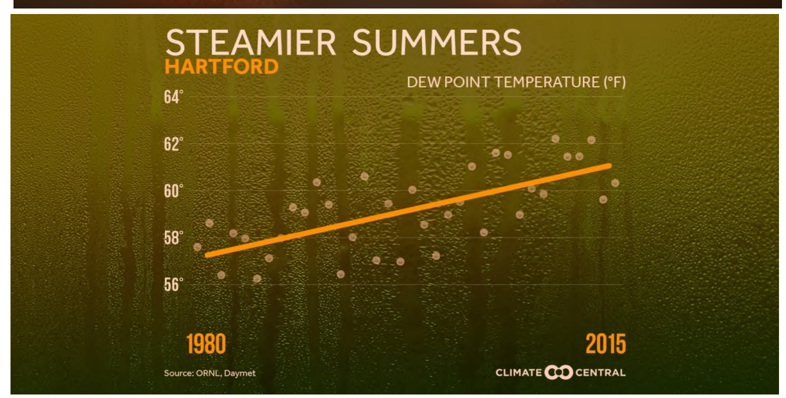
The trend of warming, characterized as average annual temperature, has been about 0.7°F per decade in Connecticut since 1970 as shown in **Figure 2-30** (below middle right). Heat waves are projected to become more intense. **Figure 2-32** on the following page shows the predicted range of days above 100° F for Hartford and Boston. Southeast Connecticut coastal communities are expected to fall below the predicted values for both cities

As summers get hotter from the increase in greenhouse gases, they are also getting stickier. More evaporation occurs in a warming atmosphere, and on a world where water covers nearly three-quarters of the surface, it means an increase in water vapor in the air. During the period of 980 to 2015, the dew point temperature increased from about 59 ° F to 62 ° F.









Figures 2-28 through 2-31: Change in Temperature since 1900 (Image Source: NOAA) (top); Days with Heat Index above 90 and 100 degrees (bottom left) Rising temperatures since 1970 (middle right); Dew Point Increase since 1980 (bottom right)

http://statesatrisk.org/connecticut/all

Effects of Climate Change

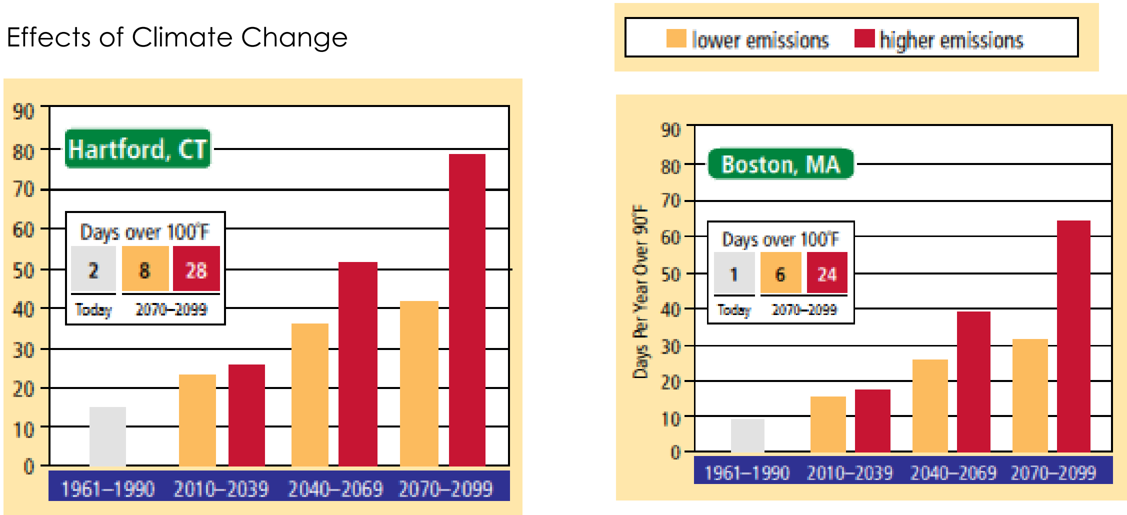


Figure 2-32: Predicted Days above 100° F (source Union of Concerned Scientists)

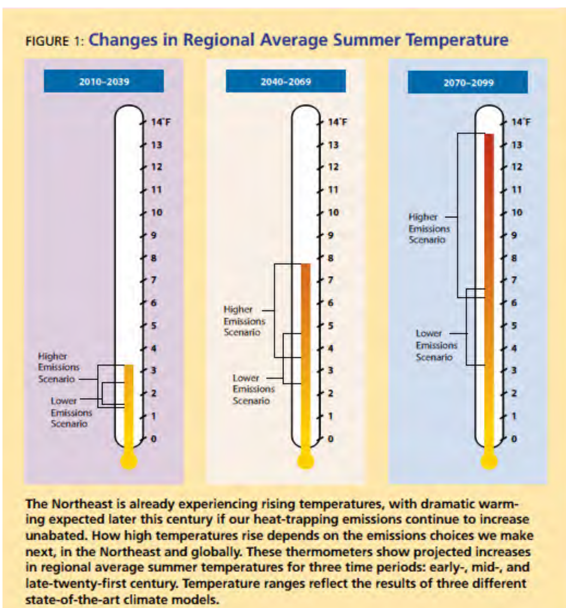


Figure 2-33: Predicted Rise in Average Northeast U.S. Temperatures (source Union of Concerned Scientists)

In addition to the effect of climate change on extreme heat events, the overall increase in global and local temperature averages will significantly change climate patterns within the Northeast U.S., including Old Saybrook and Fenwick. Spring will arrive sooner, summers are growing hotter, and the weather is becoming more extreme with swings between above-average winter temperatures to extreme cold with large snowfall events. Per the Union of Concerned Scientists summary reports, if global greenhouse gas emissions continue, the Northeast can expect dramatic temperature increases and other climate changes within the next several decades. Recent observations indicate that these effects are already underway, including within southeastern Connecticut. Average summer temperatures may increase between 6° F and 14° F by 2100 (see **Figure 2-33**). The overall effect will be a shift in the Connecticut climate equivalent to that historically experienced in lower latitudes, ranging between the Chesapeake Bay area to South Carolina. (see **Figure 2-34**)

With its coastal setting, Old Saybrook and Fenwick benefit from cooling summer sea breezes, which are the result of warming of the land area during the day (relative to the cooler water temperatures). Even these may change due to changes in both water and land temperatures.

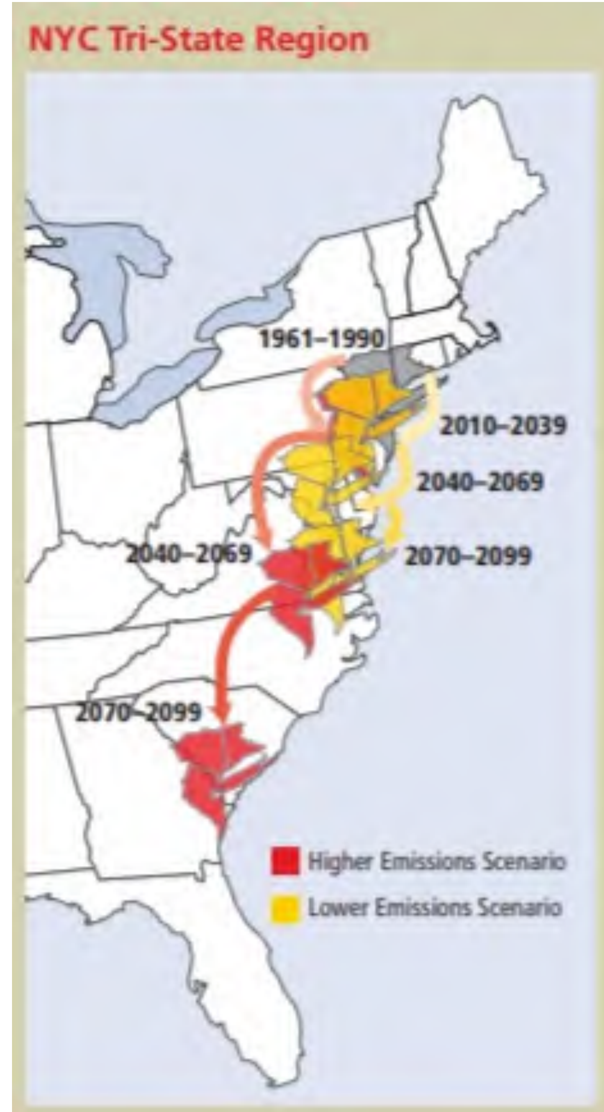


Figure 2-34: Latitudinal Changes in Regional Climate (source Union of Concerned Scientists)

EXTREME TEMPERATURE: COLD

Extreme cold events are generally defined as a prolonged period of excessively cold weather. Extreme cold conditions are often, but not always, part of winter storms. Winter in Massachusetts almost always includes periods of extreme cold weather. Exposure to cold can cause frostbite or hypothermia and has the potential to become life-threatening. Although anyone can suffer from cold-related health issues, some people are at greater risk than others, such as:

- Older adults
- Young children
- Those who are sick; and
- Those without adequate shelter

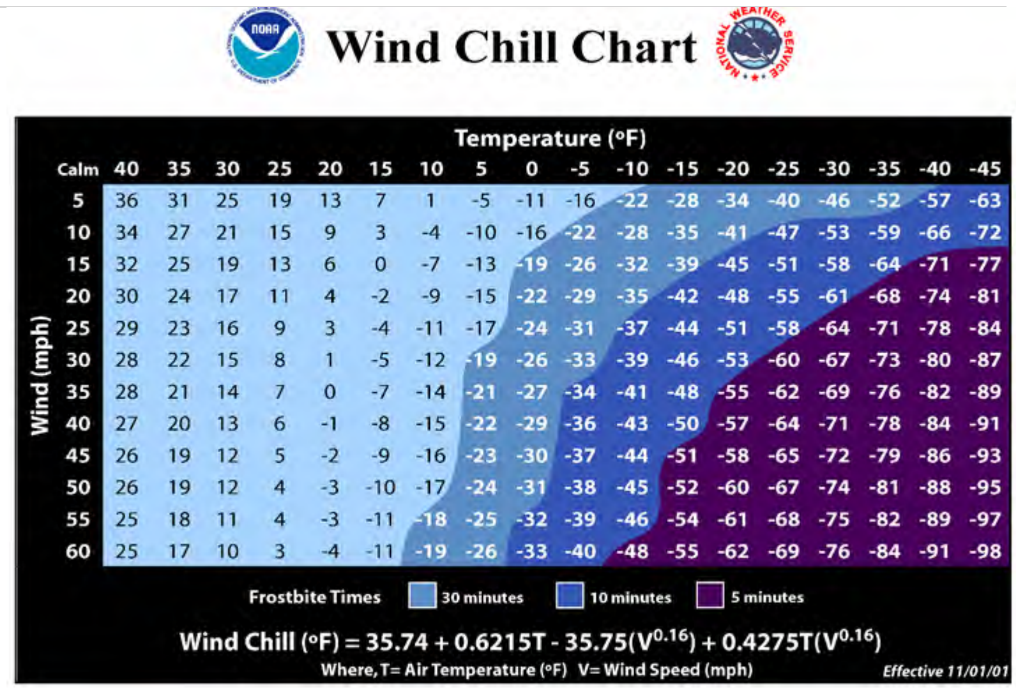
Heating sources can be impacted by power failures due to winter storms. Infants and the elderly are more at risk of serious or life-threatening health problems from extreme cold. Secondary hazards may include risk of fires or carbon monoxide poisoning from space heaters, generators, inadequately cleaned or vented fireplaces, or use of candles.

The following extreme cold warnings and advisories are issued by the National Weather Service (NWS):

- Freezing Warning – When minimum shelter temperature drops to 32° F or lower during the growing season.
- Frost Advisory – Issued under clear, light wind conditions with forecast minimum shelter temperature at 33-36° F during the growing season.
- Wind Chill Warning – Wind chill index is -25° F or lower for at least three hours using only sustained wind.
- Wind Chill Advisory - Wind chill index is between -15° F and -24° F for at least three hours using only sustained wind.

The National Weather Service Wind Chill Chart indicates the amount of time in which frostbite may occur on exposed skin based on temperature and wind speed. The National Weather Service maintains a Wind Chill Calculator, which calculated wind chill based on temperature and wind speed, as A period of extremely low temperatures or wind chill temperatures reaching or exceeding locally/regionally defined warning criteria (typical value around -35° F or colder). Ref. http://www.wpc.ncep.noaa.gov/html/windchill.shtml.

The lowest temperature recorded in Connecticut was -32° F on February 16, 1943 in Falls Village and January 22, 1961 in Coventry, according to NOAA (https://www.ncdc.noaa.gov/extremes/scec/records).



Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Figure 2-35: Wind Chill Chart

Nationally, there have been 887 recorded cold fatalities since 1988, with a 10 year average of 30 fatalities/year. http://www.nws.noaa.gov/om/hazstats/resources/weather_fatalities.pdf

Historical Occurrence at Old Saybrook and Vicinity

Middlesex County has experienced 2 day (January 17, 2000 and January 21, 2000) with an Extreme Cold/Wind Chill event resulting in no fatalities or injuries. Ref. NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/

Estimated Probability of Occurrence at and near Old Saybrook/Fenwick

- The average low temperature during January (the average coldest month) at Old Saybrook and Fenwick is 23°F.
- Quantitative probability data for Extreme Cold events is not available.

Effects of Climate Change

The confidence of attribution of Extreme Cold to climate change, and understanding, is moderate. It appears that warming trends have weakened polar vortex winds resulted in meandering of these winds. This condition allows cold Arctic air to dip further south, resulting in a variable New England winter with temperatures varying from above-average warm to periods of extreme cold.

Drought

DROUGHT

Droughts occur when there has not been enough rainfall and water levels get low, in particular when precipitation and other water resources fall below expectations but the demand for water remains. They can happen anywhere in the United States, and droughts increase the risk of other hazards like wildfires, flash floods, and possible landslides or debris flows. Drought is a slow-onset hazard that can last for months or years. Droughts are generally classified into different types including:

- meteorological drought - lack of precipitation
- agricultural drought - lack of soil moisture
- hydrologic drought - reduced streamflow or groundwater levels.

As a hazard, it has the potential to impact many aspects of life, including two of our most important needs: drinking water and food. Because of the long duration of droughts, the impacts last for years and can ripple through a community over time.

Drought is an important issue in Connecticut and the Town due to effects on agricultural and water resources. The Town's drinking water sources (the supply reservoir in Killingworth Dighton and Kelseytown distribution reservoir in Clinton) can be effected by drought.

The Connecticut Drought Preparedness and Response Plan ("Drought Plan") provides state and local decisionmakers and public water suppliers with a set of formal operating procedures and administrative guidance for proactive drought planning and response. The Drought Plan is designated as a "support plan" within the State Response Framework, Connecticut's umbrella emergency management operations document.

Connecticut maintains a Drought Management Plan and five levels of drought are used to characterize drought severity and response: Normal; Advisory; Watch; Warning; and Emergency. A determination of drought level in Connecticut is based on seven indices: groundwater levels, streamflow, reservoir levels, Palmer Drought Severity Index, Crop Moisture Index, Vegetation Drought Response Index (only available during growing season), fire danger, United States Drought Monitor intensity level, and weather forecasts. Drought levels are declared on a regional basis.

During the summer of 2002, one-third of the U.S., including Connecticut, experienced drought conditions. Connecticut has experienced drought periods in 1964-1968, 1981, 1987, 2002, and 2016-2017. The most severe drought on record in the northeastern United States was during 1961-69. For the period of 1895 to 1995, Massachusetts experienced low PDSIs (indicating drought conditions) about 5 percent of the time, indicating the relative probability of drought.

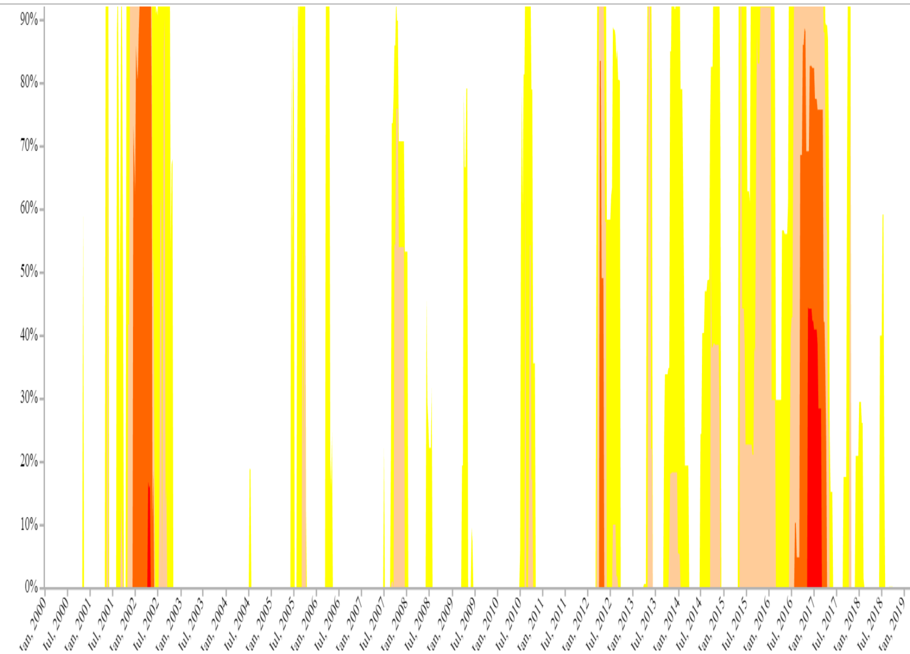


Figure 2-36: Connecticut Drought Periods from 2000 (https://www.drought.gov/drought/states/connecticut)

Historical Occurrence at Old Saybrook and Vicinity

Since 2002 to 2018, Middlesex County has experienced 3 days with drought events resulting in no fatalities, injuries or loss. The events occurred during April, May, and June 2002.

Estimated Probability of Occurrence at and near Old Saybrook/Fenwick

Based on recent drought history (2000 to 2018), the Connecticut has had a Drought Advisory during 11 of the 19 years; a Drought Watch during 5 of the 19 years; and a Drought Warning during 1 of the 19 years. Based on this limited data:

- Drought Warnings are expected in Connecticut: 5% AEP or 20-year recurrence interval

Effects of Climate Change

The confidence of attribution of Drought to climate change is moderate. Increased air temperatures and evapotranspiration can increase drought potential. In the Northeast U.S, the relationship between increased rainfall intensity and drought is uncertain.

Wildfire

WILDFIRE

A wildfire is a non-structure/vehicle fire that occurs in undeveloped, wildland vegetated areas, including grass, brush/shrub, and forested areas. Wildfires occur when natural vegetation is ignited naturally, such as by lightning, or by human activity. Sometimes, wildfires are set intentionally for management of vegetation or to limit accidental fire risk. Wildfires may be unnoticed at first. Unnoticed fires often can spread to the urban-wildland interface and threaten developed areas.

About 41.5% of Old Saybrook and Fenwick consists of non-contiguous forest, which presents an area for wildfire to occur. The Local Planning Team identified no significant brush fire hazard areas. An average of 500 acres of Connecticut woodland are burned by forest fires each year (CT DEEP).

There have been no reports of significant property damage or deaths related to brush fires or wildfire. Apparatus listed on the Old Saybrook Fire Department's website indicates that the Town has all-terrain vehicles capable of fighting remote brush fires located off existing roadways.

Historical Occurrence at Old Saybrook/Fenwick and Vicinity

The most recent wildfire in Connecticut occurred on 07/05/2002 in Litchfield County, according to the NOAA Storm Events Database. The fire was started by smoke from the Nemoscau region of northern Quebec. The smoke moved from the region on July 7, 2002. The NOAA Storm Events database lists zero (0) wildfires as having occurred in Middlesex County from 1950 to 2017.

Estimated Probability of Occurrence at and near Old Saybrook and Fenwick

The historical data indicates that the probability of wildfire within Old Saybrook and Fenwick is low. Quantitative probabilities of occurrence are not available. The number of brush fires each year is variable and usually increases during years of dry spring and summer (Ostroskey, 2014).

Effects of Climate Change

The confidence of attribution of Wildfire to climate change is low. Increased air temperatures and evapotranspiration can increase Wildfire potential.

Earthquake

EARTHQUAKE

Earthquakes occur as the result tectonic activity. An earthquake is sudden ground motion or trembling caused by an abrupt release of accumulated strain acting on the tectonic plates that comprise the Earth's crust along faults. Although earthquakes have caused much less economic loss annually in the United States than other hazards such as floods, they have the potential for causing great and sudden loss. Within 1 to 2 minutes, an earthquake can devastate part of an area through ground-shaking, surface fault ruptures, and ground failures. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth. The focal depth of an earthquake is the depth from the surface to the region where the earthquake's energy originates (the focus). The epicenter of an earthquake is the point on the Earth's surface directly above the focus. The effects of earthquakes are: 1) ground shaking; 2) ground displacement; and 3) loss of soil strength (liquefaction). Ground shaking is represented by the Peak Ground Acceleration (PGA) and spectral acceleration (SA) response. The PGA reflects the ground acceleration at the top of bedrock. Thick deposits of soil over bedrock will modify (typically increase) the acceleration, resulting in ground surface accelerations that are greater than the PGA. Liquefaction is a function of soil type and density. Earthquake intensity is characterized by: 1) the Richter Scale; and 2) the Modified Mercalli Scale. Seismic hazards include damage to structures and infrastructure, landslides and tsunamis.

The National Seismic Hazard Maps (NSHM) (and the hazard model from which they are derived) are used by engineers who construct buildings need to know how strongly a particular site might be shaken by earthquakes. The NSHMs compile known earthquake sources, their distance from the site in question, and other seismological and geological information to project potential maximum expected ground motions at a site over a particular period of time (50 years).

Soil deposits above bedrock are classified based on shear wave velocity according to Site Class. Site Class Definitions are presented in **Table 2-22.** **Figures 2-39** present the surficial geology. The geologic data indicates that the majority of Old Saybrook consists of shallow glacial till or bedrock .

Figure 2-38 presents the 2% probability of exceedance in 50 years PGA. The 2% in 50 years PGA in the vicinity of Old Saybrook is 0.14g, where g is the acceleration of gravity (32.2 ft/sec^2).

Building response is evaluated using the mapped seismic coefficients Ss and S_1. Ss is the mapped 5% damped spectral response acceleration at short periods. S_1 is the 5% damped spectral response acceleration at a period of 1 second. S_{DS} and S_{D1} are the design 5% damped spectral accelerations at short and 1 second periods respectively. S_{MS} and S_{M1} are the MCE 5% damped spectral accelerations at short and 1 second periods respectively, where MCE is the Maximum Considered Earthquake.

Richter Scale	Earthquake Effects
2.5 or less	Not felt or felt mildly near the epicenter, but can be recorded by seismographs
2.5 to 5.4	Often felt, but only causes minor damage
5.5 to 6.0	Slight damage to buildings and other structures
6.1 to 6.9	May cause a lot of damage in very populated areas
7.0 to 7.9	Major earthquake; serious damage
8.0 or greater	Great earthquake; can totally destroy communities near the epicenter

Table 2-22: Richter Scale

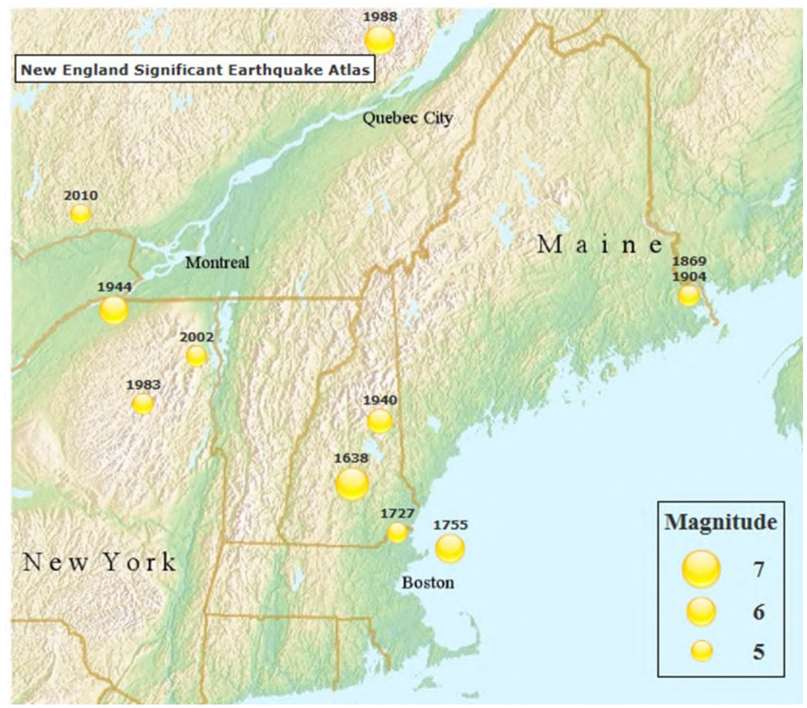


Figure 2-37: Significant Earthquakes in New England http://aki.bc.edu/quakes_historical.htm

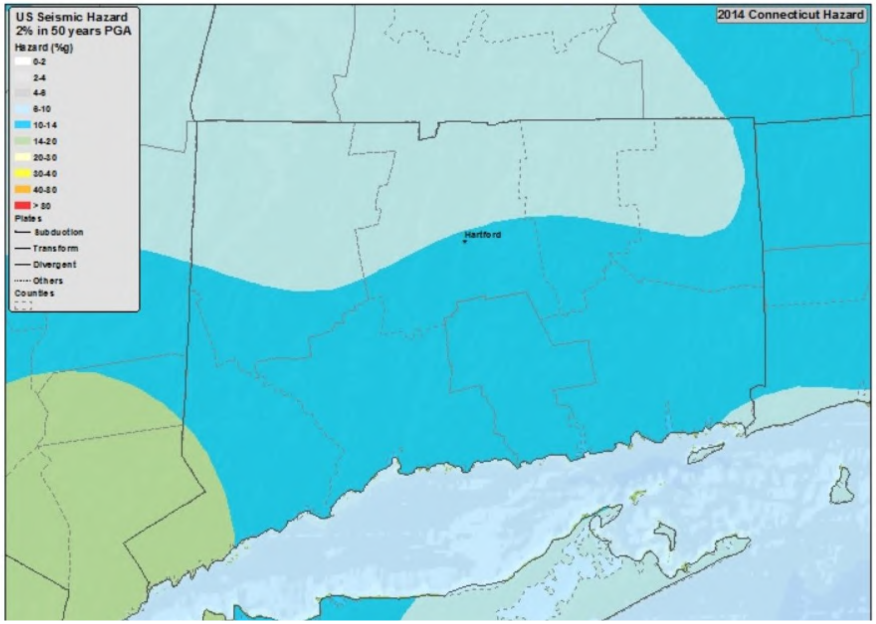


Figure 2-38: 2% probability of exceedance in 50 years Map of Peak Ground Acceleration

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index PI > 20, • Moisture content w ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response	See Section 20.3.1		

Table 2-18: Site Class Definitions

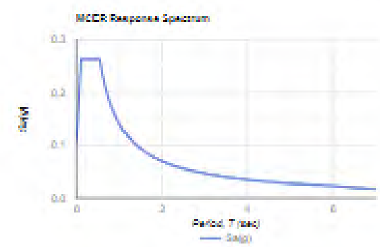
Old Saybrook/Fenwick

Old Saybrook, CT, USA
Latitude, Longitude: 41.2960159, -72.3845301

Date	5/8/2019, 4:57:15 PM
Design Code Reference Document	IBC 2015
Risk Category	II
Site Class	D - Stiff Soil

Type	Value	Description
S_S	0.165	MCE_R ground motion. (for 0.2 second period)
S_1	0.059	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.263	Site-modified spectral acceleration value
S_{M1}	0.141	Site-modified spectral acceleration value
S_{DS}	0.176	Numeric seismic design value at 0.2 second SA
S_{D1}	0.094	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	B	Seismic design category
F_a	1.6	Site amplification factor at 0.2 second
F_v	2.4	Site amplification factor at 1.0 second
PGA	0.082	MCE_G peak ground acceleration
F_{PGA}	1.6	Site amplification factor at PGA
PGA_M	0.132	Site modified peak ground acceleration
T_L	6	Long-period transition period in seconds
SsRT	0.165	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.183	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.059	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.065	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.6	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.899	Mapped value of the risk coefficient at short periods
C_{R1}	0.899	Mapped value of the risk coefficient at a period of 1 s



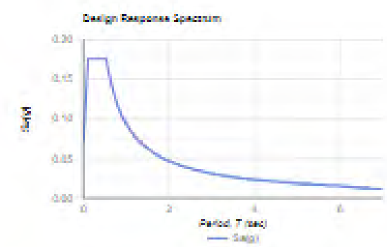


Table 2-17: Seismic Hazard Report for Old Saybrook/Fenwick (https://seismicmaps.org/)

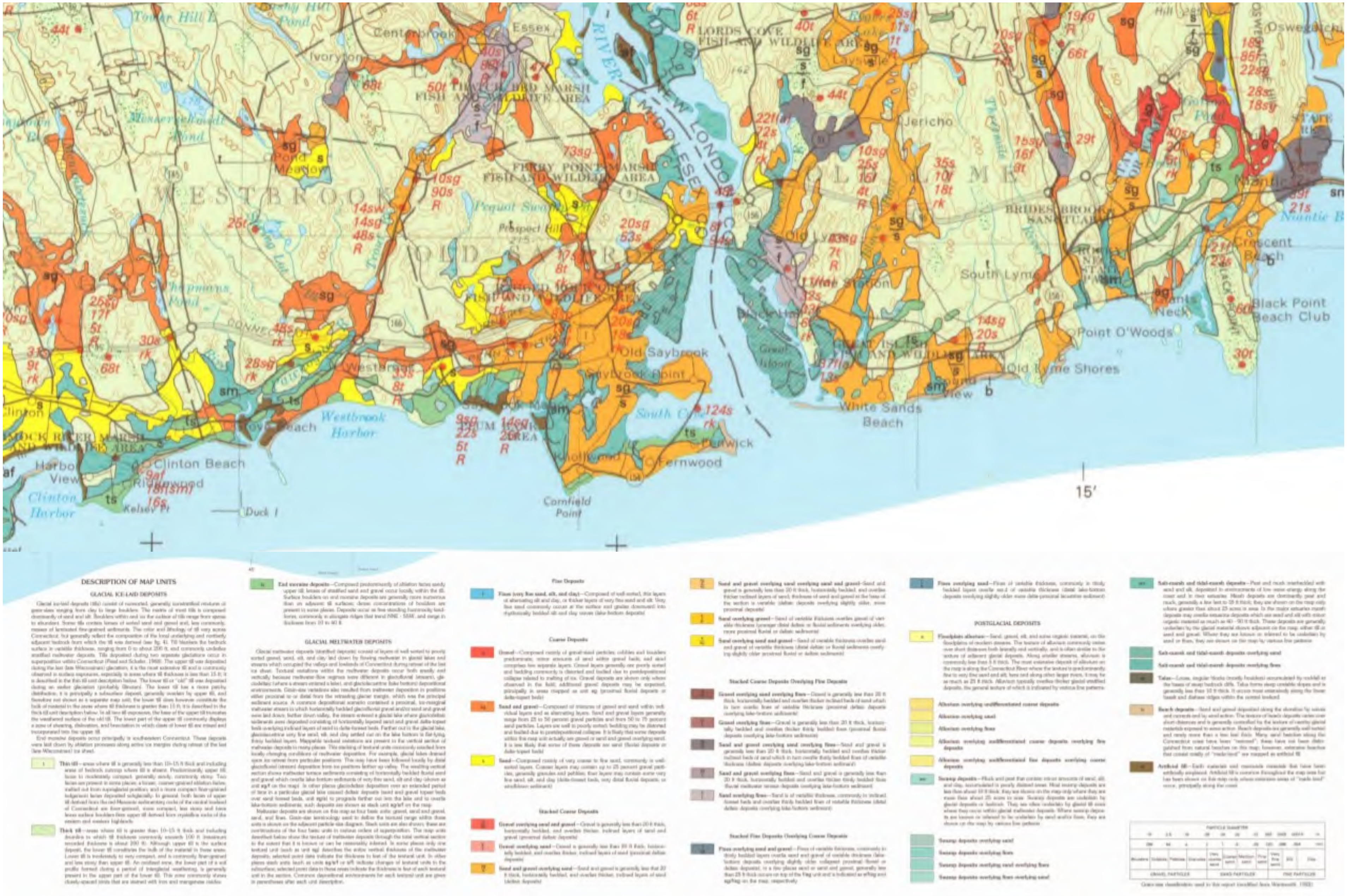


Figure 2-39: Surficial Geology of Old Saybrook/Fenwick

Historical Occurrence at Old Saybrook/Fenwick and Vicinity

According to the USGS Earthquake Catalog data search, there have been 8 earthquakes of magnitude 2.5 or greater which have occurred in Connecticut or off the coast since 1974. The largest was a magnitude 3.8 which occurred in Long Island Sound off the coast of New Haven in 1981. (https://earthquake.usgs.gov/earthquakes/search/ As show in **Figure 2-37**, there have historically been significant (Richter magnitudes between 5 and 7) earthquakes in the vicinity of Connecticut.

Estimated Probability of Occurrence at and near Old Saybrook and Fenwick

Based on the National Seismic Hazard Maps included in the Massachusetts State Building Code:,

- 2% in 50 years PGA (2,475 years recurrence interval; Maximum Considered Earthquake) in the vicinity of Old Saybrook is 0.14g
- 10% in 50 years PGA (500 years recurrence interval) in the vicinity of Old Saybrook and Fenwick is 0.03g
- Per the Connecticut State Building Code, the values of Ss and S_1 at Old Saybrook and Fenwick are 0.178g and 0.061g, respectively.
- the values of S_{DS} and S_{D1} at Old Saybrook and Fenwick are 0.142g and 0.069g, respectively (for Essential Facilities; Site Class C)
- the values of S_{MS} and S_{M1} at Old Saybrook and Fenwick are 0.213g and 0.103g, respectively for Site Class C (the majority of Old Saybrook and Fenwick)
- the values of S_{DS} and S_{D1} at Old Saybrook and Fenwick are 0.189g and 0.097g, respectively (for Essential Facilities; Site Class D)
- the values of S_{MS} and S_{M1} at Old Saybrook and Fenwick are 0.284g and 0.145g, respectively 0.142g and 0.103g for Site Class D (certain Old Saybrook and Fenwick shoreline areas)
- the values of S_{DS} and S_{D1} at Old Saybrook and Fenwick are 0.296g and 0.141g, respectively 0.142g and 0.069g (for Essential Facilities; Site Class E)
- the values of S_{MS} and S_{M1} at Old Saybrook and Fenwick are 0.443g and 0.212g, respectively for Site Class E (localized Old Saybrook and Fenwick areas of floodplain alluvium)
- See Connecticut State Building Code for application of the Seismic Coefficients
- The occurrence of historic earthquakes, PGA, Site Class and applicable seismic coefficients indicate that the seismic risk at Old Saybrook/Fenwick is low. Amplified ground motion may occur within localized areas within Old Saybrook/Fenwick classified as Site Classes D and E. These areas my also be susceptible to liquefaction.

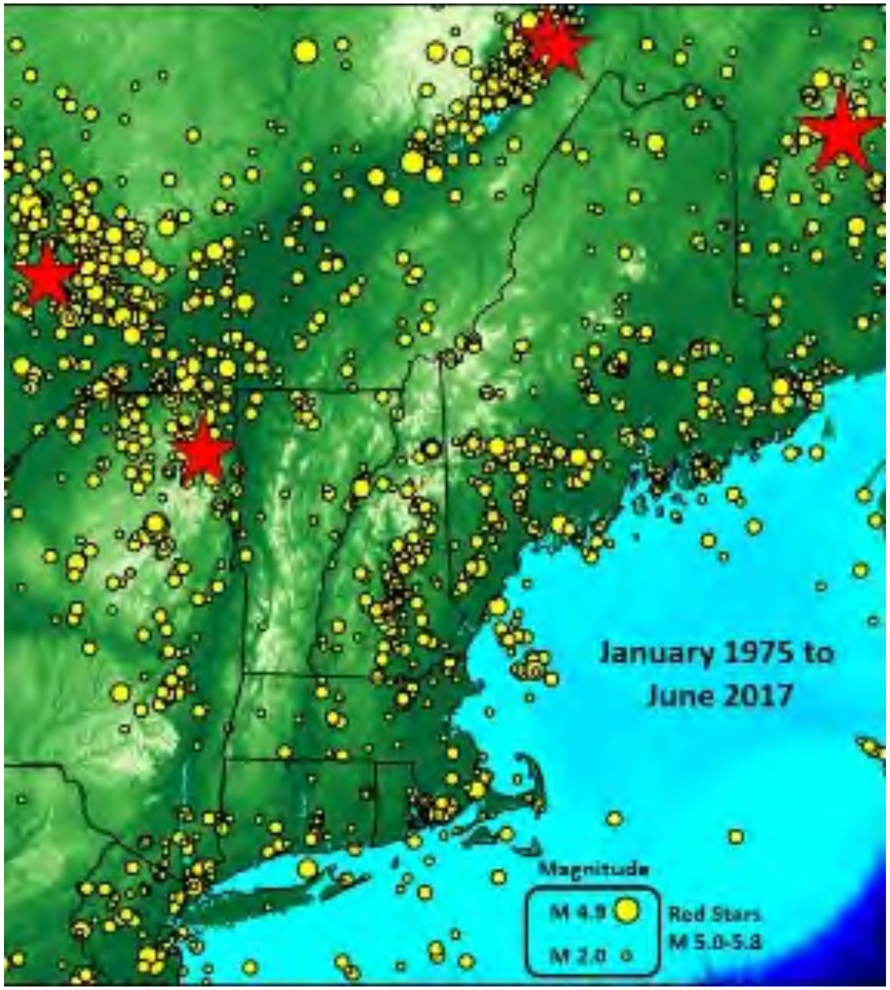


Figure 2-40: Area Earthquakes during January 1975 and June 2017
Source: Weston Observatory website

Attachment 3: Natural Hazard Risk

Old Saybrook and Fenwick Natural Hazard Mitigation Plan Update **GZA**

Attachment 3: Natural Hazard Risk

Overview

A Natural Hazard Risk Assessment was conducted by GZA to evaluate the potential consequences of natural hazards to the people, economy, and built and natural environments of the Town of Old Saybrook and Borough of Fenwick. The risk assessment was performed based on guidance provided by the FEMA Local Mitigation Planning Handbook, and included the Local Planning Team (LPT).

The Natural Hazard Risk Assessment evaluates the effects of the relevant natural hazards (described in Attachment 2) on the community assets (identified in Attachment 2). The methodology assesses risk in terms of: 1) the likelihood (i.e., frequency) of the natural hazard occurring; 2) the predicted effects (damages, losses, etc.); and 3) the consequences (e.g., costs) associated with those effects.

A vulnerability analysis was performed based on historical data and by on spatially comparing the hazard data to the community assets. In particular, the vulnerability of the Town to flooding was assessed by identifying which assets are located within the FEMA flood zones (Special Flood Hazard Areas).

The FEMA Multi-Hazard MH-HAZUS program was used to evaluate losses due to seismic, flood and hurricane hazards. The hazards were ranked using a scoring system. The scoring system is based on the likelihood/frequency, severity/magnitude, and potential impact area.

Historical Hazard Events

Previous federal Presidential Disaster Declarations in Connecticut and in Middlesex County were reviewed. FEMA Repetitive Loss Property data within the Town was also evaluated.

Presidential Disaster Declarations:

Under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C. §§ 5121-5207 (the Stafford Act), a Governor of a State affected by an emergency or a disaster can submit a request for a declaration by the President of the United States that a major disaster exists. The President can declare a major disaster for any natural event, including any hurricane, tornado, storm, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought, or, regardless of cause, fire, flood, or explosion, that the President determines has caused damage of such severity that it is beyond the combined capabilities of state and local governments to respond.

A major disaster declaration provides a wide range of federal assistance programs for individuals and public infrastructure, including funds for both emergency and permanent work (FEMA, "The Disaster Declaration Process", https://www.fema.gov/disaster-declaration-process).

Table 3-1 presents disaster declarations which have been made since 1991 in Connecticut (current through April 2019). These disaster declarations included Middlesex County. Based on the occurrence rate, the expected frequency of disaster declarations is about 1 every 2 years.

Based on past declarations, the most common natural disasters were Severe Weather Hazards, including flooding, winter storms, snowstorms; and hurricanes and tropical storms.

Disaster	Year	Incident Period
Severe Storms, Tornado, and Straight-line Winds (DR-4385)	2018	May 15
Severe winter storm and snow storm (DR-4213)	2015	January 26—29
Severe winter storm and snow storm (DR-4087)*	2013	February 8—11
Hurricane Sandy (DR-4087)*	2012	October 27—November 8
Severe Storm (DR-4046)*	2011	October 29-30
Tropical Storm Irene/Hurricane (EM-4023)*	2011	August 27—September 1
Snowstorm (DR-1958)	2011	January 11—12
Severe Storms & Flooding (DR-1904)*	2010	March 12—May 17
Severe Storms & Flooding (DR-1700)*	2007	April 15—27
Severe Storms & Flooding (DR-1619)	2005	October 14-15
Tropical Storm (DR-1302)	1999	September 16—21
Blizzard (DR-1092)	1996	January 7—13
Coastal Flooding, Winter Flood (DR-972)	1992	December 10—13
Hurricane (DR-916)	1991	August 19

*Emergency Declaration for Middlesex County

Table 3-1: Disaster Declarations in Connecticut 1991 to 2018

Ranking Hazards

The natural hazards were ranked based on impacts to the Town based on likelihood/frequency, severity/magnitude, and potential impact area. Each hazard category was provided a score based on the criteria as shown in **Table 3-2**. For each hazard, the product of the points from each category was determined and the hazards ranked from highest value to lowest. The hazard rankings are presented in **Table 3-3.** The details of each natural hazard are presented in **Attachment 2**, including the expected probability of occurrence (i.e. Likelihood/Frequency). A Hazard Vulnerability Assessment was performed to evaluate the expected consequences (i.e., the Severity/Magnitude and Impact Area) of the top ranked hazards. The results of the vulnerability assessment are presented in this Attachment, in order of the hazard rank.

Likelihood/Frequency		
Point Value	Category	Characteristics and Frequency
1	Very Low	Events that occur or are exceeded less often than once in 100 years (less than 1% probability)
2	Low	Events that occur or are exceeded from once in 50 years to once in 100 years (1% to 2% probability)
3	Medium	Events that occur or are exceeded from once in 5 years to once in 50 years (2% to 20% probability)
4	High	Events that occur or are exceeded more frequently than once in 5 years (greater than 20% probability)
Severity/Magnitude		
Point Value	Category	Characteristics
1	Minor	Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e., 1 or 2 communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.
2	Serious	Scattered major property damage (more than 50% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services are briefly interrupted; some injuries and/or fatalities.
3	Extensive	Consistent major property damage; major damage to public infrastructure (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and fatalities.
4	Catastrophic	Property and public infrastructure destroyed; essential or lifeline services stopped, thousands of injuries and fatalities.
Impact Area Assessment		
Point Value	Category	Characteristics
1	Small	In localized, unpopulated or lightly areas of Town, without structures or critical facilities
2	Medium	Impacting only portions of the Town
3	Large	Town-wide and/or essential and lifeline facilities

Table 3-2: Natural Hazard Ranking Classification

Severe Weather Hazards:	Rank
Severe Wind:	
Hurricanes/Tropical Storms	3
Thunderstorms	6
Tornadoes	5
Lightning	8
Intense Rainfall	7
Hail	7
Flood:	
Storm Surge	1
Sea Level Rise	2
Urban Drainage Flooding	5
Severe Winter Weather	
Snowfall	4
Ice Storms	6
Climate-Related Hazards:	
Extreme Temperature:	
Hot	8
Cold	8
Drought	7
Wildfire	9
Geologic Hazards:	
Earthquake	7
Landslides	0
Tsunami	0
Secondary Hazard:	
Dam Failure	4

Table 3-3 : Natural Hazard Ranking Results for Old Saybrook and Fen-

Table 3-3 presents the results of the hazard ranking for the Town. The top ranked hazards include: 1) coastal storm surge; 2) sea-level-rise; 3) hurricanes (severe wind and related effects); 4) a dam failure (breach) of the Obed Reservoir, Turnpike Road and Chalker Millpond Dams; and 4) severe winter weather (large snowfall event).

The extent of coastal storm surge impacts a large area of shoreline and low-lying areas of Town south of Interstate 95, it is the top-ranked hazard due to: 1) flood inundation impacts to the Town's Essential Facilities; 2) impacts to transportation infrastructure, including Routes 1 and 154, and several bridges lower deck elevations; 3) impacts to the lifeline systems decentralized wastewater management system 4) impacts to Beach Communities, Town Center, Saybrook Point; and 5) marshes and beaches.

Sea level rise is the 2nd ranked hazard due to the increasing extent and depth of flooding, as well as the worsening effects of waves resulting principally to rising sea levels. This will in turn result in greater impacts to even larger extents of shoreline and increasing the vulnerability of major transportation, essential facilities, lifeline systems, residential and commercial properties as well as increasing the size of regularly flooded marshes while further eroding the beaches.

Severe wind and related damages during hurricanes is ranked third due to its relatively high frequency, its coincidence with coastal flooding and its potential for wide-spread damage. In particular, a hurricane strike at or near Old Saybrook and Fenwick with a 1% probability of occurrence would be catastrophic (similar to ones in 1938 & 1954).

Failure of the high-hazard Obed Reservoir Turnpike Road and Chalkers Millpond Dams due to a dam breach is a high ranked hazard due to the potential extent of flood inundation and potential loss of life.

