
TOWN OF GROTON ANNEX DOCUMENT

Southeastern Connecticut Council of Governments
Multi-Jurisdictional Hazard Mitigation and Climate Adaptation Plan Update

March 2023



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1. Introduction

1.1. Purpose of Annex

The planning process for the multi-jurisdiction hazard mitigation plan update commenced in April 2022 and ended in December 2022, spanning a period of nine months. The planning process included 24 jurisdictions (22 municipalities and two tribal governments) with two participating together (Griswold and Jewett City) for a net total of 23 local planning teams represented. For this 4th edition of the plan, SCCOG elected to link the planning process to a parallel planning process administered by the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) that is known as “Resilient Connecticut 2.0” (stylized as *Resilient Connecticut*). The *Resilient Connecticut* program is described on CIRCA’s web site at <https://resilientconnecticut.uconn.edu/> and the expansion of the program into southeastern Connecticut is described at <https://circa.uconn.edu/2022/02/23/resilient-connecticut-expands-statewide/>.

The linkage of the two planning processes was advantageous for the following reasons:

- Incorporation of climate change into the hazard mitigation plan update
- Increased interest from the local communities, especially for those interested in developing climate adaptation strategies.
- Direct incorporation of climate change vulnerability products developed by CIRCA including the Climate Change Vulnerability Index (CCVI) for flood and extreme heat vulnerabilities.
- Direct incorporation of combined sea level rise and coastal flood inundation simulations from CIRCA
- Positioning of the SCCOG jurisdictions for new funding sources in Connecticut such as the new Department of Energy and Environmental Protection (DEEP) Climate Resilience Fund (DCRF)
- Consistency with the Governor’s Council for Climate Change (GC3) outcomes from the 2020-2021 planning process
- Positioning of the actions for incorporation on the State’s “resilience project pipeline” per Executive Order (EO) 21-3 issued at the end of 2021.

The planning process commenced for the local communities on April 20, 2022 with a presentation to the SCCOG Board. During this presentation, the consultant and CIRCA described the planning process and the approach for incorporating the *Resilient Connecticut* program into the hazard mitigation plan update, and notified the chief elected officials that invitations to local planning meetings would follow at the end of April. Local planning team meetings commenced on May 23, 2022 and ended on July 8, 2022. Workshops with local coordinators were conducted in July and September 2022, and supplemental meetings with water utilities in the region and specific stakeholders continued through November 2022.

1.2. Hazard Mitigation and Climate Adaptation Goals

The primary goal of the previous hazard mitigation plans adopted in 2013 and 2018 was to identify risks to hazards and potential mitigation measures for such hazards in order to **reduce the loss of or damage to life, property, infrastructure, and natural, cultural, and economic resources**. This included the reduction of public and private damage costs. Limiting losses of and damage to life and property was also meant to reduce the social, emotional, and economic disruption associated with a natural disaster.

Coinciding with the incorporation of climate adaptation and the alignment of this HMCAP with the *Resilient Connecticut* planning process administered by CIRCA, five new goals were developed for this HMCAP:

- Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.
- Address risks associated with extreme heat events, especially as they interact with other hazards.
- Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.
- Reduce losses from other hazards.
- Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.

2. Community Profile

The Town of Groton is an urbanized municipality located in the south-central portion of the southeastern Connecticut shoreline. The local government of the Town is separate from that of the City of Groton (a political subdivision of the municipality). The Town is bordered by the Thames River to the west, Ledyard to the north, Stonington to the east, and Fishers Island Sound to the south. The Town of Groton can be accessed by Interstate 95 and the Boston Post Road (Route 1). According to the 2010 U.S. Census, Groton had a year-round population of 40,115 people. The 2020 census data revealed a population of 27,450, a large decrease, though this figure does not include the population of Groton City which is 9,146 as of 2020.

2.1. Physical Setting

The Town of Groton is a coastal community located on the Connecticut shoreline. Elevations range from sea level along the Thames River and Fishers Island Sound to just over 300 feet in the northern portion of the Town.

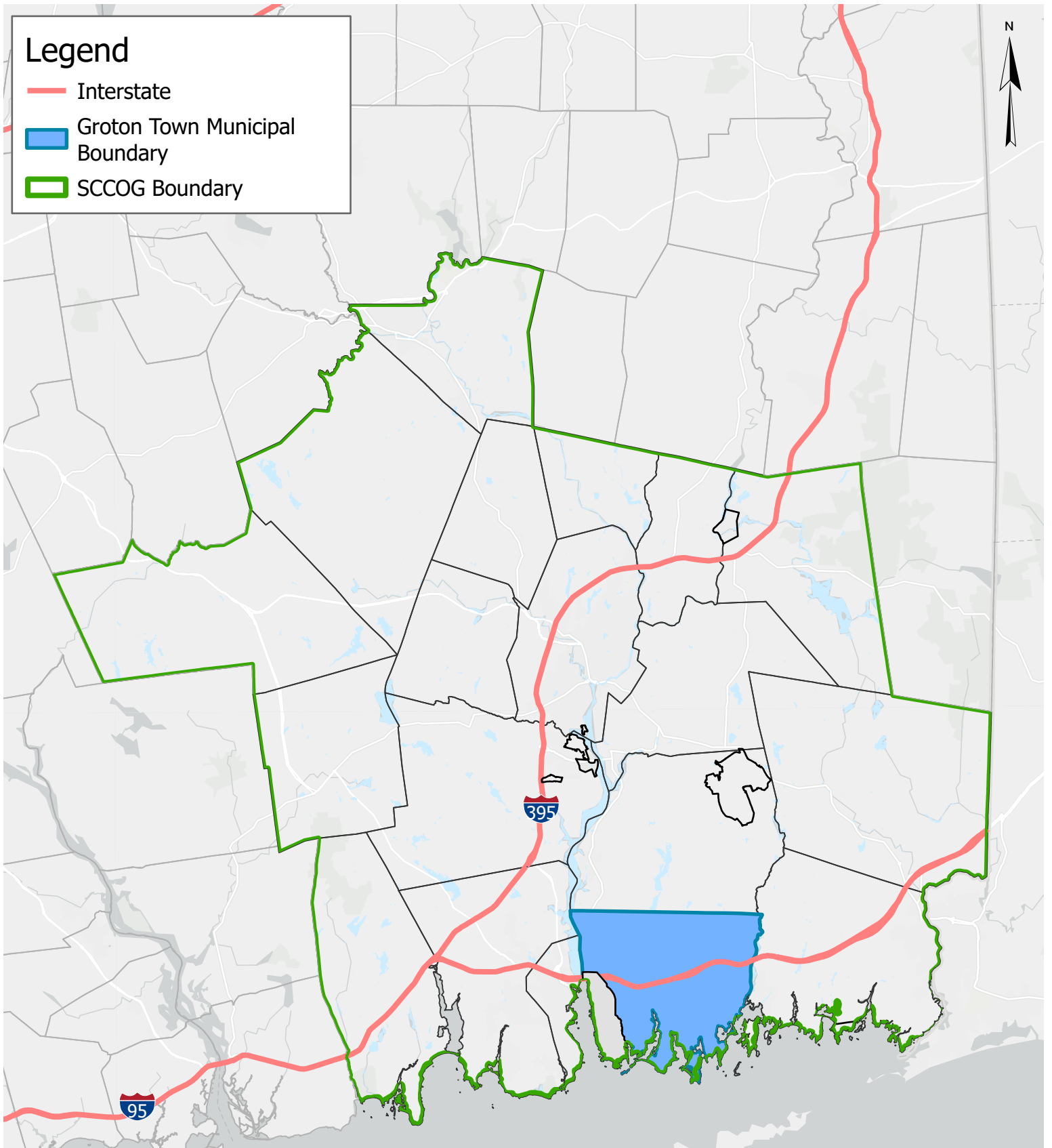
Geology is important to the occurrence and relative effects of natural hazards such as earthquakes. The Town of Groton lies above four bedrock types which trend northwest to southeast across the area. These are the Potter Hill Granite Gneiss, the Plainfield Formation and the quartzite member of the Plainfield Formation, Rope Ferry Gneiss, and small intrusions of Westerly Granite. Each of these formations consists primarily of gneiss, a relatively hard metamorphic rock except for the hard, igneous granite intrusions. Two faults are mapped within the eastern section of the town, trending north-south. Although they are believed to be inactive, they are associated with the Honey Hill/Lake Char fault system that extends west to east through Salem, Montville, and Preston and has been linked to minor seismic activity in East Haddam.

The Town's surficial geologic formations include glacial till, stratified drift, and coastal formations. Refer to the Multi-Jurisdictional HMCAP for a generalized view of surficial materials. The majority of the Town is underlain by glacial till. Till contains an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. The exception is a vast area from Poheganut Reservoir and Smith Lake, extending south along the Poquonock River (also spelled "Poquonnock") and west through the airport which is underlain by stratified drift. Other minor stratified drift deposits are found along watercourses.

The amount of stratified drift present is important as areas of stratified materials are generally coincident with floodplains. These materials were deposited at lower elevations by glacial streams, and these valleys were later inherited by the larger of our present day streams and rivers. However, the smaller glacial till watercourses can also cause flooding. The amount of stratified drift also has bearing on the relative intensity of earthquakes and the likelihood of soil subsidence in areas of fill.

Legend

- Interstate
- Groton Town Municipal Boundary
- SCCOG Boundary

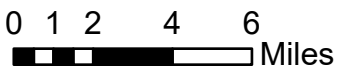


Regional Location of Groton Town

SCCOG Hazard Mitigation and Climate Adaptation Plan

Town of Groton

Date: 7/22/2022



Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS

2.2. Drainage Basins and Hydrology

Groton is divided among six sub-regional watersheds: Great Brook (including the Poquonock River, Haleys Brook, Mystic River, Southeast Shoreline, Thames River, and Whitford Brook. All of the drainage basins directly or indirectly drain to Long Island Sound.

Streams in the extreme western part of Town drain to the Thames River. Streams in the north-central region of the Town drain to Great Brook, which discharges to the Poquonock River. Streams in the northeast part of Town drain to Red Brook, Haleys Brook, and Blindloss Brook, flowing eastward towards the Mystic River. Streams in the central and southern portion of the Town drain southward to Birch Plain Creek eventually discharging to the sound in Baker Cove; Fort Hill Brook eventually discharging to the sound in Mumford Cove; and Eccleston Brook or Fishtown Brook eventually discharging to the sound in Palmer Cove.

In addition, the town contains a number of large reservoirs, namely Ledyard Reservoir, Groton Reservoir (extending both north and south of I-95), Poheganut Reservoir, and Smith Lake. These are public water supply reservoirs owned by Groton Utilities.

2.3. Land Cover

According to the 2016 1-meter resolution land cover developed by the NOAA Office of Coastal Management, Groton is predominantly comprised of mixed forest, with approximately 55.77% of the town classified as such. The second largest land cover type is developed impervious, which covers about 14.82%, and next is developed open space which is about 12.42% of land cover. All land covers and their percent coverage can be found in Table 2-1.

Table 2-1 Town of Groton Land Cover

Land Cover Type (2016)	% Coverage
Barren Land	1.43
Developed, Impervious	14.82
Developed, Open Space	12.42
Estuarine Emergent Wetland	1.56
Estuarine Scrub/Shrub Wetland	0.09
Grassland/Herbaceous	2.15
Mixed Forest	55.77
Open Water	4.34
Palustrine Aquatic Bed	0.30
Palustrine Emergent Wetland	0.64
Palustrine Forested Wetland	3.97
Palustrine Scrub/Shrub Wetland	0.29
Scrub/Shrub	1.88
Unconsolidated Shore	0.35

2.4. Population, Demographics, and Development Trends

The principal communities of Groton include:

- Burnett's Corner
- Center Groton

- City of Groton (addressed in a separate annex)
- Poquonock Bridge
- Groton Long Point
- Noank
- Long Hill
- West Mystic (the village of Mystic spans eastern Groton and western Stonington)
- Old Mystic (Old Mystic also spans eastern Groton and western Stonington)
- Submarine Base area

The Town of Groton has an extensive coastline which includes several peninsulas (such as Groton Long Point and Noank) as well as the west bank of the Mystic River and its shoreline. A large tract of land called Bluff Point, a State coastal preserve, lies along the shoreline between the Poquonock River estuary and Mumford Cove. Groton-New London Airport is located within the south-central portion of Groton. The U.S. Naval Submarine Base is situated along the Thames River spanning into the Towns of Groton and Ledyard. A large number of residents living in the Town of Groton are employed by or stationed at the submarine base. Other notable employers in the area include the Pfizer Corporation, Electric Boat, and the University of Connecticut at Avery Point (all three located in the City of Groton).

Developable land and opportunities are present in Groton, and a number of new developments have been completed within the last few years:

- A mixed-use building at 3 Water Street was recently completed. It is thought that this is the type of construction that could continue in town.
- Moderate development/pressures recently in Mystic near the Poquonock Bridge.
- A new middle school was recently constructed.
- The Chester School property is closed, and discussions are beginning on how to redevelop the site. There are thoughts that the location may become playing fields, or portions of the building may be redeveloped to house businesses or daycares. The future of the site is yet to be determined.

For the most part, these projects are located outside of flood hazard areas and away from steep slopes, within areas of public water service and fire protection. Therefore, disaster resilience is expected to remain high for new projects.

As of the 2020 Decennial Census, the population for the town (excluding the City of Groton) is 27,450, which equates to about 713 people per square mile. The 2020 American Community Survey 5-year estimates identified the annual average median income for Groton to be \$88,615, with an average of 42.1% of the population holding a Bachelor’s Degree or higher, and an average unemployment rate of 6.8% throughout town.

2.5. Governmental Structure

Groton is governed by a Council-Manager form of government. The Town Council is the legislative body of the Town. The Town Manager is appointed by and is directly responsible to the Council and serves for no definite term. The Town Manager plans, organizes, coordinates, and administers the day-to-day

functions of the Town government. The Manager is responsible for the preparation of the general government budget. Before approving the budget, the Council must hold public hearings.

The Town of Groton is responsible for education, public works, and police services throughout its municipal boundaries. The City of Groton is responsible for most services within its own boundaries and maintains its own HMP annex. Groton has three additional political subdivisions or jurisdictions. These are Noank, Groton Long Point, and the Navy Base. Although all three are covered in the subject HMP annex, they maintain separate governmental or organizational structures. In particular, Groton Long Point and Noank maintain their own zoning regulations. The following graphic (Figure 2-2) depicts the relationships between Groton Town, Groton City, Noank, Groton Long Point, and the Navy Base. For clarification, some of the Groton villages such as Center Groton are listed in the chart.