Severe winter weather (including greater than 10-inches snowfall) most frequently occur during Nor'easters, coincident with high winds, cold temperatures and blizzard conditions. They present risks due to transportation impacts (limited use of roadways), cold temperatures (including wind chill) and the potential for structure damage (roof failures). Its relative high probability of occurrence makes severe winter weather as a high ranked hazard.

Certain hazards currently rank low, but are expected to become more impactful in the future due to climate change. In particular, these include:

- Urban flooding due to intense local precipitation. The intensity and frequency of rainfall events is expected to increase (significantly) in the future that will affect the capacity of the Town's stormwater infrastructure provide adequate drainage.
- Extreme temperatures. The frequency and intensity of heat waves is expected to increase in the future. Overall warming will also increase the duration and intensity of tick-borne diseases such as Lyme's Disease.
- Drought. Droughts are expected to increase in the future with potential impacts to the Town's water supply.

For comparison of Old Saybrook's and Fenwick's hazard ranking with the Connecticut in general, **Table 3-4** and **Figure 3-1** summarizes the hazard risks for Connecticut's 2019 Plan Update. The Town's hazard ranking is generally consistent with the State.

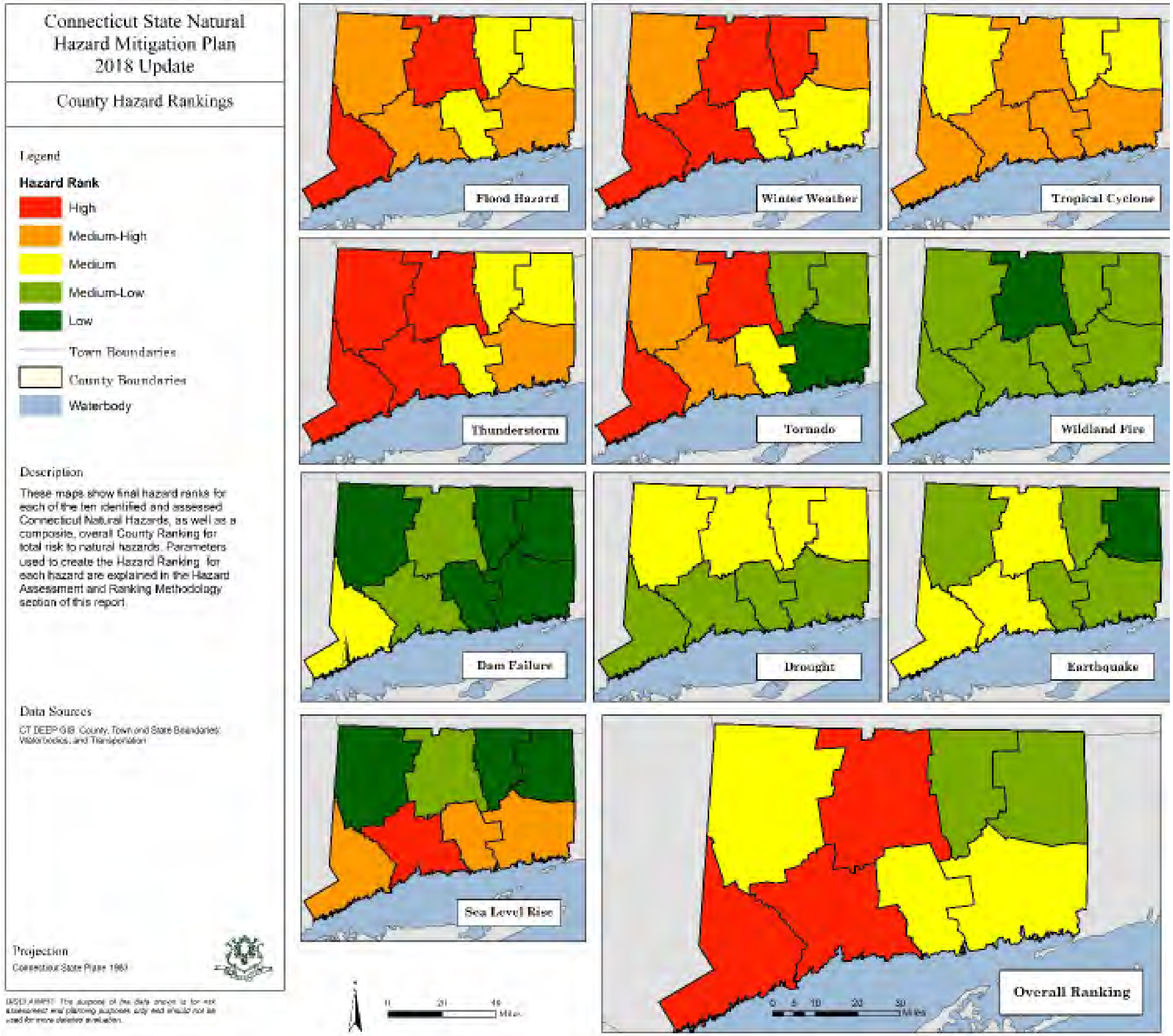


Figure 3-1: Connecticut State Hazard Assessment - County Hazard Rankings

County	Dam Failure Hazard Ranking	Drought Hazard Ranking	Earthquake Hazard Ranking	Flood Hazard Ranking	Sea Level Rise Hazard Ranking	Thunderstorm Hazard Ranking	Tornado Hazard Ranking	Tropical Cyclone Hazard Ranking	Wildland Fire Hazard Ranking	Winter Weather Hazard Ranking
Fairfield	Medium	Medium-Low	Medium	High	Medium-High	High	High	Medium-High	Medium-Low	High
Hartford	Medium-Low	Medium	Medium	High	Medium-Low	High	High	Medium-High	Low	High
Litchfield	Low	Medium	Medium-Low	Medium-High	Low	High	Medium-High	Medium	Medium-Low	Medium-High
Middlesex	Low	Medium-Low	Medium-Low	Medium	Medium-High	Medium	Medium	Medium-High	Medium-Low	Medium
New Haven	Medium-Low	Medium-Low	Medium	Medium-High	High	High	Medium-High	Medium-High	Medium-Low	High
New London	Low	Medium-Low	Medium-Low	Medium-High	Medium-High	Medium-High	Low	Medium-High	Medium-Low	Medium
Tolland	Low	Medium	Medium-Low	Medium	Low	Medium	Medium-Low	Medium	Medium-Low	High
Windham	Low	Medium	Low	Medium	Low	Medium	Medium-Low	Medium	Medium-Low	Medium-High

Table 3-4: Connecticut State Hazard Assessment - County Hazard Rankings

Note: Hazards indicated in red and orange represent the greatest risk based on frequency, severity and range of impact.

Table 3-5 Definitions

Frequency:

Very Low: Events that occur less frequently than once in 1,000 years (less than 0.1% per year).

Low: Events that occur from once in 100 years to once in 1,000 years (0.1% to 1% per year)

Medium: Events that occur from once in 10 years to once in 100 years (1% to 10% per year).

High: Events that occur more frequently than once in 10 years (greater than 10% per year).

Severity:

Minor: Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e., 1 or 2 communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.

Serious: Scattered major property damage (more than 50% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services are briefly interrupted; some injuries and/or fatalities.

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

Catastrophic: Property and public infrastructure destroyed; essential services stopped, thousands of injuries and fatalities.

Hazard Vulnerability Assessment

As indicated by the past Presidential Disaster Declarations, Old Saybrook and Fenwick (like most of Middlesex County and much of coastal Connecticut) are principally vulnerable to the following frequent severe weather hazards: 1) coastal flooding that occurs during hurricanes, tropical storms and nor'easters; 2) sea level rise; 3) severe winds due primarily to hurricanes, which can occur coincident with coastal flooding; and 4) heavy snowfall during winter nor'easters, which can occur coincident with coastal flooding. Climate change has the potential to amplify the intensity and frequency of each of these hazards.

Although less frequent (or effecting less area), Old Saybrook and Fenwick are also vulnerable to: 1) tornadoes; and 2) localized intense precipitation, resulting in localized urban flooding. The attribution of climate change to tornadoes frequency and intensity has not been established. Climate change effects on precipitation are well understood and significant, with the frequency and magnitude of intense precipitation events expected to increase significantly in the near future.

The population of Old Saybrook and Fenwick are also vulnerable to extreme heat events. Climate change effects on the frequency and intensity of extreme heat events is well-understood and significant, with the frequency and duration of heat waves expected to increase.

Although earthquakes are infrequent in the vicinity of Old Saybrook and Fenwick, their potential impacts are high. As discussed below, certain areas of Old Saybrook and Fenwick are more vulnerable to earthquake effects than others due to geologic soil conditions.

The Obed Heights, Chalkers Millpond and Turnpike Road dams presents a dam failure hazard.

Coastal Flood and Sea-Level-Rise Vulnerability

Old Saybrook and Fenwick are highly vulnerable to coastal flooding and the long-term effects of sea level rise. The Town's vulnerability to coastal flooding presents risk, including: economic, property, public safety and natural resources. These risks will likely impact all residents in the future, some of whom will be directly impacted by flooding and others whose risk will be limited to financial such as increased taxes.

Attachment 2 summarizes the results of a detailed evaluation of the Town's and Borough's vulnerability to coastal flooding, including the effects of sea level rise, and the predicted consequences based on the 2018 Coastal Community Resilience Study. Coastal flood "risk" is defined as the product of the flood event, vulnerability and consequences (all in terms of probability of occurrence). Determination of the coastal flood risk is a necessary step in planning for resilience and adaptation and in identifying available and appropriate mitigation measures.

The vulnerability of Old Saybrook and Fenwick to coastal flooding is a function of the elevation of the ground surface relative to predicted flood elevations. **Figure 3-2** presents the Old Saybrook and Fenwick topography (ground elevation).

Topography (the ground surface elevation and land form, relative to sea level) is one of the most significant factors that contribute to the vulnerability of Old Saybrook to flooding due to tides, coastal storm surge and sea level rise.

This evaluation specifically looks at the vulnerability and consequences of the flood hazards detailed in **Attachment 2** of this plan as well as **Attachment 4** of the 2018 Coastal Community Resilience Study**.** The vulnerability and consequences are evaluated categorically as follows:

- Essential Facilities
- Lifeline Facilities
- High Potential Loss Facilities
- Transportation Infrastructure
- Commercial and Industrial Districts
- Communities
- Support, High Occupancy and Vulnerable Populations facilities
- Natural Resources: Marshes
- Natural Resources: Beaches
- Historic Districts
- Shelter and Evacuation Requirements

Although not evaluated by FEMA for the National Flood Insurance program (NFIP), structures, businesses, property and residents located within flood inundation areas with recurrence intervals less than 100-years (i.e., more frequent flooding) are considered to be in areas with a very high flood vulnerability. The evaluation of coastal flood risk also considered the type of structure and its importance to public safety and loss potential.

The presence of waves, along with flood inundation, can significantly increase flood risk since waves are the primary cause of structural building damage and beach erosion. High flood hazard areas exposed to waves greater than 3 feet in height are located in a "high velocity" zone (i.e., large wave and hydrodynamic forces). Waves of 3 feet and greater height result in significant building damage.

The extent and depth of flooding, as well as the effects of waves, are predicted to get worse in the future, principally due to sea level rise. The current flood risk will increase (including the future limits of flood hazard areas defined by FEMA and the NFIP).

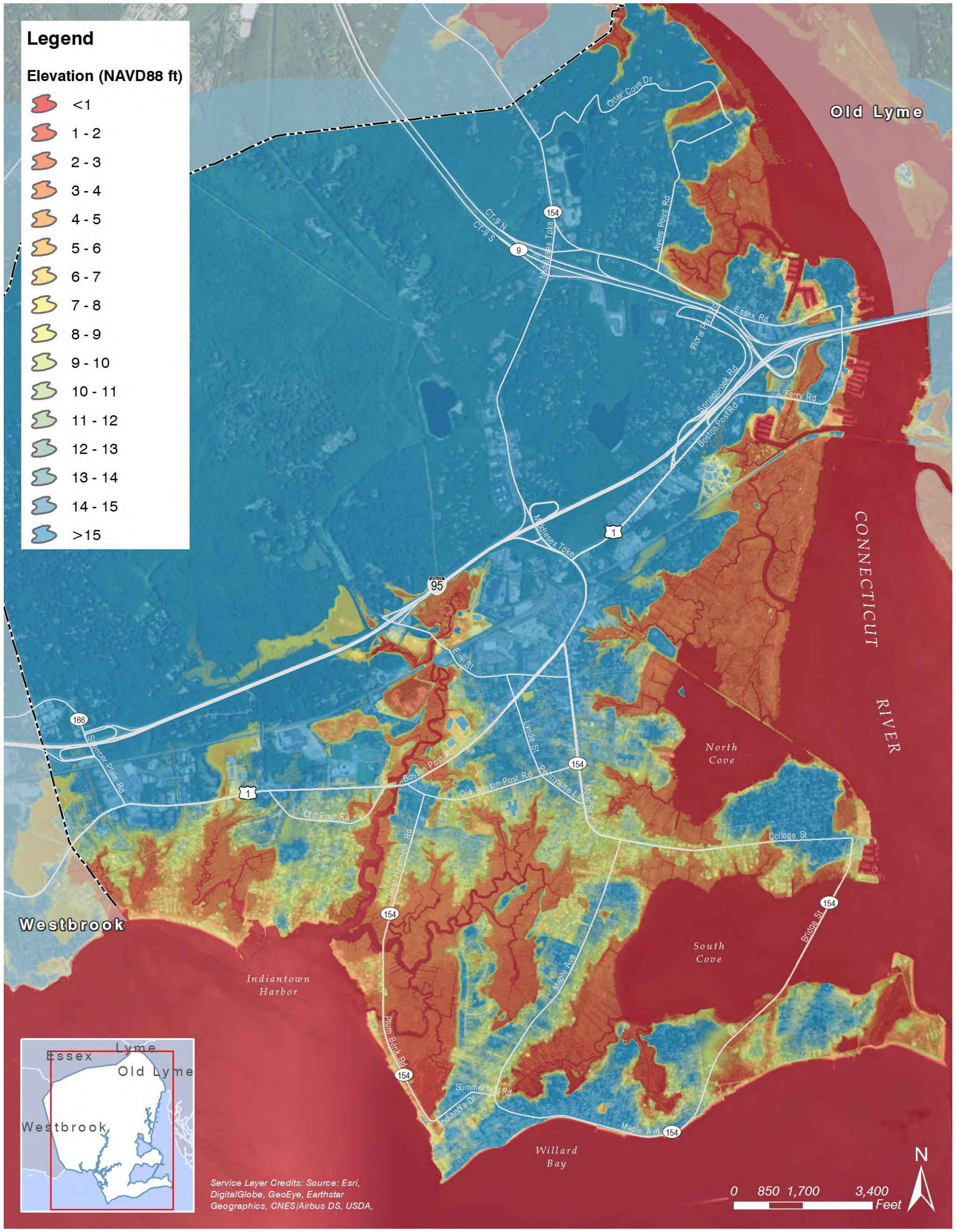


Figure 3-2: Digital Elevation Data based on Current Connecticut LiDAR

Topography:

Topography (the ground surface elevation and land form, relative to sea level) is one of the most significant factors that contribute to the vulnerability of Old Saybrook to flooding due to tides, coastal storm surge and sea level rise.

The most current Connecticut high resolution LiDAR (Light Detection and Ranging) topographic survey was utilized for this study. **Figure 2-3** presents color imagery reflecting the change in ground surface elevation within Old Saybrook based on the high-resolution LiDAR survey data. The colors are differentiated by ground surface elevation, relative to the North American Vertical Datum (NAVD88). NAVD88 is the datum used by FEMA, by the State, and by the Town of Old Saybrook. All elevations presented in this plan reference NAVD88.

The topographic elevation data presented in **Figure 3-2** clearly delineates the transition from the upland portions of Old Saybrook (which are defined by bedrock and the ice-laid glacial till hills and valleys) to the southern coastal low-lying areas which are defined by the coarse-grained glacial meltwater deposits (sand and gravel) and salt marsh and tidal marsh deposits (peat and muck interbedded with sand and silt). The low-lying areas (which are reflected by the red to yellow colors, corresponding to elevations ranging from less than 1 foot to about 8 to 9 feet NAVD88) are dominated by tidal marsh and wetlands systems and the low elevation land areas abutting the tidal marshes and wetlands. Certain low elevation areas (near the shoreline) consist of former marsh areas that have been artificially filled. The areas located within the southern portion of Old Saybrook, characterized by blue, represent areas with thick deposits of sand and gravel glacial meltwater deposits and correspond to higher ground surface elevation (generally on the order of Elevation 10 to 15 feet NAVD88).

The tidal marsh and wetlands systems are developed around waterways (brooks, creeks and rivers), and are hydraulically connected to the Lower Connecticut River and the Long Island Sound. The tidal marsh and wetland systems are primarily irregularly flooded "high marsh". These areas are periodically inundated due to astronomically high tides and storm-related flood events. The marshes are channelized, with the channels regularly inundated due to tides. The marshes are also primary points of entry for inland flooding due to coastal storm surge. GZA computer simulations of flooding during a 100-year return period coastal flood, presented in the 2018 Coastal Community Resilience Study and later in this attachment, demonstrate how these low-lying areas contribute to flooding of the inland areas of Old Saybrook during coastal storms.

Beaches, including beach communities, also represent low-lying Town areas. These areas are directly inundated by coastal flooding, including tides, storm surge and waves.

ESSENTIAL FACILITIES

	Current	2041	2066	2116
LOCATION				
Police Station at 36 Lynde Street	Low	Moderate	Moderate	Moderate
Fire Department at 310 Main Street	High	High	High	High
Emergency Management at 302 Main Street (Town Hall)	High	High	High	High
Ambulance Association at 316 Main Street	High	High	High	High
Emergency Shelter at 1111 Boston Post Road (Old Saybrook Senior High School)	Low	Moderate	High	High

Risk Profile of Old Saybrook Essential Facilities

Figure 3-3. Location of Fire, Police, Emergency Management and Ambulance relative to FEMA special flood hazard areas

The vulnerability of Old Saybrook's Essential Facilities was evaluated relative to coastal flooding up to the 500-year recurrence interval flood (FEMA BFE). Essential facilities are classified as Flood Design Class 4 per ASCE/SEI 24-14. Flood Design Class 4 structures are evaluated for risk relative to the 100-year recurrence interval flood (plus a minimum freeboard) or the 500-year recurrence interval flood, whichever is higher.

The High Risk classification of the Fire and Emergency Management is due to portions of these structures being located within the 500-year floodplain. Flood protection of these structures can be readily provided using building scale permanent or deployable measures. A detailed building Flood Vulnerability Assessment and Flood Emergency Response Plan (FERP) is recommended for each of the high risk Essential Facilities. The ambulance facility is located within a FEMA AE zone and relocation of this facility should be planned for.

A significant, additional, risk is road flooding which will impact the capability of the Town to provide essential services (e.g., emergency response).

See **Attachment 4** of the 2018 Coastal Community Resilience Study for a detailed description of the flood risk of each of Old Saybrook's Essential Facilities.

LIFELINE FACILITIES

LOCATION	Current	2041	2066	2116
Electricity (Elm Street Substation only)	Moderate	Moderate	Moderate	Moderate
Natural Gas	Low	Low	Low	Low
Water	Low	Low	Low	Low
Sewer	High	High	High	High
Communication	Low	Low	Low	Low

Risk Profile of Old Saybrook Lifeline Facilities

The vulnerability of Old Saybrook's Lifeline Facilities was evaluated relative to coastal flooding, up to the 500-year recurrence interval flood (FEMA BFE). Essential facilities are classified as Flood Design Class 4 per ASCE/SEI 24-14. Flood Design Class 4 structures are evaluated for risk relative to the 100-year recurrence interval flood (plus a minimum freeboard) or the 500-year recurrence interval flood, whichever is higher.

The flood risk of Old Saybrook's Lifeline Facilities is generally low except for:

- The on-site subsurface sanitary wastewater treatment at certain communities. The Old Saybrook Water Pollution Control Authority (WPCA) recently completed the "Old Saybrook Wastewater Pollution Control Authority [WPCA]) Community Wastewater System Desktop Evaluation (2019) study to evaluate the use of Community Systems for high risk communities. **Figure 3-5** shows the fifteen wastewater areas in relation to the 500-year recurrence flood, and
- The Elm street electrical substation (see **Figure 3-6 and 3-7**), which is the responsibility of Eversource.

See **Attachment 4 of** the 2018 Coastal Community Resilience Study for a detailed description of the flood risk of each of Old Saybrook's Lifeline Facilities.

Figure 3-4. Location of Lifeline Facilities relative to FEMA special flood hazard areas. Green indicates FEMA AE zones (100-year recurrence interval flood) and brown indicates the 500-year recurrence interval flood.

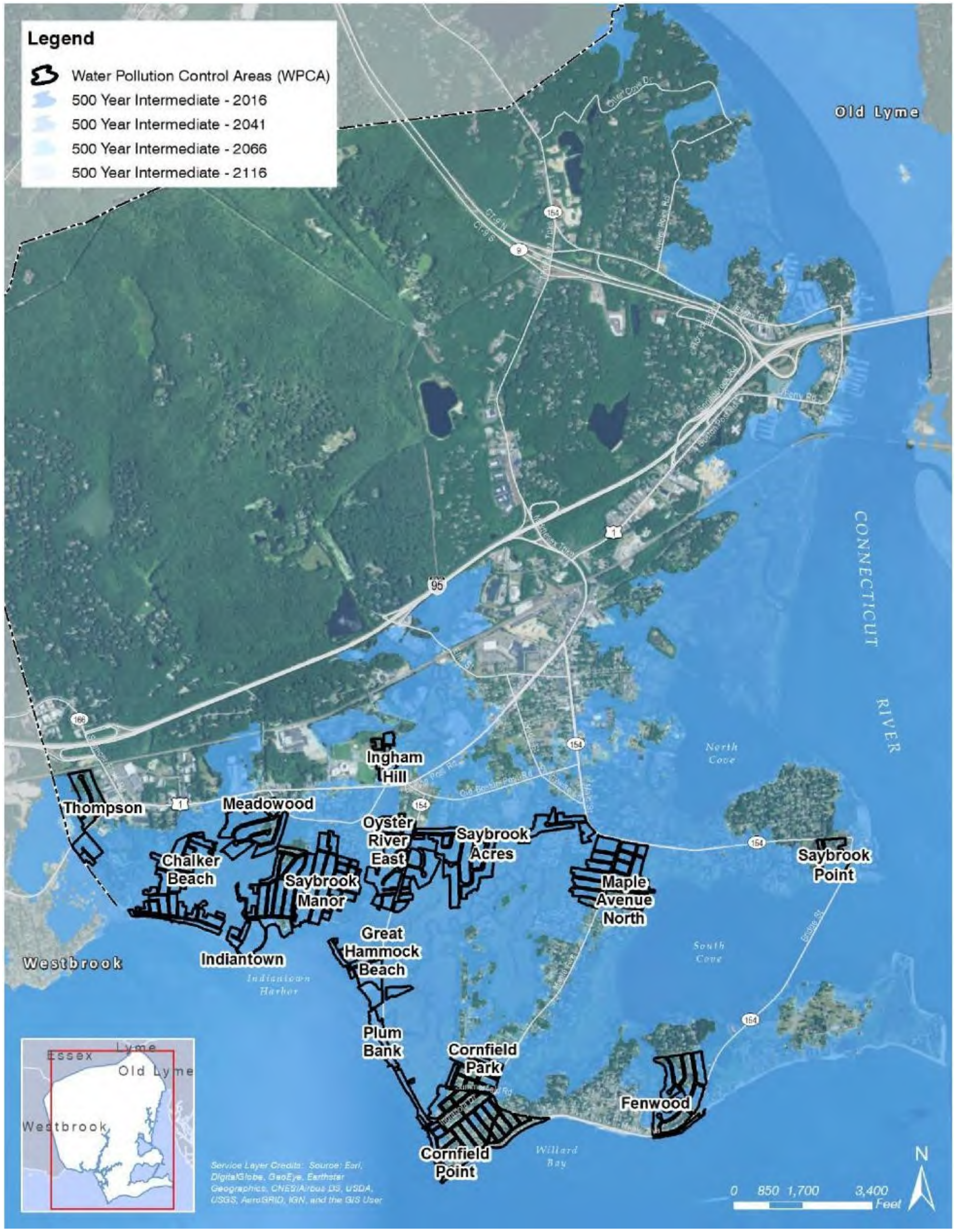


Figure 3-5: Wastewater Areas located within the Modeled 500-year return period flood limits

Figure 3-6: Vicinity of Eversource Elm Street Substation; Ground Surface Elevation +/- 14 feet NAVD88 (top image)

Figure 3-7: Location of Eversource Elm Street Substation relative to effective FEMA FIRM Flood Hazard Zones

HIGH LOSS POTENTIAL FACILITIES

High potential loss facilities are those facilities that would result in significant loos of property of life should they fail. The only facilities located within Old Saybrook are dams, two of which are classified as high hazard or significant hazard dams (Class C and Class B). High Loss Potential Facilities are not classified or regulated using ASCE/SEI 24-14. At a minimum, Class C and B dams should be evaluated for risk relative to the 500-year recurrence interval flood. **Figure 3-8** shows the 11 dams located in the Town and Borough.

A detailed assessment of dam failure risk was beyond the scope of this Plan Update. In general, coastal flooding can negatively impact dams by: 1) coastal floodwaters overtopping the dam spillway and/or dam crest; 2) scour or erosion, resulting in damage to the dam or spillway; and/or 3) temporary changes to the hydrologic and geohydrologic conditions that could induce piping or stability failures.

A preliminary determination of the location of the dams relative to the limits of coastal flood inundation was performed. The following describes the coastal flood conditions in the vicinity of the Old Saybrook Class C and B dams.

- Obed Heights Reservoir Dam: the Obed Heights Reservoir and Dam are located at a high ground elevation, approximately 60 feet NAVD88 and outside the limits of current and future coastal flooding.
- Chalkers Millpond Dam: The Chalkers Millpond Dam is a low earthen dam located at the southern extent of the Chalkers Millpond. The spillway is located at the east end of the dam. Based on recent Lidar data, the crest elevation of the dam appears to be about Elevation 20 to 22 feet NAVD88. The spillway discharges to a drainage swale that appears to be hydraulically connected to the Oyster River via several roadway drainage culverts. The area immediately downgradient from the dam is classified as a FEMA A zone. Although the risk to the dam due to coastal flooding appears low, further investigation is required to evaluate the potential effect of coastal flooding at the spillway.
- Turnpike Pond Dam: The Turnpike Dam is located at a high ground elevation, approximately 56 feet NAVD88 and outside the limits of current and future

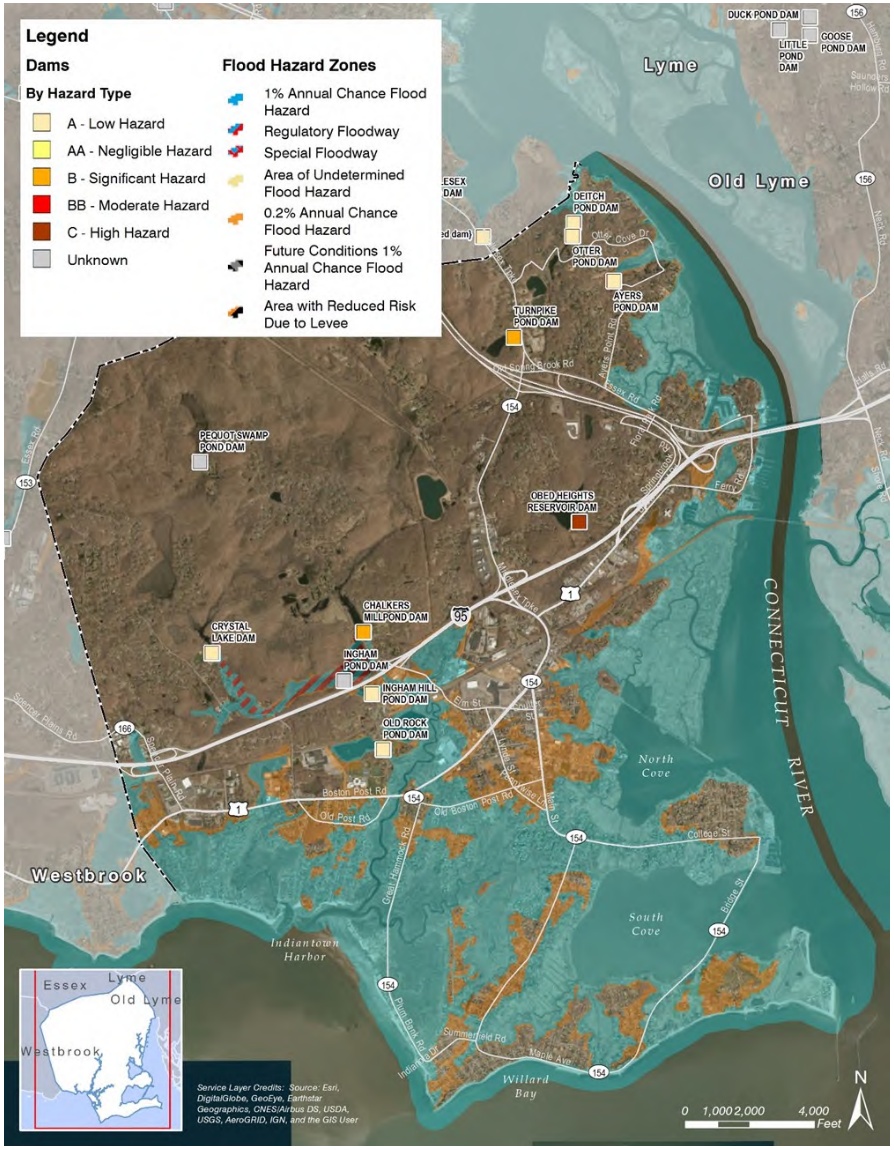


Figure 3-8. Location of Old Saybrook Dams relative to FEMA spe-

ROADS, BRIDGES AND CULVERTS

	2-yr	10-yr	20-yr	50-yr	100-yr	500-yr
State (%)	2.9	7.4	9.6	11.3	13.1	16.9
State (miles)	1	2.4	3.2	3.7	4.3	5.6
Municipal (%)	3	8.5	12.4	16.2	20.6	32.3
Municipal (miles)	2.6	7.4	10.7	14.0	17.9	28.0
Private (%)	3.6	10.5	15	23.7	50.4	71.4
Private (miles)	0.1	0.3	0.4	0.7	1.5	2.1
Total (miles)	**+/-4**	**+/-10**	**+/-14**	**+/-18.5**	**+/-24**	**+/-36**

Vulnerability Profile of Old Saybrook Roads

A detailed analysis of roadway impacts due to coastal flooding was performed and is presented in **Attachment 4** of the 2018 Coastal Community Resilience Study**.** There is a total of approximately 135 miles of roadway in Old Saybrook including about 47 miles of State roads and 88 miles of Town roads. There are 22 bridges including highway and railroad bridges, river crossing and the causeway. There are 11 drainage culverts.

GZA estimated the location and extent of roadway inundation under current coastal flood conditions, including storm events corresponding to the following recurrence intervals: 2-year; 10-year; 20-year; 50-year; 100-year; and 500-year recurrence interval floods - see table above and **Figures 3-9 through 3-11**. About 24 miles and 36 miles of roadway are vulnerable under the current coastal flood risk scenarios of the 100-yr and 500-yr recurrence interval floods, respectively. These flood recurrence intervals represent the appropriate evaluation risk levels for transportation infrastructure investment planning at State and municipal levels. The total impacted roadway under these coastal flood scenarios represent about 24% to 36%, respectively, of the roads within the Town. More frequent flood events, such as the 2-year and 10-year return periods should be specifically considered as important due to their high frequency and "chronic flood inun-

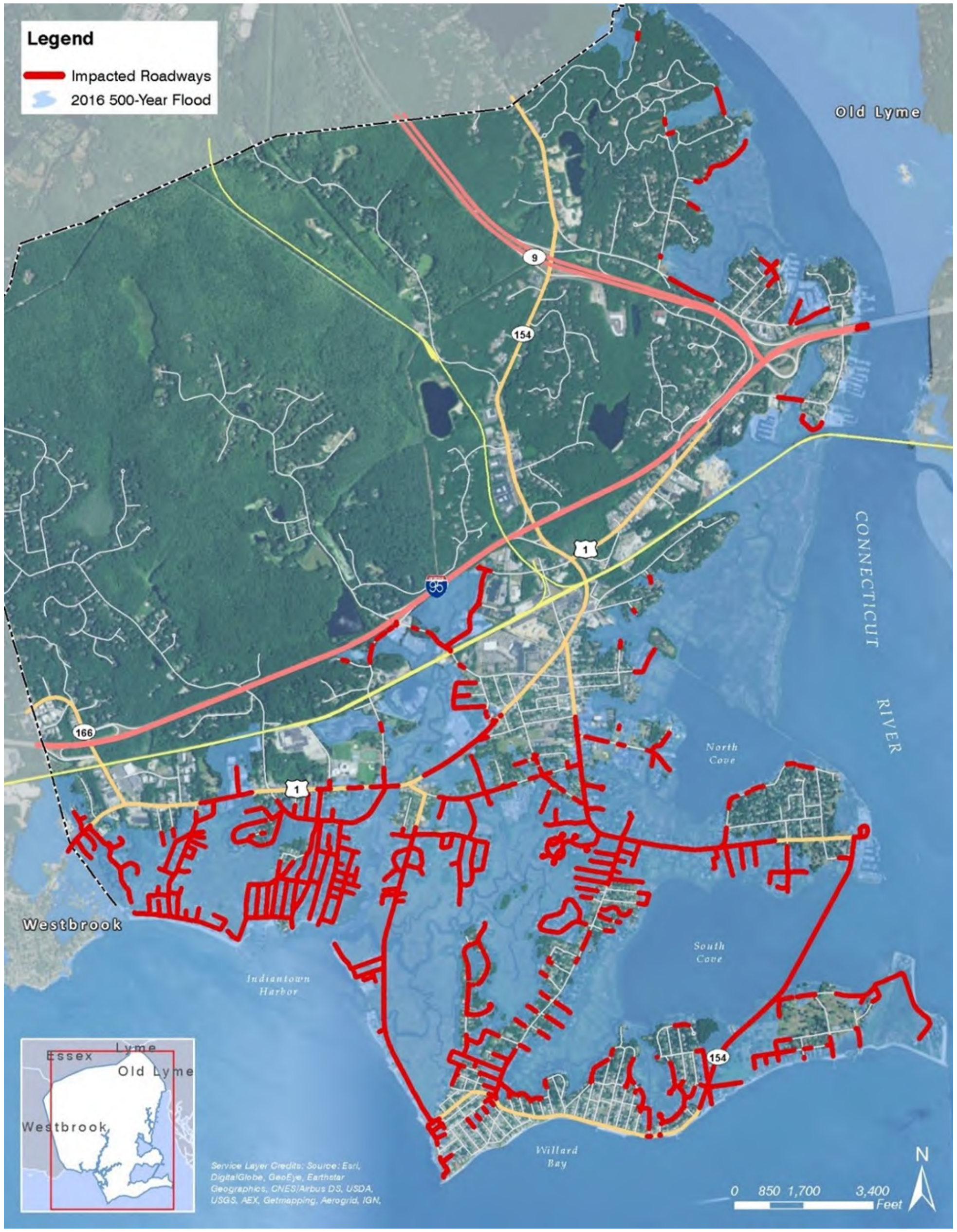


Figure 3-9: Inundated roads during the 500-year recurrence interval flood

Figure 3-10. Inundated roads during the 10-year recurrence interval

Figure 3-11. Inundated roads during the 50-year recurrence interval

ROADS, BRIDGES AND CULVERTS (Cont.)

Overtopped Bridges	Approximate Bridge Deck Elevation (feet, NAVD88)[1]	Estimated current 100-year recurrence interval stillwater elevation (feet, NAV-D88)	Estimated 100-year recurrence interval wave crest elevation (feet, NAVD88)
South Cove Causeway:			
North Bridge over South Cove	6	10	15 (VE)
Middle Bridge over South Cove	6	10	15 VE)
South Bridge over South Cove	8	10	15 (VE)
Great Hammock Road Bridge over Back River	6	10.5	13 (Coastal AE)
Nehantic Trail Bridge over Hagar Creek	10	10.5	14 (VE)
Plum Blank Road Bridge over Plum Blank Creek	7	10	14 (VE)
Route 1 Bridge over Oyster River	13	11.5	12.5
Sequassen Avenue Bridge over tidal creek	6	10	13 (VE)

Vulnerability Profile of Old Saybrook Bridges. Estimated deck eleva-

A detailed analysis of roadway impacts due to coastal flooding was performed and is presented in **Attachment 4** of the 2018 Coastal Community Resilience Study. Based on the flood elevations relative to bridge deck elevations, a preliminary evaluation of bridge damage potential during the current 100-year recurrence interval flood is:

- South Cove Causeway Bridges: High
- Great Hammock Road Bridge over Back River: High
- Nehantic Trail Bridge over Hager Creek: Moderate
- Plum Bank Road Bridge over Plum Bank Creek: High
- Route 1 Bridge over Oyster River: Low
- Sequassen Avenue Bridge over tidal creek: High

Bridge damage potential is a function of: 1) deck elevation relative to stillwater and wave crest elevations (resulting in hydrostatic and hydrodynamic loads); 2) debris impacts to substructure and superstructure; 3) hydrodynamic loads to piers ; and 4) scours around piers. The potential for bridge overtopping or damage, and the very high cost to elevate or replace the bridges, is a key transportation issue for the Town. Due to the low deck elevation of many of the Town bridge, bridge flooding and temporary loss of use will occur frequently in the future.

South Cove Causeway during Irene showing wave overtopping bridge deck. This photo, by Mara Lavitt, won a first-place award in the Connecticut SPJ contest. "Thrill seekers on the causeway between Old Saybrook and Fenwick Point during Tropical Storm Irene, on Aug. 28, 2011." The tide gage data indicated a peak water level during Irene of about Elevation 6.5 feet NAVD (about or slightly higher than the bridge deck elevation). In comparison, the same tide gage measured a peak water level of about Elevation 8 feet NAVD during Sandy.

COMMERCIAL AND INDUSTRIAL DISTRICTS

LOCATION	Current	2041	2066	2116
Saybrook Point SP-1 through SP-3	High	High	High	High
Central Business B-1	Low	Moderate	Moderate	Moderate
Shopping Center B-2	High	High	High	High
Restricted Business B-3	High	High	High	High
Gateway Business B-4	Low	Moderate	High	High
Industrial I-1	Low	Moderate	High	High
Marine Commercial District	Low	Moderate	High	High

Risk Profile of Old Saybrook Commercial and Industrial Districts

The vulnerability of Old Saybrook's commercial and industrial districts was evaluated relative to coastal flooding, up to the 100-year recurrence interval flood (FEMA BFE). Commercial and industrial structures (not containing hazardous materials) are typically classified as Flood Design Class 2 per ASCE/SEI 24-14. Flood Design Class 2 structures are evaluated for risk relative to the 100-year recurrence interval flood (i.e., FEMA Base Flood). The coastal flood risk of the commercial and industrial districts ranges from Low to High.

Due to their waterfront location and low ground elevation, the Saybrook Point SP-1 through SP-3 Districts and the Marine Commercial Districts have the highest coastal flood risk of the Old Saybrook's commercial districts. SP-1 to SP-4 districts are also effected by: 1) frequent roadway flooding, preventing customer access to the area; and 2) disruption of operations and resulting economic loss. The high real estate value, optimal waterfront location and re-development potential of these districts makes their flood protection a Town priority.

See **Attachment 4** of the 2018 Coastal Community Resilience Study for a detailed description of the flood risk for Old Saybrook's commercial and industrial districts.

Figure 3-12: Saybrook Point Districts SP-1 to SP-3 relative to FEMA special flood hazard areas. Green indicates FEMA AE zones (100-year recurrence interval flood) and brown indicates the 500-year recurrence interval flood.

COMMUNITIES

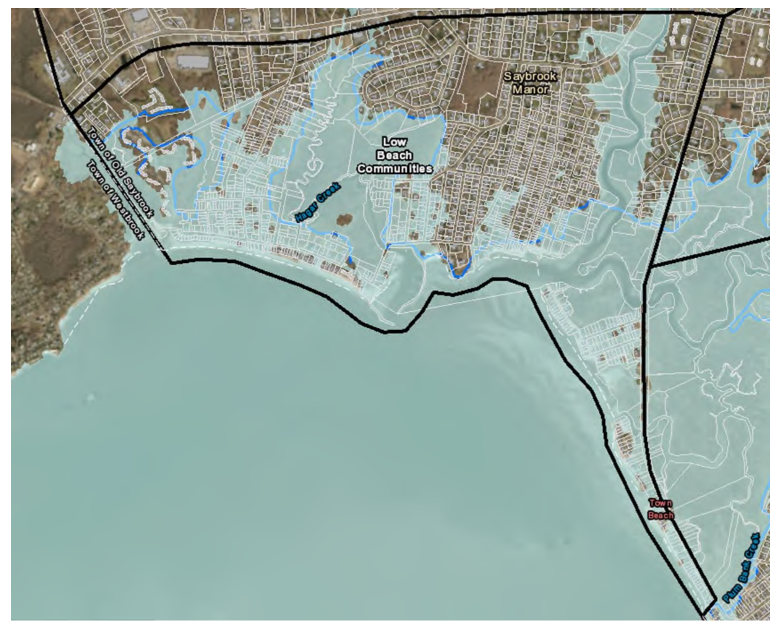
	Current	2041	2066	2116
LOCATION				
Low Beach Communities	High	High	High	High
Cornfield Point to Fen-wood	Moderate	Moderate to High	High	High
Saybrook Point and Town Center	High	High	High	High

Risk Profile of Old Saybrook Communities and Neighborhoods

The vulnerability of Old Saybrook's communities and neighborhoods was evaluated relative to coastal flooding, up to the 100-year recurrence interval flood (FEMA BFE). Different levels of risk apply to different types of Town assets. Communities primarily consist of residential and commercial structures, classified as Flood Design Class 2, and are evaluated for risk relative to the 100-year recurrence interval flood.

With frontage on Long Island Sound and surrounded by tidal marsh, the Low Beach Communities (including Chalker Beach; Indiantown; Saybrook Manor; Great Hammock Beach and Plum Bank) are very vulnerable to coastal flooding and have a High Risk. These communities are located entirely within the FEMA AE zone and have developed beaches fronting on the Sound that are exposed to high waves and located within a FEMA VE zone. These communities are also vulnerable to frequent flooding, with a potential to be chronically inundated by mid-century.

See **Attachment 4 of the 2018** Coastal Community Resilience Study for a detailed description of the flood risk of each of Old Saybrook's communities and neighborhoods.



Images of the Low Beach Communities relative to FEMA special flood hazard areas (above). Green indicates FEMA AE zones (100-year recurrence interval flood) and brown indicates the 500-year recurrence interval flood. Higher probability flooding, represented by the 10-year recurrence interval flood is shown below.

Support, High Occupancy and Vulnerable Populations

Twelve of the Support, High Occupancy and Vulnerable Populations facilities (SHOVPFs) are highly vulnerable to coastal flooding.

Figure 3– 13 shows the locations of the SHOVPFs relative to FEMA special flood hazard zones. The following are located within the FEMA AE special flood hazard zone (none of these are located within a Coastal AE zone):

Hotels:	Pier Blue Guesthouse
Schools:	Kathleen E. Goodwin Elementary School; and Community Nursery School
Museum and galleries:	The general William Hart House and Hart House Gardens,
Religious Institutions:	First Church of Christ, Full Gospel Tabernacle Church, St. Paul Lutheran Church, Valley Shore Assembly of God
Grocery & Supply:	Town Beach Store

The following are located within a FEMA VE special flood hazard zone:

Town Administration:	Vicki G. Duffy Pavilion
Hotels:	Saybrook Point Inn and Spa

These facilities are classified as Flood Design Class 3 per ASCE/SEI 24-14 and are evaluated for risk relative to the 100-year recurrence interval flood (i.e., FEMA Base Flood).

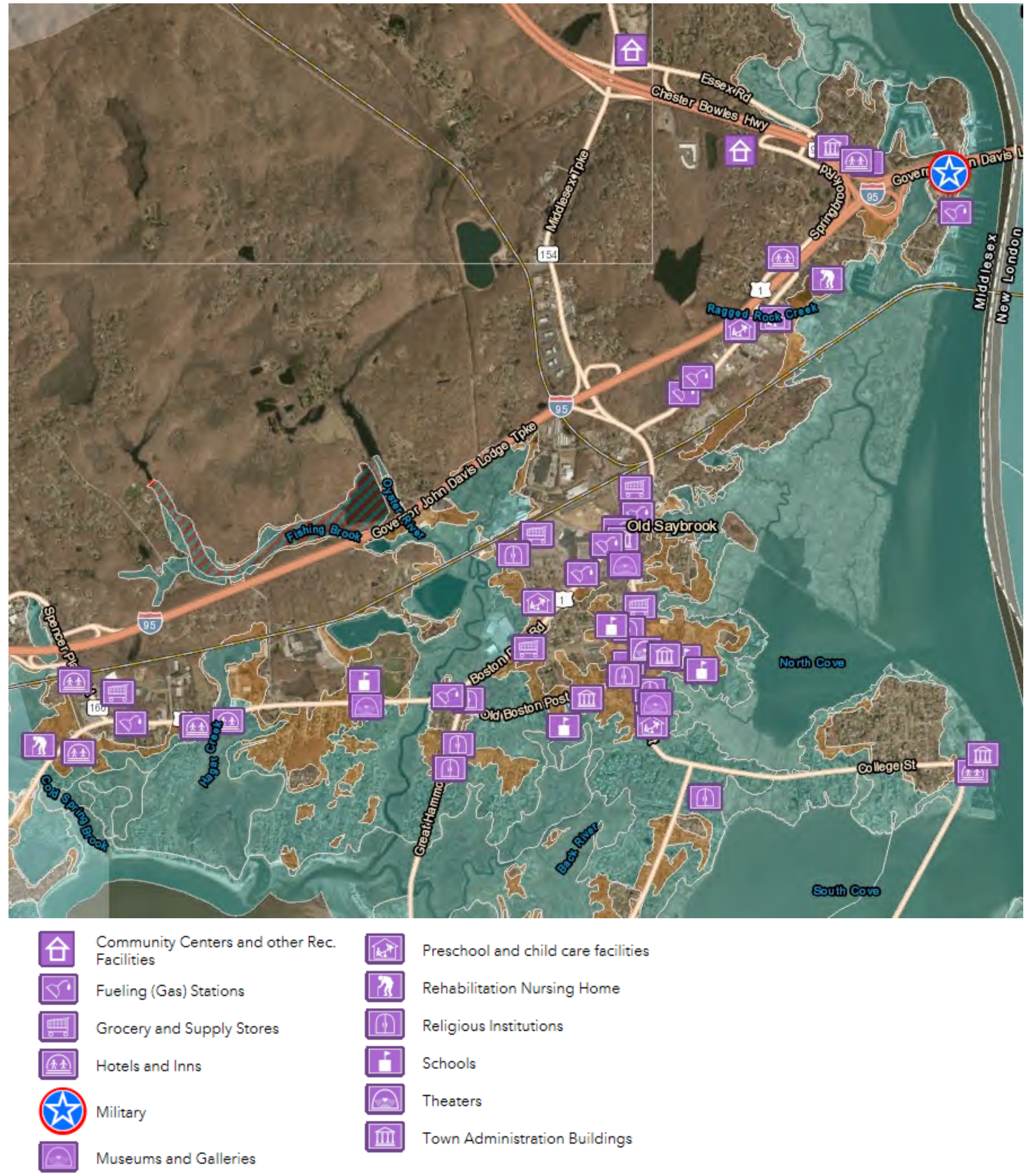


Figure 3-13 Old Saybrook Hazardous Materials Facilities relative to FEMA Special Flood Hazard Zones

NATURAL RESOURCES: MARSHES

The “Application of the Sea-Level Affecting Marsh Model to Coastal Connecticut”, prepared for the New England Interstate Water Pollution Control Commission by Warren Pinnacle Consulting, Inc. provides insight into the behavior of Old Saybrook’s marshes when subject to sea level rise. The marshes provide ecological and human benefits, including habitat for fish, shellfish, birds, and other wildlife as well as recreational value and some protection for inland areas from coastal flooding. However, they are highly susceptible to sea level rise and climate change due to:

- land subsidence;
- rapid changes to water depth;
- marsh substrate;
- sea level rise rate relative to sedimentation rate;
- frequency of inundation;
- changes in tidal flow patterns;
- landward migration of tidal waters;
- changes in salinity, water acidity and oxygen content;
- increased flood vulnerability; and
- species diversification.

Because of the complexity of the various factors affecting a marsh’s fate, a simple comparison of current marsh elevations to future projections of sea level does not accurately predict wetland vulnerability to sea level rise. Model evaluations of Connecticut’s tidal wetlands have been performed (by others) using the Sea Level Affecting Marshes Model (SLAMM). SLAMM simulations were performed starting from the date of the initial wetland cover layer tthrough 2100. Maps and numerical data were output for the years 2025, 2055, 2085, and 2100.

The SLAMM model results for the Rapid Ice Melt maximum sea level rise scenario, which is a reasonable characterization of the predicted sea level rise for Old Saybrook. Under this scenario, significant changes to the marshes begin between 2025 and 2055, at which point most of Old Saybrook’s marshes have converted into Low Marsh. Significant loss of beach has also occurred. By 2085, much of the marsh has converted to tidal flat. By 2100, almost all of the marsh is lost and has converted to open estuary water and tidal flat, with almost no beach barrier.

The analysis also indicates that the effect of sea level rise is not just a function of the total amount of sea level rise but also the rate of relative sea level change. The higher rate of sea level change under the SLAMM Rapid Ice Melt maximum sea level rise scenario, relative to scenarios with lower sea level rise projections results in more significant marsh transformation since the rate of sea level rise under the this scenario is occurring faster than the natural marsh accretion rates. See **Attachment 4** of the 2018 Coastal Community Resilience Study for a detailed description the predicted marsh response to sea level rise.

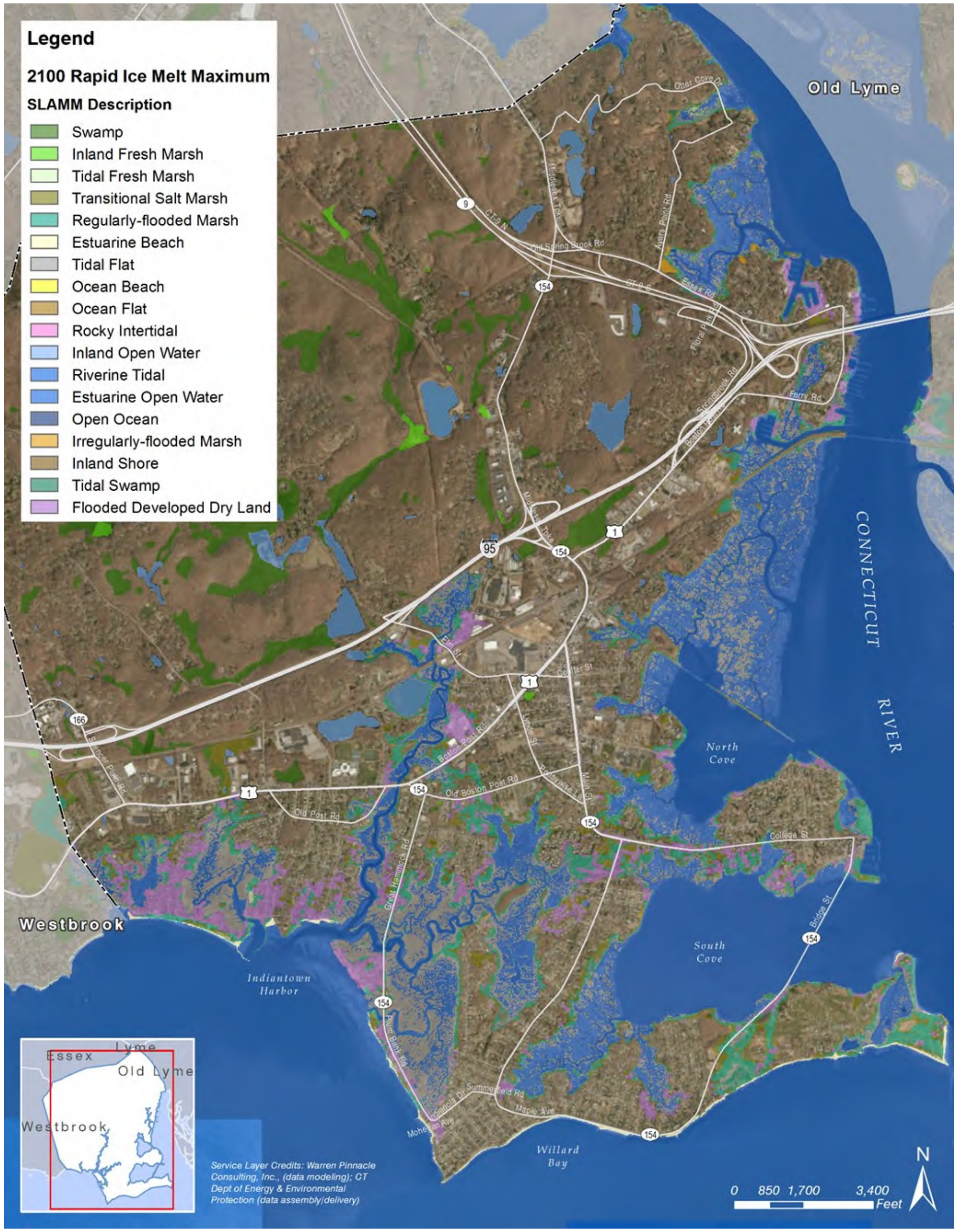


Figure 3-14: SLAMM Rapid Ice Melt maximum simulation of marsh response at Old Saybrook.

NATURAL RESOURCES: BEACHES

Old Saybrook's southern shoreline includes 14 beaches. Typical of the Connecticut coast, Old Saybrook's beaches consist of barrier spits and pocket beaches. Beach shoreline protection in the form of groins and jetties have been constructed along most of the beaches in Old Saybrook. About 8 miles of the Old Saybrook shoreline is potentially erodible, of which about 2 miles have been significantly affected by erosion. Areas that have been historically affected by shoreline erosion include: Chalker Beach, Chapman Beach, Westbrook, Plum Beach and Great Hammock Beach. The "Analysis of Shoreline Change in Connecticut", completed by University of Connecticut (CLEAR), Sea Grant and the Connecticut Department of Energy and Environmental Protection (DEEP), analyzed how the Connecticut shoreline has changed between the late 1800s and 2006 through loss (erosion) and gain (accretion) over time. Shoreline statistics include:

<u>Old Saybrook – Long Island Sound Beaches</u>

Short-Term (1983 to 2006):

Net Shoreline Movement:
Minimum: -19.9 meters
Maximum: 23.8 meters
Average: -2.6 meters
End Point Rate (average): -0.12 meters/year

<u>Old Saybrook – Connecticut River Shoreline</u>

Short-Term (1983 to 2006):

Net Shoreline Movement:
Minimum: -20.5 meters
Maximum: 2.8 meters
Average: 6.2 meters
End Point Rate (average): 0.28 meter/year

The long term effects of sea level rise on the beaches will be increased erosion and migration of barrier beaches and spits landward. Over the past century, the sea level in Long Island Sound has risen approximately 10 inches. Landward beach migration can progress as long as there are glacial deposits available to replenish the sediment supply and infrastructure does not impede the natural movement of the beach. At Old Saybrook, sediment supply is limited, and the large number of coastal structures impedes natural sediment transport. By 2100, the barrier spits, in particular Plum Bank, may have disappeared entirely.

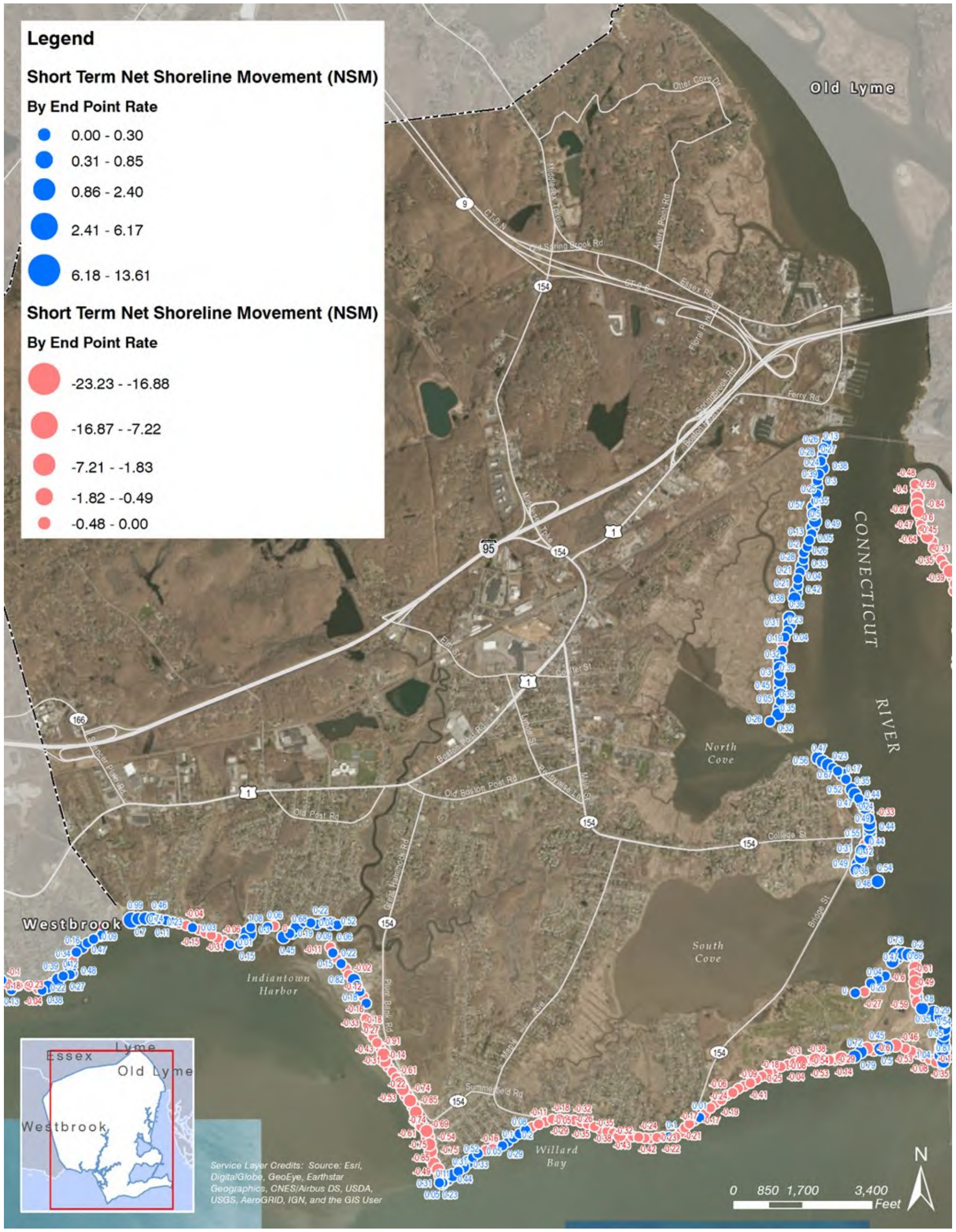


Figure 3-15: Observed net shoreline change (meters/year) for the period of

HISTORIC DISTRICTS

Type of Historic Property	Total Number	Total Number in VE/V Zone	Total Number in AE/A Zone
National Register Federal Historic Properties	17	3	3
State Register Historic Properties	76	1	17
Locally Significant Historic Properties	236	2	38
Other Significance	6	None	None
Total	335	6	58

Vulnerability Profile of Old Saybrook Historic Properties

Location of Old Saybrook Historic Properties relative to FEMA special flood hazard areas. Green indicates FEMA AE zones (100-year recurrence interval flood) and brown indicates the 500-year recurrence interval flood.

There are three historic districts and 335 historic properties located within Old Saybrook. The Historic Districts include: 1) the North Cove Historic District; 2) the South Green Historic District; and 3) the Fenwick Historic District. The first two historic districts were evaluated by this study.

The 335 historic properties located within Old Saybrook include:

- 17 National Register Federal Historic Properties;
- 76 State Register Federal Historic Properties;
- 236 Locally Significant Historic Properties; and
- 6 Historic Properties with Other Significance.

Historic properties are classified as Flood Design Class 2 per ASCE/SEI 24-14 and are evaluated for risk relative to the 100-year recurrence interval flood (i.e., FEMA Base Flood).   As summarized in the table, 64 of Old Saybrook's historic properties are located within FEMA special flood hazard zones.

Historic properties, however, are exempt from certain requirements of federal and State flood regulations, providing greater flexibility relative to available flood mitigation alternatives.

National Flood Insurance Program (NFIP) Repetitive Losses

According to the FEMA Flood Insurance Manual, Effective April 1, 2017, a Repetitive Loss Structure is defined as a National Flood Insurance Program (NFIP)-insured structure that has had at least 2 paid flood losses of more than $1,000 each in any 10-year period since 1978, and a Severe Repetitive Loss Building is any building that:

1. Is covered under a Standard Flood Insurance Policy made available under this title;
2. Has incurred flood damage for which:
    - 4 or more separate claim payments have been made under a Standard Flood Insurance Policy issued pursuant to this title, with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or
    - At least 2 separate claims payments have been made under a Standard Flood Insurance Policy, with the cumulative amount of such claim payments exceed the fair market value of the insured building on the day before each loss.

As of 02/28/2019, there are eighty-five (85) Repetitive Loss Property (RLP) and three (3) Severe Repetitive Loss Properties (SRLP) within the Town of Old Saybrook and Fenwick, as provided by the Connecticut NFIP Coordinator. The 82 of the 85 RLPs are buildings located in the FEMA Special Flood Hazard Area with 20 of the 82 located in the coastal high hazard area (i.e. V or VE Zone). The addresses of the RLPs is protected under the Privacy Act of 1974, 5 U. S. C. section 552(a); however, it may be noted that flooding of the 3 properties is likely associated with the Atlantic Ocean in Long Island Sound.

Table 3-5 and **Table 3-6** provides an overview of NFIP information for the Town of Old Saybrook and Fenwick. FEMA maintains a database on these flood insurance policies and claims, which can be found at https://www.fema.gov/policy-claim-statistics-flood-insurance.

Item	(as of 02/28/2019)
Flood insurance policies in force	1,360
Coverage amount of flood insurance policies	$360,716,200
Premiums paid	$2,060,827
Total losses (all losses submitted regardless of the status)	631
Closed losses (Losses that have been paid)	631
Open losses (Losses that have not been paid in full)	0
CWOP losses (Losses that have been closed without payment)	0
Total payments (Total amount paid on losses)	$32,060,827

Table 3-5: Old Saybrook Flood Insurance Policies and Claims

Item	(as of 02/28/2019)
Flood insurance policies in force	29
Coverage amount of flood insurance policies	$9,852,600
Premiums paid	$90,800
Total losses (all losses submitted regardless of the status)	7
Closed losses (Losses that have been paid)	7
Open losses (Losses that have not been paid in full)	0
CWOP losses (Losses that have been closed without payment)	0
Total payments (Total amount paid on losses)	$217,374

Table 3-6: Fenwick Flood Insurance Policies and Claims

Coastal Flood Risk Summary

Old Saybrook is highly vulnerable to coastal flooding and the long-term effects of sea level rise. The Town's vulnerability to coastal flooding presents risk, including: economic, property, public safety and natural resources.

Likelihood/Frequency:

While coastal flooding occurs frequently at Old Saybrook and Fenwick (at least once per year), significant coastal flood events are associated with the 1% and 0.2 AEP.

Severity/Magnitude

As part of the Plan preparation, GZA completed a Level 1 HAZUS-MH damage analysis for flood scenario (based on FEMA flood hazard delineation). The results are presented at the end of this Attachment. The results predict about $240M to $882M building and content damage for the 1% AEP (100-year recurrence interval) and the 0.2% (500-year recurrence interval flood, respectively. As discussed below, these estimates do not include impacts to the Lifeline Systems in Old Saybrook or Fenwick.

As noted in **Table 3-5** and **3-6**, there are currently 1,389 NFIP-subsidized flood insurance policies in place. The Level 1 HAZUS scenario analyses identified 910 and 2,624 buildings vulnerable to flood damage (ranging from slight to substantial) for the 1% AEP and 0.2% AEP, respectively. Substantial damage will trigger specific flood regulations within the State Building Code, requiring that building repair or replacement be in compliance with current flood regulation.

Impact Area:

- 910 buildings are predicted to be impacted during to the 1% AEP flood. This number represents over 15% of the total number of Old Saybrook and Fenwick buildings.
- 2,624 buildings are predicted to be impacted during to the 0.2% AEP flood. This number represents 42% of the total number of Old Saybrook and Fenwick buildings.

SHELTERING AND EVACUATION

GZA completed a FEMA HAZUS analysis to evaluate flood-related losses resulting in the following predictions for shelter requirements. This analysis relates displacement and shelter needs to building damage. The following summarizes predicted displaced people and shelter needs for different recurrence interval floods:

- 10-year return period flood: 256 households displaced, 648 people seeking temporary shelter
- 25-year return period flood: 305 households displaced, 801 people seeking temporary shelter
- 50-year return period flood: 431 households displaced, 1,161 people seeking temporary shelter
- 100-year return period flood: 1,166 households displaced, 3,096 people seeking temporary shelter
- 500-year return period flood: 1,811 households displaced, 4,709 people seeking temporary shelter

Old Saybrook Public Emergency Shelter (Old Saybrook High School) relative to FEMA special flood hazard areas. Green indicates FEMA AE zones (100-year recurrence interval flood) and brown indicates the 500-year recurrence interval flood.

A detailed analysis of New England hurricane evacuation needs and capabilities was also performed by the USACE and FEMA and presented in "New England Hurricane Evacuation Study, Technical Data Report", dated June 2016. Per this study, evacuation statistics were developed for three evacuation zones within Old Saybrook:

- Zone 1 (Category 1 and 2 hurricanes flood inundation): about 8,200 to 10,750 people are vulnerable, will be impacted and may require evacuation;
- Zone 2 (Category 3 and 4 hurricanes flood inundation): about an additional 90 to 260 people may require evacuation; and
- Zone 3 (areas located outside of coastal flood inundation): about an additional 440 to 800 people may require evacuation.

For comparison, the 10 through 50-year recurrence interval floods can be considered to be analogous to Zone 1, and the 100 to 500-year recurrence interval floods can be considered to be analogous to Zone 2.

A percentage of evacuating people will require shelter within Old Saybrook and the remainder of evacuating people will shelter out-of-town. Old Saybrook's current public shelter capacity is about 450 to 500 people. "Sheltering at home" is also an alternative, in particular for smaller, higher frequency flood events.

A key consideration for evacuation is the predicted road flooding which will restrict residents' ability to evacuate once flooding occurs.

See **Attachment 4** of the 2018 Coastal Community Resilience Study for a detailed description of the flood risk of each of Old Saybrook's Sheltering and Evacuation needs and capabilities.

Severe Winds

Old Saybrook and Fenwick are vulnerable to severe wind events due to hurricanes and tropical storms, nor'easters, thunderstorms and tornadoes. **Attachment 2** presents details about both community's wind hazards. Severe winds at Old Saybrook and Fenwick occur most frequently due to hurricanes and tropical storms which can occur coincident with coastal floods and heavy precipitation. Severe winds can also occur, although rarely, during tornadoes and more frequently during severe thunderstorms. High winds can also occur, frequently, during nor'easters (along with heavy rain and snow).

Likelihood/Frequency

The annual exceedance probability of experiencing sustained winds of 74 mph or greater at Old Saybrook and Fenwick is about 1.5% (+/-70-year recurrence interval). High wind events (defined as sustained winds of 40 mph and gusts of 58 mph) are expected to occur at least once a year at Old Saybrook and Fenwick.

Severity/Magnitude

Damages due to severe winds include: 1) damage to trees, often resulting in power outages and also potentially fatal accidents related to treefalls; 2) structure damage. **Table 3-7** presents the typical physical effects associated with different wind speeds. As shown on **Table 3-7**, significant, widespread damage can be expected due to sustained wind speeds of about 74 mph or greater.

The Connecticut State Building Code requires that structure be constructed in Old Saybrook to larger wind speeds (minimum wind gust for Risk Category I structures is 126 mph, the 0.3% AEP gust speed), so all recently constructed structures should expect minimal wind damage. Older, out-of-compliance structure may experience wind damage. As discussed in **Attachment 2**, since 1996, Middlesex County has experienced 17 days of "High Wind" events (an average of about 1 event per year) resulting in about $560,000 in property damage and no deaths.

As part of the Plan preparation, GZA completed a Level 1 HAZUS-MH damage analysis for hurricane scenario. The results are presented at the end of this Attachment. The results predict about $27.14 Million dollars (M) to $182.92M in building and content damage, and business interruption losses for the 1% AEP (100-year recurrence interval) and the 0.2% (500-year recurrence interval flood, respectively.

Impact Area:

The Level 1 HAZUS scenario analyses identified 621 buildings (10.4% of total buildings) and 2326 buildings (39% of total buildings) vulnerable to hurricane wind damage (ranging from minor damage to destroyed) for the 1% AEP and 0.2% AEP, respectively.

Other Extreme Wind Events

Thunderstorms contribute to Old Saybrook's and Fenwick's wind risk. Ninety thunderstorm wind events have occurred in Middlesex County from 1966 to 2017, resulting in about $211k in property damage (about $2,350 per event) and 0 deaths. Twenty-five of these events resulted in damage and no event resulted in death or injury. Of these, two (2) thunderstorm events impacted the Town of Old Saybrook and Borough of Fenwick. The most severe thunderstorm, resulting in $1.5K in wind damages, occurred on May 27, 2010. Other severe thunderstorms were reported in Old Saybrook on October 14, 1995. Based on proportional land area, the estimated AEP at Old Saybrook and Fenwick is about 1 to 2% (+/- 50 year recurrence interval), with expected damage on the order of $4K to $8K per event. This risk is significantly less than the risk associated with hurricane winds.

Eight (8) tornadoes occurred in Middlesex County, the F3 tornado during August, 1951 resulted in the largest degree of damages at $250,000 and eight (8) injuries. The 6 other tornadoes combined accounted for less than $7.8 thousand in total damages where most of the tornadoes ranged in severity from F0 to F1. Based on proportional land area, the estimated tornado AEP at Old Saybrook and Fenwick is about 0.2% (+/- 500 year recurrence interval), with expected damage on the order of $10K per event. This risk is significantly less than the risk associated with hurricane winds. Old Saybrook and Fenwick would experience much greater damages during a major tornado; however, the probability of a major tornado tracking through Old Saybrook and Fenwick appears to be very low (less than 0.2% AEP). Old Saybrook's and Fenwick's tornado wind risk appears to be is significantly less than the risk associated with hurricane winds.

Sustained Wind Speed	Annual Recurrence Interval (years)	Physical Effects
6-38 kts (30-44 mph)	<1	Trees in motion. Light-weight loose objects (e.g., lawn furniture) tossed or toppled.
39-49 kts (45-57 mph)	2 to 10	Large trees bend; twigs, small limbs break, and a few larger dead or weak branches may break. Old/weak structures (e.g., sheds, barns) may sustain minor damage (roof, doors). Building partially under construction may be damaged. A few loose shingles removed from houses. Carports may be uplifted; minor cosmetic damage to mobile homes and pool lanai cages.
50-64 kts (58-74 mph)	10 to 70	Large limbs break; shallow rooted trees pushed over. Semi-trucks overturned. More significant damage to old/weak structures. Shingles, awnings removed from houses; damage to chimneys and antennas; mobile homes, carports incur minor structural damage; large billboard signs may be toppled
65-77 kts (75-89 mph)	70 to 300	Widespread damage to trees with trees broken/uprooted. Mobile homes may incur more significant structural damage; be pushed off foundations or overturned. Roof may be partially peeled off industrial/commercial/warehouse buildings. Some minor roof damage to homes. Weak structures (e.g., farm buildings, airplane hangars) may be severely damaged.
78+ kts (90+ mph)	>300	Many large trees broken and uprooted. Mobile homes severely damaged; moderate roof damage to homes. Roofs partially peeled off homes and buildings. Moving automobiles pushed off dry roads. Barns, sheds demolished.

Table 3-7: Physical Effects associated with different wind speeds

Dam Failure

High potential loss are those facilities, such as dams, whose failure can result in catastrophic loss of human life and property damage to homes, businesses and local and major roadways The Connecticut Department of Energy and Environmental Protection (DEEP) requires the registration of all dams over six feet in height. As of 2019, there were eleven such dams in Old Saybrook:

Class C High Hazard Dam:	**Obed Heights Reservoir Dam**
Class B Significant Hazard Dams:	**Chalkers Millpond Dam; Turnpike Pond Dam**
Class BB Moderate Hazard Dam:	None
Class A Low Hazard Dams:	Old Rock Pond Dam, Ingham Hill Pond Dam, Crystal Lake Dam, Ayers Pond Dam, Otter Pond Dam, and Deitch Pond Dam
Class AA Negligible Hazard Dams:	None
Unclassified:	Pequot Swamp Pond Dam, Ingham Pond Dam

Dam classifications include:

Class C High hazard potential dams: Failure could cause any of the following: probable loss of life; major damage to habitable structures, residences, hospitals, convalescent homes, schools, etc.; damage to main highways; or great economic loss.

Class B Significant hazard potential dams: Failure could cause: possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, schools, etc.; damage to or interruption of the use of service of utilities; damage to primary roadways and railroads; or significant economic loss.

Class BB Moderate hazard potential dams: failure could result in: damage to normally unoccupied storage structures; damage to paved local roadways; or moderate economic loss.

Class A Low hazard potential dams: Failure could cause: damage to agricultural land; damage to unimproved roadways or minimal economic loss.

Class AA Negligible hazard potential dams: failure would result in: no measurable damage to roadways; no measurable damage to land and structures; and negligible economic loss.

In 2016 Connecticut's Department of Energy and Environmental Protection (DEEP) moved forward to fully implement provisions of state law Act 13-197 that for the purpose of this Plan Update require:

- Dam owners to have periodic inspections of their dams by a professional engineer (Regulation regulations, 22a-409-1 and 2). Requirements for the frequency of inspections are based on the hazard class assigned to a dam – from every two years for High Hazard Dams to every 10 years for Low Hazard Dams.
- Owners of dams categorized as high or significant hazard to prepare and submit an Emergency Action Plan (EAP) every two years. (Regulation 22a-411a). Dams are considered to be of High or Significant Hazard if their failure poses a risk to downstream residents and properties.

Old Saybrook has three (3) Class C and B dams that pose a risk to residents, businesses, property owners and the public if these high potential loss facilities are not properly maintained and comply with the DEEPs dam safety requirements as outline above.

Preparing an EAP is intended to be a practical document that defines conditions which require a response, and provides clear direction for action in an emergency situation. An EAP provides the owner of a dam with a procedure to follow in making a determination when to alert local emergency response agencies that conditions are deteriorating at a dam and that an evacuation of the downstream area may be necessary. The local emergency management authority will have their own procedures in place to issue a warning or evacuation notice to downstream residents should that be necessary. As noted above, dam owners are now required to submit an EAP to the Commissioner of DEEP, the chief executive official of a city or town, and the emergency management officer of any municipality potentially impacted by an emergency involving the owner's dam. The Town of Old Saybrook who owns the Chalkers Millpond Dam recently submitted EAP to DEEP for review and approval. The private owners of the Turnpike Pond Dam are in the process of completing their EAP and will submit to DEEP upon completion.

The private owners of the Obed Heights Reservoir Dam have yet to prepare or submit an EAP to DEEP for review making this dam at greater risk to potential dam failure. It will be important for the Obed Heights Reservoir to prepare an EAP so that effective measures are in place to assist in preventing a dam failure that otherwise may result in significant impacts including loss of life, injuries, property damage, and impacts to roadways.

In addition it will be critical that each of the three dams update their EAPs every two years and make repairs and improvements as presented in inspection reports drafted by a professional engineer. These recommendations are included as high priority actions in this Plan Update.

DEEP notes on their Dam Safety website, that the vast majority of dam failures in Connecticut occur during flooding. Two of the most significant flood events in the state's modern history occurred in 1955 and 1982. As a result of rains in 1982, 17 Connecticut dams failed and another 31were damaged. There were 11 flood related deaths during this flooding and present day estimates put the cost of property damage at approximately $500 million.

A detailed assessment of dam failure risk is beyond the scope of this Plan Update. In general, coastal flooding can negatively impact dams by: 1) coastal floodwaters overtopping the dam spillway and/or dam crest; 2) scour or erosion, resulting in damage to the dam or spillway; 3) temporary changes to the hydrologic and geohydrologic conditions that could induce piping or stability failures.

Severe Winter Weather

Old Saybrook and Fenwick are vulnerable to frequent snowstorms, usually associated with nor'easters. The U.S. Northeast annually experiences about 20 to 40 nor'easters. Beginning in October and ending in April, the nor'easter season runs for seven months. Out of the 20 to 40 annual storms, at least two are severe. **Attachment 2** presents details about Old Saybrook's and Fenwick's severe winter weather hazards.

Damages due to severe winter weather include: 1) damage to trees, often resulting in power outages and also potentially fatal accidents related to treefalls; 2) structure damage, including roof collapse; and 3) roadway issues including access limitations and vehicular accidents.

Likelihood/Frequency

Between 1996 and 2018, there were a total of 70 Heavy Snow events including 42 days in Middlesex County, 5 days with property damage and no injuries or fatalities. Estimated Old Saybrook and Fenwick snowfall frequency:

- 8 to 10 snow days per year
- Average annual snowfall of 23 inches
- 86% AEP or 1 year recurrence interval Heavy Snowfall (19 years with 1 or more events over 22 years)
- Reasonable estimate of average monthly snowfall: 6 to 8 inches
- Reasonably conservative monthly snowfall upper bound: 40 inches (maximum monthly upper bound of 60 inches)

Severity/Magnitude

The severity/magnitude of severe winter weather is a function of the type of vulnerability. Snowfall vulnerabilities generally include: 1) building damage (e.g., roof collapse) due to snow weight; 2) branch fall and power line failure due to snow and ice weight and wind; and 3) snow roadway clearance capabilities relative to snow fall rates.

Building Damage: The Connecticut State Building Code requires that structures be constructed in Connecticut , at a minimum, to snow loads of 30 pounds per square foot (psf). The relationship of snow load to snow depth is a function of the water content of the snow (i.e., wet snow is heavier) and can be variable. In general, 30 psf snow loads correlates to about 24 inches of snow. For weight snow events (saturated snow = +/- 2 pcf), 30 psf correlates to about 15 inches of snow. During periods of cold, snow will not melt on roofs and will accumulate due to multiple snowfall events. Ref. https://www.mutualbenefitgroup.com/insurance-101/storm-center/prevent-roof-collapse-on-your-home/

Tree and Powerline Damage: 1/2" of ice can add 500 pounds load on power lines and trees, resulting in extensive damage. Similarly, greater than 6 to 8 inches of heavy snow accumulation on tree branches can result in significant tree damage.

Roadway Clearance Requirements: the vulnerability of Old Saybrook's and Fenwick's transportation system to snowstorms is a function of the Town's snow removal capabilities. Snowfall frequency data provides insight to the minimum recommended capability necessary to reduce the Town's vulnerability. Based on a limited analysis by GZA for purposes of Plan preparation, the Town's snowfall removal capabilities should include:

- Equipment and operator availability to remove snow for 20 days per year;
- Equipment, material and operator availability to sand/salt for 20 days per year; all paved roads;
- Equipment capability to remove up to 24 inches in 24 hours;
- Equipment and operator capability to remove up to 40 inches per month;
- Equipment, operator and communications capability to remove snow in blizzard conditions (i.e., high wind, drifting and low visibility);
- Back-up equipment and operator capability to remove up to 60 inches per month; and
- Service or close flooded roads. Assume coincident coastal storm surge along shoreline areas for roads at Elevation 9 and lower.

Impact Area: Townwide

Other Severe Winter Weather Events

Other Old Saybrook and severe winter events include ice storms and extreme cold. **Attachment 2** presents details for each of these.

Old Saybrook ' and Fenwick's vulnerability to ice storms is primarily loss of power and tree fall. The probability of damaging ice storms is low.

The vulnerability of residents to extreme cold during cold spells (polar vortex) and winter storms can be moderate to high in consideration of wind chill. The NWS issues Wind Chill Warnings when the wind chill index is expected to be -25^{o} F or less. This can occur over a range of wind speed and temperature combinations. The average Winter low temperature at Old Saybrook and Fenwick is about 23^{o}F, which will not cause wind chill conditions. However, periods of colder temperatures occur at Old Saybrook and Fenwick and can cause wind chill conditions. Wind chill example conditions:

- 0^{o} F and 25 mph sustained wind speeds, 30-minute exposure
- 5^{o}F and 55 mph sustained wind speeds, 30-minute exposure

Extreme Temperature - Heat

The residents of Old Saybrook and Fenwick are vulnerable to the effects of excessive heat. Heat effects include heat cramps, heat stroke, and death. Extreme heat also exacerbates preexisting chronic conditions, such as various respiratory, cerebral, and cardiovascular diseases. These serious health consequences usually affect more vulnerable populations such as the elderly, children, and those with existing cardiovascular and respiratory diseases. Socioeconomic factors, such as economically disadvantaged and socially isolated individuals, are also at risk from heat-related burdens.

Likelihood/Frequency

Excessive Heat Warnings are issued when the daytime heat indices reach 105° F or greater for 2 or more hours. A Heat Advisory is issued when the daytime heat indices reach 100-104°F for 2 or more hours. A Heat Wave is defined as 3 or more days of temperatures of 90° F or above. Connecticut currently experiences between 5 and 8 days per year when the Heat Index is expected to exceed 105° F. Between 2010 and 2018, there were a total of 4 events in Middlesex County with Excessive Heat, including 2 days with Excessive Heat and no fatalities or injuries. These included July 22, 2011 and July 1, 2018.

The results indicate that the probability of Excessive Heat near Old Saybrook/ Fenwick and (Middlesex County) is:

- 25% AEP or 1 event every 4 years.

As described in **Attachment 2**, the number of days over 90°F and frequency of Heat Waves is expected to significantly increase in the near future due to climate change. By 2050, the number of Connecticut Heat Wave days may increase to about 20 to 40 per year. By 2050, the number of days with a Heat Index above 105° F could increase to 10 days per year. This may indicate that by the year 2050, the frequency of Excessive Heat events at Old Saybrook and Fenwick may increase from 1 ever 4 years on average to at least 1 every two years.

Severity/Magnitude

The severity and magnitude of extreme heat events at Old Saybrook and Fenwick is in part dependent upon: 1) demographics; and 2) the capability of residents to get cool (e.g. air conditioners in homes). Old Saybrook's demographic data indicates that about 35% of the population may be at a greater than average vulnerability.

- 25% of Old Saybrook's population is older than 65 years
- 4% of Old Saybrook's population is less than 5%
- 5% of Old Saybrook's population is at the poverty level

Impact Area: Townwide

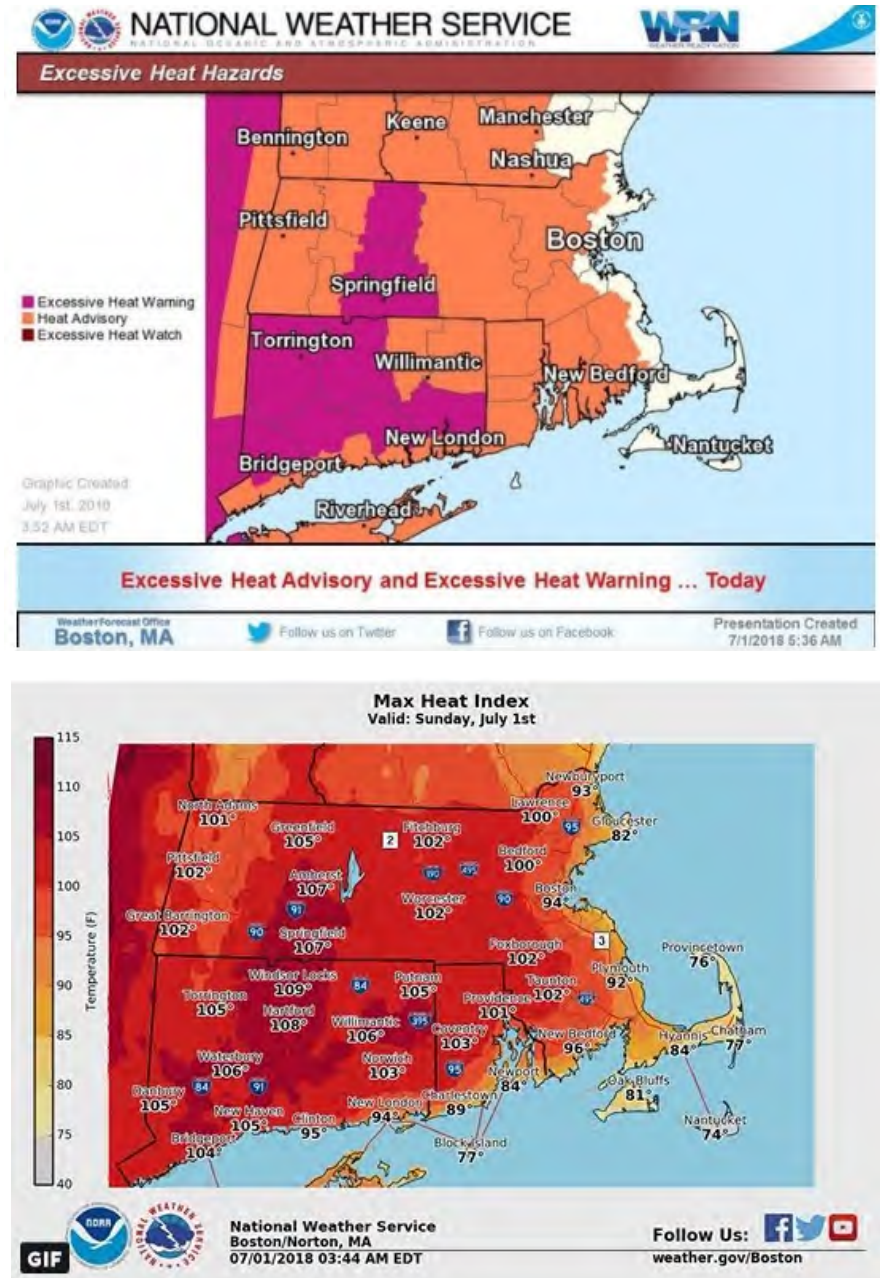


Figure 3-16: Heat Advisory at Old Saybrook during the first week of July, 2018, reference NWS

Earthquake

Old Saybrook and Fenwick is vulnerable to the effects of earthquakes. However, it is located in an area of relatively low predicted earthquake ground motion. The peak ground acceleration (acceleration on the bedrock surface) associated with the maximum Considered Earthquake for building design - the 2% in 50 years probability (about a 2,500-year recurrence interval) is 0.13g (where g equals the acceleration of gravity). In terms of felt effects and damage, ground motion at the level of several percent of gravity corresponds to the threshold of damage to buildings and houses (an earthquake intensity of approximately V). For comparison, reports of "dishes, windows and doors disturbed" corresponds to an intensity of about IV, or about 0.02g. Reports of "some chimneys broken" corresponds to an intensity of about VII, or about 0.10% to 0.20% of gravity. However, the seismic risk is not equally distributed throughout Old Saybrook and Fenwick. The presence of deposits of loose and/or soft soil above the bedrock located primarily in some areas south of Interstate 95 will cause an increase in ground acceleration at the ground surface relative to the ground motion felt at the bedrock (i.e., MCE peak accelerations will be greater than 0.13g). Loose soils can also experience a secondary earthquake effect, called liquefaction, which causes these soils to lose their shear strength during earthquakes.

Historical Occurrence

- Although rare, significant earthquakes (magnitude 6 or greater) have occurred near Old Saybrook and Fenwick, (within about 100 miles) over the last 350 years. These earthquakes would have resulted in moderate to strong ground motion in Old Saybrook and Fenwick.

Likelihood/Frequency

- 2% in 50 years PGA (2,475-year recurrence interval; Maximum Considered Earthquake) in the vicinity of Old Saybrook and Fenwick is 0.13g
- 10% in 50 years PGA (500-year recurrence interval) in the vicinity of Old Saybrook and Fenwick is 0.03g

Severity/Magnitude

The Seismic Design Category for the majority of Old Saybrook and Fenwick is A or B indicating a low seismic hazard. The 10% in 50 years (500-year recurrence interval) ground motion would be experienced as light to moderate perceived shaking and none to very light damage. The 2% in 50 years (2,500-year recurrence interval) ground motion would be experienced as very strong perceived shaking and moderate damage.

Impact Area: Townwide

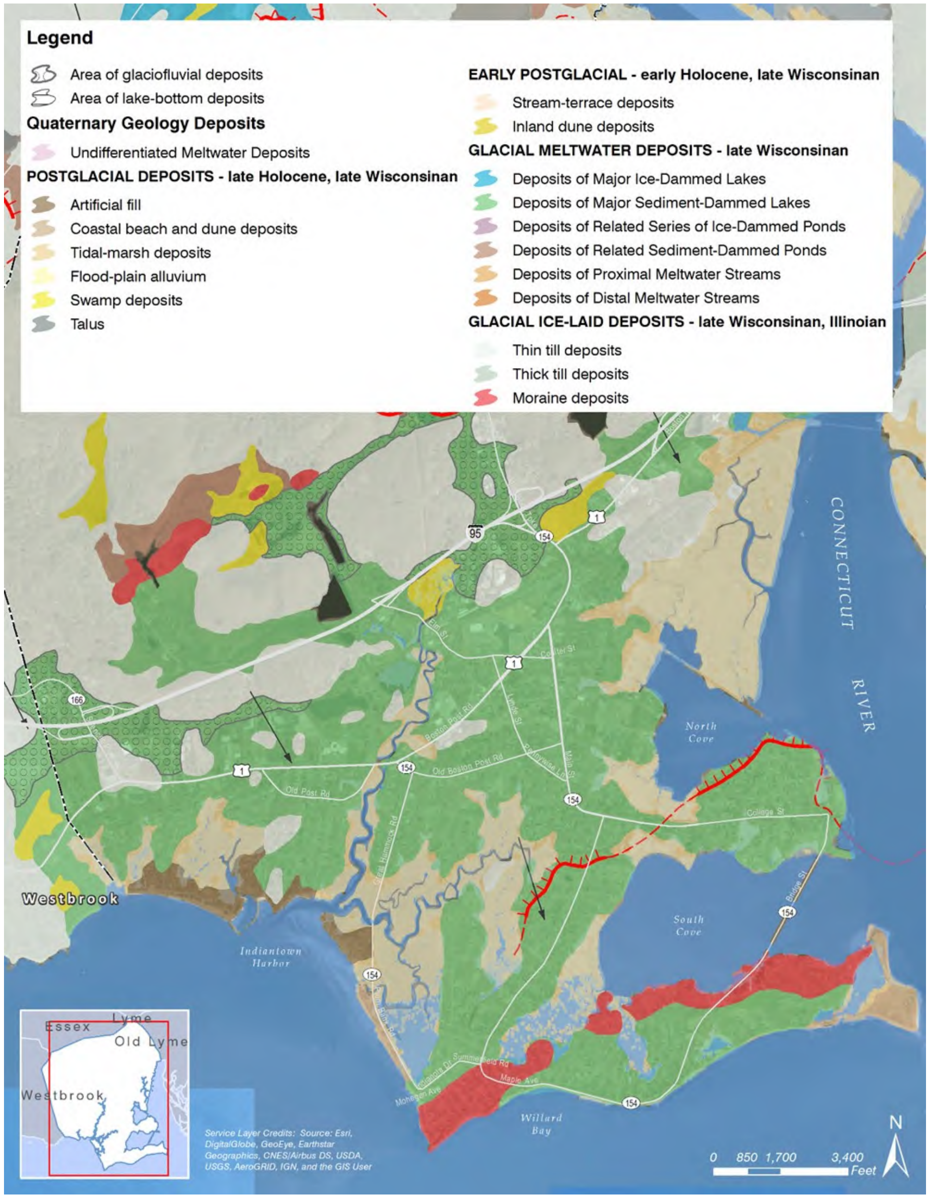


Figure 3-17: Old Saybrook and Fenwick Geologic Map

Attachment 4: FEMA HAZUS-MH Simulation Results

FEMA HAZUS-MH HAZARD SCENARIO ANALYSES

Scenario analyses predict the impacts of an event or particular type of an event. This level of analysis considers potential impacts to infrastructure, people, and cost, as well as likelihood or frequency of the event. Scenario analyses were performed using the FEMA Multi-Hazard HAZUS-MH software.