	Poquonnock Bridge	Center Groton	Mystic	Old Mystic	West Pleasant Valley	Noank	Groton Long Point	City of Groton	Navy Base
Overall Government	Town of Groton					Town & Noank	Town & GLP	Town & City	Navy
Education	Town of Groton								
Public Works	Town of Groton						GLP	City of Groton	Navy
Police	Town of Groton						GLP	City of Groton	Navy
Wetlands	Town of Groton						GLP	City of Groton	Navy
Land Use Planning	<i>Town of Groton</i>						GLP	City of Groton	Navy
Zoning	<i>Town of Groton</i>					Noank	GLP	City of Groton	Exempt
Recreation	Town of Groton					Town & Noank	Town & GLP	Town & City	Town & Navy
Ambulance, Rescue & Paramedic	Groton Ambulance Association (GAA)		Mystic River Ambulance Association		GAA	Mystic River Ambulance Association		GAA	Navy & GAA

Figure 2-2 Public Service Responsibilities by Fire District for the Town of Groton (From the 2016 POCD)

The Town of Groton has several departments that provide municipal services. Departments pertinent to natural hazard mitigation include the Office of Emergency Management, Office of Planning and Development Services, Police, and Public Works. In addition, the fire districts (described in Section 2.7) and several boards and commissions that can take an active role in hazard mitigation, including the Conservation, Harbor Management, Planning, Zoning, and Economic Development Commissions. The general roles of most of these departments and commissions are common to most municipalities in SCCOG and were described in Section 2 of the Multi-Jurisdictional HMCAP. More specific information for certain departments and commissions of the Town of Groton is noted below:

- The Office of Emergency Management is separate from the fire districts and oversees emergency management, EOC operations, and the Town of Groton's Emergency Communications Center (ECC).
- The Office of Planning and Development Services merges the duties and responsibilities of the former Planning Department, Building Inspection Office, Office of Community Development, and Economic Development staff. The agency acts as a liaison with State and local agencies, carries out development activities on behalf of the Town and provides planning and staff assistance to the Town Manager's Office, land use and other boards and commissions, and other Town

departments and political subdivisions. The office carries out its mission through four divisions: Planning and Environmental Protection, Inspection Services; Community Development; and Economic Development.

- The Building Official has a unique responsibility when it comes to hazard mitigation as he or she is responsible for overseeing a number of codes such as those related to wind damage prevention as well as those related to inland and coastal flood damage prevention. Many important types of pre-disaster mitigation are funneled through and enforced by the Building Department. For example, the Inspection Services Division enforces A- and V-zone standards for floodproof construction and building elevations, maintains elevation certificates, and enforces building codes that protect against wind and fire damage.
- Day-to-day duties of the Police Department include crime prevention, criminal investigations, traffic enforcement, motor vehicle accident investigations, and patrols. Duties related to natural hazard mitigation include planning and coordination of personnel, equipment, shelters, and other resources necessary during an emergency. The types of mitigation that are directly administered by the Police Department include mainly emergency services and public education.
- The Public Works Department maintains the infrastructure of roads, bridges, and stormwater management. The Public Works Department also conducts snow removal and deicing on roads; tree and tree limb removal in rights-of-way; and maintains and upgrades storm drainage systems to prevent flooding caused by rainfall. As is common throughout Connecticut, the Public Works Department is often charged with implementing numerous structural projects that are related to hazard mitigation. Specifically, roadway/infrastructure maintenance and complaint logging/tracking are the two primary duties of the Public Work Department. For example, the Public Works Department tracks, plans, prepares for, and responds to flooding, inundation, and/or erosion of roads and infrastructure such as the sewer pumping station and the wastewater treatment plants.
- The Inland Wetlands Agency enforces the Inland Wetland Regulations and reviews development projects in wetlands and the adjacent review areas.
- The Conservation Commission maintains an index of all open areas and recommends to the planning commission plans and programs for the development and use of such areas. The Commission may acquire land and easements in the name of the town and promulgate rules and regulations, including charges for the use of the land and easements. It may supervise and manage town-owned open space or park property upon delegation by the entity which has responsibility for such property.
- The Harbor Management Commission oversees the development and use of the coastal waters in and around the Town of Groton. The commission maintains the Town's Harbor Management Plan; proposes ordinances and regulations to implement the plan and specifies fines for violation; assists the harbormaster in the assignment of mooring and anchorage areas and the collection of mooring fees; prepares an operating budget; assists in the coordination of all agencies which provide service based upon the harbor; reviews any application for a state or federal permit within its jurisdiction and responds with recommendations; and conducts studies of the conditions and operations in and out of town waters and presents proposals.

- The Planning Commission and Zoning Commission oversees orderly and appropriate use and development of residential, commercial, and industrial land and the conservation of natural resources. They review and approve a wide range of land use applications, zoning regulation amendments, planning and development projects, and grant opportunities to ensure that development and growth in the Town is consistent with existing land use, environmental policy, and the objectives of the Plan of Conservation and Development. They are assisted by the professional staff of the Office of Planning and Development Services who administer the Town's Zoning and Subdivision regulations, administer the Coastal Management Program, perform planning studies, and provide technical assistance to developers and the public.
- The Economic Development Commission conducts research into the economic conditions and trends, makes recommendations regarding action to improve the economic condition and development, and seeks to coordinate the activities of and cooperate with unofficial bodies.
- Groton Utilities provides electricity and potable water to portions of the Town. They maintain and test fire hydrants utilized by the Fire Department. Connecticut Light & Power, Aquarion Water Company, and Comcast are the other utility providers in the area.

Town staff report that budget cuts have forced staffing reductions since the time of the previous HMP; nevertheless, the roles of Town departments have not significantly changed. Practically this has resulted in fewer staff members performing the same duties as were previously accomplished with a larger staff. Despite this, the Town of Groton continues to be technically, financially, and legally capable of implementing mitigation projects for natural hazards.

2.6. Review of Existing Plans and Regulations

The Town has several Plans and regulations that suggest or create policies related to hazard mitigation. These policies and regulations are outlined in the Emergency Operations Plan, Plan of Conservation and Development, Zoning Regulations, Subdivision Regulations, and Inland Wetland Regulations.

Plan of Conservation and Development

The Plan of Conservation and Development was adopted in 2016 with contributions from local boards and commissions, citizens, and citizen groups. The purpose of the plan is to balance growth with maintaining the quality of life that citizens within the Town embrace. A major goal of the most recent update was to incorporate the themes of energy and sustainability into each planning area.

In addition to acting as a standalone planning document, the POCD explicitly integrates other planning documents. Included in this are the Municipal Coastal Program and the 2012 edition of the Hazard Mitigation Plan.

Recommendations of the POCD include several related to hazard mitigation throughout the plan, including:

- Develop Low Impact Development Regulations
- Review and retrofit town-owned stormwater basins and drainage structures to improve water quality
- Update regulations to conserve important natural resources

- Fund open space acquisition annually in the Capital Improvement Program
- Revise the Zoning and Subdivision regulations to increase open space and recreation requirements and to provide standards for improvements
- Develop an action plan to establish, expand, and connect greenbelts and State Greenways both within Groton and with adjacent towns.
- Complete a Harbor Management Plan for Groton
- Develop a program to prioritize and implement the selected strategies outlined in the Municipal Coastal Program, including development of plans to restore eroded tidal marshes, to acquire land for marsh advancement, and to reduce the direct discharge of stormwater to coastal waters.
- Create a coastal overlay zone to manage coastal development.
- Include historic assets and historic districts as critical features that merit protection and/or planning when considering Disaster Mitigation Plans, especially with regards to flooding, storm surge, sea level rise, and coastal erosion.

The Groton POCD is considered consistent with the current goals and actions of the hazard mitigation plan, as it directly references the 2012 Hazard Mitigation Plan. The next update to the POCD (scheduled for 2026, outside the life of the current hazard mitigation plan) should continue to incorporate the elements of the hazard mitigation plan and climate change adaptation planning.

Emergency Operations Plan

The Town has an Emergency Operations Plan (EOP) that is updated annually. This document provides general procedures to be instituted by the Town Manager and/or designee, Police Department, and Fire Department in case of an emergency. Emergencies can include but are not limited to natural hazard events such as hurricanes and nor'easters. The EOP is directly related to providing emergency services prior to, during, and following a natural hazard event. A physical copy of the EOP is housed at the Police Department.

Zoning and Subdivision Regulations

In Groton, the Planning and Zoning Commission is charged with administering the Zoning Regulations. Current Zoning Regulations are effective November 2, 1987 and have been revised through July 15, 2022. Updates since the previous HMP include incorporation of the DFIRMS adopted in 2013, and changes to the Waterfront Design District, Open Space Subdivisions, and Erosion and Sediment Control Plan. Additional changes to Flood Protection Regulations were made in 2015.

Flood protection regulations are found in Section 7.2 and Coastal Resource Setbacks are found in Section 6.1. Section 7.2 is essentially the local articulation of the NFIP regulations. Groton identifies Coastal AE zones (seaward of the Limit of Moderate Wave Action) as having a higher risk than other AE zones and requires that new or substantially improved residential structures have one-foot of freeboard in Coastal AE zones. One foot of freeboard is also required for all new construction and substantial improvement in V zones. Substantial Improvement is defined as cumulative over a one-year period.

The Coastal Resources Setback section prohibits new building construction, including minor additions to or modifications of existing buildings or detached accessory buildings, such as garages, utility sheds, pools, tennis courts, or parking lots within 50 feet of any of the following Coastal Resource Areas: coastal waters, tidal wetlands, coastal bluffs, escarpments, beaches or dunes. This section is believed appropriate for facilitating disaster-resistant construction. The section does not apply to water-dependent uses.

One of the more recent updates, made in August 2021, includes an exception that allows building heights in the SFHA to be increased five feet above the allowed maximum to allow for elevations in the flood zones.

Subdivision Regulations

The Groton Subdivision Regulations have been amended through November 1, 2006. In Groton, the Planning Commission is charged with administering Subdivision Regulations. Components of the regulations that directly or indirectly address hazard mitigation (flooding, public safety, etc.) are found in Section 4.4 - Drainage, Storm Sewer, and Flood Prevention. The regulations also require fire protection by extension of the public water system and installation of hydrants, where feasible.

Inland Wetland and Watercourses Regulations (2011)

In Groton, the Inland Wetlands Commission is charged with administering the Inland Wetland and Watercourses Regulations. The Groton Inland Wetlands and Watercourses Regulations have been amended through July 1, 2011. In Connecticut, wetlands are identified as related to flood hazard mitigation within the state enabling regulations, and this is often stated as such in the title section of local regulations. Review areas in Groton are variable as follows:

- Within 150 feet measured horizontally from Eccleston Brook, Bindloss Brook, Fort Hill Brook and Birch Plain Creek;
- Within 200 feet measured horizontally from Great Brook, Beaver Dam Brook, Hatching House Brook, Hempstead Brook, and Haley Brook; and
- Within 100 feet measured horizontally from the boundary of any other wetland or watercourse.

The variable regulated area is believed to moderately assist with review of flood-related issues when considering land development applications.

Municipal Coastal Program (2016)

The Municipal Coastal Program (MCP) exists as a stand-alone document, and its recommendations are included within the POCD. It was updated concurrently with the POCD. The document includes identification and description of the major coastal-related issues and problems such as erosion, flooding, recreational facilities, and utilization of port facilities. It includes a description of the municipal boards, commissions and officials responsible for implementing and enforcing the coastal program and review of coastal site plan reviews. Most significantly, the MCP serves as the Town's coastal resilience plan, since it reviewed sea level rise and future flood risks to help inform objectives and specific actions.

Climate Change Planning

The Town of Groton has participated in an EPA-funded climate change planning process in 2010 and 2011. The process resulted in the report "Preparing for Climate Change in Groton, Connecticut: A Model Process for Communities in the Northeast" (April 2011). During the workshops held in Groton, workshop participants identified the following as climate related impacts likely to affect Groton:

- More frequent river and coastal flooding;
- Increased coastal erosion;
- Increased precipitation, flooding, drought, and erosion;
- More frequent flooding that could prevent access to and reduce function of Groton-New London Airport;
- Access to state parks such as Bluff Point and Haley Farm could be hampered by flooding;
- Docks and marina facilities could be damaged by flooding and sea level rise;
- Increased economic impacts related to infrastructure replacements, loss of employment hours, additional emergency service personnel, and others arising from no action scenarios;
- Sections of Amtrak railroad could flood under certain sea level rise and storm flooding scenarios;
- Mystic River bridge may experience additional openings for smaller boats as bridge clearance diminishes with sea level rise;
- Overall quality of life, aesthetics, and enjoyment of citizens may be reduced.

Specific locations were also identified by workshop participants as vulnerable to climate change impacts such as sea level rise, increased storm frequency, and increased storm intensities:

Transportation

- Poquonnock Road
- Fort Hill Road
- Groton Long Point Road
- Route 649 Amtrak railroad underpass
- Route 117 at Route 1
- Route 1 at Fishtown Road
- Route 1 at Poquonnock Bridge
- Route 27 at Mystic River Bridge
- Mystic River Bridge

Other Town/City Infrastructure

- Reservoir and Water Treatment Plant
- Wastewater Treatment Plant and Pump Stations – 30% of pump stations are along the coastline
- Claude Chester Elementary School
- Cutler Middle School

Residential Locations

- Mumford Cove
- Groton Long Point
- Noank
- Eastern Point
- Mystic

Commercial Locations

- Downtown Mystic
- Poquonnock Bridge
- Airport Industrial Park

Ecological Resources

- Birch Plain Creek – Baker Cove
- Fort Hill Brook – Mumford Cove
- Eccleston Brook – Palmer Cove
- Groton Long Point Marshes

Emergency Services

- Police and Fire Operations
- Emergency Medical Services

Numerous adaptation strategies were developed by workshop participants:

1. Relocate/Elevate vulnerable roads and infrastructure – ensure emergency access and preservation of public safety during extreme events;
2. Develop Memorandums of Understanding with state personnel regarding funding of local police costs incurred to protect safety along vulnerable state owned road infrastructure during and after storm, so that police can also monitor other hazardous areas;
3. Stormwater runoff reduction program designed to control peak discharges and to require post-development rates of runoff to be no greater than pre-development conditions in most circumstances;
4. Flood-proofing of existing buildings;
5. Conversion of land upriver to wetlands in order to accommodate increased sea level rise;
6. Creation of incentives for retreat zoning and/or zoning and redevelopment restrictions and building code changes or enforcement to prevent building in the most vulnerable locations;
7. Educational programs that alert residents about climate change and vulnerable areas of the Town;
8. Purchase of vulnerable land or land that will act as a buffer by Groton;
9. More stringent building and engineering design standards that anticipate future climate conditions, as opposed to just existing conditions;
10. Beach nourishment;
11. Installation of flood/tide gates at locations such as Groton Long Point and Mumford Cove;
12. Creation of a comprehensive watershed management plan for debris and culverts, in partnership with Amtrak and CTDOT;
13. Improved road condition reports during extreme events, in order to help the school district and other agencies to identify the safest transportation routes;
14. Identification of Town, State, and Federal funding available to make the improvements to infrastructure that is deemed highly vulnerable;
15. Integrate climate preparedness into the Capital Planning process, Master Plan of Conservation and Development update process, the zoning regulations revision, and streetscape project; and
16. Investigate the logistical challenges of incorporating climate change, adaptation, and preparedness into school curriculum.

Many of the above strategies and actions were incorporated directly into the 2012 HMP, the 2016 Plan of Conservation and Development, and the Municipal Coastal Program. Specifically, strategies 1, 3-5, 7-11, and 16 were incorporated into the 2012 HMP annex as specific recommendations, with several of these themes carrying forward to the 2017 plan, and this latest update

2.7. Critical Facilities, Sheltering Capacity, and Evacuation

The Town of Groton considers numerous facilities to be critical to ensure that emergencies are addressed while day-to-day management of the Town continues. In addition, locations with populations that may be at additional risk during an emergency are also considered to be critical. Critical facilities are presented on figures throughout this annex, summarized in Table 2-2, and described below.

Table 2-2 Town of Groton Critical Facilities

Facility	Address or Location	Emergency Power	Shelter	Cooling Center	In SFHA	Hurricane Surge Zone (Category #)
Emergency Services						
Emergency Operations Center/Public Safety/Emergency Call Center (ECC)	68 Groton Long Point Rd	✓				
Groton Ambulance	217 Newtown Road					
Mystic River Ambulance	237 Sandy Hollow Rd, Mystic					
Center Groton Fire District	163 Candlewood Road, Groton					
Groton Long Point Association (Police & Fire)	5 Atlantic Avenue, Groton Long Point				✓	1
Mystic Fire District	34 Broadway, Mystic				✓	1
Noank Fire District	Ward Avenue, Noank					
Old Mystic Fire District	295 Cow Hill Road, Mystic					
Poquonnock Bridge Fire District	373 Long Hill Road, Groton					
West Pleasant Valley Fire District	140 Broad Street, Groton City					
Municipal Facilities						
Town Hall	45 Fort Hill Road, Groton	✓				
Town Garage	134 Groton Long Point Road	✓				
Shelter: Groton Senior Center	102 Newtown Road	Limited	✓	✓		
Shelter: Fitch High School	101 Groton Long Point Road	Limited	✓			
Community Center	61 Fort Hill Road					
Health Care/Senior Living						
Fairview (nursing home)	235 Lestertown Road					
Mystic River Healthcare (nursing home)	475 High Street					
Groton Regency (nursing home)	1145 Poquonnock Road					
Academy Point (senior living)	20 Academy Lane					
Grasso Gardens (senior living)	217 Newtown Road					
Pequot Village (senior living)	11 Village Lane					
AHEPA (senior living)	251 Drozdyk Drive					
Solstice at Groton (senior living)	425 Drozdyk Drive					
Haley Brook (senior living)	2590 Gold Star Highway					
Mystic River Homes (senior living)	201 Elm Street				✓	3
Other Infrastructure/Facilities						
Groton-New London Airport	155 Tower Avenue	✓			✓	1-4

Sewer pumping stations	Various	Most			Some	Some
Groton Utilities Water Treatment Plant	Filter Plant Road				✓ (0.2%)	3
Groton Wastewater Treatment Plant	170 Gary Court				✓ (0.2%)	3
U.S. Navy Base	Northwest Groton				✓	1-4

Fire and Emergency Services

The Town of Groton has nine separate fire districts, ten station houses (all critical facilities), over 30 fire-fighting vehicles, and over 200 paid and volunteer firefighters. In addition, Groton has two ambulance service companies. The nine fire districts in Groton include:

- Center Groton Fire District
- Groton Long Point Fire Department
- Noank Fire District
- Mystic Fire District (shared with Town of Stonington)
- Old Mystic Fire District (shared with Town of Stonington)
- Poquonnock Bridge Fire District
- Mumford Cove Association (contracts fire services through the Noank Fire District)
- West Pleasant Valley Fire District (contracts fire services from the City of Groton Fire District)
- City of Groton Fire District (separate HMP annex; not listed in Table 2-1 above)

As noted in the above list, two of the fire districts extend into the Town of Stonington; these are the Mystic and Old Mystic fire districts. In most cases, there is one fire station in each district. However, the Mystic and Old Mystic fire districts each have two fire stations, with one each in the Town of Stonington. The City of Groton district has two stations, as well.

Fire services are also provided by the Groton-New London airport fire service and the U.S. Navy Base Fire Department.

Municipal Buildings

The Town Hall houses land records and is the town's IT hub and is therefore a critical facility. The Town Hall Annex on Groton Long Point Road is not considered a critical facility. The adjacent Town Garage on Groton Long Point Road is a critical facility. It has a generator. These shutters came from an HMGP grant. Since the previous HMP, three schools in town have been upgraded, which includes using the State Building Code for wind load requirements.

Emergency Operations Center/Emergency Communications Center

The Town of Groton's EOC and ECC is located within the Town's Public Safety Building at 68 Groton Long Point Road. The center is a regional 9-1-1 emergency communications center and Public Safety Answering Point (PSAP) serving the Town of Groton, all of its political subdivisions, part of Stonington, and all of North Stonington. The Center is operated 24/7 by emergency dispatchers. The center receives all 9-1-1 calls originating in Groton or North Stonington and distributes the incidents to four police departments, ten fire agencies and four emergency medical services.

The Center acts as an after-hours point of contact for the community, maintaining contact telephone lists for local businesses, public works, Groton schools and LedgeLight Health District for emergency services. The center's personnel monitor a variety of weather and emergency warning and alert systems. Any warnings or alerts received are immediately distributed to emergency services, public officials and the public if necessary.

The Groton Emergency Communications Center operates a regional Central Emergency Medical Dispatch (C-MED) radio system. This radio system allows the emergency medical technician (EMT) or paramedic at the scene of an emergency or in the ambulance to communicate with medical personnel at local hospital emergency rooms. Through this system, the EMT or paramedic can receive treatment instructions and authorizations from the emergency physician while keeping the hospital advised of the patient's condition. If needed, any ambulance passing through the region can be connected with a local emergency room physician at any time.

In addition, there are three Police stations in the town: at Groton Long Point (in the same building as the Groton Long Point fire district), at the EOC, and in the City of Groton.

SCCOG completed an assessment of critical facilities in the region in 2017, fulfilling an action listed in the 2012 edition of the multi-jurisdiction hazard mitigation plan. Some of the recommendations from the critical facility study are still of interest to the Town and have been carried forward in this HMCAP update. The Town Hall on Fort Hill Road and the Groton Long Point Police/Fire complex were addressed in this study. The assessment determined that the Town Hall was not at current risk to flooding, but risk would increase over time and could be addressed with a low berm or flood wall structure; and that the Groton Long Point Police/Fire complex was at high risk to flooding that should be addressed in the short term with additional floodproofing and in the long term through relocation of the facility.

Shelters

Emergency shelters are considered to be an important subset of critical facilities as they are needed in emergency situations. Fitch High School and the Senior Center are both shelters and are staffed by the American Red Cross. Either one can serve as the primary shelter.

Both shelters have insufficient emergency power. The generator at the Senior Center can only power about one-third of the building. Neither shelter has sufficient air-conditioning to cool the space during a summertime emergency.

During Tropical Storm Irene, the high school was opened as a shelter for two nights and ran on a generator. Then it was closed, and the Senior Center was opened as a respite/meal center because it had power from the utility lines. This is an example of how both facilities can be used. During the school year, the Senior Center may be preferable as a shelter because the high school cannot serve as a shelter as easily.

A new middle school is currently being constructed. The Town is interested in ensuring it is equipped with a sufficiently effective backup generator, and having it serve as an additional shelter space.

The town identified the senior center as an official cooling center location in Groton, with the library typically used as an official cooling center by residents. The library, however, does not stay open after hours, therefore during an extended period of time the senior center would need to be utilized.

Water and Wastewater

The Groton Utilities Water Treatment Plant (WTP) is a critical facility as the town of Groton must respond to emergencies there. Also, much of the town receives water from the system. One WPCF and 23 pumping stations are critical facilities.

The effluent pumping station at the Wastewater Treatment Plant (WWTP) was redone since 2017 to make it resilient to coastal flooding and sea level rise. Flood gates were installed and electrical panels were moved out of the basement. Funding for this project was local.

Health Care, Assisted Living, Ambulance, etc.

Groton Ambulance and Mystic River Ambulance are considered critical facilities. Pequot Health is a critical facility, as it receives overflow critical care and ER patients from Lawrence & Memorial Hospital. Pequot Health remained open and staffed during Tropical Storm Irene.

The following nursing homes and senior housing facilities were identified by the Town to be critical facilities. The three nursing homes (Fairview, Mystic River Healthcare, and Groton Regency) are all located outside any FEMA flood zones or hurricane surge areas. Six of the seven active adult assisted living and Alzheimer's care facilities are also located outside flood or hurricane surge zones (Academy Point, Grasso Gardens, Pequot Village, AHEPA, Solstice at Groton, and Haley Brook). Mystic River Homes is located within both a flood zone and a Category 3 hurricane surge zone. An alternative access route to Mystic River Homes has been developed to allow for dry access during flood events.

Health care assisted living and senior living facilities that are located in flood zones should be considered for floodproofing. In addition, the facilities in flood zones and those that may be cut off from flooding should develop site-specific evacuation plans that are understood by Groton's Emergency Management Agency and upgrade their modes of egress as necessary.

Other Facilities

The Navy base is a critical facility. Although the Town is not responsible for responding to emergencies involving the base, the Town regularly supplies mutual aid emergency services to the Base when needed to supplement emergency services at the Base. In addition, the Town is responsible for handling the effect of 5,000 to 6,000 cars leaving the facility in the event of an emergency.

Groton-New London Airport is a critical facility. It offers daily flights for people traveling to or from Electric Boat, Pfizer, the National Guard, and the Navy, among others.

Evacuation Routes

The Town has an evacuation plan on file that considers an evacuation required because of an emergency at the Millstone Nuclear Power Plant in Waterford, a coastal flooding emergency, or a hurricane. In general, evacuation routes should not include roads that can become submerged during coastal storms and riverine flooding. Any changes in shelter status or shelter locations will necessarily require modifications to the evacuation map.

2.8. Repetitive Loss Properties

A repetitive loss (RL) property is defined as any insurable building that has had two or more claims exceeding \$1,000 that were paid by the National Flood Insurance Program (NFIP) within a ten-year period. As of June 2022, the Town of Groton has six RL properties affected by inland flooding, and two affected by coastal flooding. All of the six inland RL properties are residential, and the total NFIP payments for these properties are \$152,365.66. One coastal RL property is residential and the other is commercial. These two properties are impacted by the Mystic River and Mystic Harbor. The previous HMP from 2017 reported five inland flooding RL properties and one residential coastal flooding RL property. Total payments since 2017 have increased by \$39,982.03.

2.9. Exposure to Climate-Affected Natural Hazards

Properties, people, historic resources, and critical facilities in the Town are exposed to natural hazards affected by climate change (i.e., severe storms, coastal flooding, droughts) as well as hazards that are not affected by climate change (i.e., earthquakes). As an initial screening of exposure to hazards, areas of risk have been overlaid onto parcel and point data in a GIS to understand the maximum potential exposure to hazards. The results of this analysis are found in Table 2-3.

Table 2-3 Town of Groton Exposure Analysis

Hazard	At-Risk Parcels		At-Risk Facilities		At-Risk Historic Assets	
	Value	Number	Value	Number	Value	Number
Hurricane/Tropical Storm	\$3,912,673,920	8,466	\$242,271,680	22	\$381,956,510	697
Severe Thunderstorm	\$3,912,673,920	8,466	\$242,271,680	22	\$381,956,510	697
Severe Winter Storm	\$3,912,673,920	8,466	\$242,271,680	22	\$381,956,510	697
Tornado	\$3,912,673,920	8,466	\$242,271,680	22	\$381,956,510	697
Drought	1,769	1,769	\$144,914,560	7	\$4,789,510	14
Flood						
1% Annual Chance	\$1,816,704,290	1,769	\$124,378,520	7	\$161,634,340	223
Coastal (VE)	\$582,855,150	541	\$83,293,630	1	\$49,532,070	57
0.2% Annual Chance	\$2,189,466,300	2907	\$135,212,630	9	\$194,689,600	288
Storm Surge						
Category 1	\$880,944,770	1,124	\$83,625,220	2	\$117,999,980	155
Category 2	\$1,674,688,040	1,459	\$117,529,720	5	\$154,750,960	207
Category 3	\$1,839,070,170	1,927	\$124,243,140	6	\$181,853,630	258
Category 4	\$1,872,187,930	2,107	\$124,243,140	6	\$183,418,760	261
Earthquakes	\$3,912,673,920	8,466	\$242,271,680	22	\$381,956,510	697
Wildfire	\$322,210,930	1,117	\$61,620,930	6	\$3,485,690	10

2.10. Community Climate Change Challenges

As is with all of the SCCOG communities, the Town of Groton has several concerns regarding climate change challenges. Most communities in the region are typically most concerned with the impacts of increased flooding and extreme heat events, however, there are often concerns about other climate driven hazards. The following summary sheet identifies the top flooding, heat, and other climate change concerns for the town, along with the hazard mitigation and climate adaptation actions that will work to address these concerns.

Climate Change Summary Sheet for Town of Groton

What are the Town's Top Climate Change Concerns?

Flooding: Major concerns include coastal flooding in Mystic that is becoming more frequent, flooding of the railroad underpasses, and impaired use of major roads that flood such as Route 1 at the Poquonnock River estuary.

Extreme Heat: Several high social vulnerability areas in Groton are believed at elevated risk during extreme heat events. Access to cooling centers is a concern.

Others: Standby power is limited in some of the critical facilities that are used as backup shelters and should be upgraded or expanded.

Which Hazard Mitigation and Climate Adaptation Actions Will Address Climate Change Concerns?

Flooding: Secure funding to advance at least one recommendation from the Mystic resiliency study scheduled for completion in 2023; and implement pumping station resilience recommendations resulting from the completed feasibility study.

Extreme Heat: Assess mobility constraints for accessing all emergency shelters (including cooling centers) and critical facilities; and install air-conditioning units in emergency shelters so that they can be used safely during summertime emergencies

Others: Expand the availability of standby power in the Town's critical facilities (including but not limited to the Senior Center, which can be used as a cooling center).

3. Extreme and Severe Storms

3.1. Climate Change Impacts

Climate change projections indicate varying changes in the frequency and intensity of severe storms and their relative hazards like precipitation and wind. It is expected that as global mean temperatures continue to rise, storms like hurricanes, tropical storms, and severe thunderstorms may become more frequent and more intense. The degree to which these events might change, and the confidence levels in the models, vary by event type.

Hurricanes and tropical storms are likely to be accompanied by higher wind speeds and an overall increase in intensity. Warm water and air temperatures are essentially the fuel source for the storm, therefore warmer temperatures mean an increase in fuel which can produce more intense winds and high precipitation levels.

While the future behavior of tornado and high wind events is a little more challenging to predict in comparison to hurricanes, it has been noted that the number of days of tornadic activity has decreased in recent decades, though the number of tornadoes in a single day has increased.¹ There is a similar lack in confidence when projecting severe thunderstorm and wind events. Because these events are short-lived and relatively small-scale, monitoring and modeling are more challenging. Overall, however, future climate conditions are likely to become more conducive to the development of such events, therefore increasing the potential for occurrence.

Severe winter storm events, similar to hurricanes, are expected to become more intense under future climate conditions, however they are expected to become less frequent. These storms will continue to be capable of producing large amounts of precipitation, though in future decades this precipitation will consist of less snow and more wintry mix or rain.