Level 1 HAZUS analyses were performed using the HAZUS Flood, Hurricane and Earthquake modules. A Level 1 HAZUS analysis calculates basic estimates of flood and hurricane wind losses based on national databases and expert-based analysis parameters included in the HAZUS software. The data used for this analysis included the HAZUS "default" data included in the HAZUS software and 2010 US Census Data. Level 1 analyses are appropriate for initial loss estimation at the planning level, and is not intended for establishing the flood, earthquake, or hurricane related risk of any specific parcel or property.

Potential losses estimated by HAZUS include:

- **Physical damage,** to residential and commercial buildings, schools, critical facilities, and infrastructure;
- **Economic loss**, including lost jobs, business interruptions, repair, and reconstruction costs;
- **Social impacts**, including estimates of shelter requirements, displaced households, and population exposed to scenario floods, earthquakes, and hurricanes

https://www.fema.gov/HAZUS

There are 5,963 buildings in Old Saybrook and Fenwick (2010 census), with a total building replacement value (excluding contents) of $2,411 million (2014 dollars). **Table 4-41**presents the total building value in Old Saybrook and Fenwick. Approximately 92% of the buildings (representing about 76% of the total value) are residential. **Table 4-2** provides an overview of the expected damage and loss categories that will be the focus of this scenario analysis based on the results generated from the Flood and Hurricane HAZUS module runs.

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,833,571	76%
Commercial	408,210	17%
Industrial	95,994	4%
Agricultural	5,221	<1%
Religion	30,873	1.3%
Government	20,358	<1%
Education	16,285	<1%
Total	**2,410,512**	100%

Table 4-1: Old Saybrook and Fenwick Building Exposure and Occupancy Type

DIRECT DAMAGE
General Building Stock
Essential Facilities
DIRECT LOSSES
Shelter Needs
INDIRECT LOSSES
Economic Loss
Property Damage Business Interruption

Table 4-2: Damage and Loss Categories

Flood Scenario

The Town is vulnerable to coastal flood events. The flood scenario analysis used the default building stock from HAZUS as presented categorically in **Table 4-1** and the FEMA-defined flood hazard zones and flood depths. **Table 4-3** presents the estimated damages and losses for the 100-year (1%), and 500-year (0.2%) flood events for: 1) buildings; 2) essential facilities; 3) displaced people and sheltering; and 4) Economic Losses.

Building Damages

Nine hundred and ten (910) buildings in Old Saybrook and Fenwick would experience at least moderate damage from a 100-year recurrence interval flood event and 2,624 buildings would experience at least moderate damage from a 500-year recurrence interval flood event. Of these, 9 buildings (100-year event) and 528 buildings (500-year event) are predicted to experience substantial damage.

The associated economic losses (including business interruption) range from $244 million (100-year event) to $885 million (500-year event).

Essential Facilities

One of the essential facilities (i.e. a school) is expected to be at least moderately impacted, but will not lose functionality during the 100-year interval flood events. Six of the essential facilities (i.e. 1 police station, 1 fire station and 4 schools) are expected to be at least moderately impacted, and will lose functionality for less than one day during the 500-year interval flood events.

Sheltering Requirements

Based on the HAZUS flood analysis, 1,166 households would be displaced and 3,096 people would require shelter for the 100-year flood event and 1,811 households would be displaced and 4,790 people would require temporary shelter for the 500-year flood event.

*These HAZUS results were conducted using HAZUS 4.0. The estimated residential losses are likely to be lower compared to results generated using HAZUS 4.2 largely due to the increase in assessed residential property valuations. The estimated impacts to essential facilities, non-residential building structures and sheltering requirements are expected to be similar.

Uncertainty

Loss estimations using HAZUS are highly uncertain, in particular relative to the predicted damage and resulting economic loss. The analysis is sensitive to flood depth and makes assumptions relative to: building floor elevations and percent damage (using generic depth-damage relationships). It also estimates loss based on a census block scale (i.e., not a building scale). HAZUS reasonably predicts the number of structures impacted. Significant uncertainty with economic loss analyses is also due to the uncertainty related to flood probability. Uncertainty can be reduced by performing more site-specific analysis (i.e., Level 2 and 3 analyses, using elevation certificates and building scale analyses).

	100-Yr*	**500-Yr***
Building Damages (# of Buildings)		
# of Buildings with Slight Damage (1-10%)	8	1
# of Buildings with Moderate Damage (11-50%)	893	2,095
# of Buildings with Substantial Damage (>50%)	9	528
TOTAL	**910**	**2,624**
Essential Facilities Building Damages	100-Yr	500-Yr
Emergency Operations Center	0	0
Fire	0	1
Hospitals	0	0
Police	0	1
Schools	0	4
TOTAL	**0**	**6**
Sheltering Requirements	100-Yr	500-Yr
Displaced Households (# Households)	1,166	1,811
Short-Term Shelter (# People)	3,096	4,700
Economic Losses (in $1,000s of dollars)	100-Yr	500-Yr
Residential Property	$156,110	$580,360
Total Property	$239,770	$882,320
Business Interruption	$134	$253
Total	**$241,110**	**$884,850**

Table 4-3: HAZUS Flood Scenario Results

Uncertainty can also be reduced by comparing results to observed impact and losses. Unfortunately, there is limited historical loss data that is relevant to low probability storms (i.e. 50-year, 100-year and 500-year recurrence interval floods) in Connecticut.

Hurricane Wind Scenario

The Town and Borough will likely experience increasing order of magnitude impacts from hurricane wind events with increasing intensity that have a lower probability of occurrence especially from hurricanes with storm tracks that move directly through or in close proximity to Old Saybrook and Fenwick. **Table 4-4** below shows the estimated damages for the 100-year (1%), and 500-year (0.2%) hurricane-wind events for: 1) buildings, 2) essential facilities, 3) displaced people and sheltering, and 4) Economic Losses from the 100-year and 500-year hurricane-wind events.

Building Damages

In Old Saybrook and Fenwick, 621 buildings and 2,326 buildings are predicted to experience damage, ranging from minor to destroyed, from a 100-year and 500-year recurrence interval wind event, respectively. The majority of damage is predicted to be minor.

The estimated economic losses are about $27.1 million and 183 million, for the 100-year and 500-year events, respectively.

Essential Facilities

Six of the essential facilities (i.e. 1 police station, 1 fire station and 4 schools) are expected to lose some functionality for less than one day during the 100 and 500-year interval flood events.

Sheltering Requirements

Based on the HAZUS wind analysis, 6 households would be displaced and 2 people would require shelter for the 100-year flood event and 94 households would be displaced and 44 people would require shelter.

Uncertainty

Loss estimations using HAZUS are highly uncertain, in particular relative to the predicted damage and resulting economic loss. The analysis is sensitive to wind damages and makes assumptions relative to: building floor elevations and percent damage (using generic depth-damage relationships). It also estimates loss based on a census block scale (i.e., not a building scale). HAZUS reasonably predicts the number of structures impacted. Significant uncertainty with economic loss analyses is also due to the uncertainty related to hurricane– wind probability. Uncertainty can be reduced by performing more site-specific analysis (i.e., Level 2 and 3 analyses, using building scale analyses). Uncertainty can also be reduced by comparing results to observed impact and losses. Unfortunately, there is limited historical loss data that is relevant to low probability storms (i.e. 50-year, 100-year and 500-year recurrence hurricane-wind events) in Connecticut.

	100-Yr	**500-Yr**
Building Damages (# of Buildings)		
# of Buildings with Minor Damage	570	1,707
# of Buildings with Moderate Damage	48	475
# of Buildings with Severe Damage	2	79
# of Buildings Destroyed	1	65
TOTAL	**621**	**2,326**
Essential Facilities Building Damages (Lose of Use <1 Day)	100-Yr	500-Yr
Emergency Operations Center	0	0
Fire	1	1
Hospitals	0	0
Police	1	1
Schools	4	4
TOTAL	**6**	**6**
Sheltering Requirements	100-Yr	500-Yr
Displaced Households (# Households)	6	94
Short-Term Shelter (# People)	2	44
Economic Losses (in $1,000s of dollars)	100-Yr	500-Yr
Residential Property	$23,285	$139,190
Total Property	$25,487	$164,896
Business Interruption	$1,661	$18,022
Total	**$27,148**	**$182,918**

Table 4-4: HAZUS Hurricane Wind Scenario Results

Attachment 5: Potential State and Federal Funding Sources

FEMA Hazard Mitigation Assistance and Disaster Recovery Grants

Several of the proposed hazard mitigation projects and actions may be eligible activities for funding under the three FEMA Hazard Mitigation Assistance (HMA) Grant Programs. The FEMA HMA Grant Programs include two non-disaster mitigation grant programs that include the Pre-Disaster Mitigation and Flood Mitigation Assistance grant programs, and one disaster mitigation grant program that is the Hazard Mitigation Grant Program. An overview of each program is outlined as follows.

Pre-Disaster Mitigation (PDM)

The purpose of PDM is to reduce overall risk to communities and structures from future hazard events including coastal flooding, while also assisting communities in recovering more quickly from future natural disasters. PDM funds mitigation planning and project grants designed to reduce future losses in advance of potential disaster. Funding for PDM and FMA is appropriated by Congress annually and awarded on a nationally competitive basis. Many of the proposed hazard mitigation projects and actions are eligible activities for funding under PDM. https://www.fema.gov/pre-disaster-mitigation-grant-program (03/28/19)

Flood Mitigation Assistance (FMA)

The purpose of the FMA program is to reduce or eliminate insurance claims under the National Flood Insurance Program (NFIP). FMA provides funding to States, Territories, federally-recognized tribes and local communities for projects that reduce or eliminate long-term risk of flood damage to structures insured under the NFIP. FMA funding is available for flood hazard mitigation projects, plan development and management costs. Funding for PDM and FMA is appropriated by Congress annually and awarded on a nationally competitive basis. https://www.fema.gov/flood-mitigation-assistance-grant-program (03/28/19)

Hazard Mitigation Grant Program (HMGP)

FEMA’s HMGP provides funding to municipalities, states, regional planning entities, and other eligible applicants to help communities implement hazard mitigation measures following a Presidential major disaster declaration. The most recent A declaration typically opens up a host of disaster recovery and mitigation programs to assist states in recovering from and mitigating the future impacts from all-natural hazards.

The funding for FEMA’s HMGP is 15% of the total assessed damages for a given disaster for states that meet FEMA’s standard Mitigation Plan requirements, which applies to the state of Connecticut. The HMGP application period is open for one year from the disaster declaration date. In 2012 to 2013, the Hurricane Sandy resulted in over $75 Million in Public Assistance (PA) and Individual Assistance (IA) Grants obligated, which is a FEMA Recovery grant program resulting in an additional $11..36 Million in HMGP funding available to the State for DR-4087. https://www.fema.gov/hazard-mitigation-grant-program (03/28/19)

All three HMA programs are managed by the Connecticut Department of Emergency Management & Homeland Security (DEMHS) with support from Department of Energy and Environmental Protection (DEEP).

The federal share of assistance is not less than 75 percent of the eligible cost. Each of these programs requires a 25% local match for traditional HMA projects.

There is currently one open disaster declaration in Connecticut that was announced on December 5, 2018 - Connecticut Severe Storms and Flooding (DR-4410). This application period will be open until the end of the day on December 4, 2019. (FY) 2019 PDM and FMA grant programs closed on January 31, 2019. The application process for PDM and FMA is conducted through an online application process using FEMA’s eGrants system. It is expected that the application period for FY 2019 PDM and FMA will open sometime in late July or early August of 2019.

Public Assistance (PA)

FEMA's Public Assistance (PA) grant program provides federal assistance to government organizations and certain private nonprofit (PNP) organizations following a Presidential disaster declaration. Through the program, FEMA provides supplemental federal disaster grant assistance for debris removal, life-saving emergency protective measures, and the repair, replacement, or restoration of disaster-damaged publicly-owned facilities, and the facilities of certain PNP organizations. The PA program also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process. The federal share of assistance is not less than 75 percent of the eligible cost. The Recipient (usually the state) determines how the non-federal share (up to 25 percent) is split with the subrecipients (eligible applicants). https://www.fema.gov/public-assistance-local-state-tribal-and-non-profit

HUD Disaster Recovery and Resiliency Grants

Community Development Block Grant – Disaster Recovery (CDBG-DR)

Similar to FEMA’s HMGP, HUD provides disaster recovery grants to help municipalities like Somerset and the State recover from Presidentially-declared disasters, especially in low-income areas. The goal of these grants is to rebuild the impacted areas and provide critical funding to start the recovery process. The CDBG-DR program allows for the funding of a wide range of recovery activities including planning activities that aide communities and neighborhoods that may otherwise not recover because of a lack of resources. Funds from this program support owner-occupied housing, multi-family housing, infrastructure, small business express, and planning..

US Department of Agriculture’s (USDA) and other Federal Grants

Natural Resources Conservation Services (NRCS)

The NRCS is the US Department of Agriculture’s (USDA) leading agency providing voluntary technical and financial assistance to conservation districts, private landowners, tribal governments, and other organizations to help sustainably manage, conserve and improve natural resources at the local level. Two financial programs that offer funding support in response to natural hazards are outlined as follows.

Emergency Watershed Protection Program (EWP)

Congress established the EWP to assist public and private landowners in response to emergencies resulting from natural hazards including coastal flooding and storms. The mission of the EWP program is to assist people and conserve natural resources by reducing the future impacts to public safety and property caused by floods, coastal storms and other natural hazards. The NRCS is the managing agency for the EWP program that includes two focus areas which are: EWP-Recovery and EWP-Floodplain Easement (FPE).

The EWP-Recovery provides recovery assistance to public and private landowners as a result of a natural disaster that requires a 25% local match with the NRCS providing a 75% match for the construction cost for emergency measures. The EWP-FPE provides assistance to privately-owned lands or lands owned by a local or state government that have been damaged by flooding at least once within the previous calendar year or have been subject to flood damage at least twice within the previous ten years.

Watershed & Flood Prevention Operations (WFPO) Program

The Watershed Protection and Flood Prevention Act of 1954 authorizes the NRCS to provide technical and financial assistance to states, local and tribal governments (project sponsors) for the planning and implementation of approved watershed plans. The NRCS works with local sponsors to protect and restore watersheds from damage caused by erosion, floodwater and sediment, to conserve and develop water and land resources, and to solve natural resource and related economic problems on a watershed basis. In Connecticut , the project sponsor for watershed projects is the Connecticut Department of Energy and Environmental Protection (DEEP). The DEEP provides assistance for the implementation of measures outlined in approved plans, and is focusing their efforts on reducing flood damages.

NOAA Coastal Resiliency Grants

Communities use Coastal Resilience Grants to develop projects that save lives, protect property, reduce damage to infrastructure, and benefit ecosystems and the economy. These projects connect agencies and organizations across regions, include a variety of public- and private-sector partnerships, and require a nonfederal dollar match. The grants are structured so that each applicant can request the help most needed by their community.

Since 2015, NOAA received 411 proposals requesting $327 million in federal funds, while NOAA funded 48 projects totaling $35.8 million in federal funds, with $22.3 million in matching funds.

The following summarizes the most common aspects of the projects and showcases the forward-thinking solutions found at the state and local levels.

Natural and nature-based infrastructure. Wetlands, coral reefs, mangroves, and dunes provide natural protection for coastal communities as well as other economic benefits, including habitat for commercially important fish. Nature-based infrastructure approaches mimic natural processes. Many of the grant applications use some form of natural or nature-based infrastructure.

Post-disaster recovery. Communities are figuring out the coordination and processes needed to help people and the economy begin functioning as soon as possible. Ensuring that reconstruction efforts incorporate risk reduction is an important part of this planning effort.

Assessing risk, prioritizing actions. Widespread vulnerability is making detailed risk assessment a necessity. These assessments help communities determine which activities and locations are a priority for protection and recovery efforts.

https://coast.noaa.gov/resilience-grant/

Federal Highway Administration; Nature-Based Resilience for Coastal Highways

The Federal Highway Administration (FHWA) is producing research and technical assistance that will enable transportation agencies to use natural and nature-based features, also called natural infrastructure or green infrastructure, to improve the resilience of transportation systems. FHWA sponsored five pilot projects to assess the potential for nature-based techniques to protect specific locations along coastal roads and bridges. FHWA is also developing a white paper, regional peer exchanges, and an implementation guide.

During 2016, FHWA awarded five applied research projects (pilots) in the amounts ranging from $50,000 to $100,000 for each project. The funds did require a local match. The non-federal share must be at least 20 percent and 50 percent is preferred. In-kind contributions may count as match. Additional information on this program can be found at: These five pilot projects were the result of a 2016 research funding opportunity to conduct assessments of green infrastructure solutions to improve the resilience of coastal highways and bridges to climate change impacts.

This program may be a source of future funding for similar transportation projects that would require that the Town of Old Saybrook partner with the Connecticut Department of Transportation, RiverCOG, etc. The funding recipient must be a state department of transportation, metropolitan planning organization, federally recognized tribal government, or Federal Lands Management Agency. However, partnerships with other organizations such as natural resource agencies, non-profit organizations, universities, etc. are encouraged. The scope includes US coastal areas (East Coast, West Coast, Gulf Coast, Great Lakes, Alaska, Hawaii, Puerto Rico, US Virgin Islands, and US territories in the Pacific Ocean). Eligible projects are those that analyze the feasibility of green infrastructure solutions to protect coastal roads.

Federal Highway Administration (FHWA) Surface Transportation Block Grant -- Transportation Alternatives Set-Aside — This program funds "transportation alternatives," including "off-road trail facilities for pedestrians, bicyclists, and other non-motorized forms of transportation."

Environmental Protection Agency Water and Green Infrastructure Grants

EPA Clean Water Act Nonpoint Source Grant (Section 319 Grants)—Congress amended the Clean Water Act in 1987 to establish EPA's Section 319 Nonpoint Source Management Program to provide greater federal leadership in focusing state and local nonpoint source efforts. Under Section 319, states, territories, and Indian tribes receive grant money to support a wide variety of activities, including:

- technical and financial assistance,
- education and training,
- technology transfer,
- demonstration projects, and
- monitoring to assess the success of projects implemented under the grant.

EPA Clean Water State Revolving Fund (CWSRF)—The CWSRF program is a federal-state partnership that provides communities a permanent, independent source of low-cost financing for a wide range of water quality infrastructure projects, including stormwater and green infrastructure.

Learn more about the program in Green Infrastructure Approaches to Managing Wet Weather with Clean Water State Revolving Funds.

EPA Office of Wetlands, Oceans, and Watersheds (OWOW) Funding—OWOW has created this website to provide tools, databases, and information for practitioners that serve to protect watersheds.

Five Star and Urban Waters Restoration Grant Program—The US Environmental Protection Agency and the Urban Waters Federal Partnership are proud to co-sponsor the Five Star and Urban Waters Restoration Grants Program. This program seeks to develop community capacity by providing modest assistance to diverse local partnerships for river, wetland, riparian, forest and coastal restoration, and wildlife conservation.

EPA's Water Finance Clearinghouse—This tool is a one-stop-shop for all community water finance needs. The Clearinghouse allows you to search a database with more than $10 billion in water funding sources and over 550 resources to support local water infrastructure projects, including stormwater/ green infrastructure funding.

EPA's Water Infrastructure and Resiliency Finance Center (WIRFC)—WIRFC is an information and assistance center, helping communities make informed decisions for drinking water, wastewater, and stormwater infrastructure to protect human health and the environment

Department of Energy Grants

DOE Energy Efficiency Savings EXIT-Green infrastructure can be integrated into project design to claim tax incentives and rebates. For example, in Eugene, Oregon, a new biofuel station built on an abandoned gas station site included a green roof, bioswales and rain gardens. Nearly $250,000 worth of tax credits reduced income and sales tax for the private company that built and operated the project.

State of Connecticut Grants

Connecticut Institute for Resilience & Climate Adaptation (CIRCA) Municipal Resilience Grant Program

CIRCA provides grant funding to municipal governments and councils of government for initiatives that advance resilience, including the creation of conceptual design, construction (demonstration projects or other) of structures, or the design of practices and policies that increase their resilience to climate change and severe weather. This program is focused on implementation and proposals must review and consider integration of CIRCA's research products (see link to CIRCA Research Projects report below) into proposed projects. The CIRCA Executive Steering Committee made up to $100,000 in funds available to municipal governments and councils of government in 2016 and 2017 for the execution of resilience initiatives. The committee will review proposals and expects to award 2 -5 projects on this round.

https://circa.uconn.edu/funds-muni/

Connecticut Institute for Resilience & Climate Adaptation (CIRCA) Matching Funds Program

CIRCA provides grant funding to Connecticut municipalities, institutions, universities, foundations, and other non-governmental organizations for matching funds for projects that address the mission of the Institute. CIRCA matching funds are intended for grant proposals in preparation. You are not eligible to apply if primary funds have already been awarded.

To be funded, a successful Matching Funds Request Form must have a commitment of primary funding within 6 months of the CIRCA award announcement, or have received a waiver from the CIRCA Executive Steering Committee. CIRCA Matching Funds will provide up to 25% of the primary funder's contribution other than municipal or State of Connecticut funds to enhance the likely success of project proposals that advance CIRCA research and implementation priorities. Proposals are required to leverage independent funding awarded through a competitive process.

https://circa.uconn.edu/funds/

State of Connecticut Transportation Capital Infrastructure Program

The U.S. Department of Transportation announced on September 7th, 2017 the opportunity for state and local stakeholders to apply for $500 million in discretionary grant funding through the Transportation Investment Generating Economic Recovery (TIGER) program. Connecticut transportation funding such as the TIGER Discretionary Grant program (which includes federal funds from U.S. DOT or Federal Highway Administration) are potential sources of funding for resiliency projects that have a transportation component. This includes typical State-owned transportation systems (roads, bridges, rail and bus) as well as pedestrian trail corridors. Certain maritime uses, including port infrastructure projects are also included. Connecticut DOT also has funding to conduct planning studies to address the impacts of climate change and extreme weather.

"The TIGER grant program is a highly competitive program whose winners will be awarded with the funding they need to rebuild the infrastructure of their communities," said Secretary Elaine L. Chao. "TIGER grants will continue to fund innovative projects that will improve the safety of America's passengers and goods."

The Consolidated Appropriations Act, 2017 appropriated $500 million, available through September 30, 2020, for National Infrastructure Investments otherwise known as TIGER grants. As with previous rounds of TIGER, funds for the fiscal year (FY) 2017 TIGER grants program are to be awarded on a competitive basis for projects that will have a significant impact on the Nation, a metropolitan area, or a region. The FY 2017 Appropriations Act specifies that TIGER Discretionary Grants may not be less than $5 million and not greater than $25 million, except that for projects located in rural areas the minimum TIGER Discretionary Grant size is $1 million. Additional information on the TIGER Program can be found at:

https://www.transportation.gov/tiger

Attachment 6: Public Meeting Documentation

OLD SAYBROOK Connecticut

The Borough of FENWICK

Natural Hazard Mitigation Plan Public Meeting

The Town of Old Saybrook and the Borough of Fenwick are in the process of updating the Natural Hazard Mitigation Plan (NHMP). The purpose of the MHMP Update is to update the hazards risk assessment, mitigation strategies and actions to reduce the loss of life and property resulting from natural and climate-related hazards. Public participation is essential, and everyone is welcome to attend.

Where:

1st Floor Conference Room, Town Hall, 302 Main Street

When:

December 5, 2018
6:30pm – 8:00pm

Information:

Christine Nelson, Land Use Director, 860-395-3131 or
cnelson@oldsaybrookct.gov

Learn about the planning framework for updating the Town of Old Saybrook and the Borough of Fenwick's Plan Update.

Identify critical assets and natural and climate-related hazards for the Borough and Town.

Contribute feedback to the Local Planning Team, Town, Borough, and Consulting Team for integration into the NHMP Update.

TOWN OF OLD SAYBROOK

Planning Commission

302 Main Street
Old Saybrook, Connecticut 06475

oldsaybrookct.gov

AGENDA

REGULAR MEETING
Wednesday, December 5, 2018 at 6:30 P.M.
Town Hall, 1st Floor Conference Room
302 Main Street, Old Saybrook

I. **CALL TO ORDER**

II. **ROLL CALL**

III. **PUBLIC WORKSHOP**

Natural Hazard Mitigation Plan Update

- **Learn** about the planning framework for updating the Town of Old Saybrook's and the Borough of Fenwick's Plan Update.
- **Identify** critical assets and natural and climate-related hazards for the Borough and the Town.
- **Contribute** feedback to the Local Planning Team, the Town, the Borough and the Consulting Team for integration into the NHMP Update.

IV. **ADJOURNMENT**

NEXT REGULAR MEETING
Wednesday, January 2, 2019 at 7:00 p.m.
Town Hall, 1st Floor Conference Room
302 Main Street, Old Saybrook
Subscribe to www.oldsaybrookct.gov
for electronic delivery of land use agendas.

NEXT **NHMP** PRESENTATION
Wednesday, February 6, 2019 at 6:30 p.m.
Town Hall, 1st Floor Conference Room
302 Main Street, Old Saybrook

Town of Old Saybrook & Borough of Fenwick
Hazard Mitigation Plan Update
Public Meeting
December 5, 2018

SIGN-IN SHEET

NAME	ORGANIZATION	EMAIL
Douglas McCracken	Planning Commission	mccradsul@gmail.com
Tom Cox	" "	coxlaw@gmail.com
WR Wooley	Resident	wwooley@snet
Alex Dziama	Resident	alex.dziama@gmail.com
Ken Souda	Planning Com	bvpusa@comcast.net
Paula Kay	Planning	
* Maggie Kelleher Goldberg	Resident.	maggiedrcgold@gmail.com
Jeffrey Champion	Borough of Fenwick	gm@fenwicknews.com
Trevor Ladd	Planning	trevladd1150@gmail.com
Bill Webster	Borough of Fenwick	william.webster@gmail.com
Brooke Girty	Lynde Pt Land Trust	brookegirtydesign@yahoo.com
Marilyn Ozols	Borough of Fenwick	zeo@fenwicknews.com
[illegible]	resident	
Michael Cianfaglione	Zoning	michael.cianfaglione@gmail.com
Margaret Paccione	Resident	margaretmpaccione@gmail.com
David McCarthy		David.mccarthy@yale.edu

Natural Hazard Mitigation Plan Update

Town of Old Saybrook & Borough of Fenwick

December 5, 2018

Samuel J. Bell, CFM
Senior Resiliency Planner

Known for Excellence. Built on Trust.

Today’s Meeting

- ✓ Introduce Planning Team
- ✓ Present Project Overview
- ✓ Review Planning Process
- ✓ Present Community Profile Overview
- ✓ Present Assets Inventory Update
- ✓ Provide Natural Hazard Characterization Update
- ✓ Discuss Next Steps

Second Public Meeting: February 4, 2019

Local Planning Team (Working Group)

Local Planning Team	
Old Saybrook Director of Land Use Department	Christine Nelson
Fenwick ZEO/Land Use Administrator	Marilyn Ozols
Old Saybrook First Selectman	Carl Fortuna, Jr.
Fenwick General Manager	Jeffrey Champion
Chief of Police	Michael Spera
Fire Chief	Joseph Johnson
Old Saybrook Director of Economic Development	Susan Beckman
Old Saybrook Director of Public Works	Larry Bonin
Old Saybrook Director of Parks & Recreation	Ray Allen
Old Saybrook Building Inspector	Tom Makowicki

Local Planning Team (Working Group) cont.

Local Planning Team	
Old Saybrook Planning Commission	Douglas McCracken
Connecticut River Area Health District Director	Scott Martinson
Old Saybrook CZEO	Chris Costa
Old Saybrook WPCF Project Manager	Stephen Mongillo
Old Saybrook WPCF Project Manager	Robbie Marshall
RiverCOG Executive Director	Sam Gold
RiverCOG Environmental Planner	Margot Burns
RiverCOG Transporation Planner	Rob Haramut
CT DEEP	David Kozak
CT DEEP	Diane Ifkovic

Local Planning Team (Working Group) cont.

Local Planning Team	
CT DOH Director of Resilience	Rebecca French
Connecticut Sea Grant	Juliana Barrett
CT DEEP	Carlos Esguerra
CT DEEP	Joe Wetteman
CLEAR	Bruce Hyde
CTDOT	David Elder
CT NEMO	Amanda Ryan
The Nature Conservancy	Adam Whelchel
Living Shorelines Academy	Marcy Balint
Town Engineer	Geoffrey Jacobson

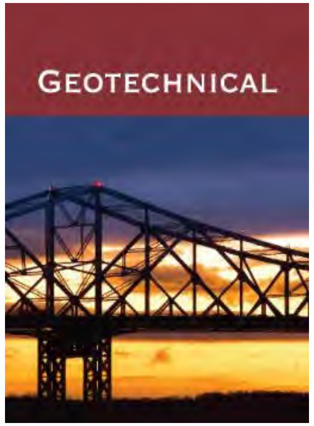
Local Planning Team (Working Group) Meetings

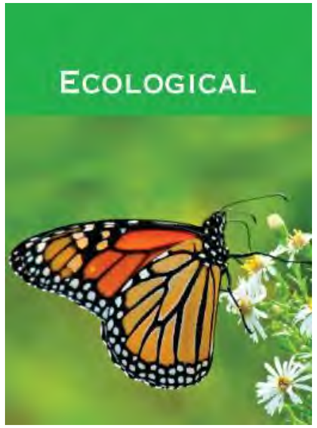
Planning Team Meetings	Date
Project Initiation Meeting	10/25/18
Working Group Meeting	12/20/18
Working Group Meeting	2/2019

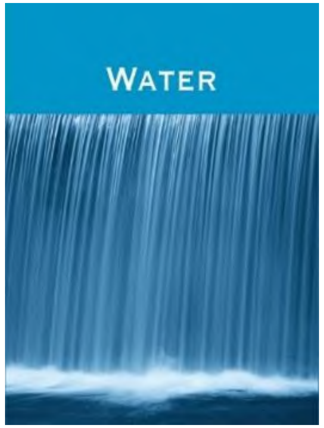
Project Hazard Planning Consultant

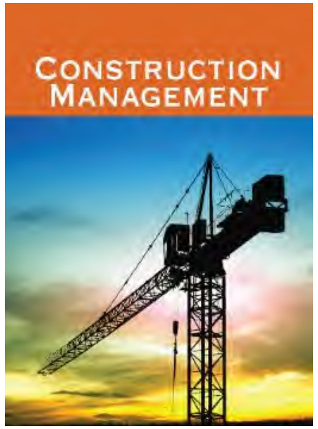
About GZA

*31 offices, 670 Engineers, Scientists, Planners and Technical Specialists providing expert, risk-informed and pragmatic advice and solutions in the following **Core Service** areas….*







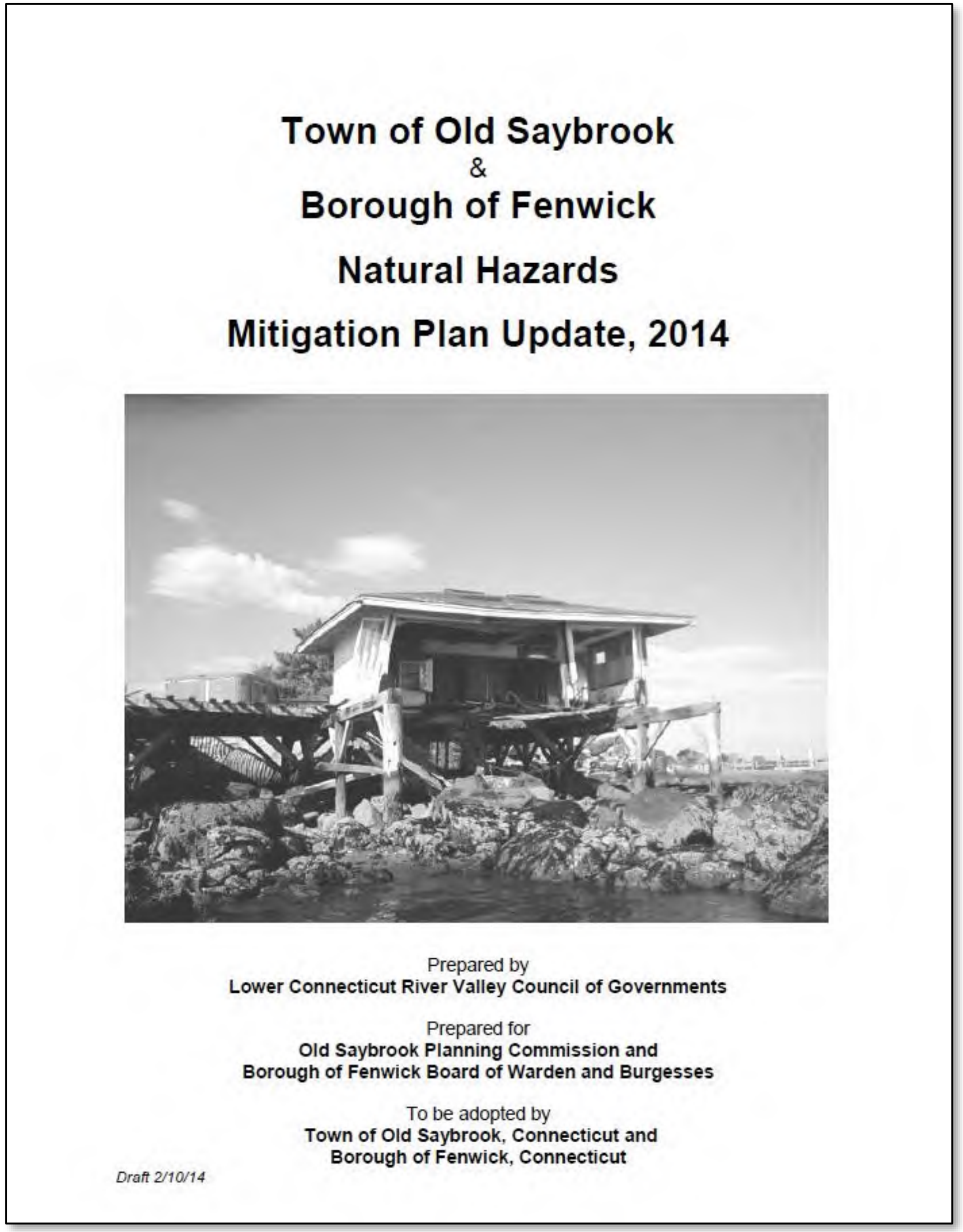


Project Overview

HAZARD MITIGATION PLANNING BACKGROUND

PURPOSE: Hazard Mitigation planning is a proactive effort to identify actions that can reduce the dangers to life and property from natural hazard events, such as hurricanes, tornadoes, winter storms and earthquakes.

REQUIREMENTS: 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.



Town of Old Saybrook
&
Borough of Fenwick
Natural Hazards
Mitigation Plan Update, 2014

Prepared by
Lower Connecticut River Valley Council of Governments

Prepared for
Old Saybrook Planning Commission and
Borough of Fenwick Board of Warden and Burgesses

To be adopted by
Town of Old Saybrook, Connecticut and
Borough of Fenwick, Connecticut

Draft 2/10/14

Natural Hazard Mitigation Plan Update

Planning Goals:

- ✓ Document progress made per the 2014 Plan Update
- ✓ Update Town (Old Saybrook and the Borough of Fenwick) asset inventory
- ✓ Characterize the natural hazards and climate-change effects
- ✓ Assess current and future hazard vulnerability
- ✓ Provide public education and outreach throughout the planning process
- ✓ Revise and develop strategies and actions to mitigate the hazard risks
- ✓ Adopt the Plan Update

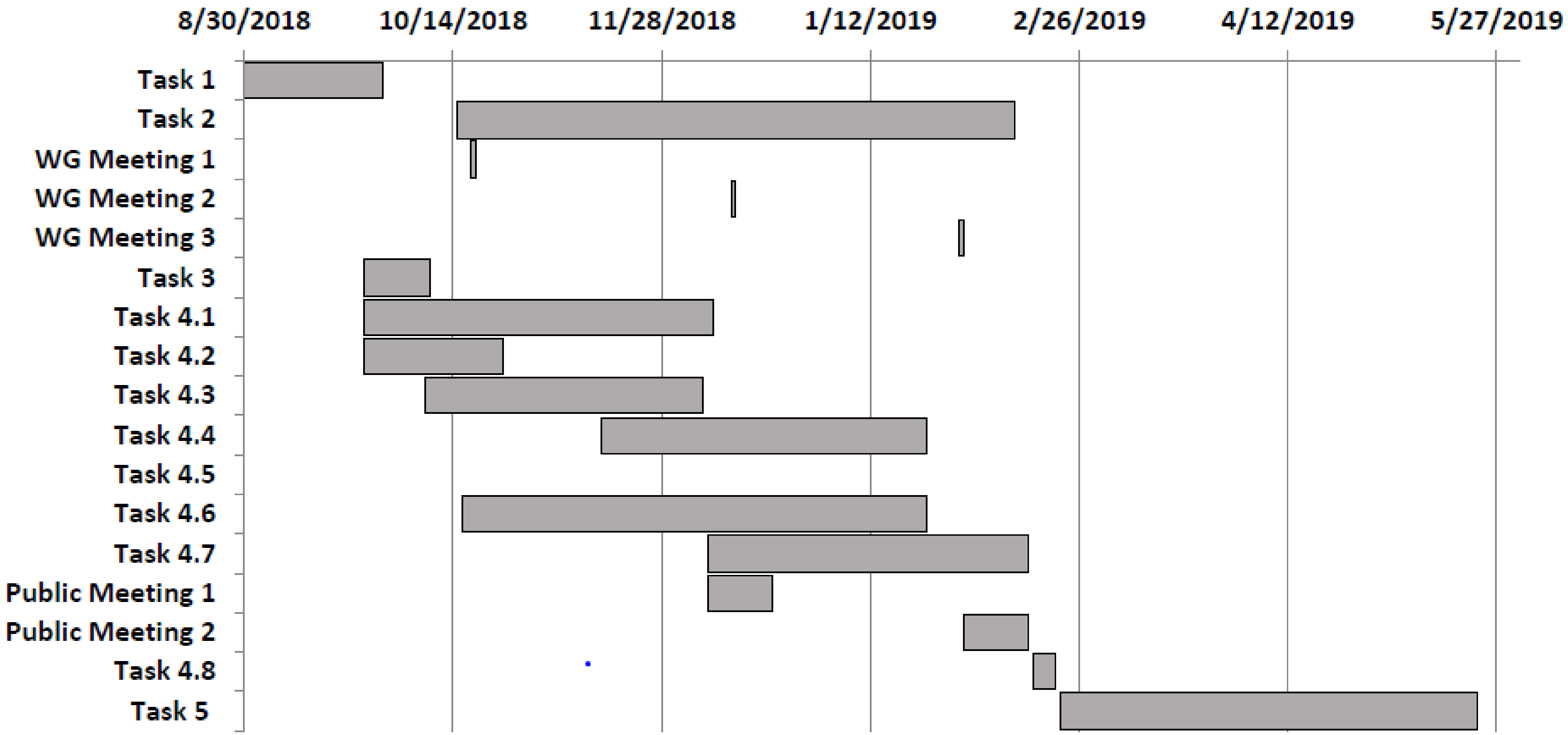
Project Overview

Planning Tasks:

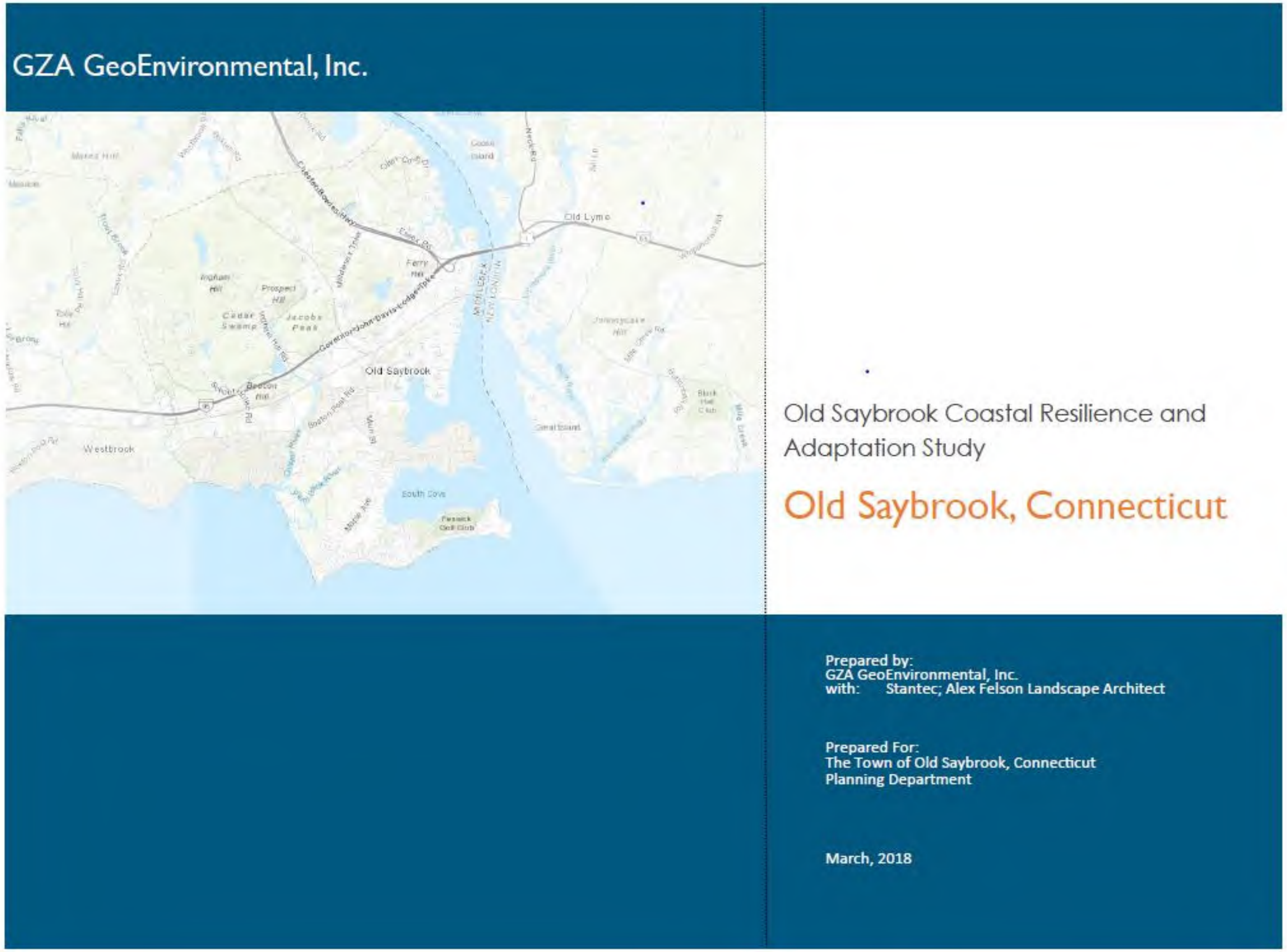
1. Project Initiation
2. Conduct Working Group Meetings
3. Planning Process Documentation
4. Multi-Hazard Mitigation Plan Update Development
5. State and Federal Plan Review Revisions and Local Adoption

Harvey's Beach

Plan Schedule



Coastal Resilience and Adaptation Study


GZA GeoEnvironmental, Inc.