These changes in storms could equate to an increase in risk throughout the town, or for specific populations, more severe storm damages and impacts, or an increase in flooding occurrences.

3.2. Hurricanes and Tropical Storms

3.2.1 Setting and Recent Occurrences

Several types of hazards may be associated with tropical storms and hurricanes including heavy winds, heavy rains, and flooding. Flooding and storm surge hazards are discussed in Section 5.2 and Section 4.2 of this annex. Wind hazards are widespread and can affect any part of the Town. However, some buildings in the Town are more susceptible to wind damage than others.

Tropical Storm Irene heavily impacted the region in August 2011. Following the storm, power outages topped 90% of the town's population. The power outage lasted up to six days in CL&P's utility territory. Groton Utilities was able to restore power to customers more quickly in its territory.

¹ <https://nca2018.globalchange.gov/chapter/2/>

Super Storm Sandy struck the region in October of 2012. The storm caused damage to some structures in town, such as Fitch High School, and caused flooding. There were power outages and tree damage from the 60+ mile per hour wind gusts.

On August 2, 2020, Tropical Storm Isaias swept through the State bringing severe winds which resulted in the highest number of outage events Connecticut has ever experienced. With over 620,000 outages reported by Eversource alone, the state's largest electric supplier, residents across the SCCOG region were without power, cable, and internet for extended periods of time. While this storm did not generate typical amounts of rainfall experienced during a tropical storm event, the wind damage exceeded expectations bringing down trees and power lines across the state.

In 2021, there were four tropical storm events that passed through, or within 50 miles of, the state. Some of these events, which are described in more detail below, resulted in flooding along several brooks and stream crossings, including roadway washouts. During Hurricane Ida, the Town reported that the areas that "are known to flood" did so during this heavy precipitation tropical event. Power outages during these events, and other severe storms, were still a challenge for the town.

The 2021 events included Elsa, Fred, Henri, and Ida.

- July 9, 2021 (T.S. Elsa) – Elsa made landfall as a tropical storm in Florida and traveled along the eastern seaboard. It passed through Southeastern New England bringing high winds and rainfall. Gusts were reported over 40 mph, and residents throughout the region and state were left without power.
- August 19, 2021 (Extratropical Storm Fred) – This tropical event passed north of the state bringing heavy rain to some areas in Connecticut; there was a reported 5.14 inches in West Hartford. Fred also produced an EF-0 tornado in Windham County.
- August 22, 2021 (T.D. Henri) – Hurricane Henri made landfall in Rhode Island as a tropical storm and then traveled northwest across the State of Connecticut. While the impacts for Henri were projected to be more severe than they actually were, the storm did result in heavy rainfall and thousands of power outages.
- September 1, 2021 (Extratropical Storm Ida) – Though Hurricane Ida made landfall in Louisiana as a category 1, the storm moved south of Long Island as an extratropical storm and is reported to be costliest storm even since Hurricane Sandy a decade earlier. Ida caused major flooding across Connecticut and the Southeastern Region. For the first time, a statewide flash flood warning was issued. Several communities in the state, including the City of Norwich, warned residents to have minimal contact with surface waters due to the discharge of untreated sewage. There were reports of 7 to 8 inches of rainfall in the Southeastern Region, and as high as 8.58 inches in Uncasville.

3.2.2 Existing Capabilities

Wind loading requirements are addressed through the state building code. The Connecticut State Building Code was most recently adopted with an effective date of October 1, 2016. The code specifies the design wind speed for construction in all the Connecticut municipalities. The basic wind speeds for the town range from 120 to 140 miles per hour, and the ultimate design wind speed for the Town of Groton is 128. Design speeds used vary depending on the building use (for example, hospitals must be

designed to the higher wind speed). Note that changes in design wind speed figures since the previous HMP are largely the result of a shift from "nominal" to "ultimate" wind speeds, for compatibility purposes; see the Connecticut Building Code or the American Society of Civil Engineers website for more information. The Town of Groton has adopted the Connecticut Building Code as its building code.

Parts of trees (limbs) or entire tall and older trees may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. Utility lines are located underground in only a few areas of the Town. The Town of Groton receives utility service from Groton Utilities and Eversource (which acquired the previous regional utility provider, Connecticut Light and Power (CL&P)). Groton Utilities and Eversource have active tree pruning programs, and Eversource specifically, in response to widespread outages after Tropical Storm Irene, Hurricane Sandy, and Winter Storm Nemo, has implemented a more aggressive trimming regime than what was previously performed under CL&P. Eversource has also replaced a lot of wires to strengthen the regional grid.

In addition, Groton has a full time Tree Warden operating as part of the Public Works Department. The Tree Warden can post and remove trees in rights of way or town land. The Town's tree trimming program has been affected by budget cuts, with trimming decreased from one day per week at the time of the previous HMP to one day every two weeks. A contractor is utilized for this program.

All new subdivisions are required to install utilities underground. This requirement has been in place for about 25 years. The Mystic streetscape project completed in 2012 resulted in the placement of utilities underground.

Warning is one of the best ways to prevent damage from hurricanes and tropical storms, as these storms often are tracked well in advance of reaching Connecticut. The Town accesses National Weather Service forecasts via the internet as well as local media outlets (television, radio) to receive information about the relative strength of the approaching storm. This information allows the Town to activate its EOP and encourage residents to take protective or evacuation measures if appropriate.

Prior to severe storm events, the Town ensures that warning/notification systems and communication equipment are working properly and prepares for the possible evacuation of impacted areas. The statewide CT Alerts Community Emergency Notification System can be utilized to warn coastal residents of an impending evacuation. Although hurricanes that have impacted Groton have historically passed in a day's time, additional shelters can be outfitted following a storm with the assistance of the American Red Cross on an as-needed basis for long-term evacuees.

In the case of an extended power outage, residents would be directed to shelter at Fitch High School or the Senior Center, depending on the specific locations of the outages in the town. During Tropical Storm Irene, the high school was opened as a shelter for two nights and ran on a generator. Then it was closed, and the Senior Center was opened as a respite/meal center because it had power from the utility lines. This is an example of how both facilities can be used.

Since the previous HMP, the Town has worked successfully to lower the number of outages experienced by the Town Hall Annex.

Summary

In general, municipal capabilities to mitigate hurricane damage have not increased significantly since the 2017 edition of the hazard mitigation plan was adopted. This is likely because the Town increased its capabilities in response to the damage from Tropical Storm Irene in 2011 and Hurricane Sandy in 2012.

3.2.3 Vulnerabilities and Risk Assessment

The entire town is vulnerable to hurricane and tropical storm wind damage and from any tornadoes (Section 3.3) accompanying the storm, as well as inland flooding (Section 5.2) and coastal flooding and storm surge (Section 4.2). Of particular concern are the blockage of roads and the damage to the electrical power supply from falling trees and tree limbs. The town is also susceptible to damage occurring in other communities cutting off the electrical supply as occurred following Tropical Storm Irene.

As noted above, Eversource trims trees along power lines. After Tropical Storm Irene, the Town participated in meetings with Eversource during which they stated that their personnel needed to spend time opening roads. However, the Town believes that this is not the responsibility of CL&P. The Town favors using local forces to clear roads. Public Works personnel cleared trees and debris from roads after Irene. Within nine hours of the safe start time for clearing, every blockage was cleared that did not involve downed wires. Comparing Irene to previous events, the Town noted that the Public Works crews could open roads more quickly after Hurricane Gloria (in 1985) because there was better information about live wires back then. Therefore, utility lines in Groton will remain vulnerable until better communication with CL&P is developed.

Direct wind damage to newer buildings from hurricane or tropical storm-level winds is rare in the town since the new buildings were constructed to meet or exceed current building codes. Many buildings in the town are greater than 50 years old and do not meet current building codes. Older buildings in the town are particularly susceptible to roof and window damage from high wind events, although this risk will be reduced with time as these buildings are remodeled or replaced with buildings that meet current codes. For example, many homes have been renovated recently and some property owners have installed shutters and other wind mitigation measures.

Groton has a diverse housing stock including rental properties and trailer parks. These areas are also at particular risk of damage during a hurricane or tropical storm because rental properties are not owner-occupied and therefore may not be properly maintained, and because trailer parks contain manufactured homes that are not as structurally sound as permanent buildings. Fortunately, the usually long lead time prior to a hurricane or tropical storm event allows for timely evacuation of such areas prior to a natural hazard event.

The strength of a large hurricane could cause a significant economic impact to the town. The potential economic effect of wind damage to SCCCOC was evaluated in the Multi-Jurisdictional HMP. A separate analysis was not performed specifically for the Town of Groton.

3.2.3.1 Hazard Losses

The Town of Groton did not receive FEMA PA funds in the wake of Tropical Storm Isaias. Since 2012, the town has received \$612,767 in FEMA PA reimbursements for project costs of \$817,022. This was all

received for Hurricane Sandy. Some of these funds were distributed to the Noank Fire District, Groton Long Point, and Poquonnock Bridge Fire District.

In addition to PA, FEMA offers Individual Assistance (IA) to property owners and renters. In the wake of Hurricane Ida, one property owner in Groton received IA in the amount of \$1,500.

FEMA HAZUS-MH 6.0 was used to develop losses associated with seven probabilistic hurricane scenarios from the 10 year to 1,000 year return period. Losses include economic loss, building damages, debris, and sheltering needs. Table 3-1 through Table 3-3 presents hurricane related damages for the Town of Groton. Additional HAZUS-generated losses for the town and region can be found in the Multi-Jurisdictional document.

Downscaled tropical storm losses based on the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi-Jurisdictional document.

Table 3-1 HAZUS-MH Hurricane Related Economic Impacts

Groton	Return Period	Residential	Commercial	Industrial	Others	Total
	10-year	\$344,050	\$4,040	\$310	\$870	\$349,270
	20-year	\$7,241,860	\$235,140	\$30,770	\$98,790	\$7,606,560
	50-year	\$40,994,060	\$3,318,540	\$448,420	\$1,332,660	\$46,093,680
	100-year	\$96,264,500	\$10,669,850	\$1,874,580	\$5,029,590	\$113,838,520
	200-year	\$185,867,590	\$23,780,830	\$4,755,390	\$11,369,940	\$225,773,750
	500-year	\$363,985,030	\$52,247,440	\$10,733,910	\$23,470,350	\$450,436,730
	1,000-year	\$515,925,080	\$80,487,120	\$15,972,800	\$36,473,230	\$648,858,230

Table 3-2 HAZUS-MH Hurricane Related Building Damage

Groton	Return Period	Minor	Moderate	Severe	Destruction	Total
	10-year	8	0	0	0	8
	20-year	78	4	0	0	82
	50-year	685	88	3	2	778
	100-year	1,504	306	22	14	1,846
	200-year	2,220	635	74	45	2,974
	500-year	2,871	1,160	216	130	4,377
	1,000-year	3,082	1,500	355	215	5,152

Table 3-3 HAZUS-MH Hurricane Related Debris and Sheltering Needs

Groton	Return Period	Debris Generated (Tons)	Households Displaced	Individuals Seeking Temporary Shelter
	10-year	35	0	0
	20-year	780	0	0

	50-year	6,591	2	0
	100-year	13,044	21	9
	200-year	22,424	75	27
	500-year	39,180	217	85
	1,000-year	52,021	389	174

3.3. Tornadoes and High Wind Events

3.3.1 Setting and Recent Occurrences

Similar to hurricanes and winter storms, wind damage associated with severe thunder or summer storms and tornadoes has the potential to affect any area of the town. Furthermore, because these types of storms and the hazards that result (flash flooding, wind, hail, and lightning) might have limited geographic extent, it is possible for a severe storm to harm one area within the town without harming another. Such storms occur in the town each year, although hail and direct lightning strikes to the town are rarer.

- A funnel cloud was spotted on August 5, 2010, near Electric Boat in the nearby City of Groton as reported to the NCDC. The NCDC also reported that strong straight-line thunderstorm winds overturned a boat at Eastern Point on July 31, 2009, causing minor damage.
- On June 23, 2015, a passing cold front triggered multiple severe thunderstorms across the entirety of Southern Connecticut. Tree damage was reported in the area, including on Military Highway.

Other recent severe storm events include:

- On September 6, 2017, a cold front triggered severe storms in the county and caused tree damage in multiple communities in the region. Nearby Colchester reported trees and wires down, and the Groton-New London Airport measured sustained winds at 44 mph and gusts of 56 mph.
- On April 13, 2020, a low pressure system resulted in high winds throughout New London County.
- On November 13, 2021, a tornado touched down in Pawcatuck, and another in Plainfield. There were reports of uplifted trampolines, downed trees and powerlines, and an uplifted metal shed. This same storm also caused damage in other surrounding communities.

3.3.2 Existing Capabilities

Warning is the most viable and therefore the primary method of existing mitigation for tornadoes and thunderstorm-related hazards. The NOAA National Weather Service issues watches and warnings when severe weather is likely to develop or has developed, respectively. The Town has access to National Weather Service forecasts via the internet as well as local media outlets (television, radio) to receive information about the relative strength of the approaching storm. This information allows the Town to activate its EOP and encourage residents to take protective measures if appropriate.

Aside from warnings, several other methods of mitigation for wind damage are employed by the Town as explained in Section 0 within the context of hurricanes and tropical storms. In addition, the Connecticut Building Code includes guidelines for the proper grounding of buildings and electrical boxes to protect against lightning damage.

Summary

In general, municipal capabilities to mitigate thunderstorm and tornado damage have not increased significantly since the 2017 edition of the hazard mitigation plan was adopted.

3.3.3 Vulnerabilities and Risk Assessment

Thunderstorms are expected to occur each year and are expected to at times produce heavy winds, heavy rainfall, lightning, and hail. All areas of the town are equally likely to experience the effects of summer storms. The density of damage is expected to be greater near the more densely populated sections of the town.

Most thunderstorm damage is caused by straight-line winds exceeding 100 mph. Experience has generally shown that wind in excess of 50 miles per hour (mph) will cause significant tree damage during the summer season as the effects of wind on trees is exacerbated when the trees are in full leaf. The damage to buildings and overhead utilities due to downed trees has historically been the biggest problem associated with wind storms. Heavy winds can take down trees near power lines, leading to the start and spread of fires. Such fires can be extremely dangerous during the summer months during dry and drought conditions. Fortunately, most fires are quickly extinguished due to the Town's strong fire response.

Lightning and hail are generally associated with severe thunderstorms and can produce damaging effects. All areas of the town are equally susceptible to damage from lightning and hail, although lightning damage is typically mitigated by warnings and proper grounding of buildings and equipment. Hail is primarily mitigated by warning, although vehicles and watercraft can often not be secured prior to the relatively sudden onset of a hailstorm. Lightning and hail are considered likely events each year, but typically cause limited damage in the town. Older buildings are most susceptible to lightning and hail damage since they were constructed prior to current building codes.

Although tornadoes pose a threat to all areas of Connecticut, their occurrence is least frequent in New London County as compared with the rest of the State. Thus, while the possibility of a tornado striking the town exists, it is considered to be an event with a very low probability of occurrence.