Old Saybrook Coastal Resilience and Adaptation Study

Old Saybrook, Connecticut

Prepared by:
GZA GeoEnvironmental, Inc.
with: Stantec; Alex Felson Landscape Architect

Prepared For:
The Town of Old Saybrook, Connecticut
Planning Department

March, 2018

Planning Process

Planning Process

✓ Assess Risk:

- Community Demographics/Social Vulnerability
- Asset Inventory
- Natural Hazards Characterization
- Risk Assessment

✓ Mitigation Strategy and Actions

✓ Plan Adoption and Maintenance

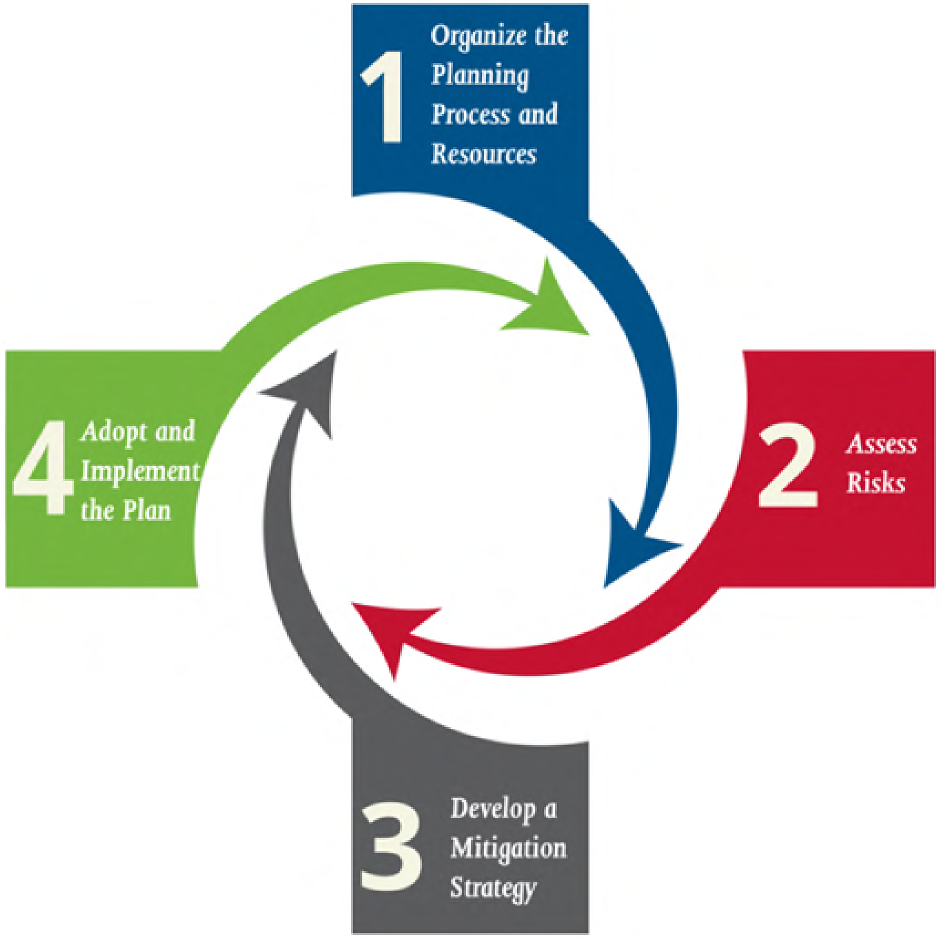
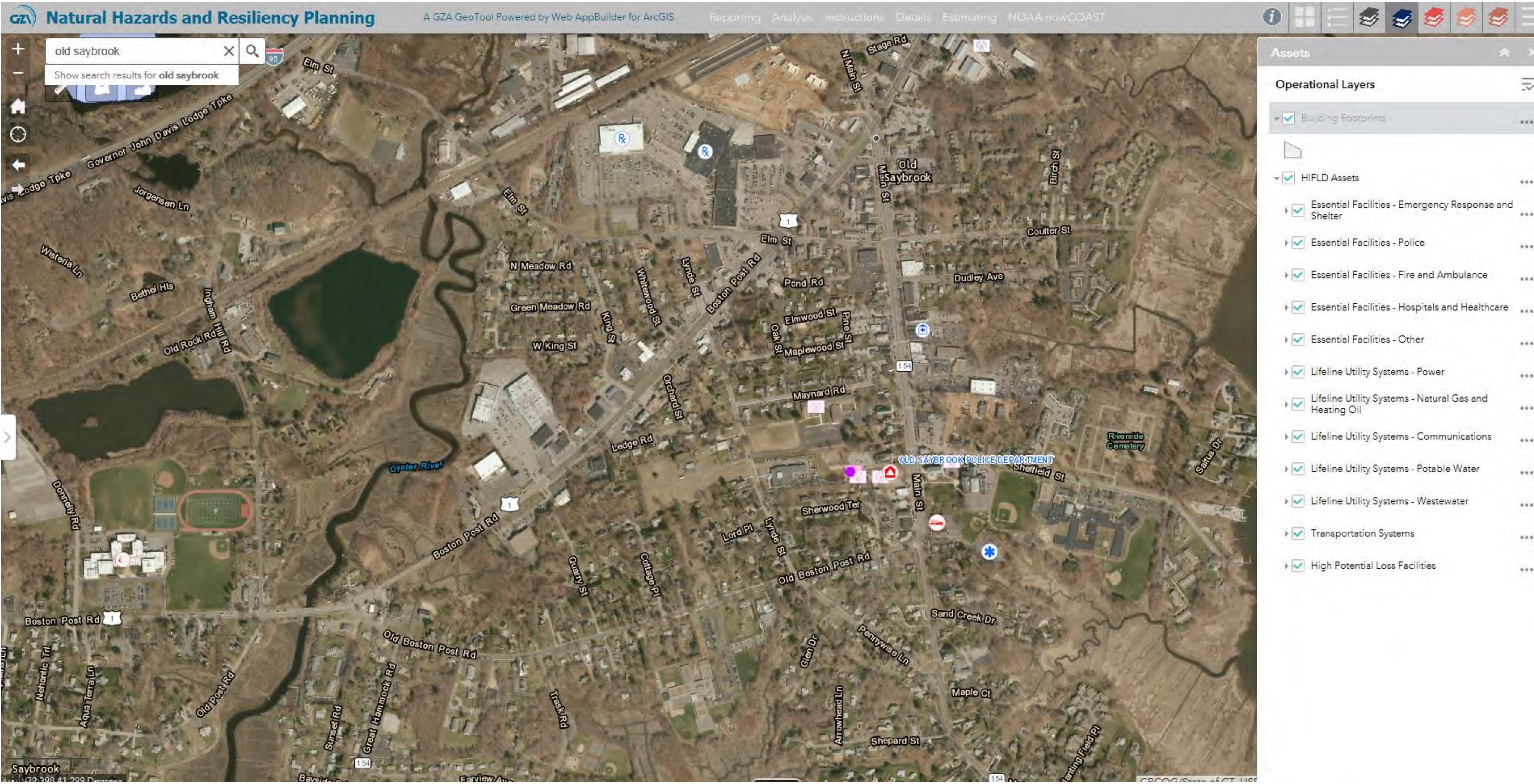


Figure credit FEMA/Jenny Burmester – Aug 21, 2017

Plan Components

Table of Contents

Project Approach:
GIS Data Management



Natural Hazards and Resiliency Planning
A GZA GeoTool Powered by Web AppBuilder for ArcGIS
Reporting
Analysis
Instructions
Details
Estimating
NOAA nowCOAST
old saybrook
Show search results for old saybrook
Assets
Operational Layers
Building Footprints
HIFLD Assets
Essential Facilities - Emergency Response and Shelter
Essential Facilities - Police
Essential Facilities - Fire and Ambulance
Essential Facilities - Hospitals and Healthcare
Essential Facilities - Other
Lifeline Utility Systems - Power
Lifeline Utility Systems - Natural Gas and Heating Oil
Lifeline Utility Systems - Communications
Lifeline Utility Systems - Potable Water
Lifeline Utility Systems - Wastewater
Transportation Systems
High Potential Loss Facilities
Old Saybrook
OLD SAYBROOK POLICE DEPARTMENT
Governor John Davis Lodge Tpke
Elm St
N Main St
Stage Rd
Jorgensen Ln
Wisteria Ln
Bethel Hts
Ingham Hill Rd
Old Rock Rd
N Meadow Rd
Green Meadow Rd
W King St
Whitewood St
Lynde St
King St
Boston Post Rd
Pond Rd
Elmwood St
Oak St
Pine St
Maplewood St
Maynard Rd
Coulter St
Dudley Ave
Birch St
Orchard St
Ledge Rd
Oyster River
Sheffield St
Riverside Cemetery
Saltus Dr
Main St
Sherwood Ter
Lord Pl
Old Boston Post Rd
Quarry St
Cottage Pl
Donnelly Rd
Sand Creek Dr
Pennywise Ln
Glen Dr
Maple Ct
Arrowhead Ln
Shepard St
Trask Rd
Great Hammock Rd
Sunset Rd
Old Post Rd
Aqua Terra Ln
Nehantic Trl
Saybrook

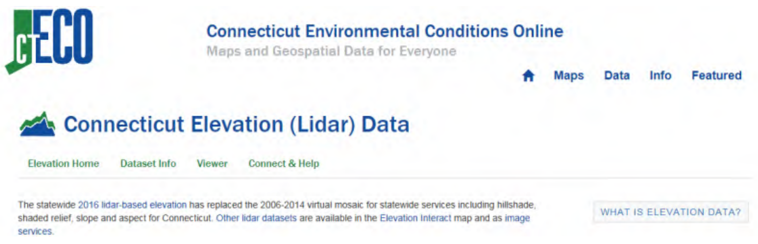
Town Setting

Old Saybrook – Town Setting

1. Uplands bordered by low-lying areas
2. 10 miles of coastline
3. Beaches – southern shoreline
4. Tidal Wetlands and Marshes
5. Connecticut River
6. Brooks and Creeks
7. 21.6 sm: 15.0 sm land, 6.6 sm water

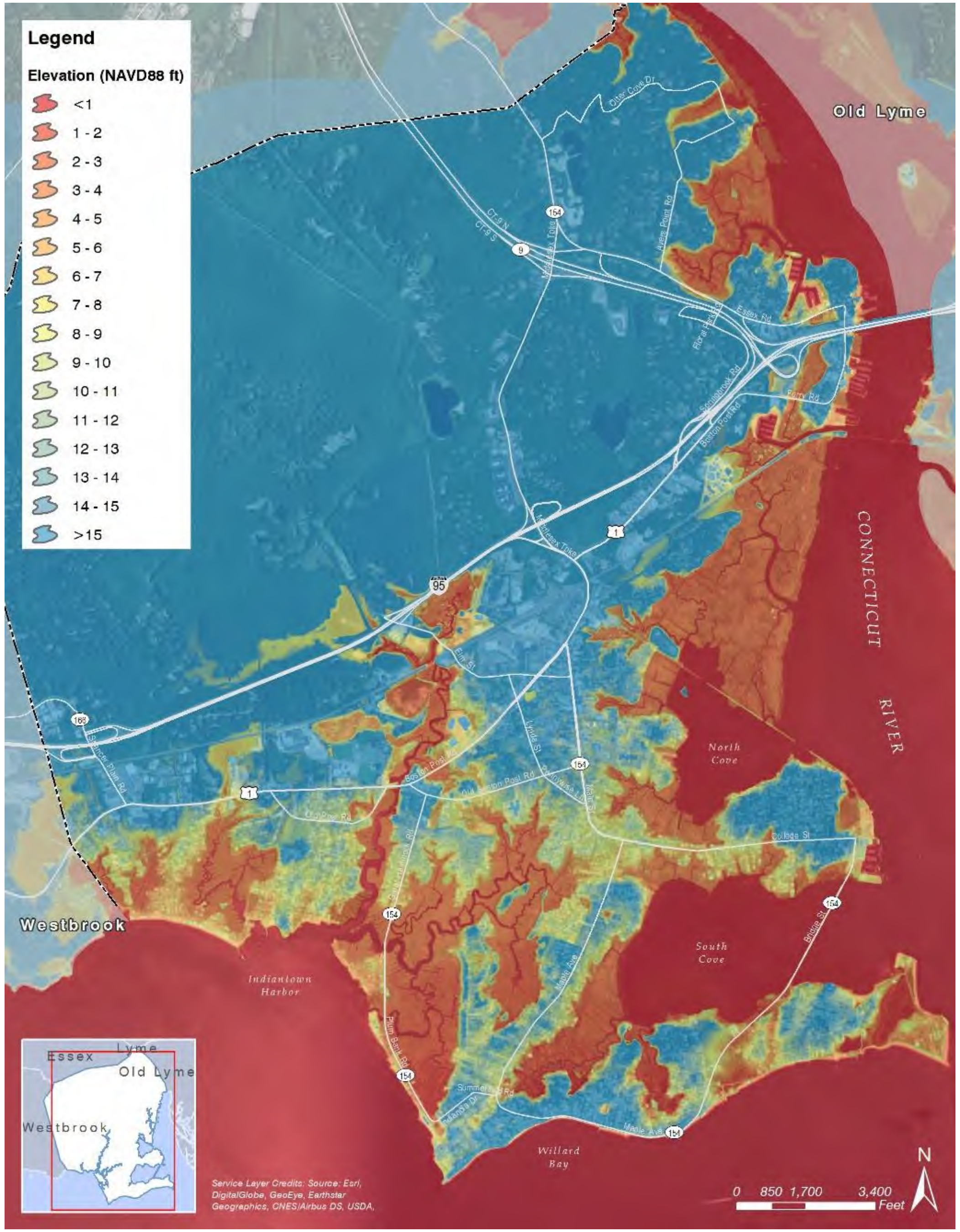
Topography and Available Lidar Data

GIS Layer DEM (2016 LiDAR)



Town Setting

- ✓ topography/bathymetry
- ✓ shoreline features
- ✓ land cover
- ✓ geology
- ✓ natural resources
- ✓ ecology
- ✓ socioeconomic data



Community Profile

People

- Population: +/- 10,160 people
- Land Area: about 15.3 square miles
- Population Density: about 681 people per square mile
- Median Age: about 50 years (compared to median age of 39 for the State)
- Households: 4,247
- Median household income: $84,546 (compared to State average of $73,433)

Social Vulnerability Flags:

✓ population age

Buildings and Property

Buildings:

- Residential: 5,730
- Commercial: 466

Median Housing Cost: $369,300

Motor Vehicles: 12,925

Schools: 3 (with +/- 1,344 enrollment)

Historic Properties: 355

Land Use

Land Use

Site - Old Saybrook GIS Planimetrics

LANDUSE LANDCOVER

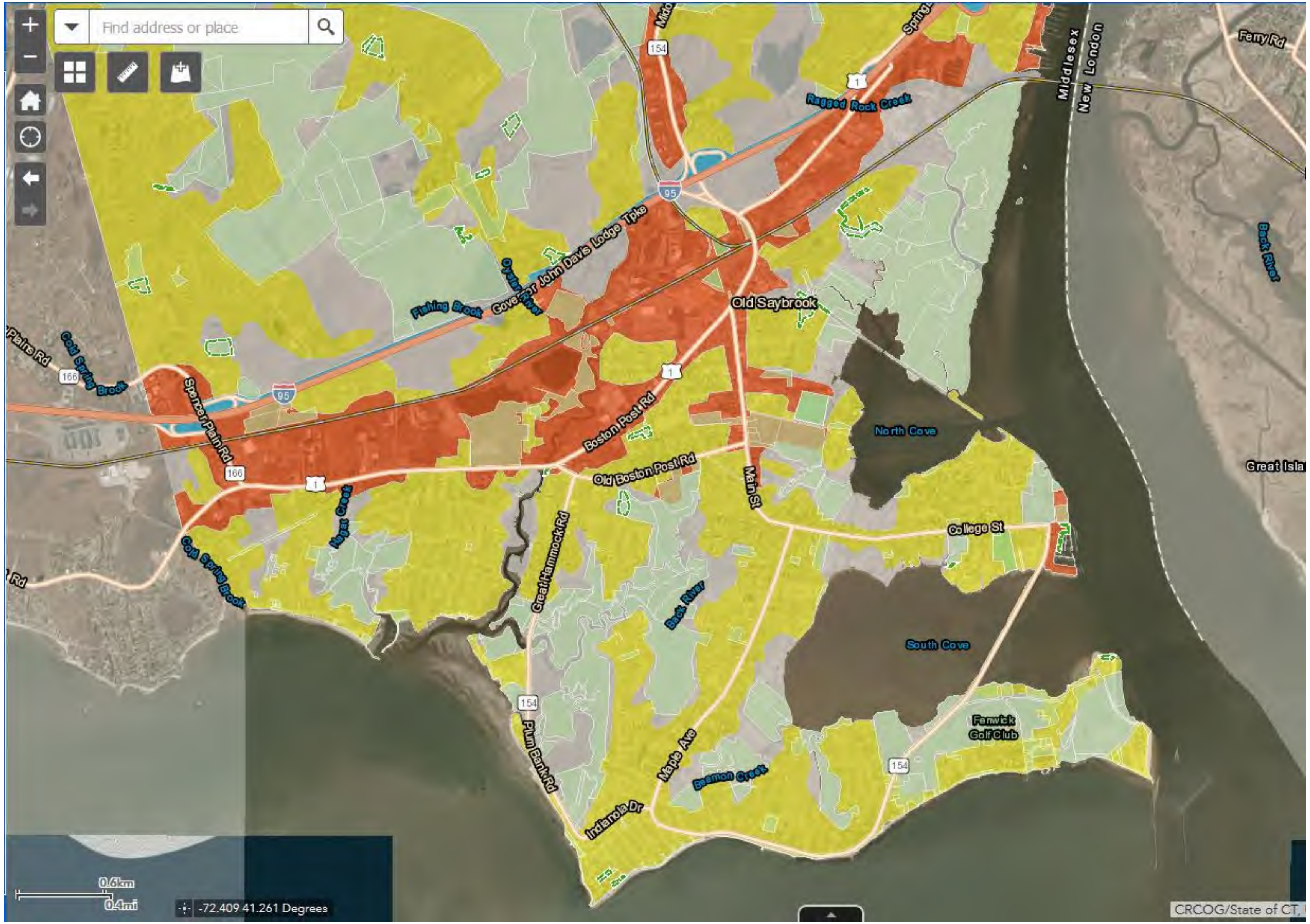
Conservation_Easements

Cemeteries

Community_Facilities_and_Open_Space_GL_2015

General Land Use

- Commercial
- Residential
- Transportation
- Vacant



Zoning Districts

ADMINSTRATIVE DISTRICTS

Zoning_Districts_GL_2015

- A
- C
- AAA
- AA-1
- AA-2
- AA-3
- B
- B-1
- B-2
- B-3
- B-4
- FEN
- I-1
- MC
- SP-1
- SP-2
- SP-3

Zoning_Ferry_Rd_IH_Zone

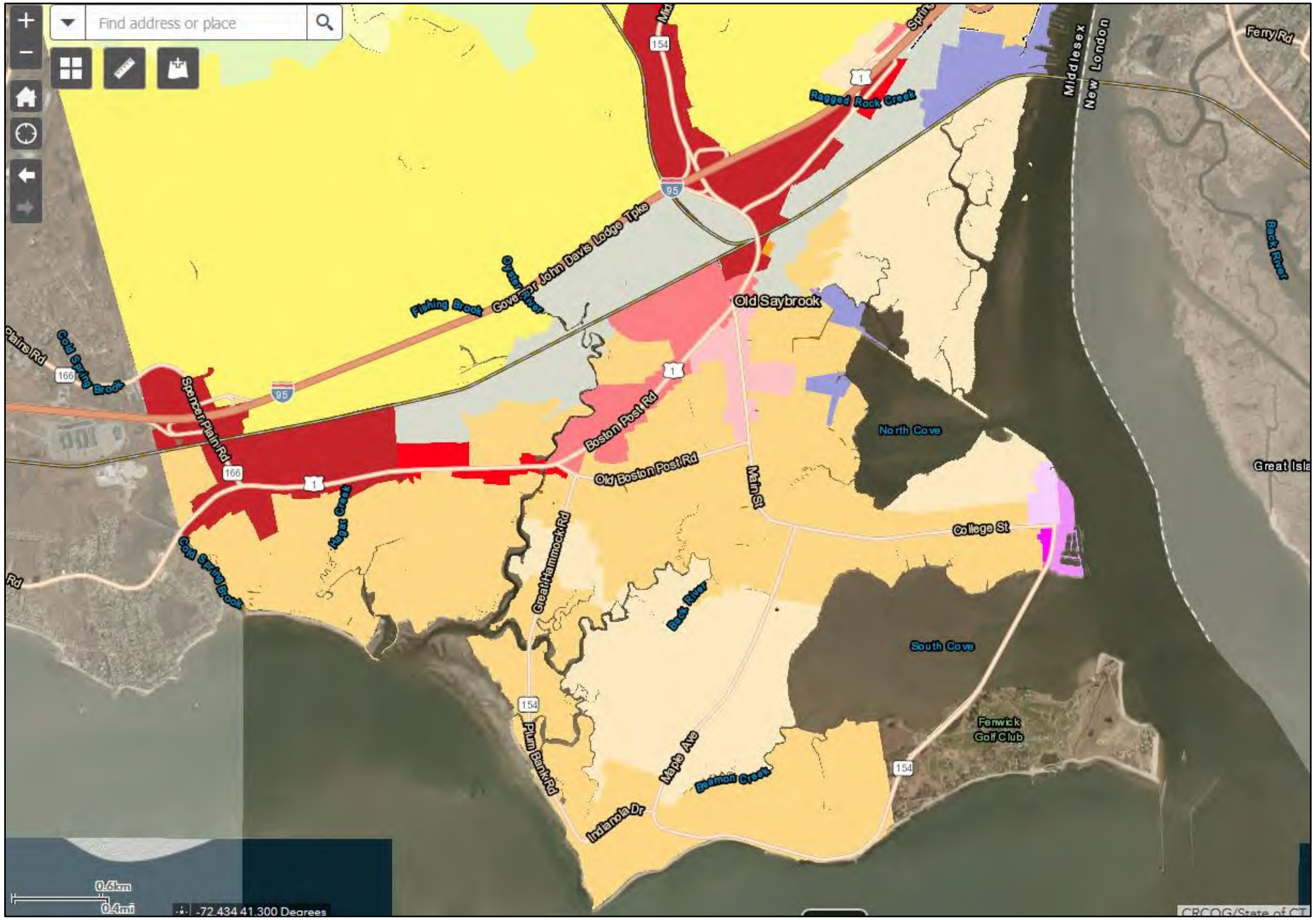
Zoning_IH_Zone

Zoning_MU_Subzone

Zoning_PRD

Zoning_ROWs

- A
- C
- AAA



Property Assessed Value

Total Appraised Parcel Value

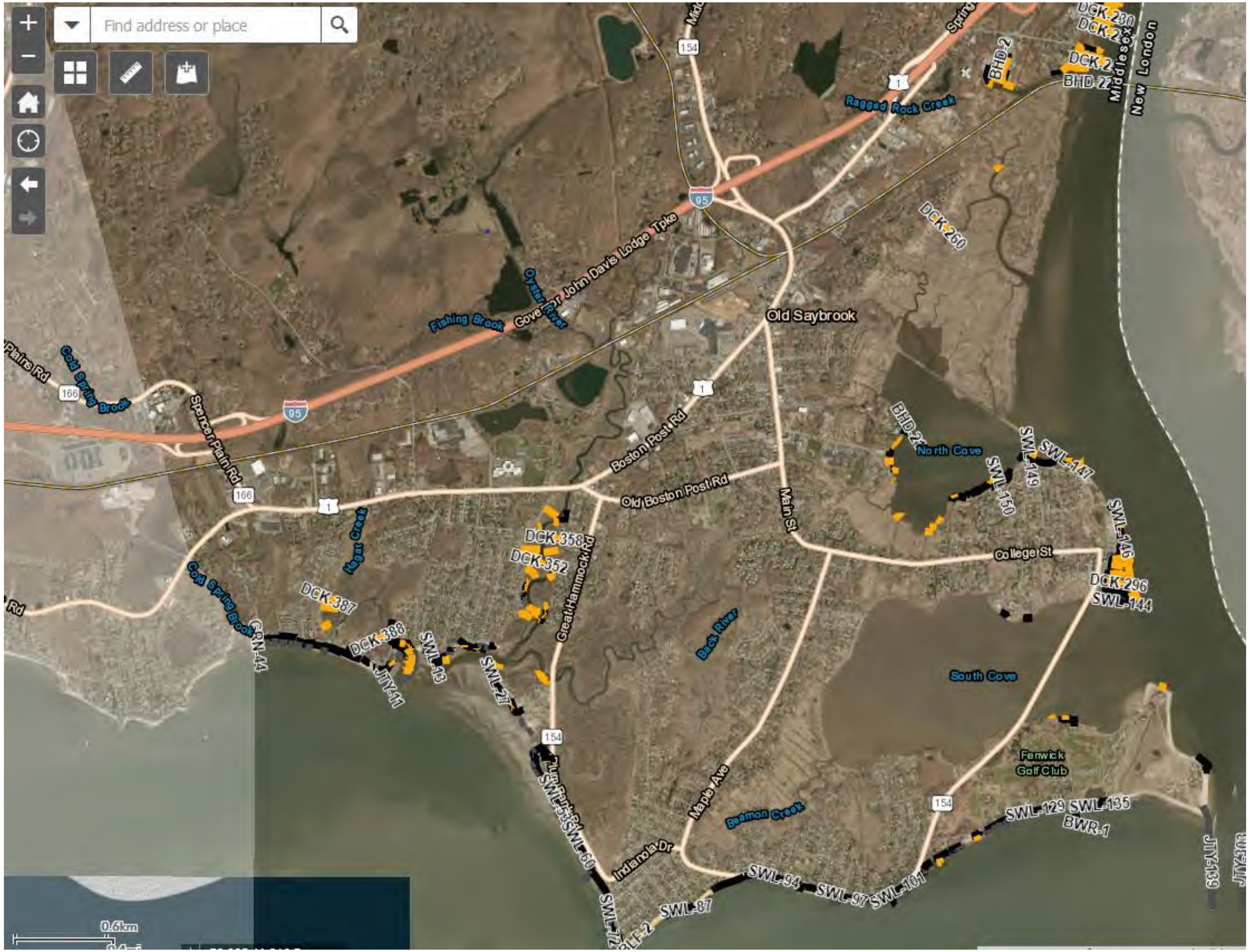
- 0 - $159,400
- $159,400 - $329,600
- $329,600 - $507,700
- $507,700 - $793,900
- $793,900 - $1,266,000
- $1,266,000 - $2,038,600
- $2,038,600 - $3,225,200
- $3,225,200 - $5,589,000
- $5,589,000 - $11,183,900
- $11,183,900 - $26,500,000

Shoreline Features and Natural Resources

Coastal Structures

Site - Shoreline Features

- Bluff
- Breakwater
- Bulkhead
- Dock
- Groin
- Jetty
- Pier
- Seawall



Coastal Wetlands & Critical Habitat

ENVIRONMENTAL

Field mapped wetland boundaries

Critical Habitats

Inland Wetlands

Inland Wetlands URA

Tidal Wetlands

Tidal_Wetlands_URA

Assets Inventory

2014 Plan Asset Categories

Economic and Cultural Resources:

- Real estate (94% of total assessment)
- Top 3 Uses include:
  - residential (86%),
  - commercial (10%), industrial (1%)
  - vacant land (2%)
- Personal property (2% of total)
- Motor vehicles (4% of total)

Environment and Ecological Resources:

- Beaches
- Tidal and inland wetlands
- Connecticut River and Long Island shoreline

2014 Plan Asset Categories

Critical Facilities

- Emergency services
- Telecommunications infrastructure
- Electric power infrastructure
- Natural gas infrastructure
- Gasoline and oil storage & distribution
- Transportation infrastructure
- Water supply infrastructure
- Government facilities
- Facilities that permanently/temporarily have large numbers of people
- Hazardous materials facilities
- Dams

2019 Plan Update Asset Categories

1. Essential Facilities
2. Lifeline Utility Systems
3. Hazardous Material Facilities
4. High Potential Loss Facilities
5. Transportation Systems
6. Support, High Occupancy and Vulnerable Populations
7. Natural Resources
8. Shoreline Structures

2019 Plan Update Community Assets

Site - Assets and Infrastructure

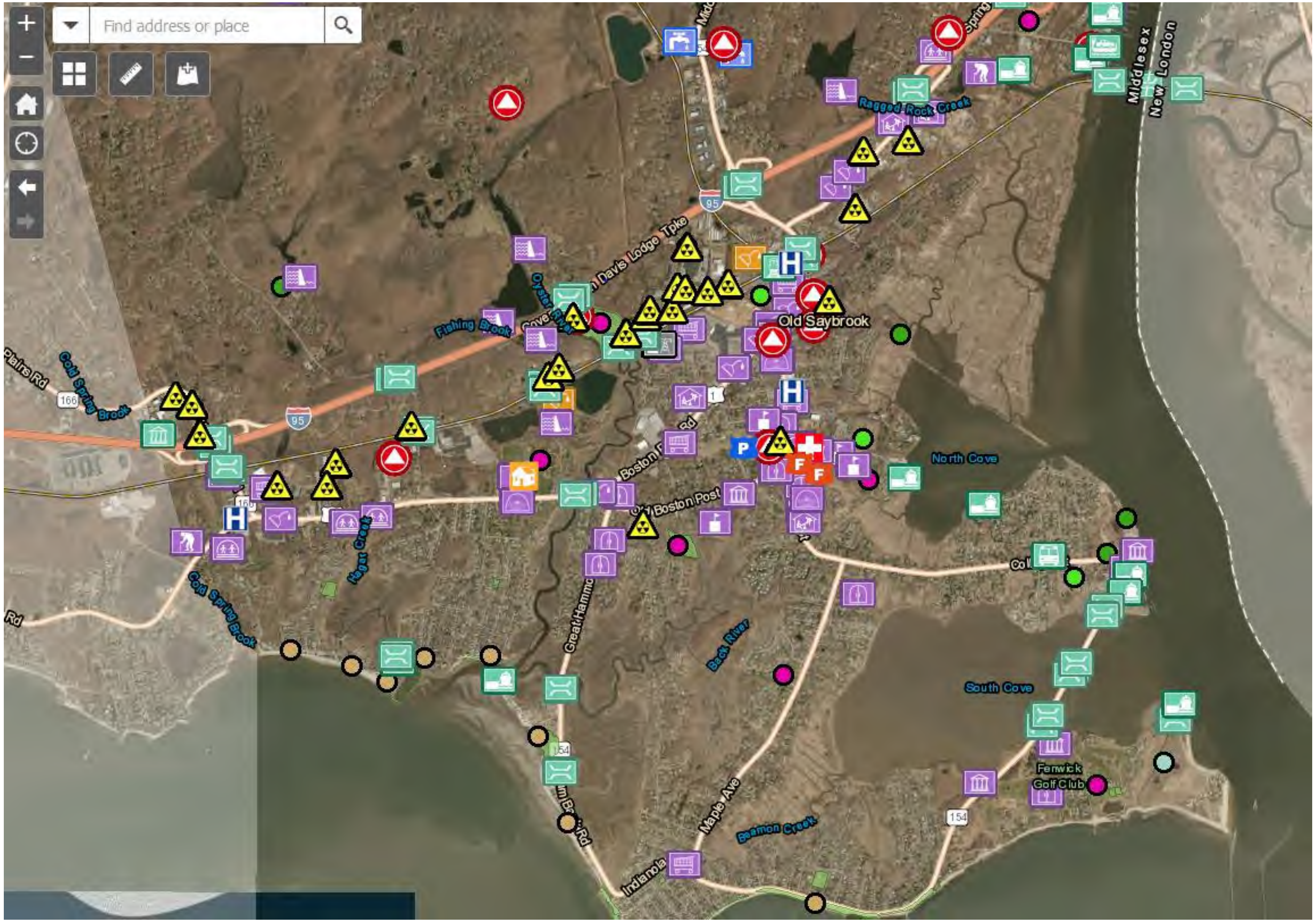
Essential Facilities
- Emergency Response Centers
- Designated Emergency Shelters
- Aviation
- Police Stations
- Fire Rescue and Ambulance
- Emergency Vehicle Garages
- Hospitals and Healthcare

Hazardous Material Facilities

High Potential Loss Facilities
- Dams and Levees

Transportation Systems
- Administration
- Bridges
- Bus Facilities
- Ferry
- Piers Docks and Marinas
- Rail Station

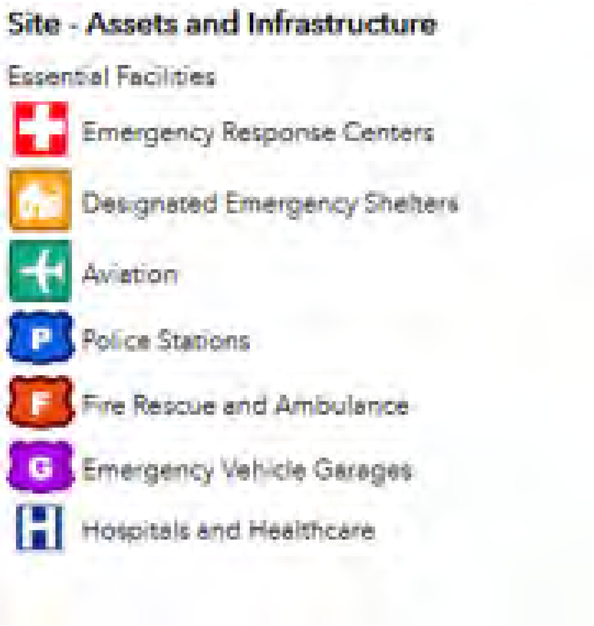
Lifeline Utility Systems
- Emergency Comm. Systems
- Elecric Power Transmission
- Heating Oil
- Natural Gas
- Potable Water Supply

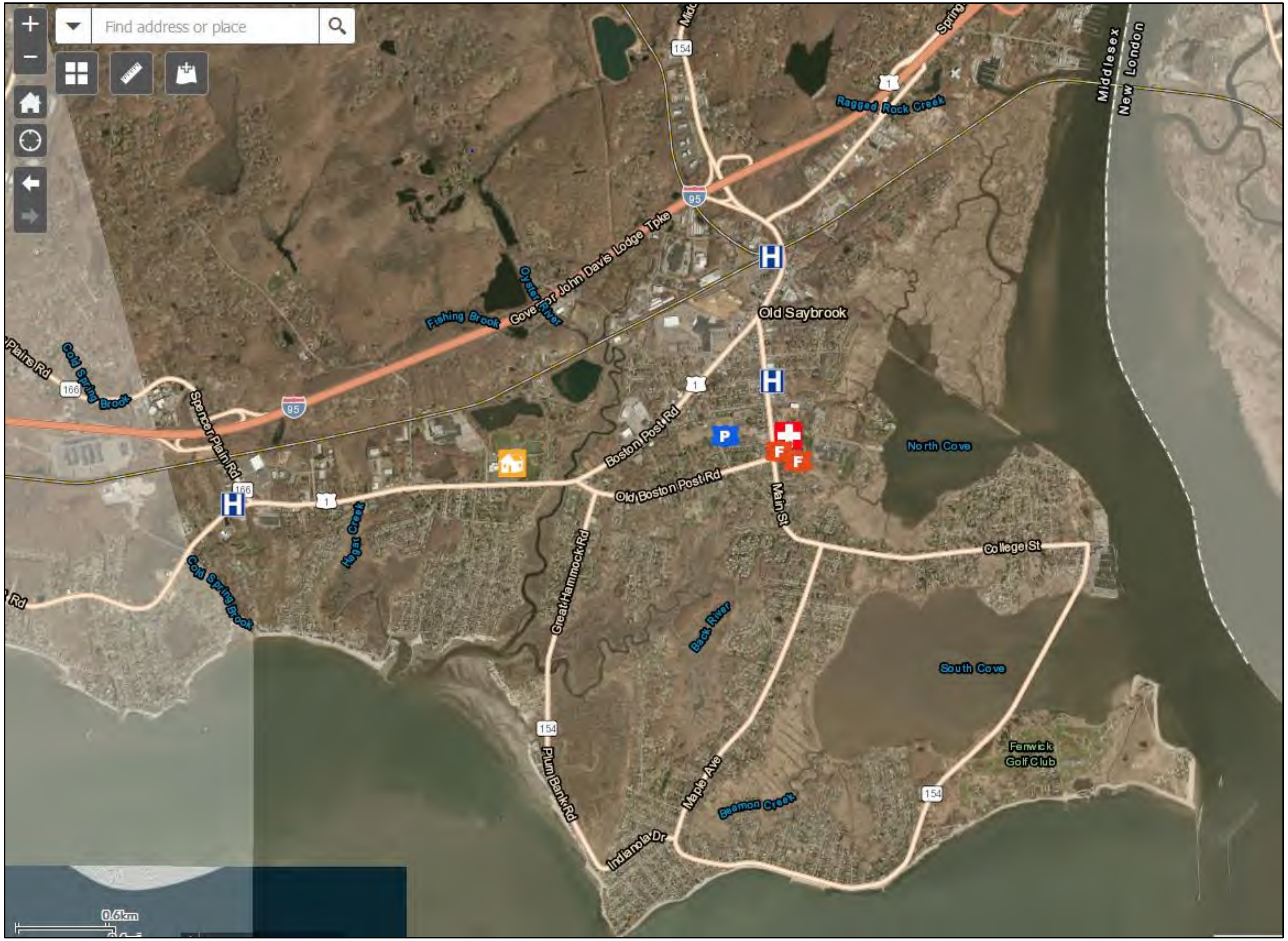


Essential Facilities

1. Hospitals/Healthcare
2. Emergency Shelters
3. Fire and Rescue
4. Emergency Response Centers
5. Police
6. Emergency Vehicle Garages
7. Aviation

Essential Facilities





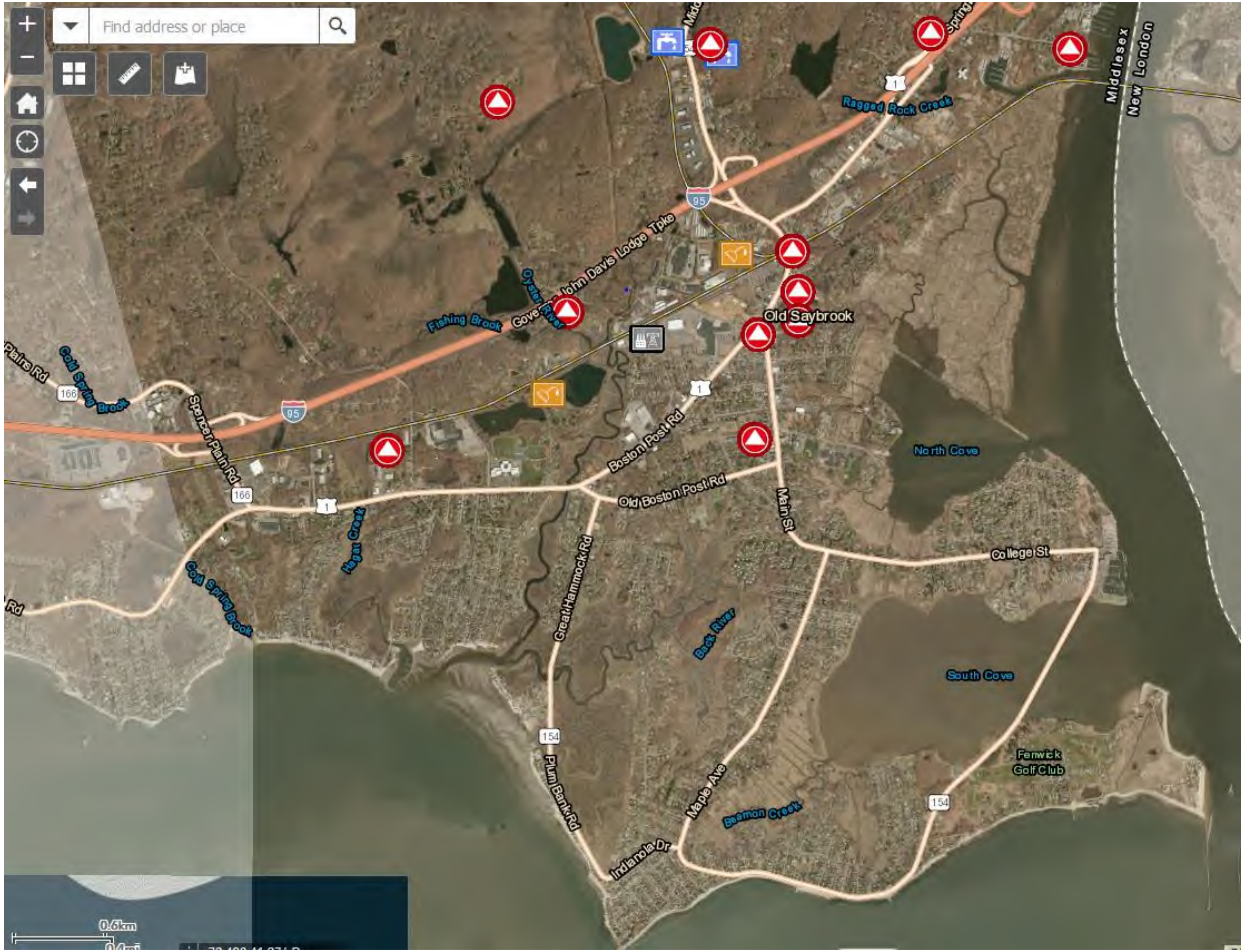
Essential Facilities:

- Hospitals: none
- Healthcare Facilities: 3
- Police Station: 1
- Fire Station: 1
- Emergency Shelter: 1

Lifeline Systems

- Electric Power Generation
- Electric Power Transmission
- Natural Gas
- Heating Oil
- Potable Water Supply
- Wastewater Distribution
  - On-site septic
  - 15 Wastewater Districts
- Telecommunications

Lifeline Systems



Water:

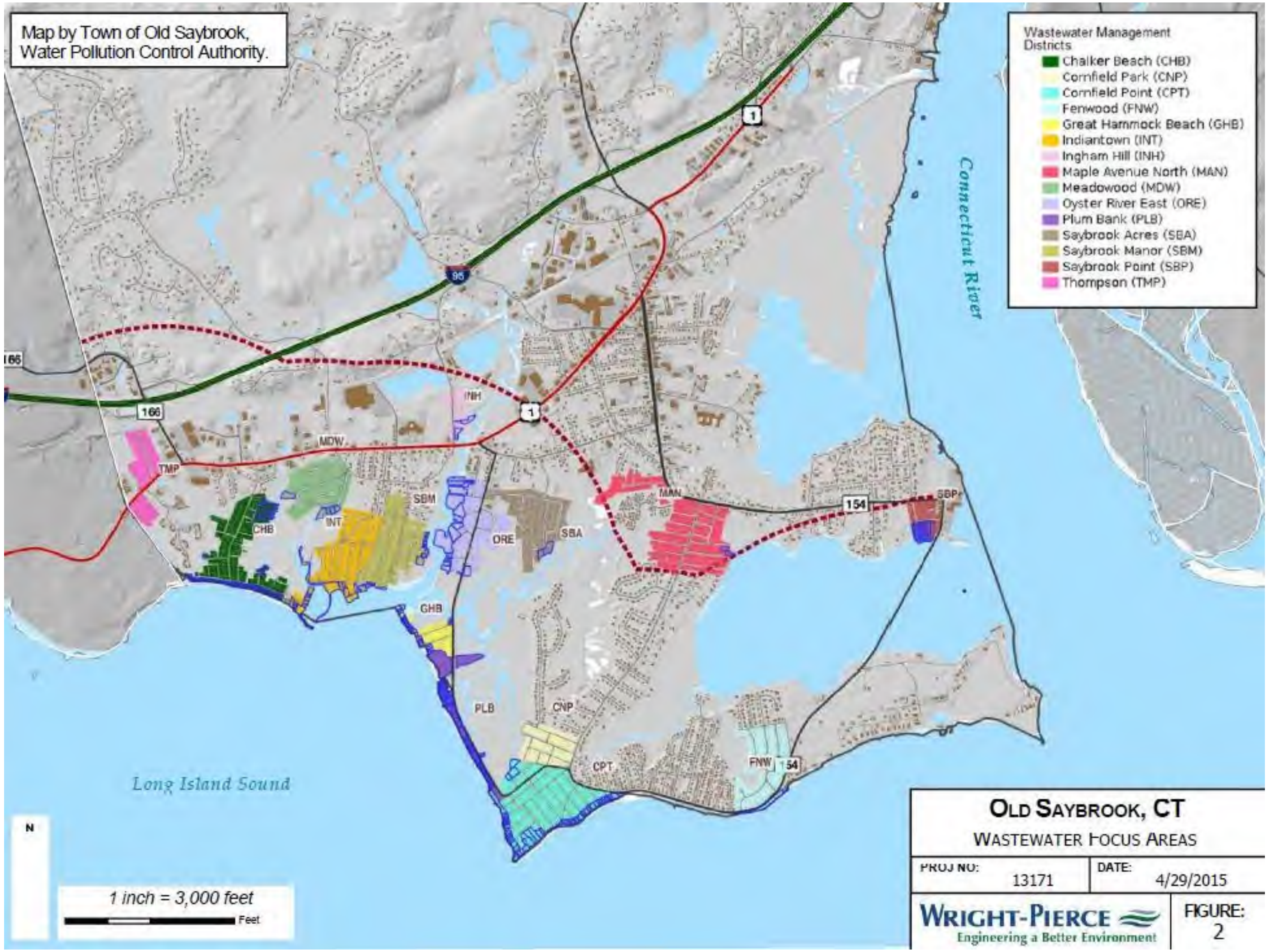
- Connecticut Water Company
- Guilford Water System (wells and reservoirs)
- Water Supply Source: Holbrook Wellfield

Electrical:

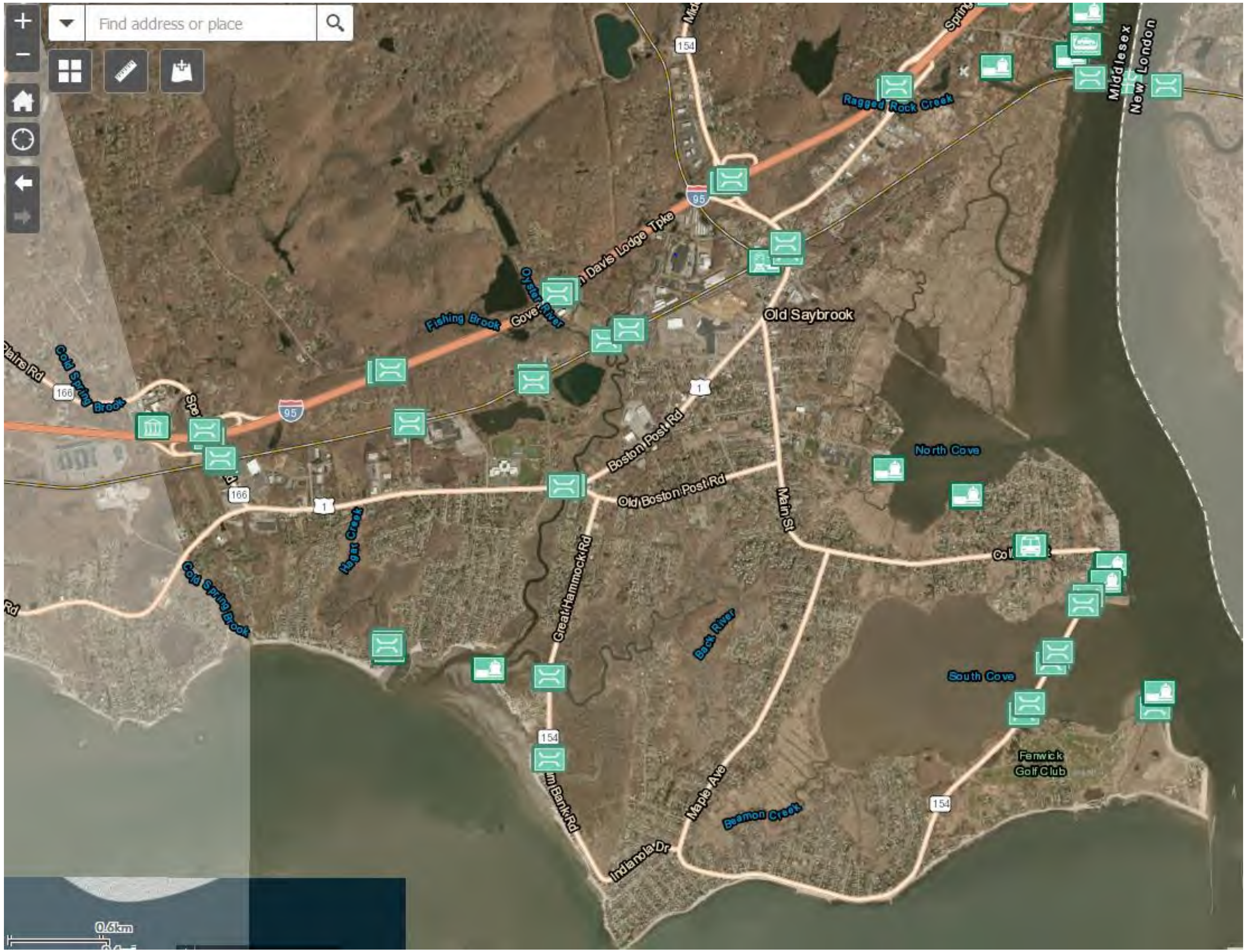
- Eversource
- Overhead transmission
- Two Substations: Bokum Road and Elm Street

Decentralized Wastewater Management

- 15 Wastewater Districts
- 1900 parcels
- 10 of 15 districts upgrades
- 5 remaining are most vulnerable



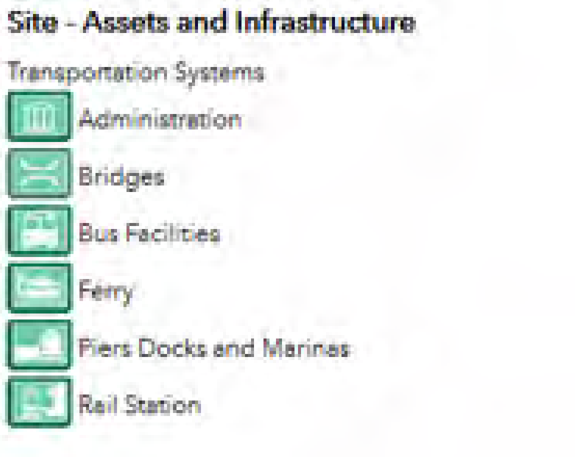
Transportation Systems



Six (6) I-95 (Connecticut Turnpike) bridges:

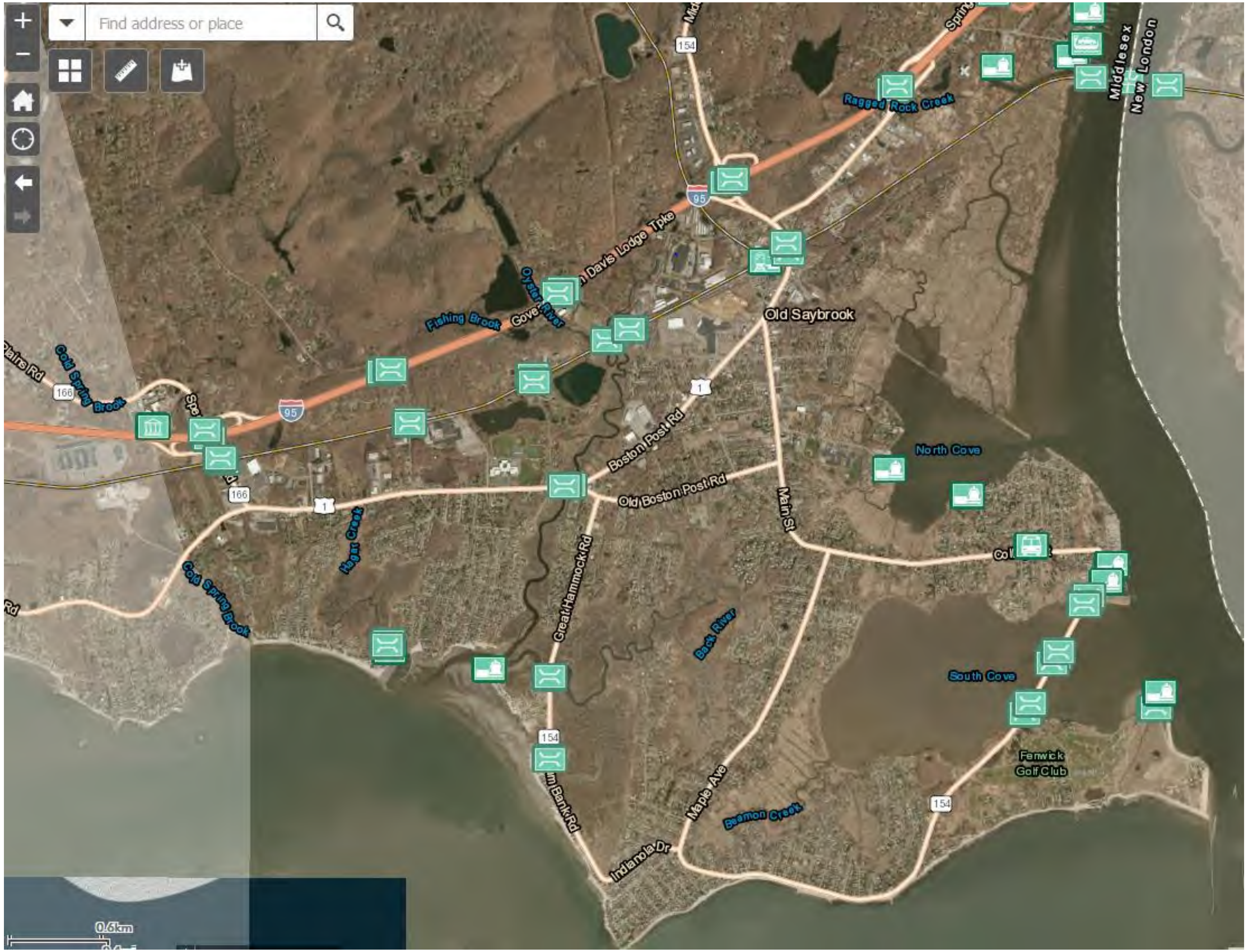
- I-95 Bridge over School House Road
- I-95 Bridge over Elm Street
- I-95 Bridge over Middlesex Turnpike
- I-95 Bridge over Springbrook Road
- I-95 Bridge over Essex Road
- I-95 Bridge over Route

Transportation Systems

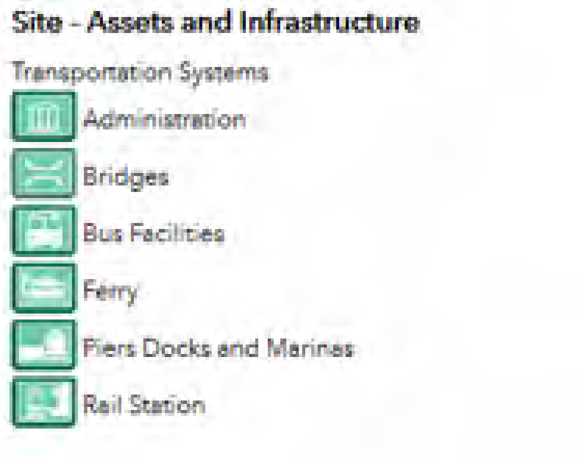


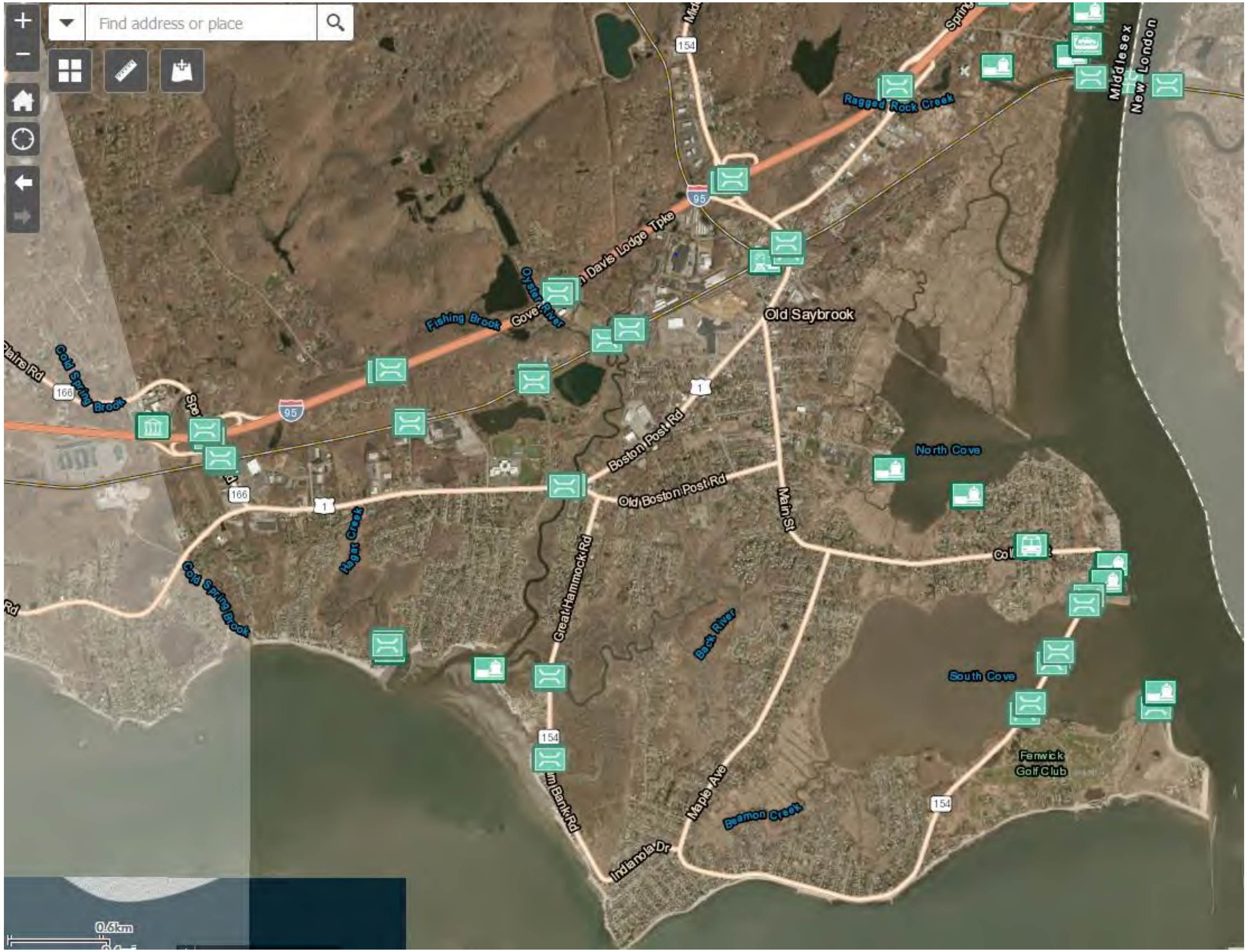
Five (5) State bridges:

- Raymond E. Baldwin Bridge over the Connecticut River
- Route 1 Bridge over the Oyster River
- Causeway Middle Bridge over South Cove (Route 154)
- Causeway North Bridge over South Cove (Route 154)
- Causeway South Bridge over South Cove (Route 154)Key Local Roadways



Transportation Systems





Eight (8) Town bridges:

- Great Hammock Road Bridge over Back River
- Ingham Hill Road Bridge over Amtrak
- Nehantic Trail Bridge over Hager Creek
- Plum Bank Road Bridge over Plum Bank Creek
- School House Road Bridge over Amtrak
- Sequassen Avenue Bridge over Crab Creek (in Borough of Fenwick)
- Spencer Plain Rd Bridge over I-95
- Spencer Plain Road Bridge over Amtrak

Transportation – Key Federal and State Roadways

1 Key Federal Roadway

- Interstate 95 (Connecticut Turnpike)

4 Key State Roadways – 18 Total

- 3 State Interstate I-95 Route 9 (Chester Bowles Highway)
- Route 1 (Boston Post Road)
- Route 154 (Main Street and College St.; Bridge Street and Maple Ave.; Indianola Dr.; Plum Bank Rd. and Great Hammock Rd.; South Cove Causeway)
- Route 166 (Spencer Plain Road)

Transportation – Key Local Roadways

Key Local Roadways:

- Essex Road
- Ferry Road
- Springbrook Road
- Elm Street
- Lynde Street
- Pennywise Lane
- Sheffield Street
- Old Boston Post Road
- Chalker Beach Road
- Niabang Avenue
- Sequassan Avenue
- Sea Lane
- Baum Avenue

Support, High Occupancy and Vulnerable Population

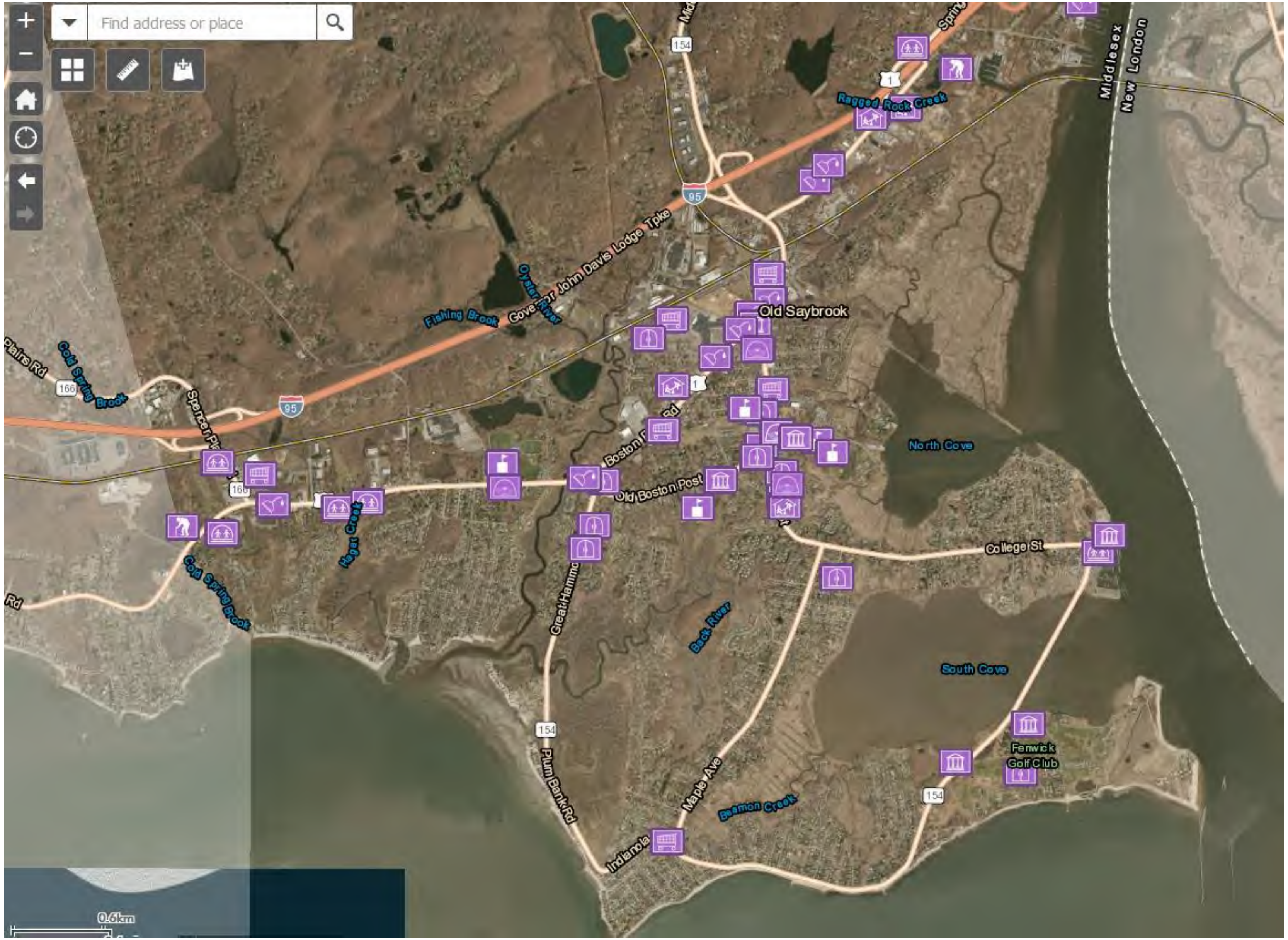
- Community Centers
- Fueling Stations
- Hotels and Inns
- Museums and Galleries
- Pre-school and Childcare Facilities
- Religious Institutions
- Schools
- Theaters
- Town Administration Buildings

Support, High Occupancy and Vulnerable Population

Site - Assets and Infrastructure

Support and High Occupancy and Vuln. Pop. Facilities

- Community Centers and other Rec. Facilities
- Fueling (Gas) Stations
- Grocery and Supply Stores
- Hotels and Inns
- Military
- Museums and Galleries
- Preschool and child care facilities
- Rehabilitation Nursing Home
- Religious Institutions
- Schools
- Theaters
- Town Administration Buildings



Natural/Ecological Resources

Site - Assets and Infrastructure

Natural Resource and Recreation Areas

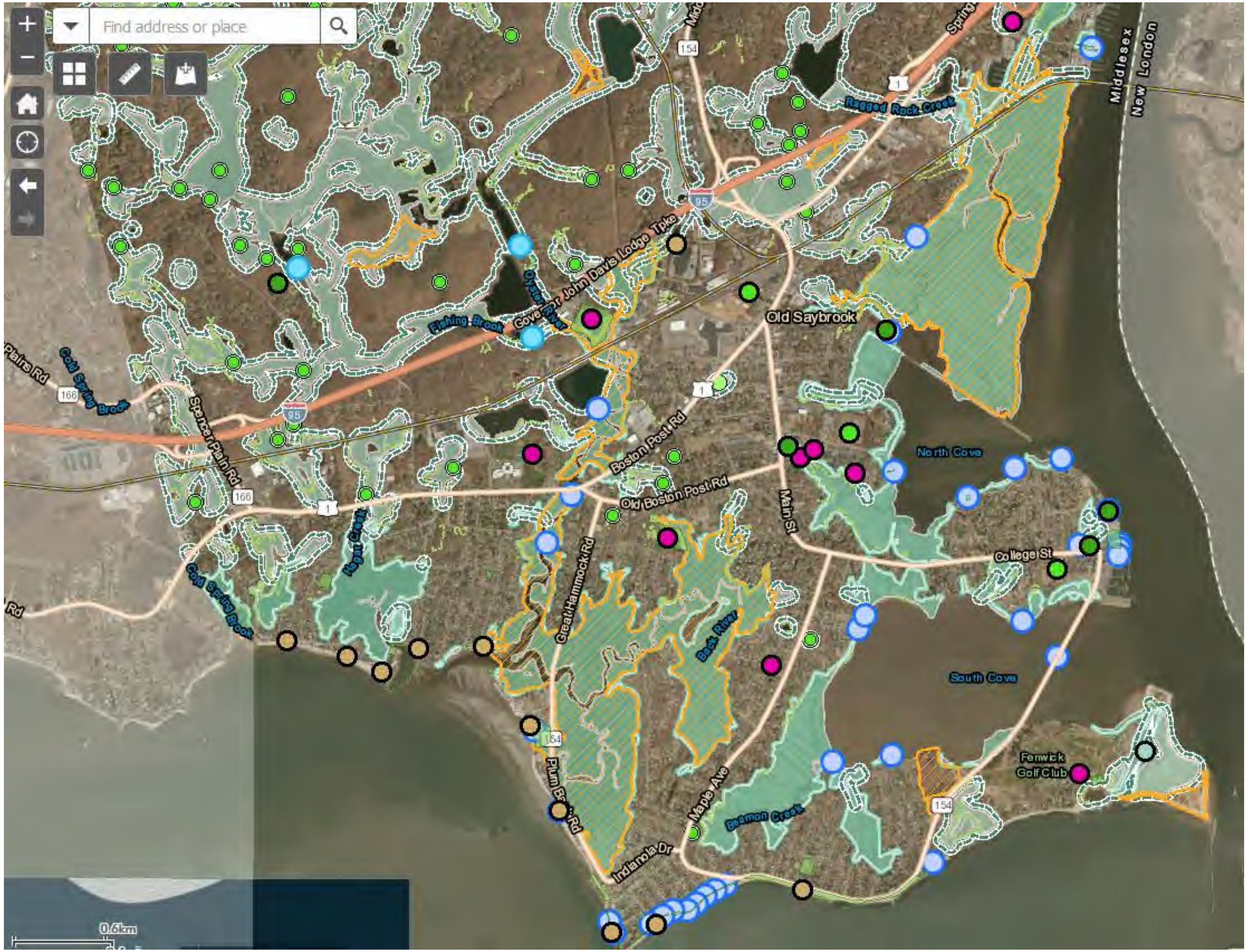
- Athletic Fields
- Beaches
- Cemeteries
- Marsh
- Parks

Community Facilities Open Space

Site - Old Saybrook GIS Planimetrics

ENVIRONMENTAL

- Coastal Access
- Fish Ladders
- Vernal Pools
- Vernal Pools 2015
- Vernal_Pools_URA
- Field mapped wetland boundaries
- Critical Habitats
- Inland Wetlands
- Inland Wetlands URA
- Tidal Wetlands



High Loss Potential Facilities: Dams

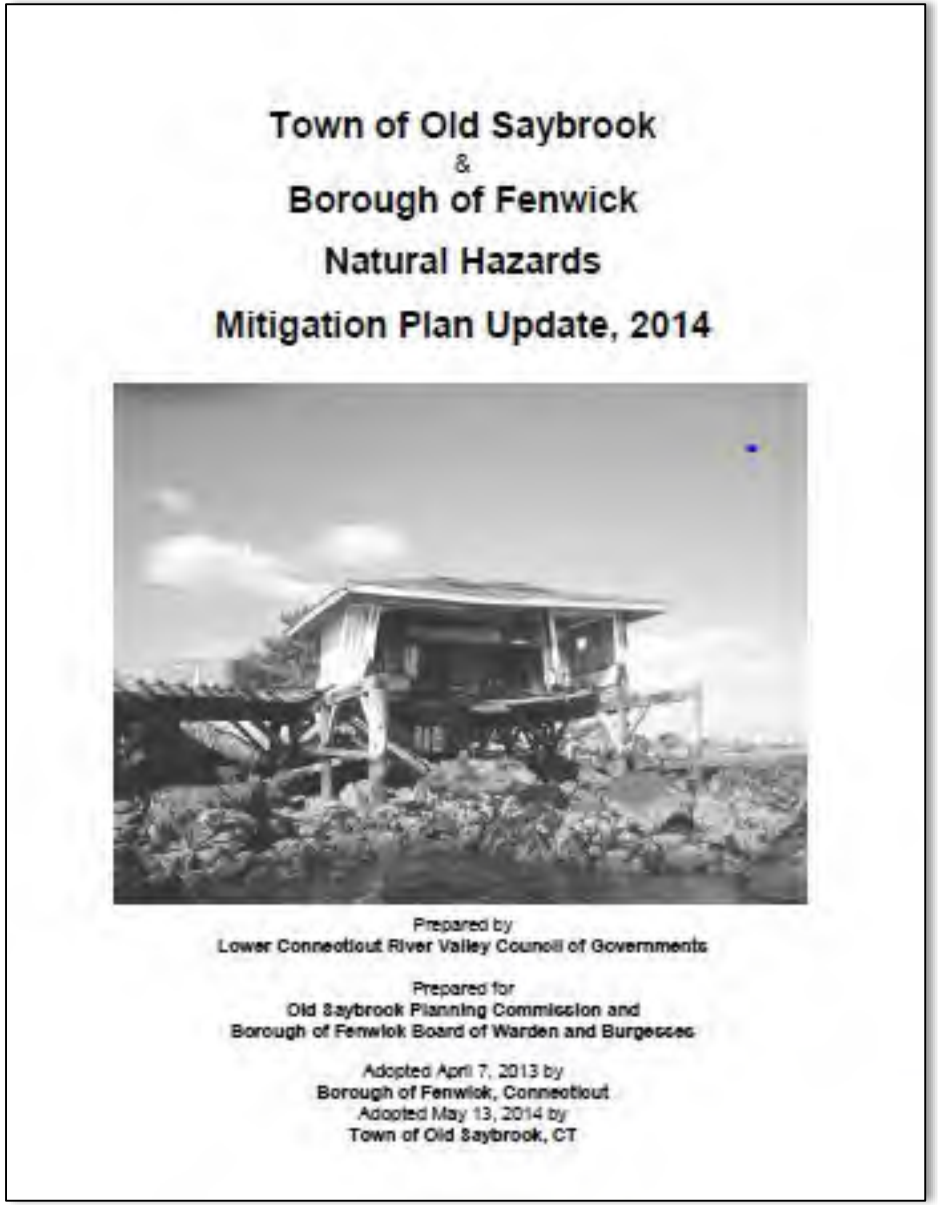
High Loss Potential Facilities:

- Dams: 11

Natural Hazards

2014 Plan Natural Hazard Categories

- ✓ Flooding
- ✓ High Wind & Tornado
- ✓ Drought & Wildfire
- ✓ Winter Storms
- ✓ Earthquake
- ✓ Hurricane & Tropical Storm
- ✓ Sea Level Rise
- ✓ Tsunami
- ✓ Heat Wave

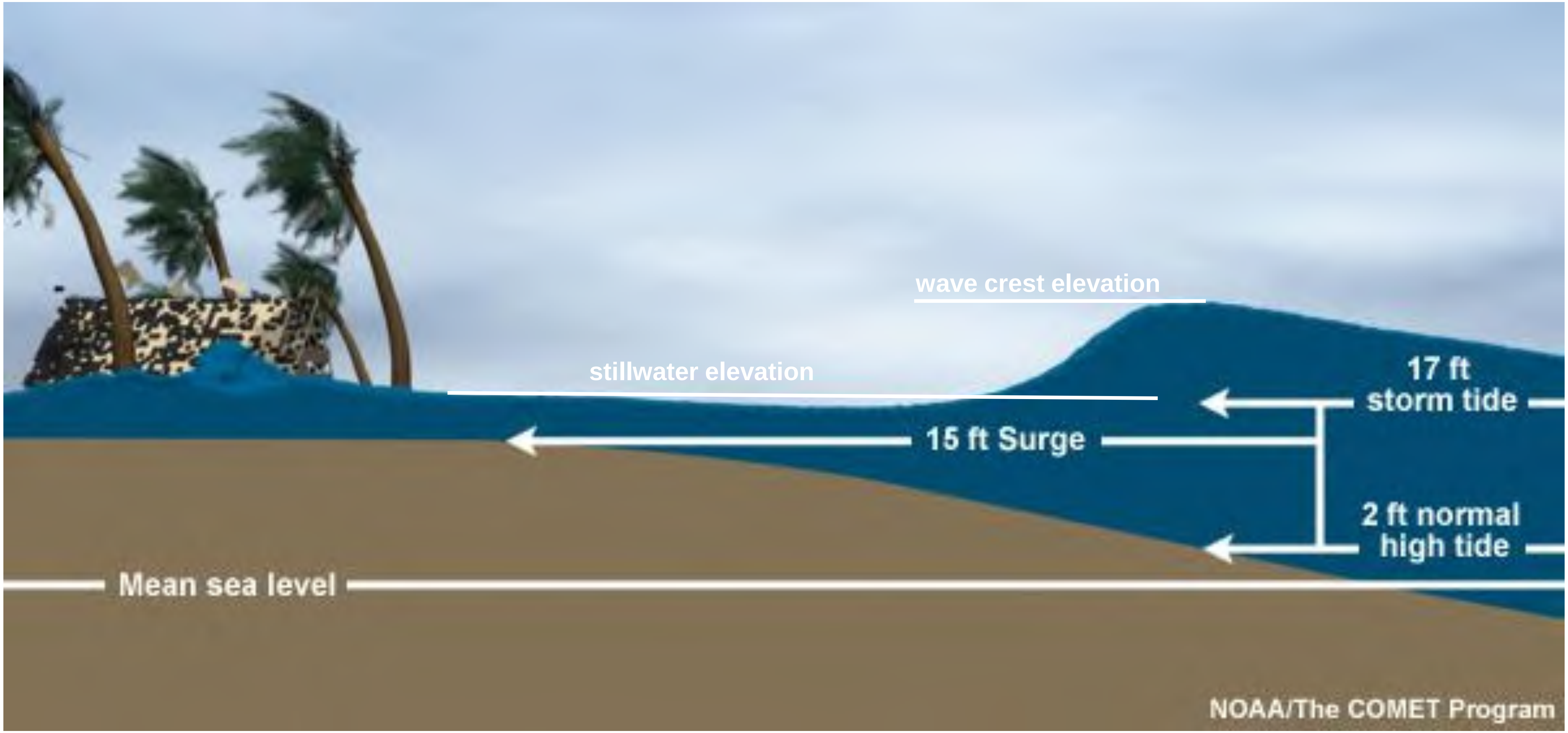


2019 Plan Update Natural Hazard Categories

- 19 natural hazards identified as applicable to Town
- Four hazard categories:
  - ✓ Severe Weather Hazards
  - ✓ Climate-Related Hazards
  - ✓ Geologic Hazards
  - ✓ Secondary Hazards

Severe Weather Hazards:	
Severe Wind:	
	Hurricanes/Tropical Storms
	Thunderstorms
	Tornadoes
Lightning	
Intense Rainfall	
Hail	
Flood:	
	Storm Surge
	Sea Level Rise
	Urban Drainage Flooding
Severe Winter Weather	
	Snowfall
	Ice Storms
Climate-Related Hazards:	
Extreme Temperature:	
	Heat
	Cold
Drought	
Wildfire	
Geologic Hazards:	
Earthquake	
Landslides	
Tsunami	
Secondary Hazard:	
Dam Failure	

Coastal Flooding

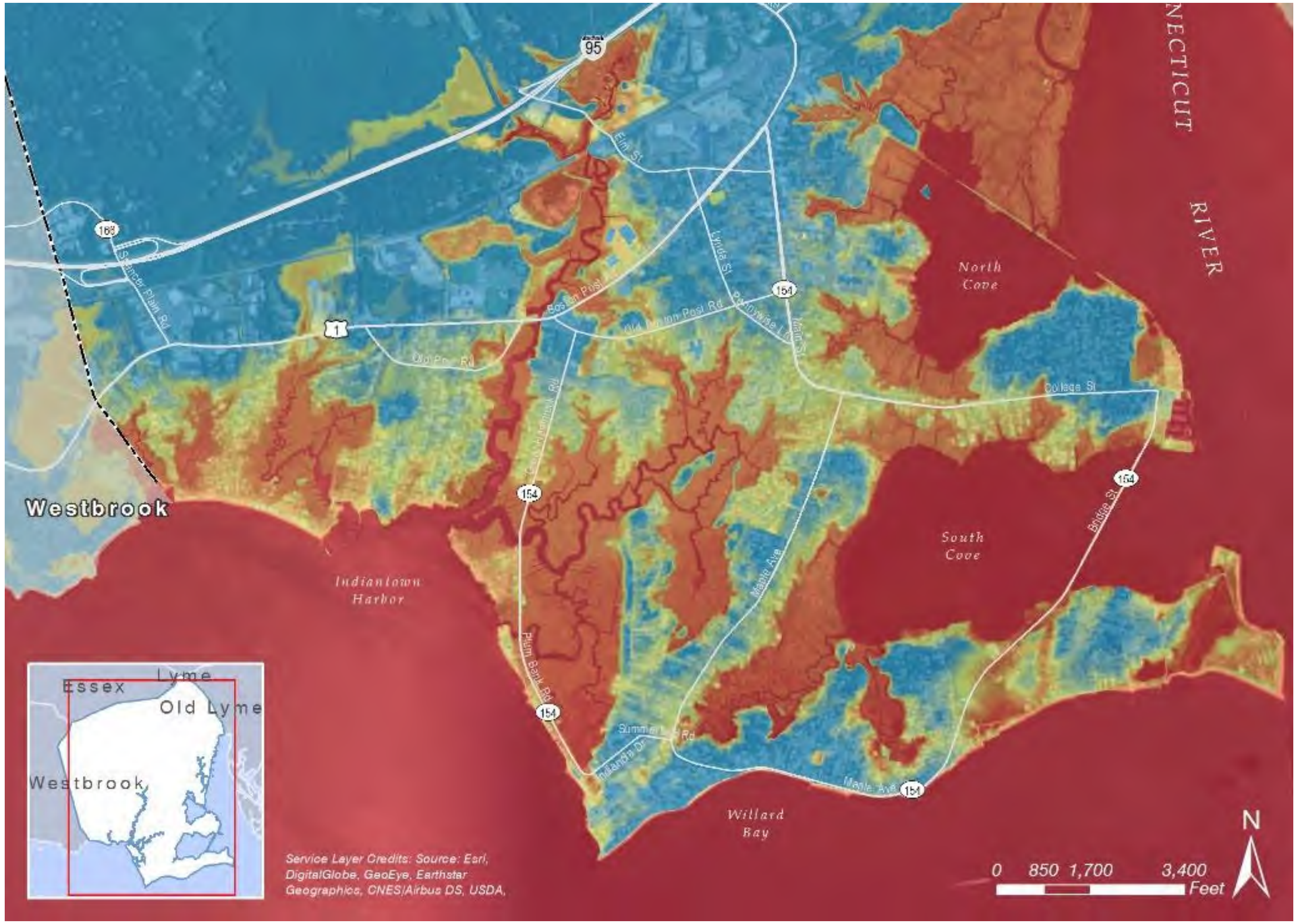


GEOGRAPHICAL FACTORS

STORM FACTORS

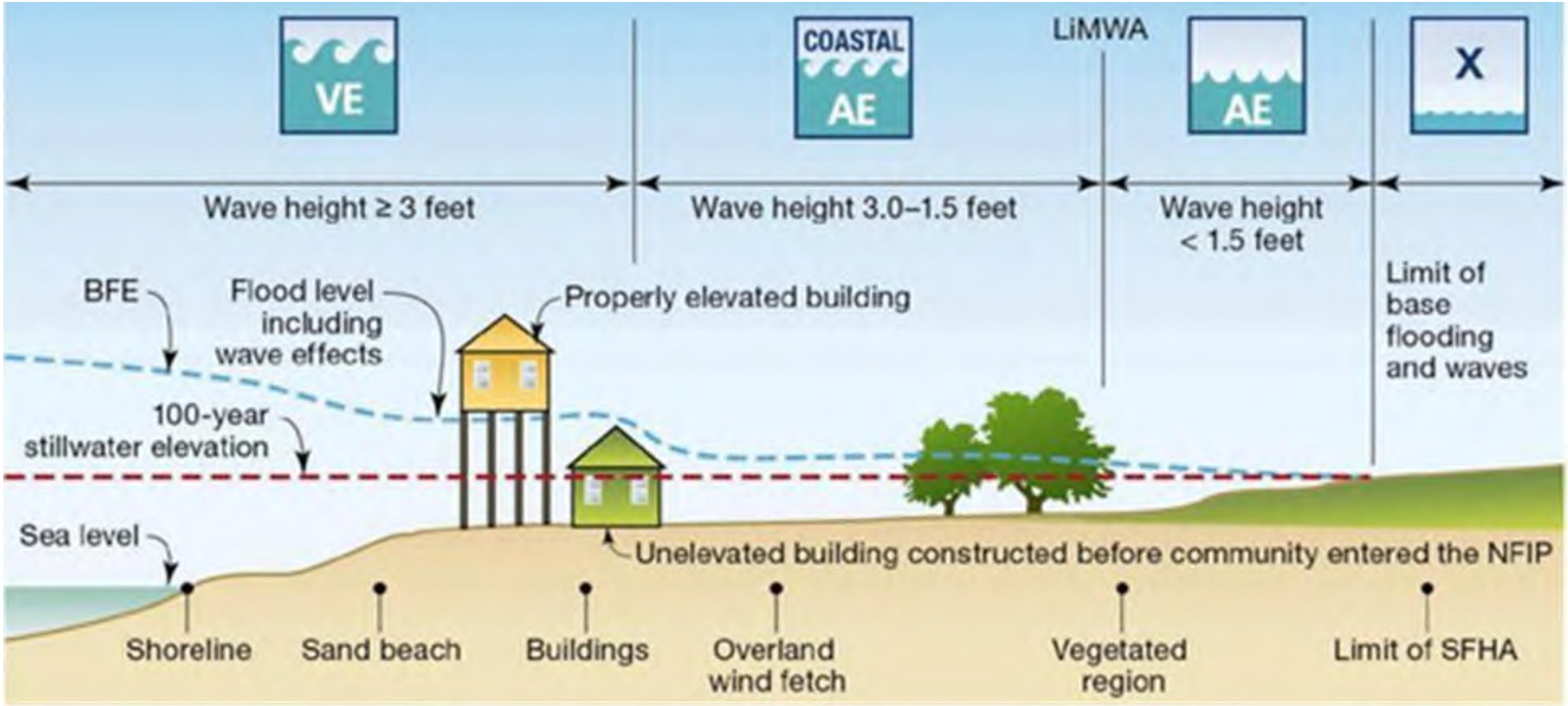
Coastal Flooding Vulnerability

- High vulnerability to coastal flooding due to coastal setting and topography
- Experienced extensive flood impacts during the Hurricane of 1938
- More recently during Sandy and Irene



FEMA Flood Insurance Rate Map: Base Flood

FEMA Flood Hazard Zones



GZA High Resolution Modeling – 2016 100-yr

Examples of Coastal Flooding Vulnerability

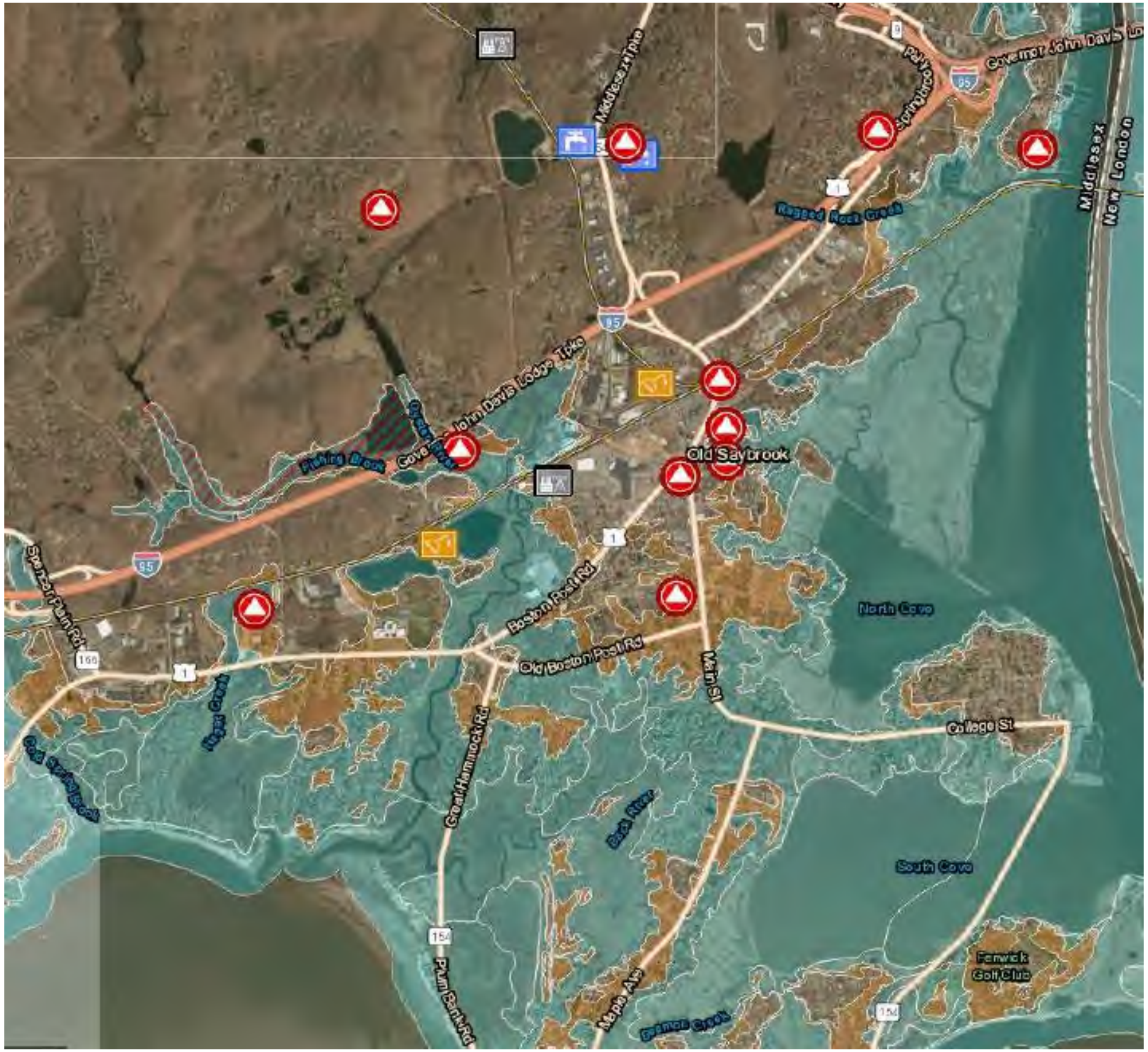
✓ Impacted Communities

Examples of Coastal Flooding Vulnerability

- ✓ Impacted Essential Facilities
- ✓ Evacuation Impacts
- ✓ Shelter Impacts

Examples of Coastal Flooding Vulnerability

✓ Impacted Lifeline Systems



Examples of Coastal Flooding Vulnerability

✓ Property Damage

Demolition of Dock and Dine on Saybrook Point after Sandy
image from http://www.wfsb.com/story/24398944/demolition-begins-at-dock-dine-in-old-saybrook

Dock and Dine on Saybrook Point one week after Sandy
image from https://gardendaze.wordpress.com/2012/11/09/storm-sandy-one-week-later-old-saybrook-ct/

Examples of Coastal Flooding Vulnerability

✓ Historic Structures

Type of Historic Property	Total Number	Total Number in VE/V Zone	Total Number in AE/A Zone
National Register Federal Historic Properties	17	3	3
State Register Historic Properties	76	1	17
Locally Significant Historic Properties	236	2	38
Other Significance	6	None	None
Total	335	6	58

Examples of Coastal Flooding Vulnerability

✓ Roadways and Bridges

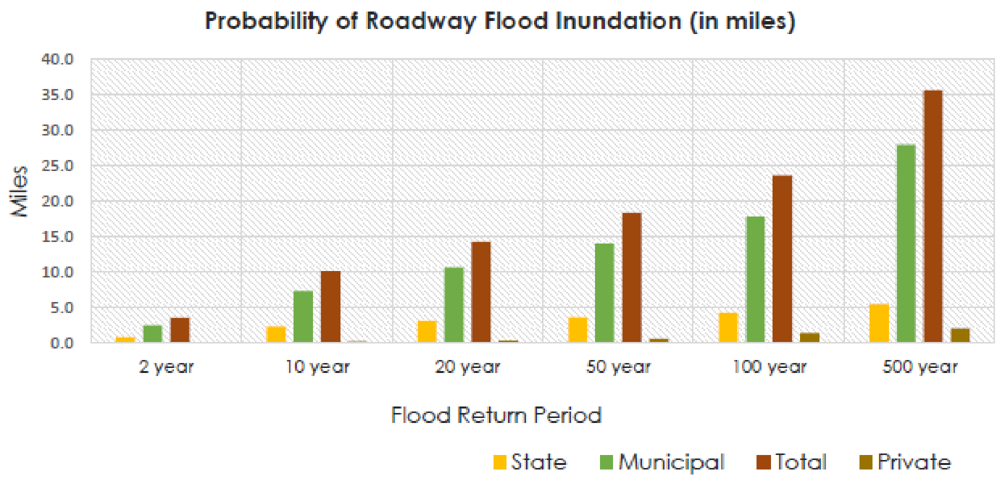


Table 4-14: Probability of Roadway Flood Inundation (in percentage) Due to Coastal Flooding under the Current Flood Risk