3.3.3.1 Hazard Losses

Since 2017, there has been one NOAA reported event associated with a severe thunderstorm and wind event. On September 6, 2017, a passing cold front which triggered severe thunderstorms cause downed trees in the western and central areas of town. A tree fell into a building on Crouch Street, there were several trees reportedly down across Eastern Point Road, and a utility pole and wires down on Thames Street. A reported \$10,000 in damages resulted from this event.

Since 2012 there have been five reports for thunderstorm wind events; one of which was for hail and the other four for wind events. The total losses reported since 2012 total \$23,000. Downscaled losses based on the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi-Jurisdictional document.

3.4. Severe Winter Storms

3.4.1 Setting and Recent Occurrences

Similar to hurricanes and summer storms, winter storms have the potential to affect any area of the town. However, unlike thunderstorms, winter storms and the hazards that result (wind, snow, and ice) have more widespread geographic extent. In general, winter storms are considered highly likely to

occur each year (major storms are less frequent), and the hazards that result (nor'easter winds, snow, and blizzard conditions) can potentially have a significant effect over a large area of the town.

- The heavy snow storms during the winter of 2010-2011 caused damage to structures across Connecticut. No roofs or buildings collapsed in January 2011. However, the Town was concerned with the Public Works garage and monitored snow load conditions. The Groton Walmart removed snow from its roof.
- Winter Storm Alfred in October 2011 did not significantly affect Groton.
- A low pressure system rapidly intensified while moving northeast to a position east of Cape Cod on the morning of Saturday, February 9, 2013, producing blizzard conditions and very heavy snowfall across southern Connecticut on February 8th and 9th. Groton Airport ASOS (KGON) reported at least three consecutive hours of blizzard conditions. Snowfall began at 7:40 am on February 8. Spotters reported an average snowfall of 6 inches by 7:50 pm. Total snowfall ranged from 15 inches in Stonington to as much as 22 inches in Ledyard Center.
- On January 26, 2015, a large snowstorm dropped nearly two feet of snow throughout the region, including Groton. The town received over \$125,000 in federal assistance to aid in the cleanup.

Some of the more recent significant winter events include:

- A heavy storm came through the region on February 9, 2017, bringing blizzard conditions and heavy snowfall. The Town of Colchester reported 14.5 inches of snow, and 13 inches were reported along the coast in Groton.
- A late winter storm on March 12, 2018, resulted in 23 inches of snowfall in Oakdale, with reports of one to two feet in other parts of Northern New London County. The southern part of the region experienced 10 to 18 inches of snow, and strong wind gusts. There were also reports of downed trees throughout the region as a result of this storm.
- On January 28, 2022, the region was hit by a heavy snowstorm and blizzard like conditions. Parts of the region reported up to 22 inches of snowfall, and gusts up to 65 mph. There were also several hours of less than ¼ mile visibility. Snow drifts were also reported to be a challenge, with some areas experiencing drifts up to three and a half feet deep.

3.4.2 Existing Capabilities

Existing programs applicable to winter storm winds are the same as those discussed in Sections 3.2.2 and 3.3.2. Programs that are specific to winter storms are generally those related to preparing plows and sand and salt trucks; tree trimming and maintenance to protect power lines, roads, and structures; and other associated snow removal and response preparations.

As it is almost guaranteed that winter storms will occur annually in Connecticut, it is important to locally budget fiscal resources toward snow management. Snow is the most common natural hazard requiring additional overtime effort from Town staff, as parking lots and roadways need constant maintenance during storms.

The Public Works Department oversees snow removal in the town and along town roads. Since the previous HMP, the Town has relinquished the responsibility for plowing the roads of private associations to those associations, allowing the Town to focus on important public ways. Treated salt is used for de-icing. The Town has established plowing routes that prioritize access to and from critical facilities. Main roads are plowed before secondary roads. Plows are diverted to address emergency service needs whenever necessary. The Connecticut Department of Transportation plows the State roads in the town.

Groton's plowing fleet has not changed since the previous HMP and has been sufficient for the Town's needs. An area for dumping excess snow has been designated and permitted.

The Connecticut Building Code specifies that a pressure of 30 pounds per square foot be used as the base "ground snow load" for computing snow loading for roofs. The Town performed visual assessments of many buildings during the winter of 2010-2011 as noted above and cleared several town-owned roofs. Many residents also shoveled their own roofs or hired contractors to clear their roofs of excessive snow. Snow load has not posed as great a risk since the 2010 storms.

Summary

In general, municipal capabilities to mitigate snowstorm damage have not increased significantly since the 2017 edition of the hazard mitigation plan was adopted. This is because the Town continues to experience heavy snow each winter.

3.4.3 Vulnerabilities and Risk Assessment

Severe winter storms can produce an array of hazardous weather conditions, including heavy snow, blizzards, freezing rain and ice pellets, flooding, heavy winds, and extreme cold. Further "flood" damage could be caused by flooding from frozen water pipes. Often, tree limbs on roadways are not suited to withstand high wind and snow or ice loads.

This section focuses on those effects commonly associated with winter storms, including those from blizzards, ice storms, heavy snow, freezing rain, and extreme cold. Warning and education can prevent most injuries from winter storms. This is particularly important as the town includes many residents who are elderly and additional elderly developments are proposed. Most deaths from winter storms are indirectly related to the storm, such as from traffic accidents on icy roads and hypothermia from prolonged exposure to cold. Damage to trees and tree limbs and the resultant downing of utility cables are a common effect of these types of events. Secondary effects can include loss of power and heat.

Many buildings in the town that are recently constructed are not susceptible to damage from heavy snow. While some Town buildings could be susceptible to heavy snow loads, they will be cleared quickly if safety is a concern. Some buildings in the town have flat roofs which are more susceptible to damage from heavy snow than sloped roofs. A more detailed response plan is necessary to ensure that town buildings, including schools, are properly inspected and cleared if excessive snow is an issue in the future.

Icing is not a significant issue in the town. In general, there are few steep slopes such that extra salting of the roadways in necessary locations alleviates any trouble spots.

3.4.3.1 Hazard Losses

There have been no reported winter storm losses for Groton since 2017. In the past decade, the town has received FEMA PA funds in the amount of \$233,854 for winter storms. Downscaled losses based on the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi-Jurisdictional document.

4. Sea Level Rise

4.1. Climate Change Impacts

Sea levels are rising at an increased rate across the globe. These rising waters are attributed to melting glaciers and ice sheets, as well as thermal expansion from warming ocean waters. Global sea level rise takes into account the major causes of rise, and the averages of rise around the world. Local sea level rise estimates consider the global changes, but also characterizes what is happening more locally such as changes in currents or land subsidence.

The University of Connecticut, Connecticut Institute for Resilience and Climate Adaptation (CIRCA) has, in accordance with state statute, developed local sea level rise projections for communities to use as a planning threshold (Figure 4-1). CIRCA recommends that communities plan for 0.5 meter (1.64 feet) of sea level rise above 2001 levels by 2050. CIRCA intends to revisit this estimate and update the planning thresholds in the lifespan of this plan (2023-2028).

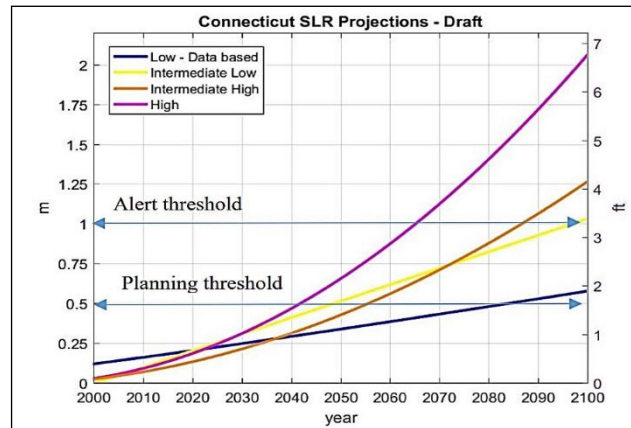


Figure 4-1 Four Localized Sea Level Rise Scenarios for

Even though sea level rise occurs over a longer time period than other hazards, coastal communities are becoming increasingly concerned with the cascading impacts. Increased sea levels can cause a greater geographic reach for coastal flooding events, an increase in frequency or extent of “sunny day” flooding, an increase in storm surge extent, and saltwater inundation along the shoreline. All of these impacts can damage properties, deteriorate infrastructure, cause access and egress challenges, and exacerbate coastal erosion processes.

4.2. Coastal Flooding

4.2.1 Setting and Recent Occurrences

The shorefront of the Town of Groton contains developed shorefront along the Thames River; areas of rocky shorefront at Bushy Point, Bluff Point, and Groton Long Point; coastal bluffs and escarpments at Bluff Point; modified bluffs and escarpments at Groton Long Point, Noank, and West Mystic; and beaches and dunes at Bluff Point Beach, Bluff Point, and Groton Long Point. Portions of Baker Cove, Poquonnock River, Mumford Cove, Palmer Cove, Beebe Cove, and Mystic Harbor are estuarine embayments. The coastal resources found in Connecticut and described by DEEP can be found in the Multi-Jurisdictional HMCAP.

Homes, businesses, and industry are located in close proximity to the coastline along the Thames River and Fishers Island Sound. Structures and infrastructure in the southern section of the Town are closer to sea level than in northern areas and are therefore more susceptible to coastal flooding. Hurricanes and tropical storms have the potential to induce coastal flooding and storm surge that can impact structures. Many coastal roads have been closed during prior flood events, and many coastal structures in Groton have been flooded.

- On August 28, 2011, the region was impacted by Hurricane Irene, which had since weakened to a tropical storm.
- On October 29, 2012, Coastal communities along Southern New London County experienced two successive tidal cycles with at least moderate coastal flooding on Monday October 29th. The peak of this surge occurred Monday Night as Sandy made landfall in Southern New Jersey, with widespread major coastal flooding occurring along the Southern New London coast. Peak storm tides surpassed water levels from Hurricane Irene in 2011, only being topped by Hurricane Carol in 1954 and the 1938 Hurricane. The record storm tide levels along Eastern Long Island Sound resulted from a peak storm surge of about 5 to 7 feet that coincided with normal high tides. These storm tides resulted in up to 2 to 3 feet of inundation a few blocks inland along low lying portions of Long Island Sound, with one to two feet of inundation working north of I-95 in several low spots along waterways such as the Niantic River in Niantic, Mystic River in Mystic, and almost 15 miles inland along the Thames River.
- On January 17, 2022 a nor'easter came through the area and though it resulted in snow accumulation in certain parts of the region, coastal communities, including Groton, experienced coastal flooding. Groton Town Police reported that road closures occurred as a result of tidal flooding. Closures included River Road and Route 1 in the area of South Road. There was also flooding in downtown Mystic which caused road closures; it was noted that this is a common occurrence with coastal storms.

The Town is very concerned with the potential long-term effects of sea level rise and its potential to exacerbate flooding conditions in the future, and has been planning for adaptation as described elsewhere in this annex. Even during lesser storm events and high tides, coastal flooding occurs in Groton. For example, a king tide occurring on a sunny day (October 28, 2015; refer to the picture on the right) caused water to flow onto, and inundate, many sections of roads in the Groton side of Mystic.



Though the Town has experienced coastal storms in recent years, few major coastal flooding events have occurred in the last five to ten years. However, a significant coastal flood event occurred on December 23, 2022 during the final stages of the planning process for this document. The coastal water surface elevation at the New London tide gauge was reportedly the sixth highest on record. Numerous roads and structures experienced flooding in coastal southeastern Connecticut, including Mystic and other parts of Groton.

4.2.2 Existing Capabilities

The Town primarily attempts to mitigate coastal flood damage and flood hazards by controlling and restricting activities in floodprone areas, encouraging the elevation of homes and roadways, maintaining hard structures in good condition, and providing signage and warning systems. Many of the Existing Capabilities utilized in the Town for inland flood mitigation (Section 5.2) are also applicable to coastal flood mitigation.

Coastal sewer pumping stations in Groton are designed to be floodproofed to a 14-foot elevation. This minimizes the risk of coastal and storm surge flooding.

As noted in Section 5.2.2 and Section 2.6, the Town utilizes the 1% annual chance floodplains delineated by FEMA. These consist of the 1% annual chance floodplain with elevations (Zone AE), and the 1% annual chance floodplain subject to wave velocity (Zone VE) for coastal flooding areas. As noted by the Zoning Regulations and the Subdivision Regulations, building activities in these areas are restricted and new construction or substantial redevelopment must prove that the lowest horizontal member of the new construction will be more than one foot above the base flood elevation (freeboard). The Planning Commission and the Building Official are required to review and approve portions of applications that involve structures within FEMA Special Flood Hazard Areas.

As explained elsewhere in this HMP, the National Weather Service issues a flood watch or a flash flood watch for an area when conditions in or near the area are favorable for a flood or flash flood, respectively. A flash flood watch or flood watch does not necessarily mean that flooding will occur. The National Weather Service issues a flood warning or a flash flood warning for an area when parts of the area are either currently flooding, highly likely to flood, or when flooding is imminent. The Town of Groton utilizes these warnings and forecasts to prepare emergency responders for flooding events.

The shoreline of Groton contains many coastal flood control structures. Small, private seawalls and bulkheads can be found in many of the residentially developed coastal neighborhoods. Groins and jetties are also common in beach areas. Most of these structures were designed to retain land as well as protect against wave action but have the secondary effect of reducing coastal erosion. Many coastal homes have been elevated at the owners' expense. A number of private homeowners in Groton Long Point have elevated their homes since the previous HMP; Groton Long Point requires buildings be elevated or floodproofed to one foot above the Base Flood Elevation. Elevation is a very important type of mitigation that has proven to be successful in reducing flood damage.

The Town of Groton has actively pursued coastal resiliency planning and climate change planning in its update to the POCD and MCP as explained in Chapter 2. These efforts built on prior efforts that were undertaken in 2011-2012. Even more recently, the Town participated in a resiliency planning initiative with SCCOG and TNC in 2016-2017².

Together, the policies of the POCD and MCP and the existing regulations and codes will build a foundation for addressing coastal resilience and adaptation.

As explained in the regional part of this multi-jurisdiction hazard mitigation plan, the State Historic Preservation Office (SHPO) embarked on a resiliency planning study for historic and cultural resources beginning in 2016. During winter 2016-2017, individual meetings were held with the shoreline SCCOG communities. Reports were issued to these communities in December 2017. The Town of Groton report outlines eight strategies that can be employed to make historic and cultural resources more resilient:

- Identify Historic Resources

² <https://tnc.app.box.com/s/8nne60yjk2g3m1mgzkfa86rndxyjiawf>

- Revisit Historic District Zoning Regulations
- Strengthen Recovery Planning
- Incorporate Historic Preservation into Planning Documents
- Revisit Floodplain Regulations and Ordinances
- Coordinate Regionally and with the State
- Structural Adaptation Measures
- Educate

Subsequently, a best practice guide for planning techniques to make historic resources more resilient was distributed in September 2017.

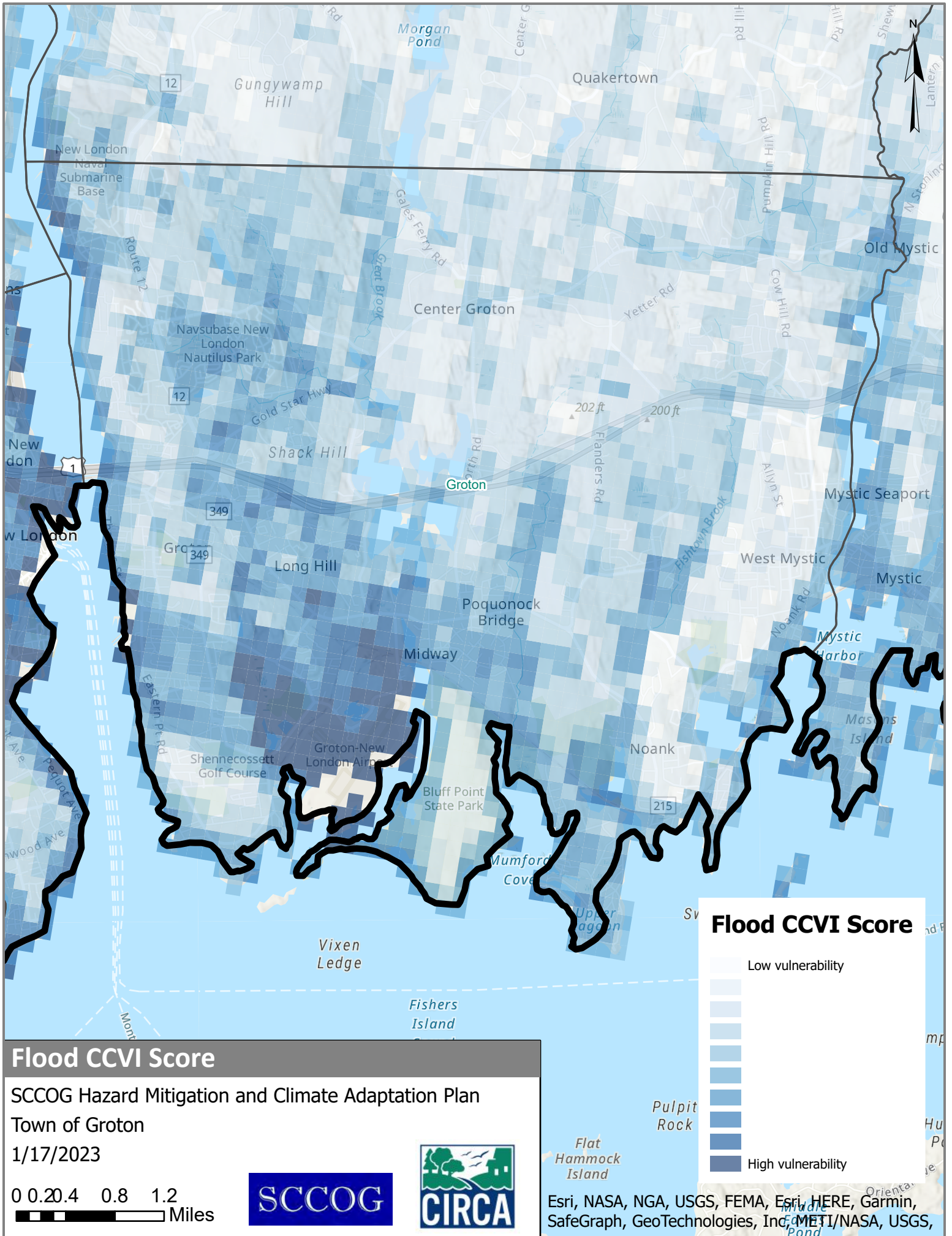
Summary

Municipal capabilities to mitigate coastal flood damage have not increased significantly since the 2017 edition of the hazard mitigation plan was adopted. This is because the Town updated its POCD and MCP prior to the recent edition, participated in the historic resources resiliency planning, and generally increased its capabilities in response to the flooding associated with storms Irene and Sandy in 2011 and 2012, respectively.

4.2.3 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk of coastal flooding within the Town. This flooding can be the result of astronomical high tides, hurricanes, nor'easters, or storm surge. As shown by the historic record, coastal flooding can impact many roads and neighborhoods, potentially cause severe damage, and impede transportation in the Town. Refer to Figure 5-1 for a depiction of areas susceptible to coastal flooding, and Figure 4-3 for areas susceptible to storm surge from hurricanes.

UConn CIRCA has developed a tool to aid in understanding flood vulnerability for communities across the state. This tool, known as the Climate Change Vulnerability Index (CCVI), is comprised of dozens of factors that contribute to a community's flood sensitivity, exposure, adaptive capacity, and ultimately the overall flood vulnerability. The CCVI has been used as a tool to characterize flood vulnerability for the town. The distribution of flood vulnerability throughout the community can be seen in Figure 4-2. The CCVI demonstrates that flood vulnerability in the town ranges from moderate to high. Most of the vulnerability score is due to coastal flood exposure.



Vulnerability Analysis of Areas along Coastal Waters

As noted in the previous HMP annex, the entire coastline of Groton is subject to flooding and coastal storm damage, as are the peninsula areas of Noank and Groton Long Point, which are entirely exposed. Most of Groton's velocity zones are located along the immediate shoreline. The beachfront properties in the velocity (VE) zone are very susceptible to damage.

Residences are heavily concentrated along the coastline and they are subject to damage from tidal flooding with wave action. Many residential and commercial structures are located in low-lying areas further inland and though not subject to damage from waves, they are subject to tidal flooding. The southern portion of Groton Long Point, in the Shore Avenue area, is exposed to the wave action from Fishers Island Sound. This location has been exposed to the most flood damage in the past. The shoreline structures along Mumford and Palmer Coves have also experienced wave damage, but to a lesser degree.

Groton Long Point is a highly populated section of the Town of Groton. There are approximately 1,200-1,300 persons living in Groton Long Point during the winter months and 3,000 to 4,000 residents in the summer months. It is a low-lying peninsula surrounded by Fishers Island Sound on three sides. The entire area of Groton Long Point except for a few roads including Duryea Drive, Burrows Street, Smith Street, and several other elevated areas, are in the flood zone.

Groton Long Point's entire shoreline is a VE zone and many structures have the potential to be damaged by waves and storm surges. The Groton Long Point Road Bridge is the only access/egress to the area and utilities pass along the bridge to the Groton Long Point residents. Town officials have expressed concern because of the sole access/egress as well as the fact that gradual shifting of rip-rap along the bridge could be catastrophic during a major storm.

Another highly populated section of Groton is Noank. Noank is a peninsula that is surrounded by Fishers Island Sound; however, most of the land is elevated above the flood zone. A few of the roads with structures located in the flood zone include Morgan Point, Marsh Road, Noble Avenue, and sections of Elm Street, Front Street, and Brook Street. There are numerous cul-de-sacs along Noank's shoreline which are also affected by tidal flooding. The entire shoreline of Noank is in a velocity zone and structures may be damaged by waves and storm surge during severe storms. The adjacent areas of Beebe Cove and Spencer Point are protected by old walls and riprap. Due to the relatively large number of residences, the potential for heavy flood damage exists along the shores of Palmer, West, and Beebe Coves. The shores of Noank have long been the site of boat yards and other facilities such as the Noank Shipyard, Abbott's Lobsters, and the Morgan Point Lighthouse.

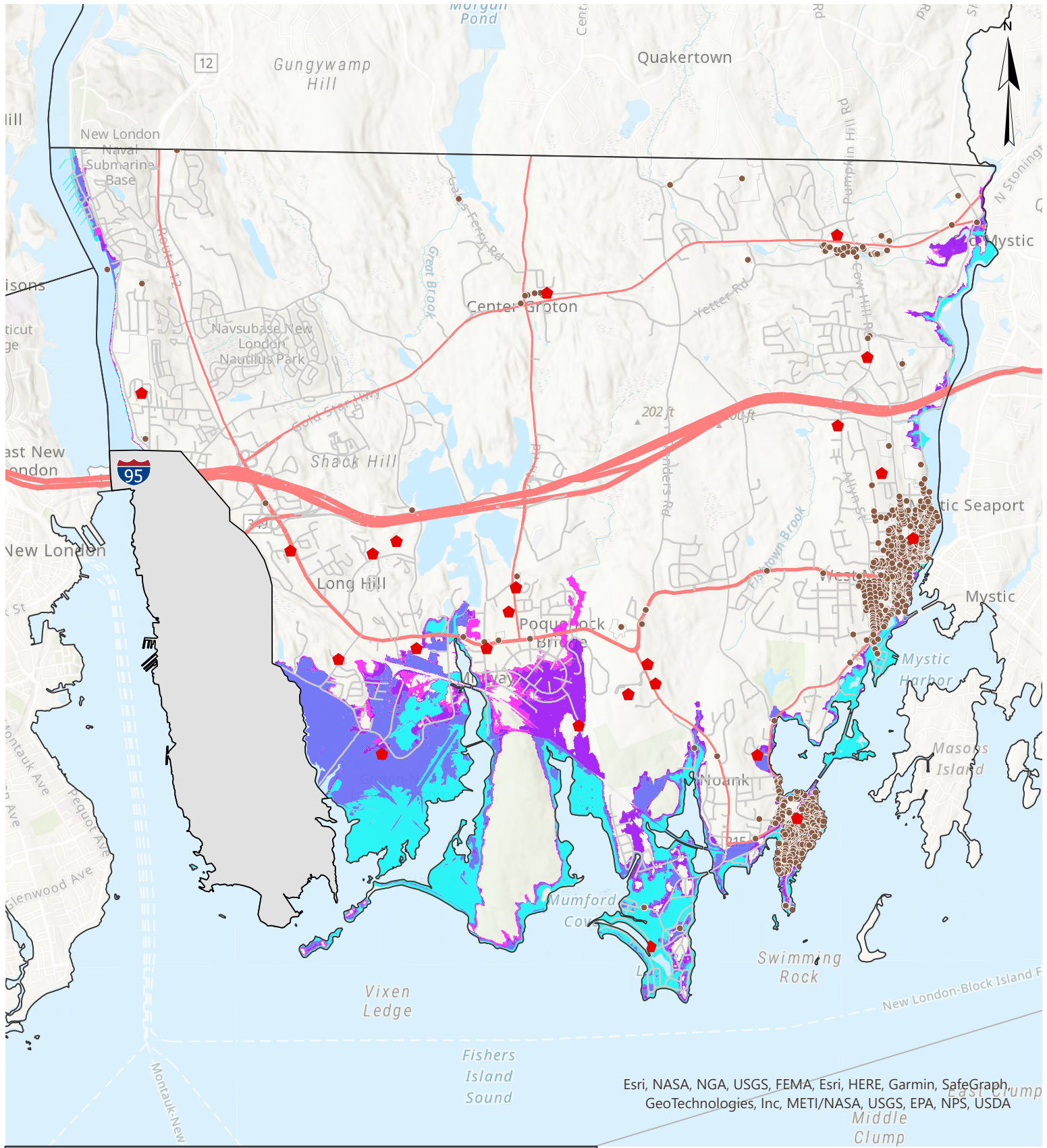
Groton has several major transportation facilities such as Interstate 95, Route 1, Route 12, Route 184, Route 117, and the Amtrak and Providence/Worcester rail lines. The embankments for railroad tracks act as dikes in limiting the encroachment of tidal floods. A series of crossings of the railroad and the highway have been constructed to allow passage of roadways under and over the highway and railroad. Town officials are concerned with Amtrak underpasses such as Poquonnock Road and South Road. These low bridges make passage of emergency vehicles difficult under normal conditions. When these areas are flooded out they are not passable and emergency services are forced to take a longer route.

Town officials are concerned that problems could also arise with the evacuation of people and getting materials to residents.

The Town of Groton shoreline has several flooding sources which include Mumford Cove, Palmer Cove, Fishtown Brook, and Fishers Island Sound. There are many residential structures located in flood zones in these areas around the shoreline. Roads in the flood hazard area include Midway Oval, Hartford Court, and sections of Joliet Court, Birmingham Court, and Concord Court, which are flooded by Mumford Cove. Palmer Cove floods Haley Farm Road and Beebe Cove affects a flood zone on Route 215.

The Mystic River affects many roadways and structures in the flood zone from the mouth of the river to the end of River Road, which is the eastern corporate limit of Groton. Along the Mystic River many of the roads in the flood zones include Cedar Road and the roads around Spencer Point and Willow Point, and Water Street.

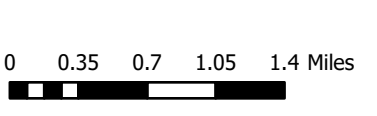
Town officials are concerned with Willow Point due to its low-lying areas and the potential for the area to be isolated during flooding.



Esri, NASA, NGA, USGS, FEMA, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA

Hurricane Storm Surge Inundation Areas

SCCOG Hazard Mitigation and Climate Adaptation Plan
 Town of Groton
 Date: 8/3/2022



Legend

- Historic Resources
- ⬠ Critical Facilities

Hurricane Category

- 1
- 2
- 3
- 4

Vulnerability Analysis of Private Properties

The coastal areas of the Town of Groton have many properties that are inhabited year-round. This intensifies risk to life and property in coastal areas. Waterfront properties are very susceptible to damage, not only as a result of flooding but also due to the velocity zones located along the shoreline. Shoreline erosion is a relatively minor concern for private property owners at this point in time since most have seawalls or rocky shorefront protecting their structures.

Buildings located in flood hazard areas are primarily residential. Most of the structures that are threatened by flooding are located within the 1% annual chance floodplain, but some are also in the coastal velocity zone. Location in the velocity zone poses an increased threat to structures due to high wind and potential wave damage, as well as inundation by flood waters. Other areas located more inland or behind protective seawalls are only subject to coastal flooding without wave action. Drainage systems in low-lying areas can also backup during coastal storms, resulting in flooding along roadways.

Floodprone residences are located throughout the coastal areas of Groton. Areas located in the coastal velocity zone are believed to be particularly at risk.

As of November 2011, four repetitive loss properties were reported in Groton, but none were believed related to coastal flood zones. Since then, as of June 2022, seven properties have been added to the list for a total of 11, with seven believed to be impacted by coastal flooding. Six are residential and one is commercial. The Town recognizes that many private properties may suffer coastal flood damage that is not reported because the structures are not insured under the NFIP, or because they choose to not report the damage. These residents and business owners are likely repairing structures on their own. Coastal flood mitigation as recommended in this HMCAP will likely assist many of these property owners.

The Town of Groton is interested in all forms of flood mitigation, including acquisitions, elevations, drainage upgrades, and other structural projects provided property owners are interested and funding is available.

The Town of Groton has no formalized program currently in place to identify the location or the number of structures that are susceptible to flooding. Such information would be valuable in directing hazard mitigation efforts to locations with the greatest risk. Town planning staff should use the recently released DFIRM to identify the approximately 925 structures in the town that are located in the AE zone (with or without wave velocity). This could provide a list of areas to inspect following a storm event and allow for the town to track building permits from repairs following a natural hazard. This information, in turn, would provide supporting data for future grant applications.