	2-year	10-year	20-year	50-year	100-year	500-year
State	2.9%	7.4%	9.6%	11.3%	13.1%	16.9%
	1 mile	2.4 mile	3.2 mile	3.7 mile	4.3 mile	5.6 mile
Municipal	3%	8.5%	12.4%	16.2%	20.6%	32.3%
	2.6 mile	7.4 mile	10.7 mile	14.0 mile	17.9 mile	28.0 mile
Private	3.6%	10.5%	15%	23.7%	50.4%	71.4%
	0.1 mile	0.3 mile	0.4 mile	0.7 mile	1.5 mile	2.1 mile
Total	+/4 miles	+/-10 miles	+/-14 miles	+/-18.5 miles	+/-24 miles	+/-36 miles

Town-wide Roadway Impacts

2-Year (2016)

10-Year (2016)

20-Year (2016)

Town-wide Roadway Impacts

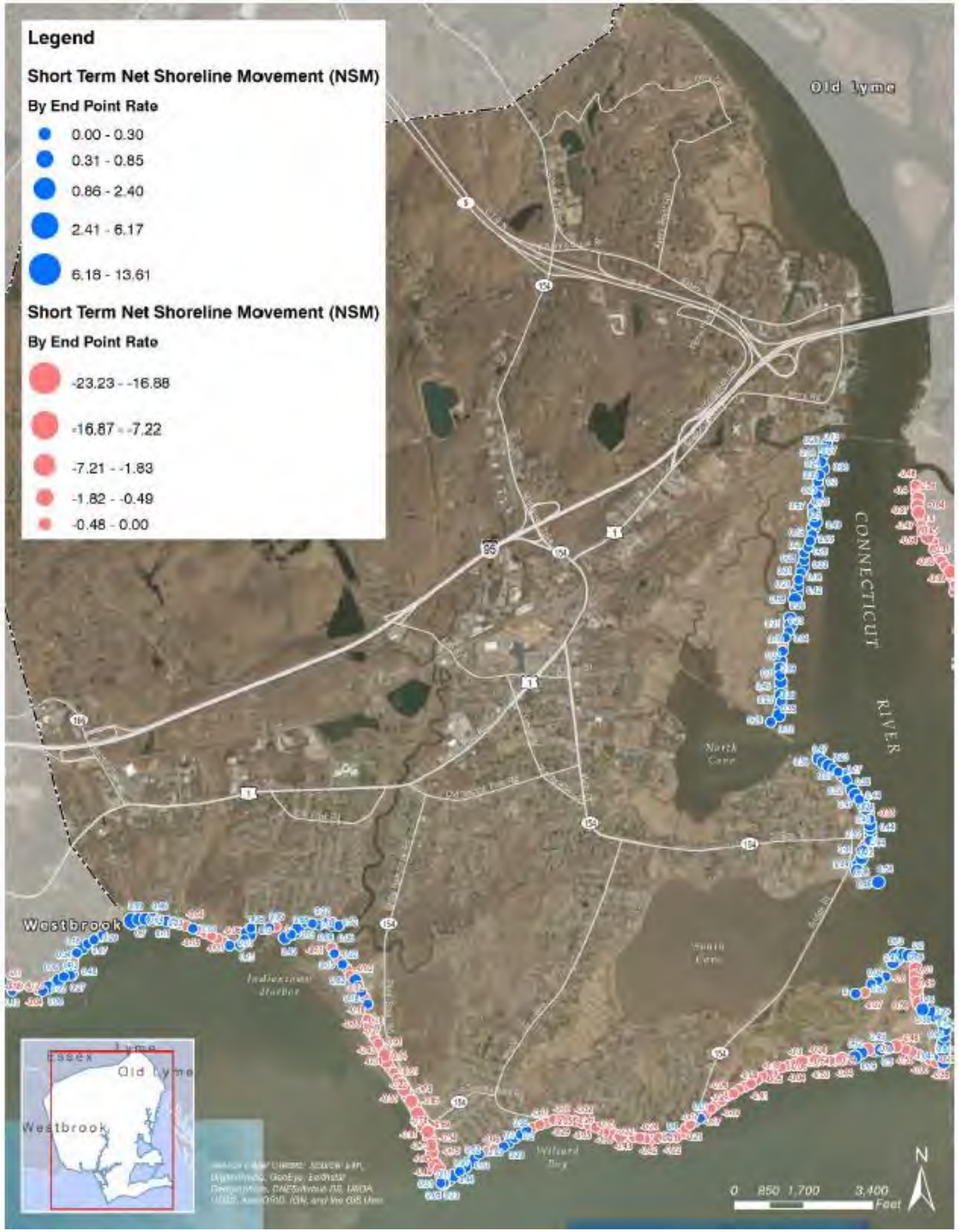
50-Year (2016)

100-Year (2016)

500-Year (2016)

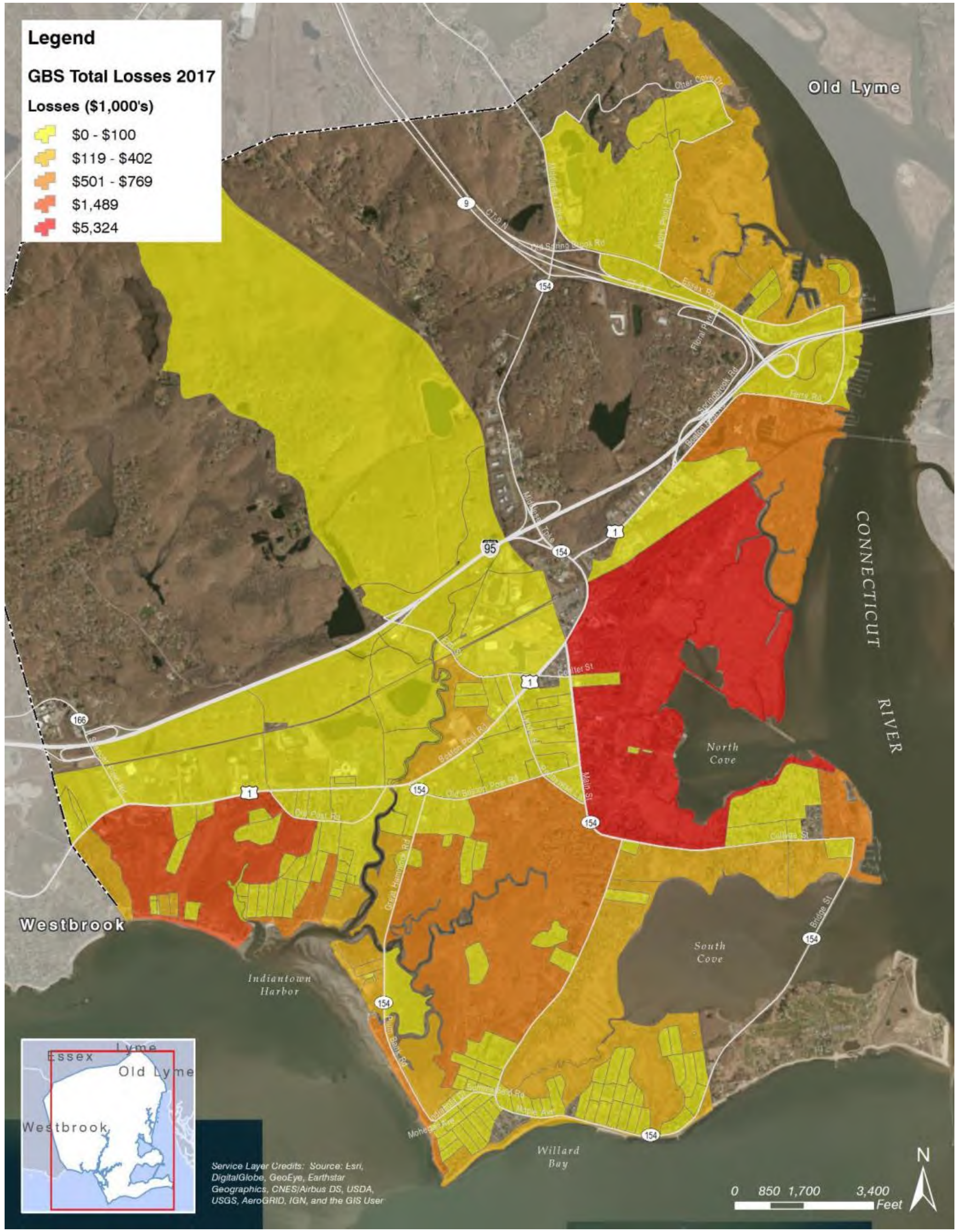
Examples of Coastal Flooding Vulnerability

✓ Shoreline Change



Examples of Coastal Flooding Vulnerability

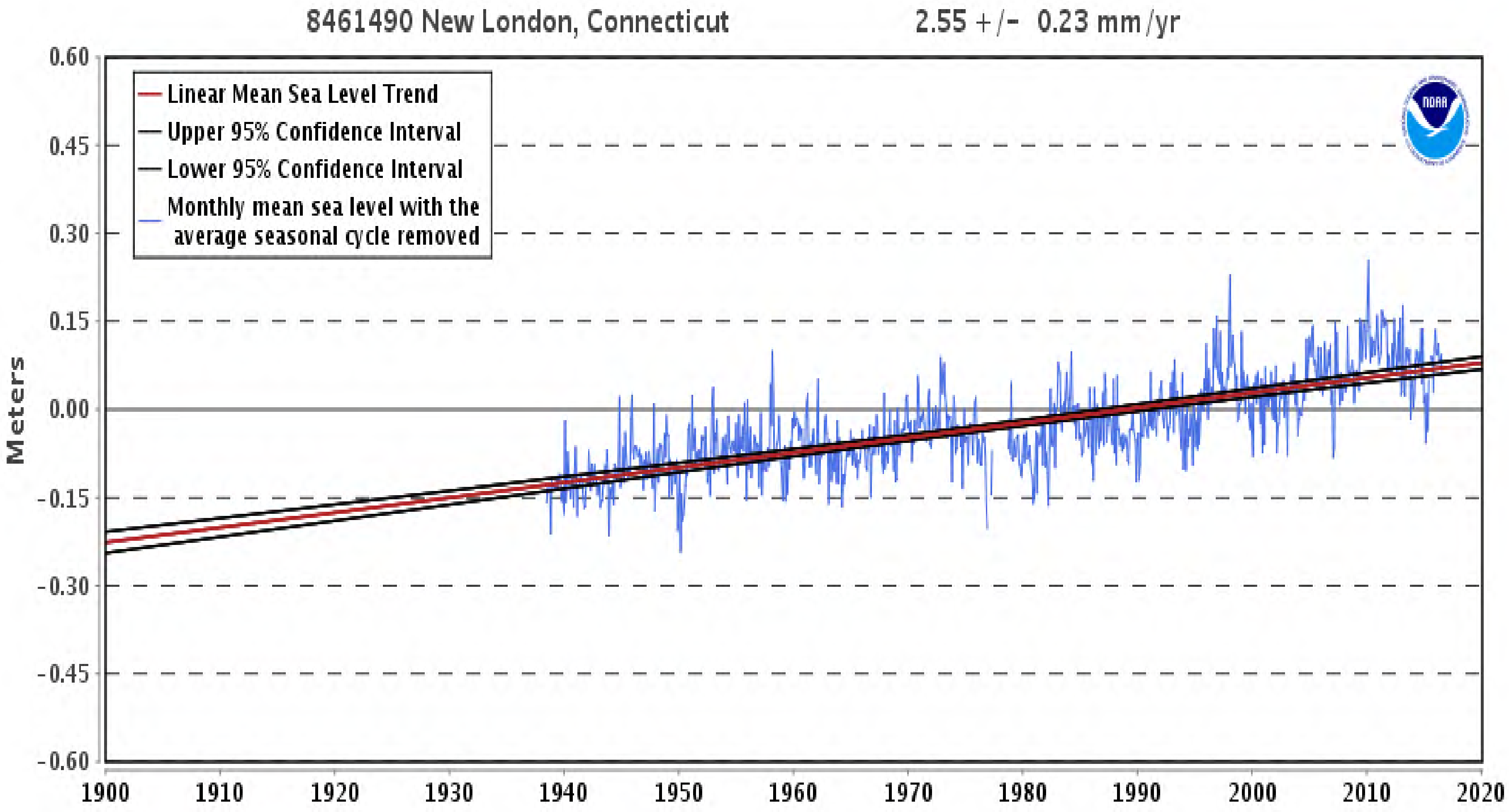
- ✓ Economic Loss (Average Annualized Loss)
- ✓ Muni Bond Rating



Climate Change Effects

Observed Rate of Relative Sea Level Rise Near Old Saybrook

2.55 +/- 0.23 mm/yr

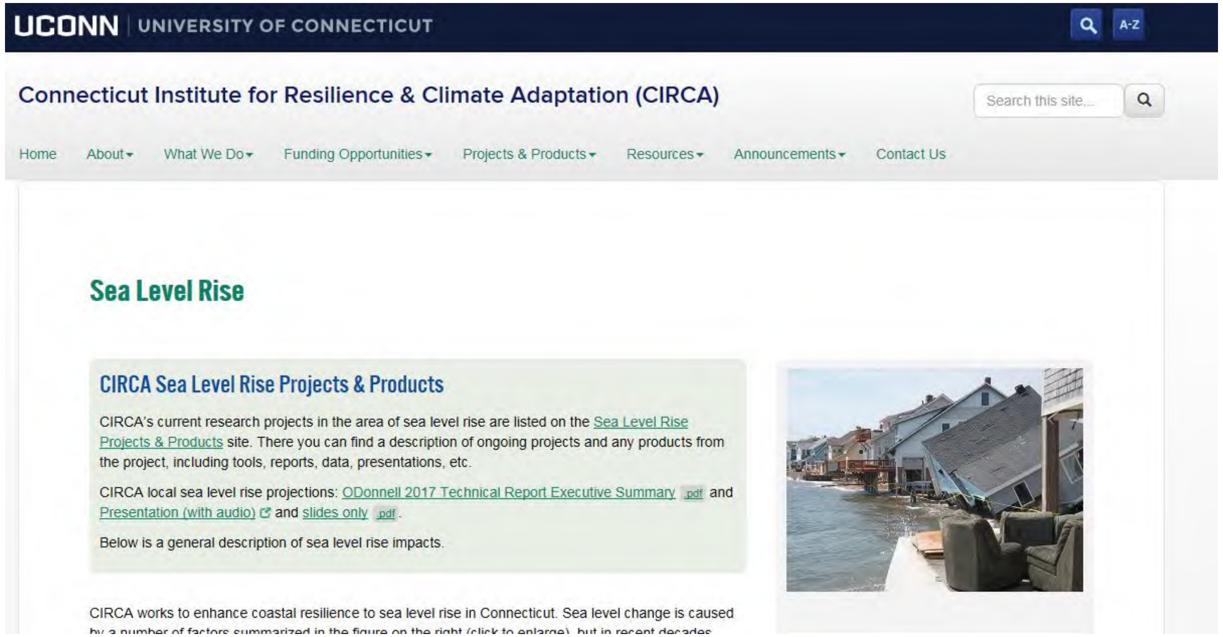


Planning Implications of Sea Level Rise

State of Connecticut Guidance and Regulation:
- PA 12-101
- PA 13-179

Must Consider RSLC:
- Plans of Conservation and Development
- Hazard Mitigation Plans
- Coastal Management
- Inconsistencies in definition of sea level rise
- Does not consider structure criticality

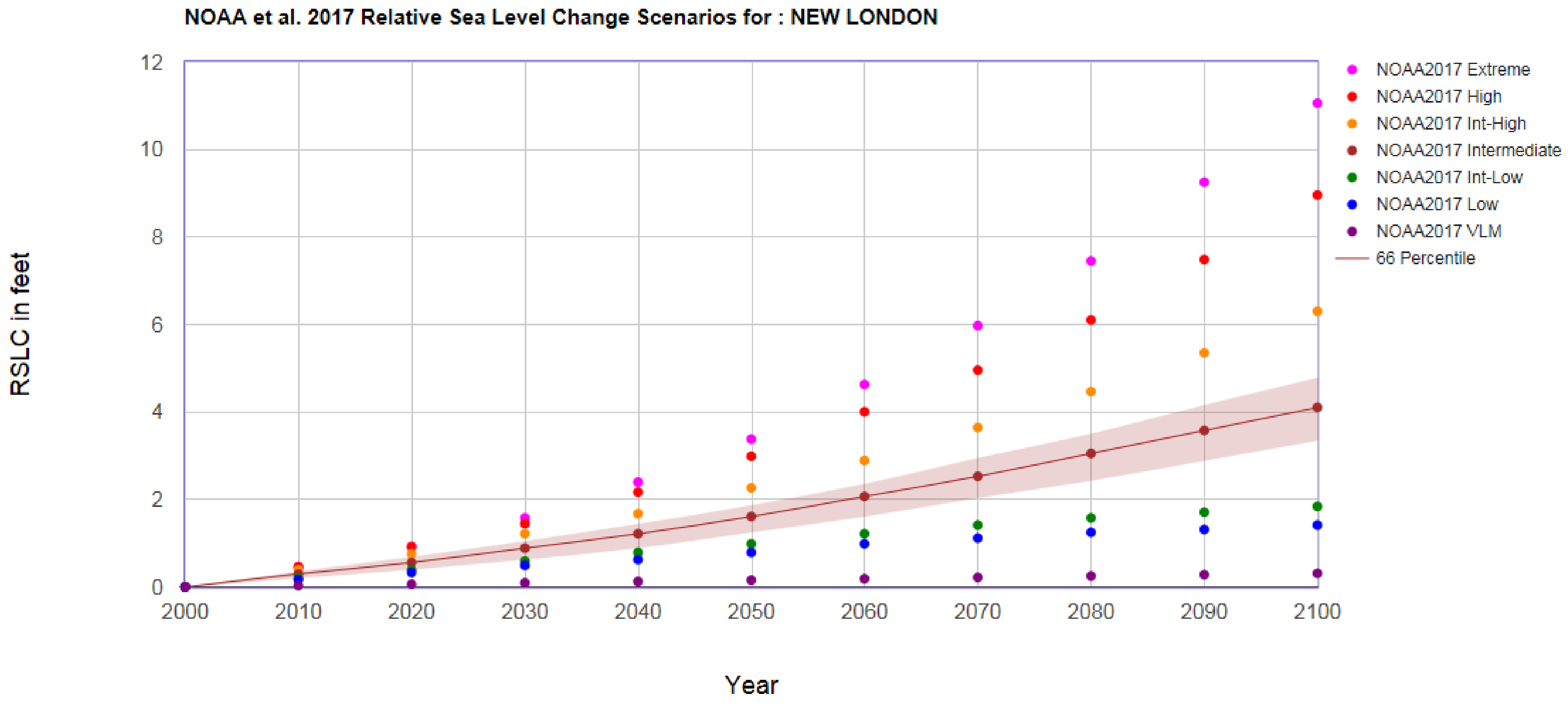
State Guidance: UCONN/CIRCA:
- Mid-range Planning 1.7 feet by 2050
- Long Term – be aware 3.25 feet by 2100
- Updated every decade



Climate Change Effects

Projected Sea Level Rise Near Old Saybrook:

2040: 0.05 to 1.23 feet
2065: 0.24 to 2.96 feet
2100: 0.5 to 6.46 feet



Rising Tides

	Current	2042			2067			2117		
		High SLR	Int SLR	Low SLR	High SLR	Int SLR	Low SLR	High SLR	Int SLR	Low SLR
Mean Sea Level (MSL)	-0.3	0.7	-0.01	-0.23	2.04	0.45	-0.05	6.12	1.71	0.32
Mean High Water (MHW)	0.92	1.92	1.21	0.99	3.26	1.67	1.17	7.34	2.93	1.54
Mean Higher-High Water MHHW)	1.21	2.21	1.5	1.28	3.55	1.96	1.46	7.63	3.22	1.83
Highest Astronomical Tide	2.04	3.04	2.33	2.11	4.38	2.79	2.29	8.46	4.05	2.66
Mean Low Water (MLW)	-1.65	-0.65	-1.36	-1.58	0.69	-0.9	-1.4	4.77	0.36	-1.03
Mean Lower-Low Water MLLW)	-1.84	-0.84	-1.55	-1.77	0.5	-1.09	-1.59	4.58	0.17	-1.22

Sea Level Rise Effects (Mean High Tide)

2017

2041

2066

2116

Implications of Sea Level Rise

1. Increased frequency, extent and depth of coastal flood inundation
2. Larger wave effects
3. Increased rate of shoreline erosion
4. Long term effects on salt marshes
5. Increased amount of property damage and economic losses
6. Long term effects to economic development
7. Long term reduction to Muni Bond Rating
8. Loss of future real estate tax revenue

Street flooding in Chalker Beach following Sandy)(mage from https://ctmirror.org/)

Next Steps

1. Conduct Risk Assessment
2. Update Mitigation Strategy and Actions
3. 2nd Public Meeting – February 4, 2019
    - Risk Assessment Results
    - Updated Mitigation Strategy & Actions
4. Provide Draft Natural Hazards Mitigation Plan Update for review

Public Workshop - Natural Hazard Mitigation Plan Update

POSTED ON: APRIL 5, 2019 - 2:43PM

Natural Hazard Mitigation Plan Update
Wednesday, April 17 @ 6:30 pm
Town Hall - 1st Floor Conference Room
302 Main St, Old Saybrook, CT

• Learn about the mitigation strategy designed to reduce the loss of life and property from natural and climate-related hazards through the Town of Old Saybrook's and the Borough of Fenwick's Plan Update.

• Identify actions specifically related to coastal flooding, sea-level-rise, severe wind resulting from hurricanes, and severe winter weather for the Borough and the Town.

• Contribute feedback to the Local Planning Team, the Town, the Borough and the Consulting Team for integration into the NHMP Update.

TOWN OF OLD SAYBROOK

Planning Commission

302 Main Street
Old Saybrook, Connecticut 06475

oldsaybrookct.gov

AGENDA
REGULAR MEETING
Wednesday, April 17, 2019 at 6:30 P.M.
Town Hall, 1st Floor Conference Room
302 Main Street, Old Saybrook

I. **CALL TO ORDER**

II. **ROLL CALL**

III. **PUBLIC WORKSHOP**

Natural Hazard Mitigation Plan Update

- **Learn** about the mitigation strategy designed to reduce the loss of life and property from natural and climate-related hazards through the Town of Old Saybrook's and the Borough of Fenwick's Plan Update.

- **Identify** actions specifically related to coastal flooding, sea-level-rise, severe wind resulting from hurricanes, and severe winter weather for the Borough and the Town.

- **Contribute** feedback to the Local Planning Team, the Town, the Borough and the Consulting Team for integration into the NHMP Update.

IV. **ADJOURNMENT**

NEXT REGULAR MEETING
Wednesday, May 1, 2019 at 7:00 p.m.
Town Hall, 1st Floor Conference Room
302 Main Street, Old Saybrook

Subscribe to www.oldsaybrookct.gov
for electronic delivery of land use agendas.

OLD SAYBROOK PUBLIC MEETING #2

Attendance April 17, 2019

Name	Email
BILL WEBSTER	WILLIAM.O.WEBSTER65@GMAIL.COM
Maggie Kelleher-Goldberg	maggiedrcgold@gmail.com
Douglas McCracken	mccracdsol@gmail.com
Nellie Perera	Nellie.Perera@gmail.com
Paula Kay	panamapaula1@yahoo.com
Trevor Ladd	trevladd1150@gmail.com
Kathy SUGLAND	Kbessom@aol.com
Tom Cox	coxlaw@gmail.com
Meryl Moskowitz	meryl.moskowitz@oldsaybrookct.gov

Natural Hazard Mitigation Plan Update

Town of Old Saybrook & Borough of Fenwick

Public Meeting

April 17, 2019

Known for Excellence. Built on Trust.

Samuel J. Bell, CFM
Senior Resiliency Planner

Meeting Overview

Natural Hazard Mitigation Plan Components

Overview of Findings

Mitigation Strategies and Actions

Next Steps

Plan Overview

Natural Hazard Mitigation Plan Components

Plan Objectives

- Simple, straightforward, easy to read
- Position Old Saybrook and Fenwick and for funding opportunities/grants
- Incorporate strategies from recent Coastal Resilience Study
- Define long-term strategies
- Set priorities

Why it matters…

- Eligibility for grant funding
- Public Safety
- Prevent Town losses and operating costs
- Prevent private property loss
- Maintain tax base
- Support Economic Planning (Plan of Conservation and Development)
- Maintain municipal bond rating

Plan Outline

Table of Contents

Planning Process

1. Assess Natural Hazard Risk:
   - Community: Demographics/Social Vulnerability
   - Asset Inventory
   - Natural Hazards Characterization
   - Risk Assessment
2. Mitigation Strategies and Actions
3. Plan Adoption and Maintenance

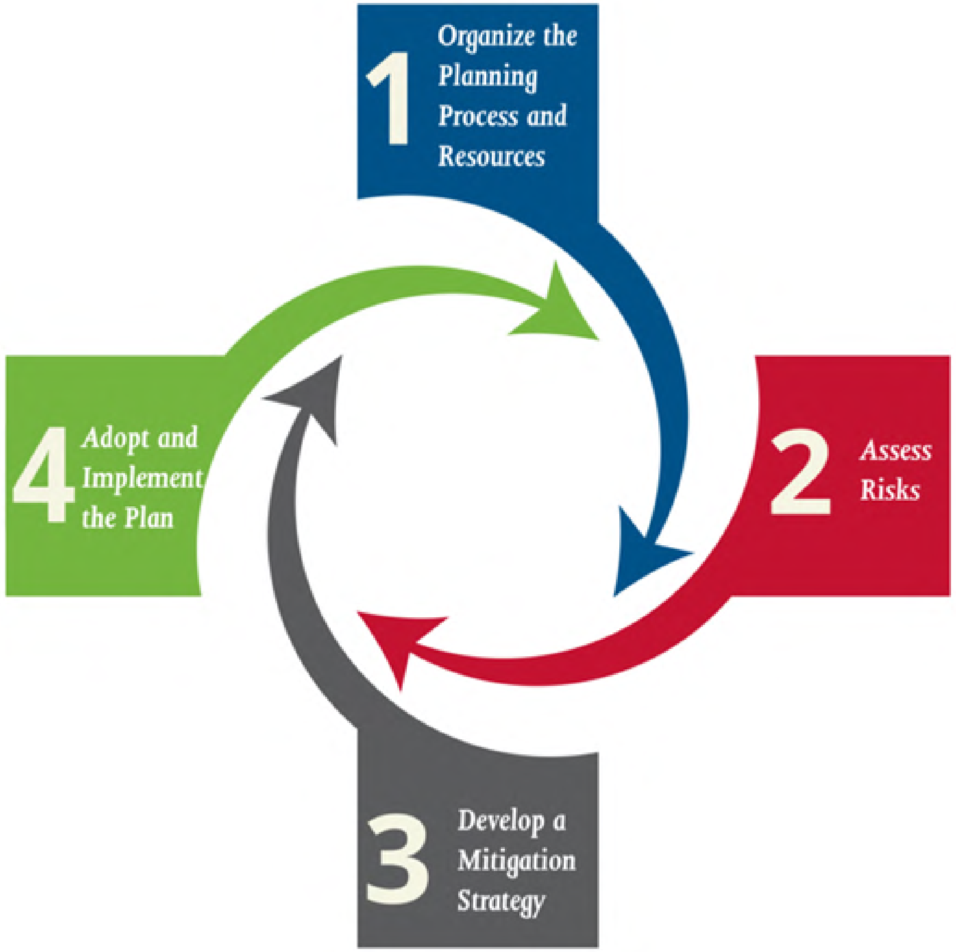


Figure credit FEMA/Jenny Burmester – Aug 21, 2017

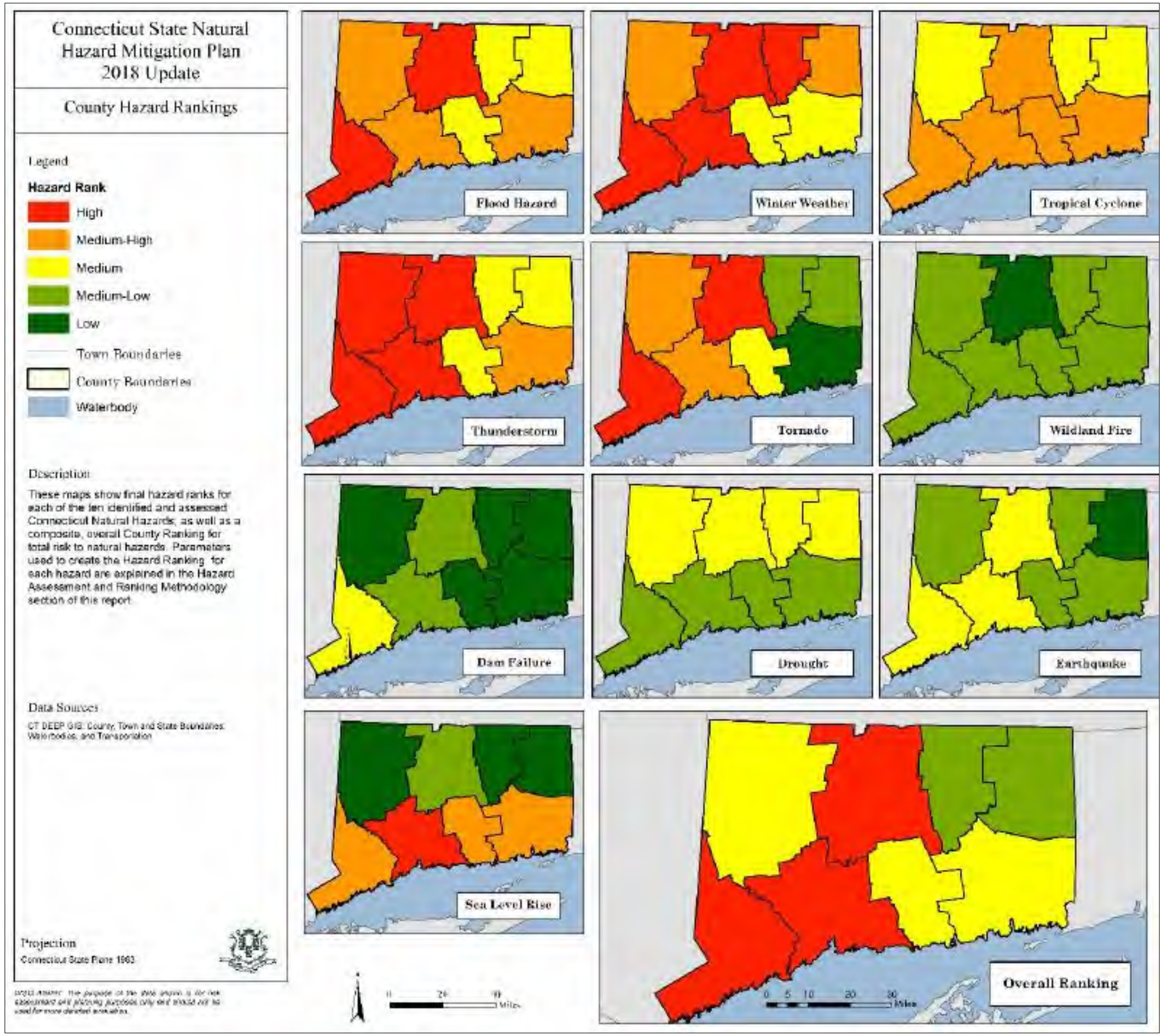
Overview of Findings

Risk Assessment Results

Significant Natural Hazards – 2019 State Plan

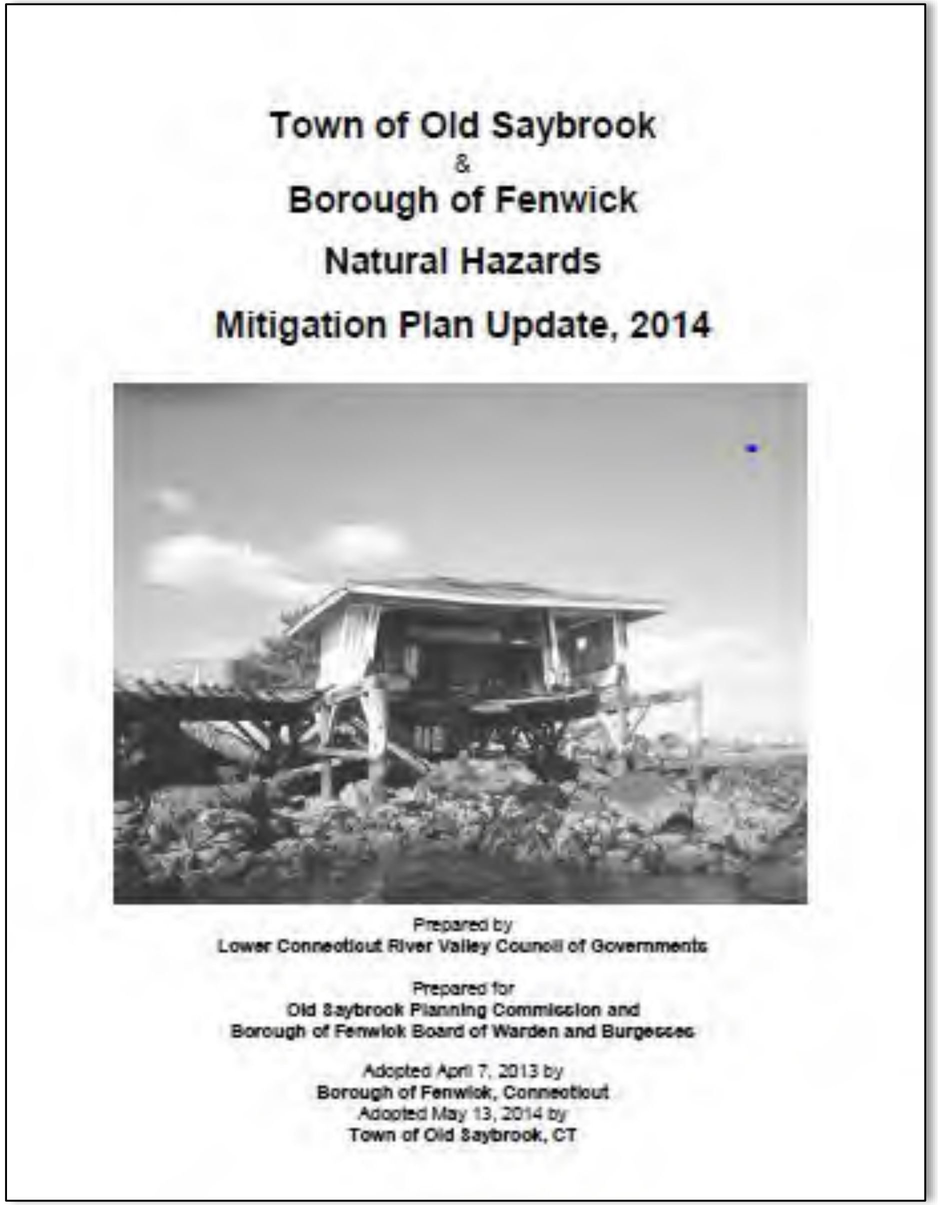
Top-ranked hazards include:

- Dam Failure
- Drought
- Earthquake
- Flood Related Hazards
- Sea Level Rise
- Thunderstorm-Related Hazards
- Tornado
- Tropical Cyclone (Hurricane and Tropical Storm)
- Wildland Fire
- Winter Weather



2014 Plan Natural Hazard Categories

- ✓ Flooding
- ✓ High Wind & Tornado
- ✓ Drought & Wildfire
- ✓ Winter Storms
- ✓ Earthquake
- ✓ Hurricane & Tropical Storm
- ✓ Sea Level Rise
- ✓ Tsunami
- ✓ Heat Wave



Town of Old Saybrook
&
Borough of Fenwick
Natural Hazards
Mitigation Plan Update, 2014

Prepared by
Lower Connecticut River Valley Council of Governments

Prepared for
Old Saybrook Planning Commission and
Borough of Fenwick Board of Warden and Burgesses

Adopted April 7, 2013 by
Borough of Fenwick, Connecticut
Adopted May 13, 2014 by
Town of Old Saybrook, CT

Natural Hazard Plan Update

- 19 natural hazards identified as applicable to Town
- Four hazard categories:
  - ✓ Severe Weather Hazards
  - ✓ Climate-Related Hazards
  - ✓ Geologic Hazards
  - ✓ Secondary Hazards

Severe Weather Hazards:

- Severe Wind:
  - Hurricanes/Tropical Storms
  - Thunderstorms
  - Tornadoes
- Lightning
- Intense Rainfall
- Hail
- Flood:
  - Storm Surge
  - Sea Level Rise
  - Urban Drainage Flooding
  - Shoreline Change
- Severe Winter Weather:
  - Snowfall
  - Ice Storms

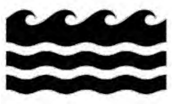
Climate-Related Hazards:

- Extreme Temperature:
  - Extreme Heat
  - Extreme Cold
- Drought
- Wildfire

Geologic Hazards:

- Earthquake

Top-Ranked Town and Borough Hazards

- ✓ Flooding due to coastal storms 
- ✓ Sea Level Rise 
- ✓ Hurricanes (Severe Wind) 
- ✓ Severe Winter Weather 

GZA Plan Natural Hazard Classification and Ranking

1. Likelihood/Frequency
2. Severity/Magnitude
3. Impact Area

Natural Hazard Characterization and Ranking

Frequency:

Very Low: Events that occur less frequently than once in 1,000 years (less than 0.1% per year).

Low: Events that occur from once in 100 years to once in 1,000 years (0.1% to 1% per year)

Medium: Events that occur from once in 10 years to once in 100 years (1% to 10% per year).

High: Events that occur more frequently than once in 10 years (greater than 10% per year).

Natural Hazard Characterization and Ranking

Severity:

Minor: Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e., 1 or 2 communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.

Serious: Scattered major property damage (more than 50% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services are briefly interrupted; some injuries and/or fatalities.

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

Catastrophic: Property and public infrastructure destroyed; essential services stopped, thousands of injuries and fatalities.

Natural Hazard Characterization and Ranking

Likelihood/Frequency		
Point Value	Category	Characteristics and Frequency
1	Very Low	Events that occur or are exceeded less often than once in 100 years (less than 1% probability)
2	Low	Events that occur or are exceeded from once in 50 years to once in 100 years (1% to 2% probability)
3	Medium	Events that occur or are exceeded from once in 5 years to once in 50 years (2% to 20% probability)
4	High	Events that occur or are exceeded more frequently than once in 5 years (greater than 20% probability)
Severity/Magnitude		
Point Value	Category	Characteristics
1	Minor	Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e., 1 or 2 communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.
2	Serious	Scattered major property damage (more than 50% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services are briefly interrupted; some injuries and/or fatalities.
3	Extensive	Consistent major property damage; major damage to public infrastructure (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and fatalities.
4	Catastrophic	Property and public infrastructure destroyed; essential or lifeline services stopped, thousands of injuries and fatalities.
Impact Area Assessment		
Point Value	Category	Characteristics
1	Small	In localized, unpopulated or lightly areas of Town, without structures or critical facilities
2	Medium	Impacting only portions of the Town
3	Large	Town-wide and/or essential and lifeline facilities

Example – Severe Wind

Tropical Cyclones: Tropical Storms and Hurricanes

Tornadoes

Thunderstorms: macrobursts and microbursts

Example – Severe Wind

- **Wind Advisory**: 1) sustained winds of 31 to 39 mph for an hour or more; and/or 2) wind gusts of 46 to 57 mph for any duration.
- **High Wind Watch/Warning**: 1) sustained winds of 40 mph for one hour or more; or 2) wind gusts of 58 mph or higher for any duration.
- **Hurricane Warning**: sustained winds of 74 mph or higher or frequent (for more than 2 hours) gusts of 74 mph or greater associated with a tropical cyclone.
- **Extreme Wind:** 1) surface winds of 115 mph or greater associated with a derecho or sustained hurricane winds.

Example – Severe Wind

Wind Direction	GEV Fit Wind Speed (mph)				Recommended Values (mph) for Modeling			
Return Period	10-year	50-year	100-year	500-year	10-year	50-year	100-year	500-year
All Direction	69	97	112	154	70	100	120	160
North	--	--	--	--	--	--	--	--
Northeast	43	53	57	68	45	55	60	70
East	49	71	82	117	50	75	90	120
Southeast	49	69	80	108	50	70	80	110
South	56	68	72	81	60	70	80	90
Southwest	48	66	75	99	50	70	80	100
West	43	59	69	98	45	60	70	100
Northwest	--	--	--	--	--	--	--	--

Table 2-1: Summary of Extreme Wind Speeds based on GZA Statistical Analysis at New London Airport

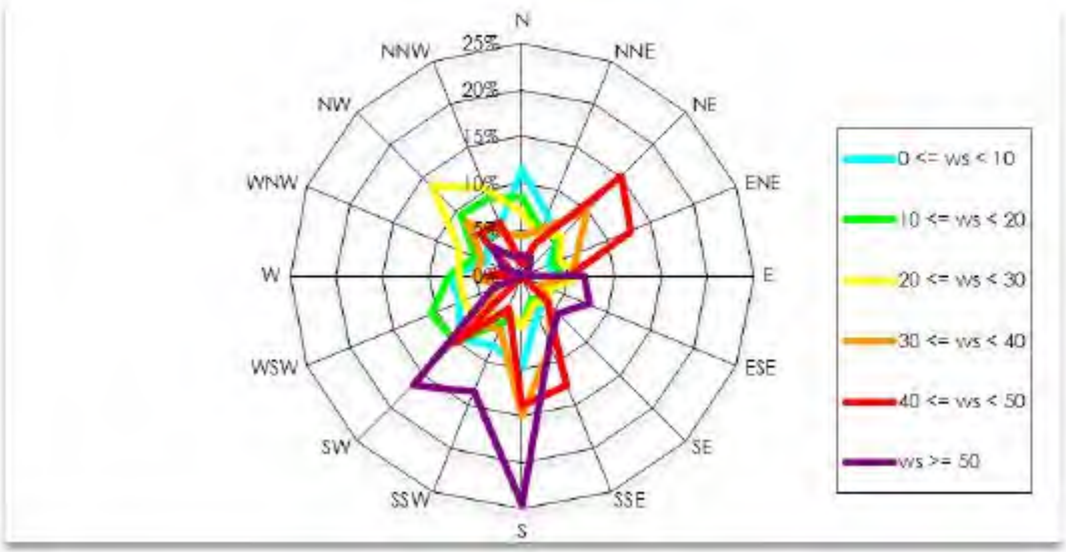


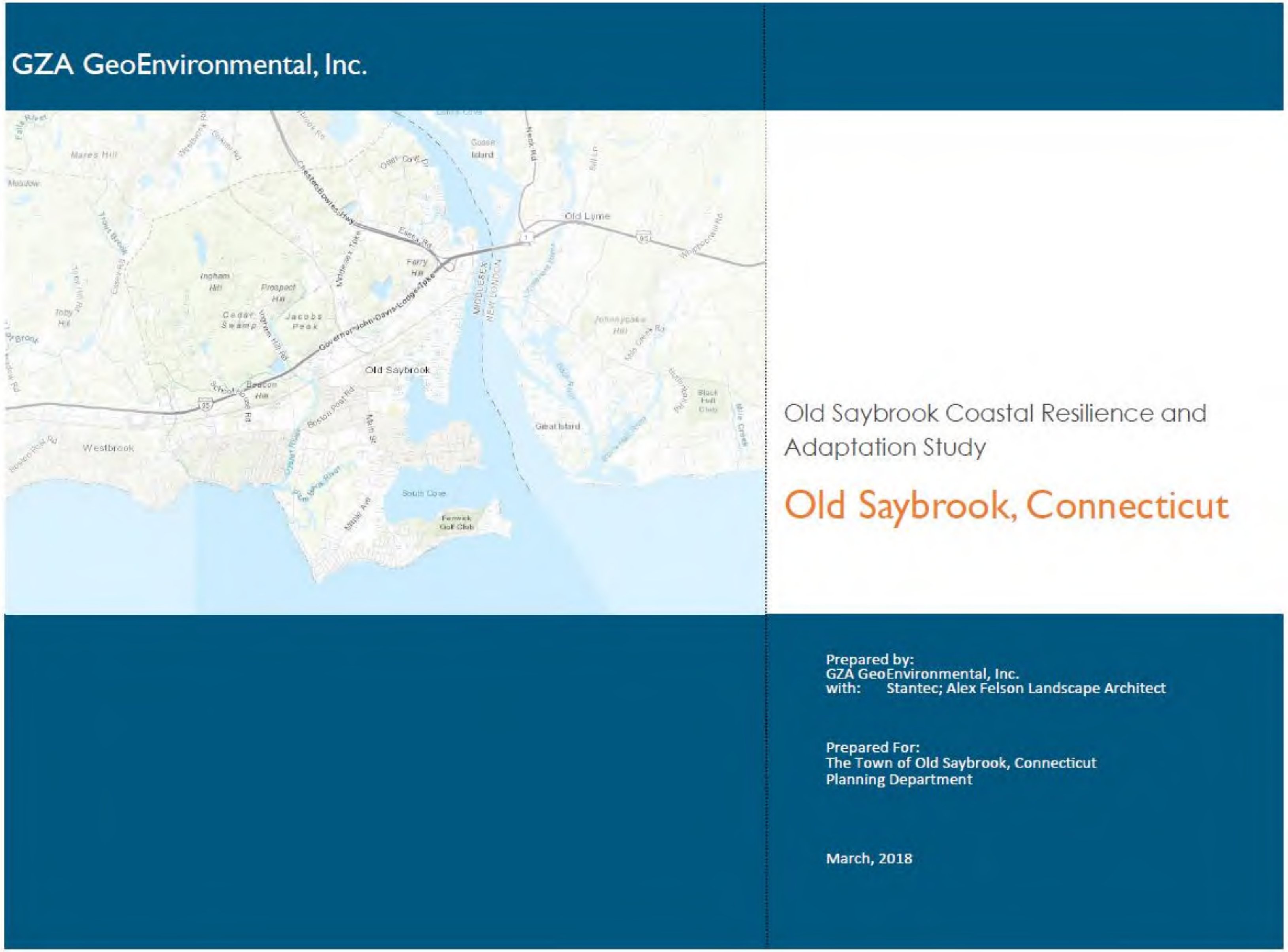
Figure 2-2: Wind Rose of Wind Seeds (miles per hour) and Direction at New London Airport

Example – Severe Wind

Natural Hazard	Likelihood/Frequency	Severity/Magnitude	Impact Area
SEVERE WEATHER HAZARDS			
Severe Wind:			
Hurricanes/Tropical Storms/ Nor'easters	• High Wind Warning (>40mph): +/- 100% AEP (1-year recurrence interval); **High**	Minor	Town-wide
	• Hurricane Wind Warning (>74mph): 1% AEP (100-year recurrence interval); **Medium to Low**	Extensive	
	• Extreme Wind Warning (>115 mph) <0.2% AEP (>500-year recurrence interval); **Very Low**	Catastrophic	
Thunderstorms (wind >58 mph)	• Within Middlesex County: 56% AEP or minimum of 1-year to 2-year recurrence interval (29 years with 1 or more events over 52 years); Probability of occurrence within Old Saybrook and Fenwick is likely lower; **Medium to High**	Minor	Town-wide or portions of Town
Tornadoes	• Tornadoes within Middlesex County: 9% AEP or 11-year recurrence interval (6 years with 1 or more events over 68 years); **Medium** • Major tornado within Middlesex County: 1.5% AEP or 70-year recurrence interval; **Low** • Based on the proportional land area, the Old Saybrook and Fenwick tornado AEP is about 0.2% and the Old Saybrook and Fenwick major tornado AEP is very low (less than 0.2%). **Very Low**	Serious to Catastrophic	Town-wide or portions of Town

Top-Ranked Town and Borough Hazard

Coastal Flooding:
- Flood inundation
- Property damage
- Shoreline change


GZA GeoEnvironmental, Inc.

Old Saybrook Coastal Resilience and Adaptation Study

Old Saybrook, Connecticut

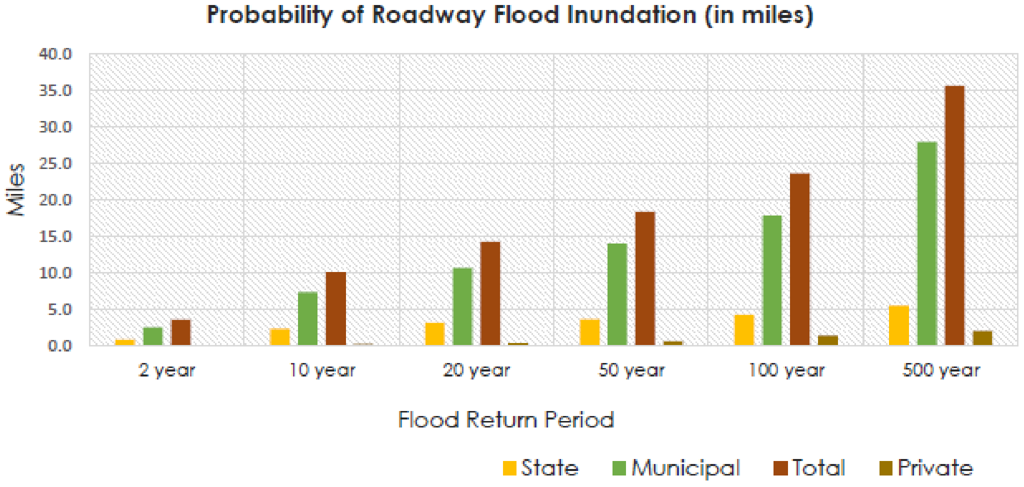
Prepared by:
GZA GeoEnvironmental, Inc.
with: Stantec; Alex Felson Landscape Architect

Prepared For:
The Town of Old Saybrook, Connecticut
Planning Department

March, 2018

Examples of Coastal Flooding Vulnerability

✓ Roadways and Bridges



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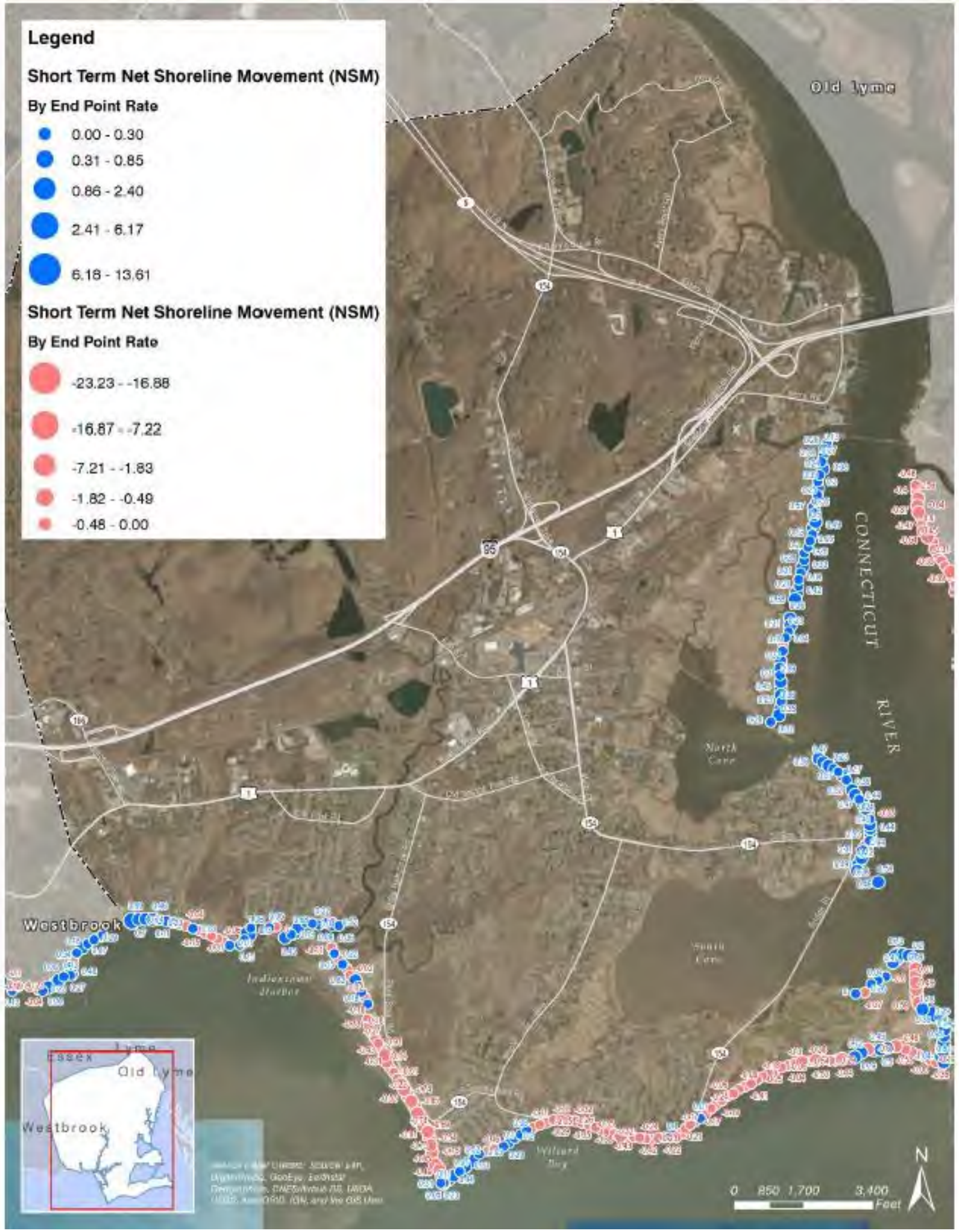

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Locally Significant Property

Other Significance

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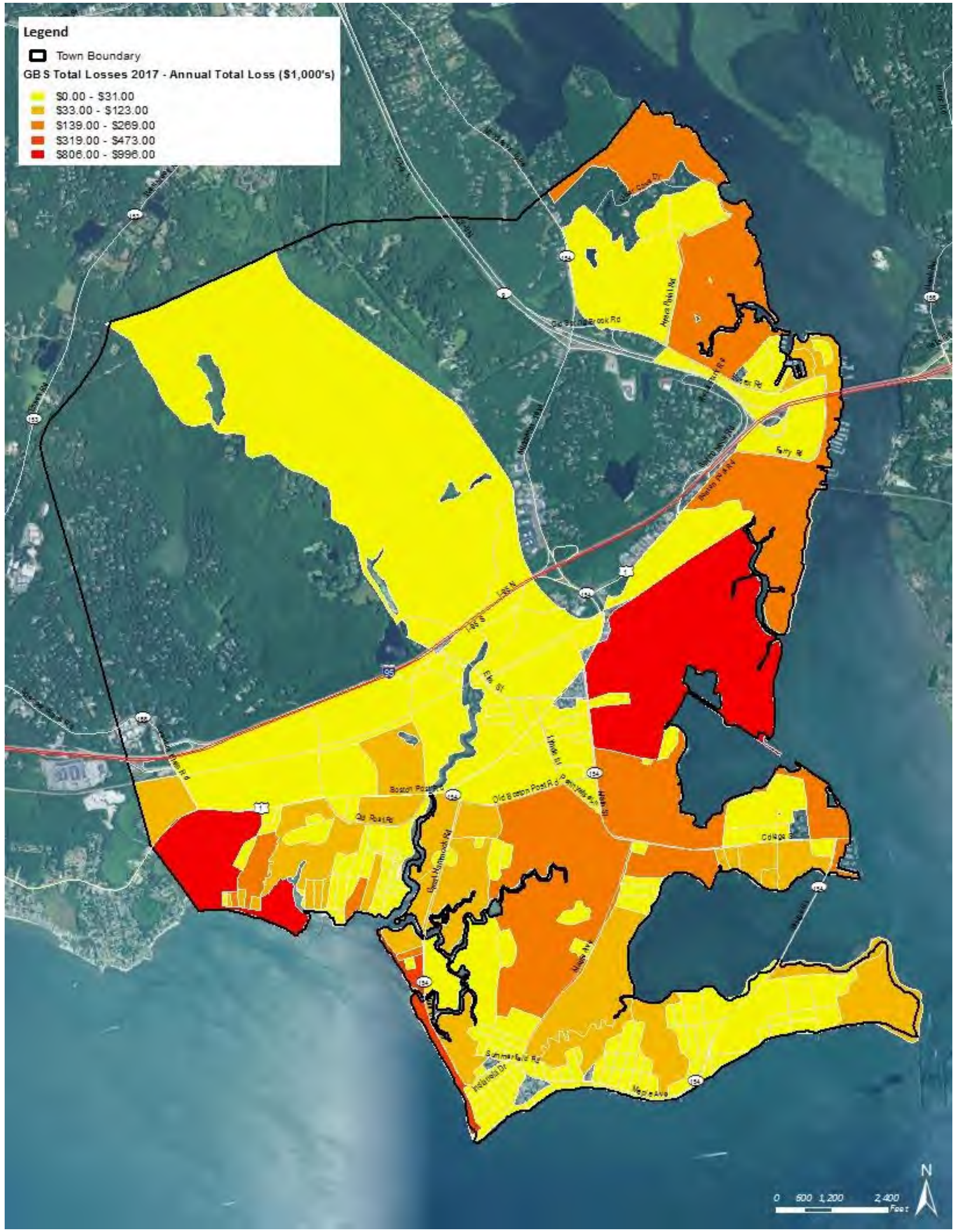
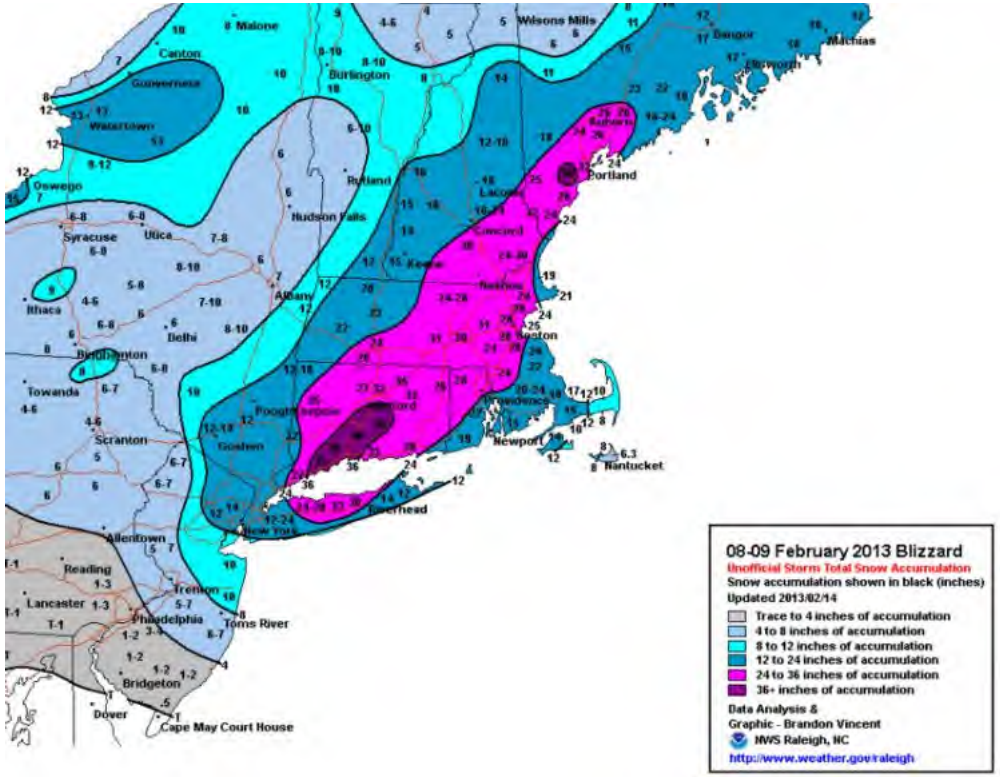
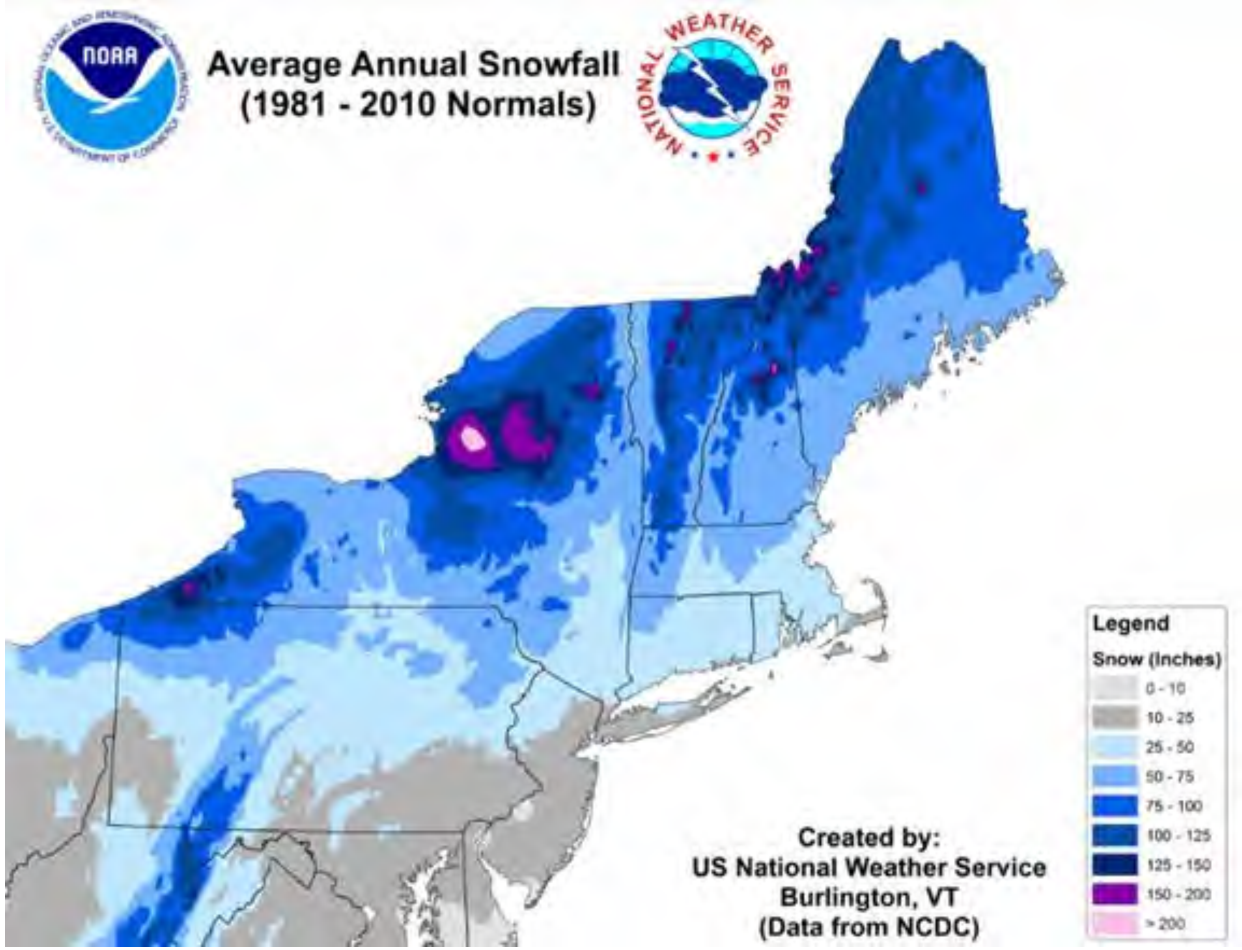


Severe Winter Weather

- ✓ Snowfall
- ✓ Extreme Cold
- ✓ Ice Storms



Observed Snowfall Winter Storm Nemo, February 2013



Average Annual Snowfall (http://www.weather.gov/btv/winter)
Note: Elevations reference feet NAVD88

Severe Winter Weather

Snowfall statistics:

- 10 to 11 snow days per year
- Average annual snowfall of 23 inches
- 90% AEP or 1 year recurrence interval Heavy Snowfall (19 years with 1 or more events over 21 years)
- Reasonable estimate of average monthly snowfall: 10 to 12 inches
- Reasonably conservative monthly snowfall upper bound: 30 inches (maximum monthly upper bound of 45 inches)

Climate Change and Old Saybrook and Fenwick

Climate Change Old Saybrook and Fenwick

Old Saybrook and Fenwick Climate Today	Old Saybrook and Fenwick Climate 2050
Temperature: The average temperature is about 60oF. • The average low temperature in Winter (December, January and February) ranges from 22oF to 32oF, with the coldest temperature occurring during January. • The average high temperature in Summer (July and August) ranges from 80oF to 81oF, with the coldest temperature occurring during January. • Days above 90oF (based on state-wide data): 7 days • Heat Index above 105oF(based on state-wide data): 5 to 8 (lower in Old Saybrook and Fenwick - about 1 event every 4 years)	Temperature: The average temperature could be between 2oF and 8oF higher than today. • Average Summer temperature (based on state-wide data): could be between 2oF and 8oF higher than today. • Days above 90oF (based on state-wide data): 20 to 40 days • Heat Index above 105oF(based on state-wide data): 14 (lower in Old Saybrook and Fenwick, but still expected to increase relative to today to at least 1 event per year) • Spring will arrive sooner, summers will grow hotter, and the weather will becoming more extreme with swings between above-average winter temperatures to extreme cold with large snowfall events.
Intense Precipitation: • The 25-year recurrence interval, 24-hour rainfall at Old Saybrook and Fenwick: 6.35 inches	Intense Precipitation: Within the Northeast U.S., from 1996 to 2014, the amount on intense rainfall (heaviest 1% of all daily events) was about 50% higher than the period of 1901 to 1995. The frequency and intensity of intense rainfall is expected to increase.
Sea Levels and Coastal Flooding: • 10% AEP Flood Stillwater Elevation: 5.5 feet NAVD88 • 2% AEP Flood Stillwater Elevation: 7.7 feet NAVD88 • 1% AEP Flood Stillwater Elevation: 9.2 feet NAVD88 • 0.2% AEP Flood Stillwater Elevation: 15.3 feet NAVD88	Sea Levels and Coastal Flooding: There is very high confidence that sea levels near Old Saybrook and Fenwick will increase by about 1 foot by the year 2050 (relative to the year 2000). A reasonable mid-range planning bound is 1.7 feet (relative to the year 2000). Assuming 1.7 feet increase: • 10% AEP Flood Stillwater Elevation: 7.2 feet NAVD88 • 2% AEP Flood Stillwater Elevation: 9.4 feet NAVD88 • 1% AEP Flood Stillwater Elevation: 10.9 feet NAVD88 • 0.2% AEP Flood Stillwater Elevation: 17 feet NAVD88

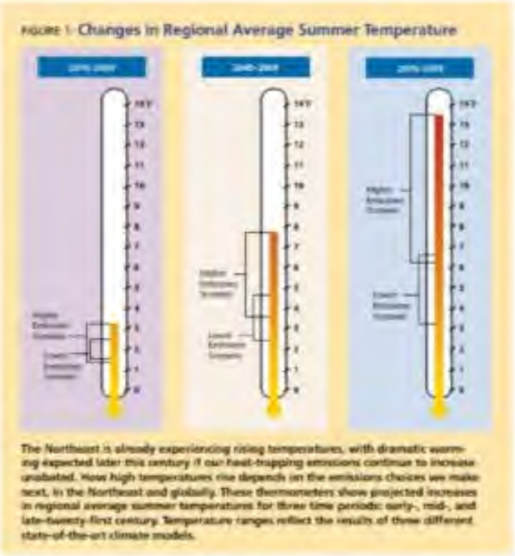


Figure 2: Predicted Rise in Average Northeast U.S. Temperatures (source Union of Concerned Scientists)

Strategies and Actions

Hazard Mitigation Strategies & Actions

Updated Town Hazard Mitigation Capabilities

- ✓ 22 existing programs already in place
- ✓ Highlights:
  - ✓ Enforcement of State Building Code
  - ✓ Emergency Generators for Critical Facilities
  - ✓ Dam Emergency Action Plans: Chalker Millpond Dam, Obed Heights Reservoir Dam, and Turnpike Pond Dam
  - ✓ National Flood Insurance Program (NFIP) Participation
  - ✓ Centralized Public Safety Dispatch/CT Alert Emergency Notification System (ENS)
  - ✓ Subdivision review

2014 Mitigation Actions

NATURAL HAZARD MITIGATION PLAN

how do we get there?	status	lead agency	partners	schedule	funding source	next steps wish list, good ideas and ongoing action items for 2019 update
NHMP Implementation, Maintenance & Review						
Annual Review of Mitigation Efforts & Plan Implementation. The Planning Commission will monitor and evaluate progress in addressing action items in this Plan and include those accomplishments in its annual report to the Town.	The Town's lead agencies report on implementation of the Plan throughout its annual report. **In 2014, the Conservation Commission's Sea Level Rise Climate Adaptation Committee issued a Report of Findings.**	PC	LUD	annually	operating budget	**Annual Review of Mitigation Efforts & Plan Implementation.** Monitor and evaluate progress in addressing action items in this Plan.
5-Year Review & Update of Natural Hazard Mitigation Plan. The Planning Commission will reconvene its multi-agency Committee every 5 years to update the Plan.	**Review and update in progress starting August 2018; Plan expires June 2019.**	PC	BOS RiverMPO	every 5 years	**CIP $25k** Federal Hazard Mitigation Grant Program (HMGP)	**5-Year Review & Update of Natural Hazard Mitigation Plan.** Combine the Coastal Resilience Working Group with the multi-agency NH Committee in 2023 to update the Plan for re-adoption in 2024.
Capital Improvement Program. Use CIP to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.	**The Town partcipates in annual updates to the 5-year capital improvement programs at the State, Regional and municipal levels;** *ongoing.*	BOS	DPW OEM RiverMPO ETD	annually	CIP, RTP, STIP HMPG	**Capital Improvement Program.** Use CIP to set aside funds for infrastructure improvements as recommended by the Sea Level Rise Climate Adaption Report of Findings (2015) and the Community Coastal Resilience Study (2018) into NHMP.
Benefit-Cost Analysis. Evaluate opportunities for public funding of mitigation projects on private property where public benefits exceed the cost for RL properties or for properties otherwise eligible for buy-out.	occurs for each project	BOS	BO TE Assessor	annually	OP	**Benefit-Cost Analysis.** Conduct BCAs for priority mitigation projects and for private property where public benefits exceed the cost for RL properties or for properties otherwise eligible for buy-out.
Grants. Identify and apply for grants to fund mitigation tasks identified in this plan.	**The Town successfully secured funds to conduct a Community Coastal Resilience Study (2018).**	PC BOS	LUD, EDC, DPW, OEM	monthly	**CT-DOH for CDBG-DR Storm Sandy funds ($125)**	**Grants.** *Continue to* apply for grants identified to fund or leverage funds needed to implement priority mitigation tasks identified in this plan.
Planning & Regulatory Standards						
Land Use Regulation. Maintain, and strengthen as appropriate, subdivision and zoning regulations to make safer new roads and lots within flood zones.	reviewed annually, changes made as necessary	PC ZC	DPW, LUD, TE	annually	OP	COMPLETE
Flood Enforcement. Enforce, through existing zoning, building and flood permitting processes, construction standards to minimize flood risks.	**The Town enforces flood standards through existing codes: the revised State Building, State Fire Safety and State Fire Prevention Codes (10/1/18).**	BOS	TE BO ZEO	daily	OP	**Flood Enforcement.** *Continue to* enforce, through existing zoning, building and flood permitting processes, construction standards to minimize flood risks.
Stormwater Management. Continue land use permitting that encourages storm water retention within new and redeveloping areas (rain gardens, curbless roads, etc.).	**The Town narrowed the pavement width in reconstructing Bokum Road; installed a rain garden in the Main Street parking lot; continues to limit non-residential development to a maximum impervious coverage per lot.**	ZC PC IWWC	LUD, DPW, TE	quarterly	CIP	**Stormwater Management.** *Continue to* implement the actions prescribed by the Town's Stormwater Management Plan (2018).

2014 to 2019 Hazard Mitigation Accomplishments

- ✓ Updated the Dam & Assets Inventories with the Coastal Community Resilience Study & Infrastructure Evaluation (2018 Resilience Study)
- ✓ Completed an inventory of stormwater catch basins, basins, and outfall (2017)
- ✓ Roadways evaluation completed (2018 Resilience Study)
- ✓ Maintained Stormwater Infrastructure (Annually)
- ✓ Participated in the CT Alert Emergency Notification System
- ✓ The Historic Commission hosted a workshop on funding rehabilitation of historic structures via tax credits
- ✓ Design of hybrid living shoreline protection Fenwick Hepburn Dune (2018-9)
- ✓ Land Acquisition (2015-2018)

Strategies and Actions

- ✓ 3 overarching goals
- ✓ 60(+)mitigation actions (including 33 new coastal resilience actions)
  - ✓ Benefit cost review to prioritize actions
  - ✓ Timeline
  - ✓ Estimated project costs
  - ✓ Priority
  - ✓ Responsible Department(s)
  - ✓ Potential Funding Sources

2014 Plan Goals

1. Elimination of Injury and Loss of Life;
2. Elimination or Reduction of Damages To Property and Natural Environments; and
3. Reduction of Associated Impacts from Natural Hazards

2019 State Plan Goals - Updated

1. Promote Implementation of Sound Floodplain Management and Other Natural Hazard Mitigation Principals on a State and Local Level;
2. Implementation of Effective Natural Hazard Mitigation Projects on a State and Local Level
3. Increase Research and Planning Activities for the Mitigation of Natural Hazards on a State and Local Level
4. Response preparedness

High Priority Actions

- ✓ Implement actions outlined in the Plan
- ✓ Develop coastal resilience roadway improvement plan
- ✓ Focus on promoting new development in non-vulnerable areas of Town.
- ✓ Evaluate the technical feasibility of constructing dunes and berms.
- ✓ Apply for $ to prepare Physical and Infrastructure Improvements Engineering Plans and Design

GZA GeoEnvironmental, Inc.
Known for excellence. Built on trust.

Town of Old Saybrook and the Borough of Fenwick Natural Hazard Mitigation Plan

Old Saybrook and the Borough of Fenwick, Connecticut

Draft for Review

Local Natural Hazard Mitigation Plan

Prepared in accordance with the requirements presented in the FEMA Local Mitigation Plan Review Guide and the Local Mitigation Handbook

Prepared by:
GZA GeoEnvironmental, Inc.

Prepared For:
The Town of Old Saybrook and the Borough of Fenwick, Connecticut Planning Department

May, 2019

High Priority Actions

- ✓ Analyze the existing stormwater infrastructure under precipitation only and combined coastal flood-precipitation events and identify the need for additional catch basins, pump stations, additional tide gates, and green infrastructure.
- ✓ Coordinate with USACE relative to proposed, future dredge projects and re-use of dredge materials for Town beach nourishment, salt marsh maintenance and restoration projects.
- ✓ Develop a Town-wide and regional beach nourishment plan.
- ✓ Evaluate the use of community-wide standards for elevating buildings to: 1) provide community aesthetic consistency; and 2) reduce the challenges of elevating roads (i.e., multiple, differing entry elevations.) Review and modify the Town's Floodplain Management Ordinance to incorporate coastal resilience and adaptation.

High Priority Actions

- ✓ Develop a permit, maintenance and operations plan for stormwater structures including tide gates and culverts for pre- and post-flood recovery operations, to promote post-flood drainage.
- ✓ Prepare detailed application plan for grant opportunities, including FEMA Hazard Mitigation Grant, USACE, NOAA, HUD, CIRCA, DOT, DECD and EPA programs. Initiate grant applications.
- ✓ Review and update annually Emergency Action Plans (EAP) and Maintenance and Operations Plans for the 3 High Hazard Dams in Old Saybrook to ensure the plans are up to date & have protocols in place to maintain safe operations of the Dams during natural hazard events.

High Priority Actions

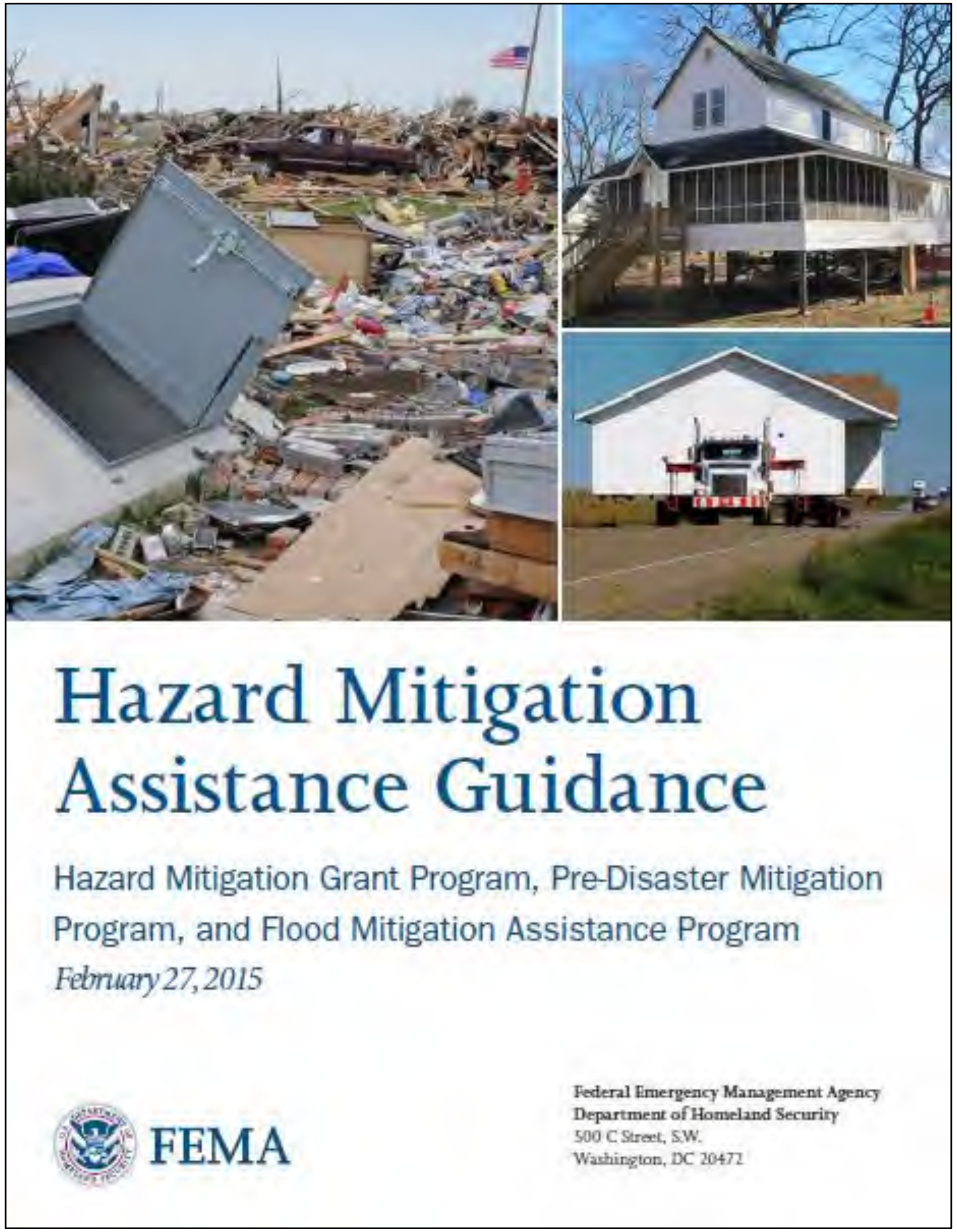
- ✓ Provide flood mitigation guidance to property owners that is consistent with Historic District Regulations. Develop a Town-wide and regional beach nourishment plan.
- ✓ Initiate an on-going discussion with residents regarding: 1) the possibility of using perimeter flood protection berms as public greenways 2) Land acquisition for: a) future relocation; b) expansion of tidal marsh; c) conservation land, including beachfront property; 3) Process for developing perimeter flood protection berms, including easements or land acquisitions, and responsibility for maintenance and operation during flooding; 4) Long-term retreat from very high vulnerability areas, including the beaches. Attachment 7 of the 2018 Coastal Resilience Study presents a detailed discussion on land acquisition.

Federal Funding Opportunities

- **FEMA Hazard Mitigation Assistance Grants**
  - Hazard Mitigation Grant Program (HMGP)
    - **DR-4385 & 4410 - $275k**
  - Flood Mitigation Assistance (FMA)
    - **FY18- $160 Million**
  - Pre-Disaster Mitigation (PDM)
    - **FY18- $235 Million**

  https://www.fema.gov/hazard-mitigation-assistance
- **HUD Disaster Recovery and Resiliency Grants**
  - Community Development Block Grant (CDBG) Disaster Recovery

  https://www.hudexchange.info/programs/cdbg-dr/



Federal Funding Opportunities

- **EPA Water Infrastructure Finance and Innovation Act**
  - $6Billion in credit that could finance $12Billion in water infrastructure projects
  - Letters of Interest due July 5, 2019

  https://www.epa.gov/wifia/how-apply-wifia-assistance-0#notice
- **NOAA Coastal Resilience Grant Program**
  - $12 Million available annually 2015 to 2017
  - Focus Areas
    - Natural and nature-based infrastructure
    - Post-disaster recovery
    - Assessing risk, prioritizing actions

    https://www.coast.noaa.gov/data/resilience/factsheet-resilience-grants.pdf

State and Additional Funding Opportunities

- **Connecticut Resilience Programs**
  - **CIRCA Grants -** $100-$300k annually
    - Municipal Resilience Grant Program
    - https://circa.uconn.edu/funds-muni/
    - Matching Funds Program
    - https://circa.uconn.edu/funds/
  - **Connecticut's Clean Water Fund**
  - **Non-point Source (Section 319) Grant Program**
- **Tax Increment Financing**
- **Local and State Tax Revenue**
- **Resilience Bonds**

Next Steps

Next Steps

1. Upload Draft Hazard Mitigation Plan
2. Make Revisions and Finalize Plan
3. Submit Draft Plan to CT DEMHS/FEMA
4. Revise, as needed
5. Plan Adoption

Attachment 7: References and Resources

Old Saybrook/Fenwick Natural Hazard Mitigation Plan **GZA**

- Connecticut 2019 State Natural Hazard Mitigation Plan. (https://portal.ct.gov/-/media/DEMHS/_docs/Plans-and-Publications/State-of-Connecticut-Natural-Hazard-Mitigation-Plan---2019.pdf)
- Connecticut 2018 State Building Code. (https://portal.ct.gov/DAS/Office-of-State-Building-Inspector/Connecticut-State-Building-Code/Regulations)Connecticut Confronting Climate
- Change in the U.S. Northeast, Union of Concerned Scientists 2007 https://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/pdf/confronting-climate-change-in-the-u-s-northeast.pdf
- Federal Emergency Management Agency (FEMA), Local Mitigation Plan Review Guide, October 2011. https://www.fema.gov/media-library-data/20130726-1809-25045-7498/plan_review_guide_final_9_30_11.pdf
- FEMA, Mitigation Ideas, January 2013. https://www.fema.gov/media-library-data/20130726-1904-25045-2423/fema_mitigation_ideas_final_01252013.pdf
- FEMA, Hazus-MH 2.1 Earthquake Model Technical Manual, July 2013. https://www.fema.gov/media-library-data/20130726-1820-25045-6286/hzmh2_1_eq_tm.pdf
- FEMA, Hazus-MH Flood Model Technical Manual, July 2013. https://www.fema.gov/media-library-data/20130726-1820-25045-8292/hzmh2_1_fl_tm.pdf
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- FEMA, Local Mitigation Planning Handbook, March 2013. https://www.fema.gov/media-library-data/20130726-1910-25045-9160/fema_local_mitigation_handbook.pdf
- FEMA, Hazard Mitigation Assistance Guidance, February 2015. https://www.fema.gov/media-library-data/1424983165449-38f5dfc69c0bd4ea8a161e8bb7b79553/HMA_Guidance_022715_508.pdf
- FEMA, National Flood Insurance Program Flood Insurance Manual, April 2018. https://www.fema.gov/media-library/assets/documents/162601
- FEMA, Flood Insurance Rate Maps (11 panels) for Old Saybrook and Fenwick effective August 28, 2008 (3 panels) and February 6, 2013 (8 panels).
- FEMA, Middlesex County, MA Flood Insurance Study No. 09007CV001B**,** February 6, 2013.
- Borough of Fenwick Flood Ordinance, effective February 6, 2013 (https://www.boroughoffenwick.com/sites/fenwickct/files/file/file/floodordinance.pdf)
- Borough of Fenwick Plan of Conservation and Development (https://www.boroughoffenwick.com/sites/fenwickct/files/file/file/borough_of_fenwick_pocd_adopted_10.07.2017.pdf) 2017
- Borough of Fenwick Zoning Regulations, effective September 1, 2018 (https://www.boroughoffenwick.com/sites/fenwickct/files/file/file/2011_borough_of_fenwick_zoning_regulations_amended_through_9.1.18.pdf)
- Middlesex Health Urgent Care Website (https://middlesexhealth.org/urgent-care)
- Mitigation Action Plan, City of Portland, Oregon (ftp://ftp02.portlandoregon.gov/pbem/MitigationActionPlan-FullText/2016_PortlandMAP_AgencyReviewDraft_2016-09-29.pdf), 2016
- National Oceanic and Atmospheric Administration (NOAA), NOAA Storm Events Database https://www.ncdc.noaa.gov/stormevents/
- The Nature Conservancy and Clark University Adapting to Coastal Storms and Flooding (https://www.rivercog.org/Documents/SaltMarshAdvancementZoneAssessmentOS092313.pdf) 2014
- The Nature Conservancy A Salt Marsh Advancement Zone Assessment of Old Saybrook (https://www.rivercog.org/Documents/SaltMarshAdvancementZoneAssessmentOS092313.pdf), 2013
- Town of Old Saybrook Zoning By-Laws, Effective March 1, 2019 (https://www.oldsaybrookct.gov/zoning-commission/pages/current-zoning-regulations)

- Town of Old Saybrook Community Wastewater System Desktop Evaluation(https://www.oldsaybrookct.gov/water-pollution-control-authority-wpca/news/wright-pierce-january-2019-desktop-evaluation-released), 2019
- Town of Old Saybrook Coastal Community Resilience and Climate Adaptation Study (https://www.oldsaybrookct.gov/conservation-commission/pages/coastal-resilience), 2018
- Town of Old Saybrook Chapter 128 Floodplain Management, effective March 6, 2017 (https://ecode360.com/8719025)
- Town of Old Saybrook Sea Level Rise Climate Adaptation Report of Findings (https://www.oldsaybrookct.gov/sites/oldsaybrookct/files/uploads/slrcac_report_of_findings_0.pdf), 2015
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- Town of Old Saybrook Plan of Conservation and Development (https://www.oldsaybrookct.gov/sites/oldsaybrookct/files/uploads/plan_of_conservation_development.pdf) 2006
- Town of Old Saybrook Local Development Program: Municipal Coastal Program Report, 1983
- Town of Old Saybrook Fire Department website (http://www.oldsaybrookfire.com/), 2019
- Town of Old Saybrook Police Department website (https://www.oldsaybrookct.gov/police-services), 2019
- U.S. Army Corps of Engineers, North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk, January 2015 http://www.nad.usace.army.mil/Portals/40/docs/NACCS/NACCS_main_report.pdf
- U.S. Census. 2010 https://www.census.gov/data.html
- U.S. Fire Death Rates by State, National Fire Protection Association (NFPA), September 2018 https://www.nfpa.org/News-and-Research/Fire-statistics-and-reports/Fire-statistics/Fires-in-the-US/Overall-fire-problem/Fire-deaths-by-state

Attachment 8: Key Contacts

Old Saybrook/Fenwick Natural Hazard Mitigation Plan **GZA**

KEY CONTACTS

CONNECTICUT DIVISION OF EMERGENCY MANGEMENT AND HOMELAND SECURITY (DEMHS)

Headquarters
360 Broad Street, Hartford, CT

Ken Dumais (**Primary point of contact)**
State Hazard Mitigation Officer
Office (860) 256-8151
Email: Kenneth.dumais@ct.gov

Natalie Simoneau (Regional point of contact)
Regional Secretary
860-685-8104

DEMHS Headquarters
860-529-6893

DEMHS Region II Office
860-685-8105

https://portal.ct.gov/DEMHS/Emergency-Management/Resources-For-Officials/Regional-Offices
https://portal.ct.gov/demhs

TOWN OF OLD SAYBROOK OFFICE OF EMERGENCY MANAGEMENT

Town Office of Emergency Management
Town Hall, 302 Main Street, Old Saybrook, CT 06475
Staff Contact: Mr. Michael Spera, Police Chief
860-395-3142

- Emergency Management
  302 Main Street
  Old Saybrook, CT 06475
  860-395-3072
- Fire Department HQ
  310 Main Street
  Old Saybrook, CT 06475
  860-395-3149
- Police Department
  36 Lynde Street
  Old Saybrook, CT 06475
  860-395-3142
- Public Works
  Town Garage
  477 Middlesex Turnpike
  Old Saybrook, CT 06475
  860-395-3186
- Water Pollution Control Authority
  302 Main Street
  Old Saybrook, CT 06475
  (860) 395-2876

911

KEY CONTACTS

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA):

Connecticut Contacts

Region I
99 High St.
Boston, MA 02110
1-877-336-2734
fema-r1-info@fema.dhs.gov

Melissa A. Surette, Senior Planner
Risk Analysis Branch, Mitigation Division

Melissa.Surette@fema.dhs.gov
Office: 617.956.7559
Cellular: 617.794.0292

DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION

DEEP Land & Water Resources Division,
79 Elm Street, Hartford, CT 06106-5127
Main Office: 860-424-3000

State National Floodplain Insurance Coordinator

Diane Ifkovic
Bureau of Water Protection and Land Reuse, Land & Water Resources Division,
Connecticut Department of Energy and Environmental Protection
79 Elm Street, Hartford, CT 06106-5127
P: 860.424.3537|F: 860.424.4075 |E: diane.ifkovic@ct.gov

AMERICAN RED CROSS:

Connecticut Contacts

1031 Route 32
Uncasville, CT 06382

1-877-287--3327
(855) 891-7325 (24/7)
https://www.redcross.org/about-us/our-work/disaster-relief.html
https://www.redcross.org/get-help.html
https://www.redcross.org/local/connecticut/about-us/our-work.html

SALVATION ARMY

Connecticut Emergency Disaster Relief

11 Governor Winthrop BLVD
New London, CT 06320
(860) 702-0003
Carol.Duperree@use.salvationarmy.org

https://ctri.salvationarmy.org/SNE/EDS
https://ctri.salvationarmy.org/SNE/I-Want-To-Volunteer-For-The-Salvation-Army