Vulnerability Analysis of Critical Facilities

A review of the Town of Groton's critical facilities indicates most of the facilities are not in coastal flood hazard areas. One facility of concern is the Groton-New London Airport. The entire Groton-New London Airport is located in a flood zone, potentially limiting its use during coastal flood events. Several fire stations are located in moderate risk zones, and Mystic River Homes senior living is in a surge zone.

Floodproofing critical facilities can help lower risks further and developing a site-specific evacuation plan for Mystic River Homes can help reduce risks to residents.

As noted in Section 2, SCCOG completed an assessment of critical facilities in the region in 2017, fulfilling an action listed in the 2012 edition of the multi-jurisdiction hazard mitigation plan. The Town Hall on Fort Hill Road and the Groton Long Point Police/Fire complex were addressed in this study. The assessment determined that the Town Hall was not at current risk to flooding, but risk would increase over time and could be addressed with a low berm or flood wall structure; and that the Groton Long Point Police/Fire complex was at high risk to flooding that should be addressed in the short term with additional floodproofing and in the long term through relocation of the facility.

4.2.3.1 Hazard Losses

There are no reported losses for the Town of Groton related to coastal flooding. However, according to NFIP statistics, as of June 30, 2022, the Town of Groton, including Noank Fire District and Groton Long Point, has had a total of 361 flood related losses, with a total of \$4,214,059 paid towards the claims. Table 5-1 presents a breakdown of the losses and dollars paid in town. It is likely that a percentage of these are coastal related, however, the data does not identify the flooding source.

4.3. Shoreline Change

4.3.1 Setting and Recent Occurrences

Shoreline change is primarily a natural process caused by wind, waves, and currents; however it can also be attributed to human driven processes such as development, grading, and beach armoring or nourishment. As climate change impacts hazards such as severe storms, hurricanes and tropical storms, and sea level rise, shorelines have the potential to change at different rates than in decades past. As tidal ranges increase, and storm surge becomes higher and potentially more intense, these processes may become exacerbated. Rapidly changing shorelines can have an impact on coastal ecosystem (particularly those that provide natural buffers), erode natural shorelines resulting in encroaching seas onto developed land, and may alter those shorelines that have been hardened to protect development and infrastructure.

4.3.2 Existing Capabilities

As discussed in Section 4.2.2, the town works to regulate and minimize development and activities in the areas that are prone to coastal flooding. By reducing activity in these areas, less disruption occurs to the existing environment and therefore potentially reducing future erosion and change. While not all erosions and shoreline change can be prevented, the town does work to mitigate excessive incidents. A current ongoing project at Esker Point Beach which includes beach nourishment and plantings, is an effort to keep up with storm and tidally related erosion at a community park. The town conducts annual monitoring to ensure efforts are helping, and adjusts the program as needed.

4.3.3 Vulnerabilities and Risk Assessment

In general, it is assumed that as sea level rises, the frequency and magnitude of coastal flooding in the Town will increase, with structures and roadways closest to existing sea level being affected more quickly. In addition, tidal marshes will either migrate inland or be eroded by constant inundation

Coastal erosion is a serious concern where beaches are present in the Town of Groton although parts of the shorefront are either rocky shorefronts or modified bluffs and escarpments consisting of seawalls,

bulkheads, or revetments. As sea level rises, the effectiveness of hard structures such as groins, jetties, bulkheads, and seawalls will be undermined such that erosion will be able to occur landward of the walls necessitating expansion of the structures.

4.3.3.1 Hazard Losses

There are no reported losses for the Town of Groton related to shoreline change. Despite the record of past events, shoreline changes losses such as coastal erosion are difficult to quantify because they are not reported via the tools typically reviewed for plan updates such as the NCEI Severe Storm database and the NFIP. Shoreline change losses are not quantified in the 2019 Connecticut Natural Hazard Mitigation Plan.

For beaches, one representation of loss is the total cost of beach nourishment, even though this does not account for occasional property damage. Another measure is to the total unmet need associated with living shoreline project costs, which have only recently become well-understood over the last five years. Recently, the largest endeavor in Groton is the Esker Point Beach and Palmer Cover resilience project. The town received \$750,000 in April 2022 to implement coastal resilience measures at the park.

5. Changing Precipitation

5.1. Climate Change Impacts

Across the United States, annual precipitation has increased in the past century, however, this change *is* dependent upon the region. Here in the northeast, precipitation has increased, and is projected to continue to increase during spring and winter months. However, climate change has also been linked to a reduction in snow cover extent, and an earlier spring melt. Winter precipitation may also change from snow to a wintry mix or rainfall due to warmer temperatures; so, while precipitation may increase it may not necessarily be an increase in snow.

Changes in precipitation can also shift the occurrence of droughts. As the climate warms, surface soil moisture is likely to decrease as evaporation rates rise. This decrease in soil moisture, and potentially longer periods of time between intense precipitation events, could potentially mean longer and stronger droughts.

These changes in precipitation can have various types of impacts. With an increase in intense precipitation, flooding events may become more frequent, damages to crops may occur, and spring flood trends may shift with less snow and more rain. Droughts on the other hand can also cause damage to crops, stress livestock and agricultural operations, and also reduce drinking water supplies or private wells.

5.2. Riverine and Pluvial Floods

5.2.1 Setting and Recent Occurrences

Flooding is the primary hazard that impacts the town each year as documented in the previous HMP. While riverine flooding is a concern, nuisance flooding and poor drainage have also created flooding challenges at several locations in the town. Flooding is typically caused by heavy rainstorms but can also be caused by relatively light rains falling on frozen ground. Flooding of roadways is more common than damage to structures, although both occur.

Sustained heavy rainfall in late March 2010 caused a 1% annual chance flood throughout southeastern Connecticut. The March 2010 storms continue to be considered the event that caused the most widespread flooding in Groton since the town began participating in the multi-jurisdiction hazard mitigation plan. According to the planning team, more homes were damaged in Groton than in any other town in Connecticut during that event. The March 2010 flood was notable for washing out the Route 184 Bridge at Whitford Brook and the River Road Bridge at Haleys Brook. The River Road crossing was closed for a year. The entire neighborhood at the Whitford Brook/Haleys Brook confluence was submerged, and people along River Road had to be rescued by boat.

On June 7, 2013, the remnants of Tropical Storm Andrea tracked up the eastern seaboard in early June resulting in a prolonged period of heavy rain, which caused flash flooding in portions of Fairfield and New London Counties. In Groton, South Road was closed at the railroad underpass due to flooding. Total reported rainfall amounts in New London County ranged from 4.12 inches in Yantic to 6.64 inches in Gales Ferry.

On September 2, 2013, several upper level shortwave troughs interacting with a warm, moist air mass and a surface trough produced scattered thunderstorms across the area. Precipitable waters ranged between 2 and 2 1/2 inches, which resulted in heavy rain and flash flooding in Fairfield and New London Counties. There were six to eight inches of flowing water on portions of Route 12 from the U.S. Naval Submarine Base south to Groton, and South Road at the railroad underpass in Groton was closed due to flooding.

The town reported that there is nothing in particular to note of by way flooding from within the past five years. There have however been several occurrences since 2017 that have caused flooding throughout the region. Some specific incidents are described below.

On September 12, 2018 a heavy rainstorm traveled through the region dropping heavy rainfall with reports of neighboring Norwich receiving 4.85 inches of rainfall and Lebanon had a reported 6.79 inches. Groton experienced some street flooding with closures at the intersections of Route 1 and Route 12, and Route 1 and South Road.

Hurricane Ida, which produced several inches of rain across the state, caused flooding in many SCCOG communities. Norwich Public Utilities recorded 6.34 inches of rainfall and Groton-New London Airport recorded 2.05 inches.

After a period of prolonged drought, a severe rainstorm event on September 5, 2022, caused flooding in southeastern Connecticut. Lebanon experienced road closures and washouts, while Norwich Public Utilities observed 5.85 inches of rainfall. There were flood and flash flood warnings throughout the region and across the state. Neighboring Rhode Island reported 11 inches of rainfall in some communities.

5.2.2 Existing Capabilities

The Town attempts to mitigate inland flood damage and flood hazards by utilizing a wide range of measures including restricting activities in floodprone areas, replacing bridges and culverts, promoting flood insurance, acquiring floodprone structures, maintaining drainage systems, through education and outreach, and by utilizing warning systems. Many mitigation measures are common to all hazards and therefore were listed in Section 2.6 and Section 2.7. No major inland flood control structural projects are in place within or upstream of Groton.

Bridge and Roadway Replacements, Drainage, and Maintenance

The Department of Public Works cleans and inspects catch basins and culverts at least annually or more often if problems are noted. The Town fields phone calls related to drainage complaints. Roadway drainage complaints are directed to the Director of Public Works. When flooding occurs, the Public Works department may handle complaints. For example, Public Works would inspect bridges and culverts and erect barricades to close roads.

The Groton Long Point road and bridge elevation projects are nearly in the final design phase. The town has been pursuing this upgrade and would like to ensure this project is complete by including the project in this edition of the HMCAP.

Regulations, Codes, and Ordinances

The Town of Groton has planning and zoning tools in place that incorporate floodplain management. The Town has recently updated its flood protection regulations in its Zoning Regulations in 2015 as noted in Section 2.6. The Town utilizes the 1% annual chance floodplain as defined by FEMA to regulate floodplain and floodway activities and requires 100 percent compensatory storage for any encroachment in the floodplain.

The Town's Subdivision Regulations require that adequate drainage be provided to reduce exposure to flood hazards and that buildings and utilities are located to minimize the effects of flood damage. Regulations covering development in or within a certain distance of inland wetland or watercourse areas are enforced by the Town's Inland Wetlands Agency.

The Town is implementing new stormwater management requirements in accordance with the State's MS4 General Permit update. Over time this should help reduce flooding caused by stormwater, but it is also having major impacts on the municipal budget.

Acquisitions, Elevations, and Property Protection

To date, the Town of Groton has not performed acquisitions or elevations of floodprone property. Property protection has focused instead on preventive measures and maintaining and upgrading drainage systems. The Town is not opposed to performing acquisitions, elevations, or relocations if property owners were willing and grant funding was available. Many coastal residents have elevated homes at their own expense, as noted in Section 4.2.

In 2022 the Town hired a consultant to conduct a study regarding the vulnerability of pump stations in the flood zones. The final report had just been delivered to the town as of summer 2022; the town hopes to incorporate any recommendations and actions into this edition of HMCAP if feasible.

The State of Connecticut also recently acquired a large tract of land referred to as "Tilcon's land" which is traversed by Fort Hill Brook.

Flood Watches and Warnings

The Emergency Management Director and the Emergency Communications Center receive weather reports from the National Weather Service and local media and disburse this information as required. Weather alerts are distributed to residents via the Connecticut Alerts Community Notification system when storms are imminent. The Emergency Management Office is responsible for operating the system as part of the Town's warning capabilities.

Summary

In general, municipal capabilities to mitigate flood damage have not increased significantly since the 2017 edition of the hazard mitigation plan was adopted. This is likely because the Town increased its capabilities in response to flooding of 2011 and 2012 associated with Tropical Storm Irene and Superstorm Sandy, and has maintained a high degree of operation since. Town personnel have participated in events of the Connecticut Association of Flood Managers in recent years and should continue to do so when time allows.

5.2.3 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk of inland flooding within the Town. Areas at risk from coastal flooding are discussed in Section 4.2 of this annex.

Vulnerability Analysis of Areas Along Watercourses

Major inland watercourses and water bodies in Groton have the 1% annual chance floodplain defined by FEMA on a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). The FIRM delineates areas within Groton that are vulnerable to flooding and was most recently published on August 5, 2013, and July 18, 2011, with the remainder of New London County. Many of the inland watercourses and water bodies in Groton are mapped as Zone AE. Hempsted Brook, Beaver Dam Brook, Great Brook, Haleys Brook, and Beebe Pond are mapped as Zone A. Refer to Figure 5-11 for the location of the 1% annual chance floodplains related to inland flooding within Groton.

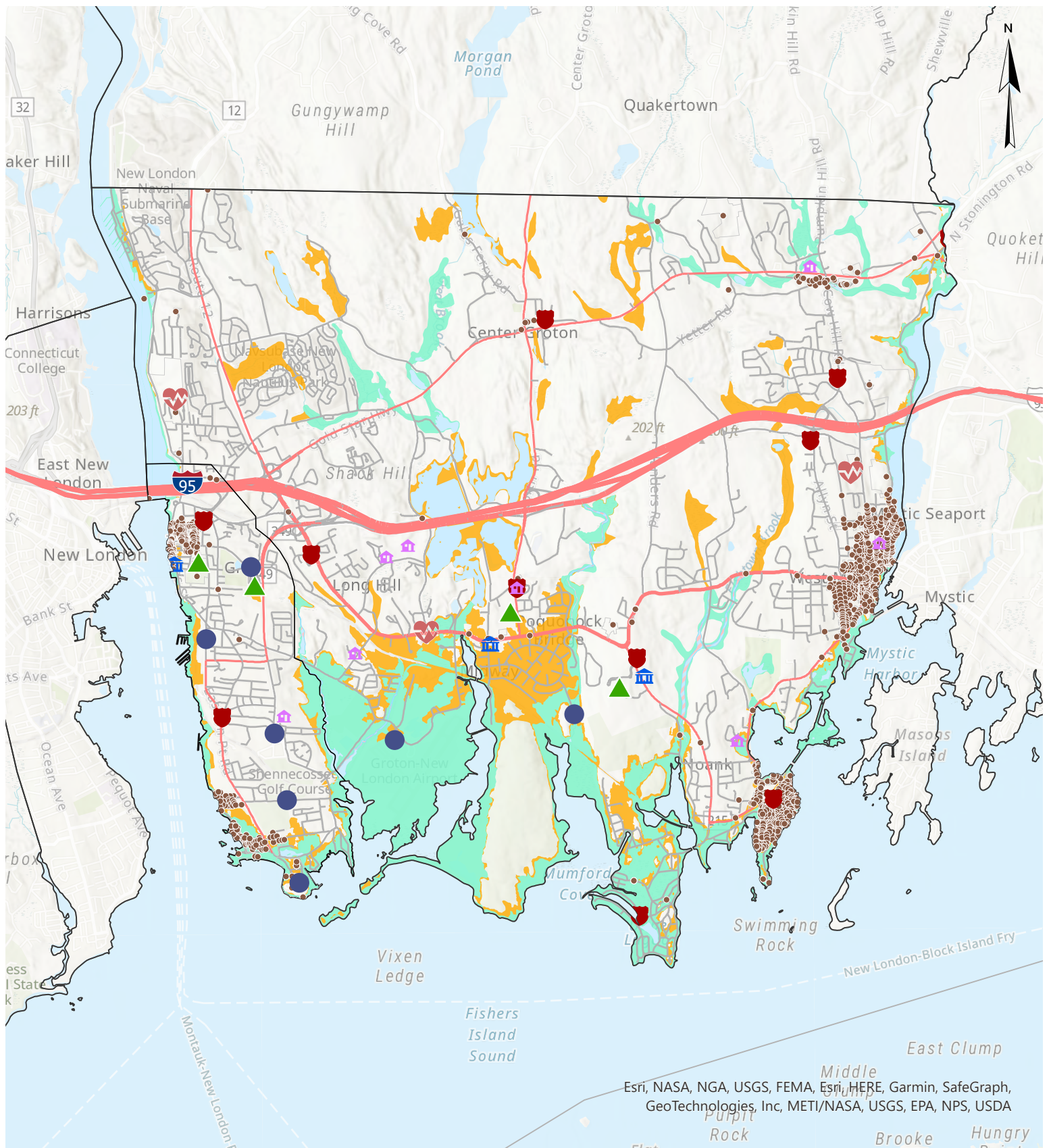
As noted in the previous HMP annex, there are many roadways throughout the Town of Groton that are in flood zones, such as Buddington Road near Hempstead Brook and Rhonda Drive and Farmstead Avenue near Fishtown Brook.

Based on the information in the previous HMP and that provided by Town officials at the January 2012 planning meeting, numerous areas along watercourses and roads are vulnerable to flooding. A map entitled "Town of Groton March 2010 Flood Damage Locations" depicts damage to the following roadways:

- Lambtown Road at tributary of Haleys Brook.
- River Road, Cold Spring Road, and two locations on Packer Road at Haleys Brook.
- Pumpkin Hill Road at West Branch Red Brook.
- Welles Road at Red Brook.
- Gungywamp Road at Great Brook.
- Candlewood Road at Hatching House Brook.
- Bindloss Road at Bindloss Brook.
- Drozdyk Road at unnamed stream.
- Poquonnock Road at unnamed stream.
- Brook Street at Eccleston Brook.
- Fishtown Road and Farmstead Avenue at Fishtown Brook.

As noted in Section 5.2.1, the March 2010 flood was notable for washing out the Route 184 Bridge at Whitford Brook and the River Road Bridge at Haleys Brook. The River Road crossing was closed for a year. The entire neighborhood at the Whitford Brook/Haleys Brook confluence was submerged, and people along River Road had to be rescued by boat.

During the 2022 municipal planning meeting the town also voices concerns regarding the railroad underpass at South Road. This location continues to be a flooding challenge and few solutions for the problem are evident.



Esri, NASA, NGA, USGS, FEMA, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA

Critical Facilities and Historic Resources with Flood Zones

SCCOG Hazard Mitigation and Climate Adaptation Plan

Town of Groton

Date: 8/1/2022

0 0.4 0.8 1.2 1.6 Miles



Legend

- Historic Resources
- 🏠 Senior Housing
- ❤️ Care and Medical Facility
- 🏛️ Municipal
- Other Infrastructure and Facilities
- ▲ Shelter or Cooling Center
- ❤️ Care and Medical Facility
- 1% Annual Chance Flood Hazard Area
- .2% Annual Chance Flood Hazard Area
- 🌊 Floodway

In addition to reports from the Town, Save the Sound, a non-profit organization working to protect the land, air, and water of Long Island Sound, conducted an analysis of road and stream crossings in Groton and Ledyard. Four locations in Groton were analyzed, and recommendations were made for restoration. These are summarized below.

- **Route 1 at Fishtown Road/Noank Ledyard Road on Fishtown/Eccleston Brook:** Replace with Stream Simulation Design culvert or bridge: widen to increase hydraulic capacity, restore continuity and sunlight throughout the span of the crossing
- **River Road on Haley's Brook:** Replace with Stream Simulation Design culvert or bridge, and/or: reduce velocities, restore natural heterogeneous substrate, eliminate perched outlet. If replacement is not feasible, consider retrofits to reduce water velocities (e.g., baffles and inlet weir) and eliminate perched outlet (engineered cascade or weirs)
- **Pumpkin Hill Road on Haley's Brook:** Replace with Stream Simulation Design culvert or bridge, and/or: increase hydraulic capacity, eliminate perched outlets, provide dry-land passage
- **Cow Hill Road at Route 184 on Haley's Brook:** Replace with Stream Simulation Design culvert or bridge, and/or: widen to increase hydraulic capacity. Maintain inlet area to prevent debris blockages

As discussed earlier in this section, the town has also noted a concern at Fishtown Road, River Road and Pumpkin Hill Road.

Vulnerability Analysis of Private Properties

Most of the structures located in Zone AE are residential and are vulnerable to inland flooding, with the remainder being vulnerable to coastal flooding (although some may be susceptible to both types of flooding). The Town of Groton should make an effort to identify properties within the 1% annual chance floodplain and distribute information regarding floodproofing and home elevation to the owners of these properties.

The map described above ("Town of Groton March 2010 Flood Damage Locations") depicts the following areas of residential flood damage from the March 2010 flood:

- River Road neighborhood in Old Mystic (Haleys Brook/Whitford Brook)
- Deerfield Ridge/Heather Glen neighborhood
- Midway Oval neighborhood
- Parts of Noank
- Parts of Mystic
- Ocean View Avenue neighborhood
- Farmstead Avenue/Judson Avenue neighborhood
- Lamphere Road neighborhood
- The Wayne Road/Woodland Drive neighborhood suffered basement damage from drainage – related flooding and high groundwater.
- The Virgo Drive/Pegasus Drive neighborhood in Bailey Hill was flooded from runoff coming down the hill. Inches of water flowing over foundations and into basements.

- On the north side of Route 1/Fort Hill Road, homes near Fort Hill Brook experienced at least a foot of inundation.
- The High Rock Road trailer park experienced flooding from a tributary of Baker Cove.

The numerous instances of residential flood damage are not surprising, given the high number of structures in A, AE, and VE zones.

As of November 2011, four repetitive loss properties were reported in Groton. One was not linked to an address and could not be located. The remaining three were related to inland flooding. These properties were along Haleys Brook, Whitford Brook, and an area of internal drainage in the Poquonock Bridge neighborhood that is not associated with a watercourse. One of the structures is located within a 100-year floodplain but two appear to be in 0.2% annual chance areas. The most recent claim-related damage events are listed in Table 3-1.

The dates of the recent losses for the property along Haleys Brook confirm that the March 2010 and October 2005 floods (both presidentially-declared disasters in Connecticut) were likewise damaging in Groton. The other two properties had not reported damage in quite some time, and it is possible that the owners are repairing flood damage on their own.

As of 2017, five repetitive loss properties are located in Groton. The single new entry on the list is located in Noank and is believed to be affected by coastal flooding.

As of June 2022, there are 11 RL properties in Groton that are impacted by flooding, four of which are impacted by riverine and pluvial flooding. All of those inland properties are residential, and the coastal properties are a single residential and a single commercial property.

Vulnerability Analysis of Critical Facilities

Critical facilities in the Town do not normally suffer from inland flooding, although several fire stations are located in moderate risk zones. The risk of inland flooding to critical facilities is therefore considered to be low. Floodproofing critical facilities can help lower risks further.

5.2.3.1 Hazard Losses

According to NFIP statistics, as of June 30, 2022, the Town of Groton, including Noank Fire District and Groton Long Point, has had a total of 361 flood related losses, with a total of \$4,214,059 paid towards the claims. Table 5-1 presents a breakdown of the losses and dollars paid in town.

Table 5-1 Town of Groton NFIP Communities, Number of Losses, and Dollars Paid

Community	Number of Losses	Total Net Dollars Paid
Town of Groton	143	\$1,594,079
Groton Long Point	186	\$2,109,837
Noank Fire District	32	\$510,143
Total	361	\$4,214,059

5.3. Drought

5.3.1 Setting and Recent Occurrences

A drought can occur during any season when there is a long, abnormally dry period of time. These events are naturally occurring during periods of limited precipitation. The effects of drought may vary throughout Town, with some sectors impacted more than others.

In recent years, droughts have become flashier and more frequent throughout the region. During recent events, there have been reports in the region of wells going dry on residential and farming properties. Some of the more severe and impactful events include:

- **2016** – A statewide drought that lasted almost two years and peaked in 2016, resulted in water conservation efforts throughout the southeastern part of the region, elevated fire risks in some areas, and was noted as the 11th driest spring on record.
- **2020** – From June to December, New London County experienced a moderate to severe drought, with the county being declared a Stage 3 by the Connecticut Interagency Drought Work Group.
- **2022** – During the development of this plan, the region was in an ongoing drought, with severe drought conditions in August 2022. New London County was declared a Stage 3 drought emergency on August 18, 2022.

5.3.2 Existing Capabilities

The Town of Groton has been progressively working toward climate and hazard mitigation and adaptation, as outline in Section 2.6; this work also includes drought and water conservation measures.

The Zoning Regulations have specific site standards in Section 8 that are geared toward landscaping, screening, and buffering. In section 8.1-3.D, the town promotes selecting drought resistant lawn seed mixes to increase lawn drought tolerance. This same section also promotes the use of selecting plant varieties that are drought tolerant in landscaping applications.

The U.S. Drought Monitor is a national resource that many state and local entities use to monitor regional conditions in relation to drought development. The weekly reporting issued by the partnership includes a drought intensity scale which includes five stages from “abnormally dry” to “exceptional drought”. While this resource is available to Town for determining drought conditions, the Connecticut Interagency Drought Workgroup (IDW) uses this and other resources to monitor drought conditions specifically for the state. The Town of Groton has this IDW and state-specific drought emergency declarations as a resource to prepare for, and respond to, droughts.

5.3.3 Vulnerabilities and Risk Assessment

The entire Town of Groton is vulnerable to drought, but the degree of vulnerability varies. Some locations in the northern areas of town rely on private wells for their residential or commercial drinking water. These wells could potentially be impacted during a drought, limiting water supplies. Agricultural operations in town, including growers and livestock farms, may also feel the impacts during droughts as water supplies for irrigation or livestock watering may become stressed.

5.3.3.1 Hazard Losses

There have been no reported drought losses for the Town of Groton. Downscaled drought losses from the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi Jurisdiction document.

5.4. Dam Failure

5.4.1 Setting and Recent Occurrences

Dam failures can be triggered suddenly with little or no warning and often in connection with natural disasters such as floods and earthquakes. Dam failures can occur during flooding when the dam breaks under the additional force of floodwaters. In addition, a dam failure can cause a chain reaction where the sudden release of floodwaters causes the next dam downstream to fail. While flooding from a dam failure generally has a limited geographic extent, the effects are potentially catastrophic depending on the downstream population. A dam failure affecting Groton is considered a possible event each year with potentially significant effects. No dam failures have impacted the town since the previous HMP.

5.4.2 Existing Capabilities

The Connecticut DEEP administers the Dam Safety Section and designates a classification to each state-registered dam based on its potential hazard as detailed in the regional plan. According to the DEEP Dam Safety Division, as of September 2022, there are three DEEP-registered high (C) or significant (B) hazard dams within Groton. Dams in Groton are listed in Table 5-2.

Table 5-2 Dams Registered with DEEP in the Town of Groton

CT Dam#	Dam Name	Dam Class	Owner Type
5929	Hempstead Brook Weir	-	Municipal
5906	Warren Mill Pond Dam	A	Municipal
5907	Little Pond Dam	A	Municipal
5908	Ymca Pond Dam	A	State Owned
5909	Tollgate Pond Dam	A	Municipal
5910	Lake George Dam	A	Municipal
5911	Small Pond Dam	A	Municipal
5912	Poquonock Lake Dam	A	Municipal
5913	Buddington Pond Dam	A	Municipal
5914	North Road Pond Dam	A	Municipal
5916	Eaton Pond Dam	A	Private
5917	Edge Pond Dam	A	Private
5920	Beebe Pond Dam	A	Municipal
5921	Wolfebrook Dam	A	Municipal
5922	Bindloss Brook Pond Dam	A	Land Trust
5923	Haley's Pond Dam	A	Private
5924	Hatchell Dam	A	Private
5925	River Road Pond Dam	A	Private
5926	Billings Pond Dam	A	Municipal
5927	Hatching House Bk Weir	AA	Municipal
5931	Poquonock Dam Weir	AA	Municipal
5902	Ledyard Reservoir Dam	B	Municipal

5905	Poheganut Reservoir Dam	B	Municipal
5904	Poquonock Reservoir Dam	C	Municipal

Failure of a Class C dam would result in any of the following: loss of life; major damage to habitable structures, residences, hospitals, convalescent homes, schools, and main highways; and a significant economic loss. Failure of a Class B dam failure would result in any of the following: possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, and schools; damage or interruption of the use of service of utilities; damage to primary roadways and railroads; and a significant economic loss. Both hazard classes of dams are regarded as significant in the state of Connecticut.

Dams in the region whose failure could impact Groton are under the jurisdiction of the Connecticut DEEP. The dam safety statutes are codified in Section 22a-401 through 22a-411 inclusive of the Connecticut General Statutes. Sections 22a-409-1 and 22a-409-2 of the Regulations of Connecticut State Agencies have been enacted, which govern the registration, classification, and inspection of dams. Dams must be registered by the owner with the DEEP according to Connecticut Public Act 83-38.

Owners of high and significant hazard dams are required to maintain EAPs for such dams. EAPs are not on file for the three dams listed in Table 5-2, although it is presumed that they could be obtained from Groton Utilities. The Town has reached out to Groton Utilities to obtain these documents.

Summary

In general, municipal capabilities to mitigate dam failure damage have not increased since the 2012 edition of the hazard mitigation plan was adopted. However, changes in the State's regulation of dams have increased Statewide capabilities.

5.4.3 Vulnerabilities and Risk Assessment

The impacts related to the Class C and Class B dams in Town are described below. The description below is based on information available at the Connecticut DEEP Dam Safety Section.

- Ledyard Reservoir has a Class B dam located in north-central Groton off Gales Ferry Road. Failure of this dam would inundate the Great Brook corridor and damage commercial and residential properties along Route 184 before floodwaters reached the Poquonock Reservoir, described below.
- Poquonock Reservoir has a Class C dam located 1,500 feet north of Route 1 at the Poquonock River estuary, adjacent to the water treatment plant. The impoundment is the terminal reservoir of the Groton water supply system. The dam is considered intermediate in size, has a watershed of 15.9 square miles, and impounds 1,000 acre-feet. The structure was built in 1901 and was incorporated into an earlier dam. In 1968, the stonefill structure was surfaced with flat stones placed against the spillway. In 1974, Metcalf & Eddy developed preliminary designs to enlarge the spillway and raise the dam. This study included a DFA and is on file at the CT DEEP. According to the 1980 Phase II report by Lenard & Dilaj Engineering, the dam is a masonry earthfill structure with a length of 290 feet and a maximum height of 12 feet. The 90-foot long

spillway is a masonry wall, sloped stonefill. The downstream face is surfaced with flat stones. The impoundment has an irregular shape but is generally oriented in a north-south direction and is approachable on all sides by roads. The reservoir is bisected by Interstate 95.

An Operations, Inspection and Maintenance Plan for the dam was reportedly written in 1980. Failure of this dam would damage commercial and residential properties along Route 1 in the Poquonock Bridge area before floodwaters reached the Poquonock River estuary. Failure of the Ledyard Reservoir Dam could lead to failure of the Poquonock Reservoir dam.

- Poheganut Reservoir has a Class B dam located near I-95. Although located very near the Poquonock Reservoir, the level of Poheganut Reservoir is some 12 feet higher. Failure of the Poheganut Reservoir Dam could lead to failure of the Poquonock Reservoir dam and thus flooding of Route 1 and associated commercial and residential properties.

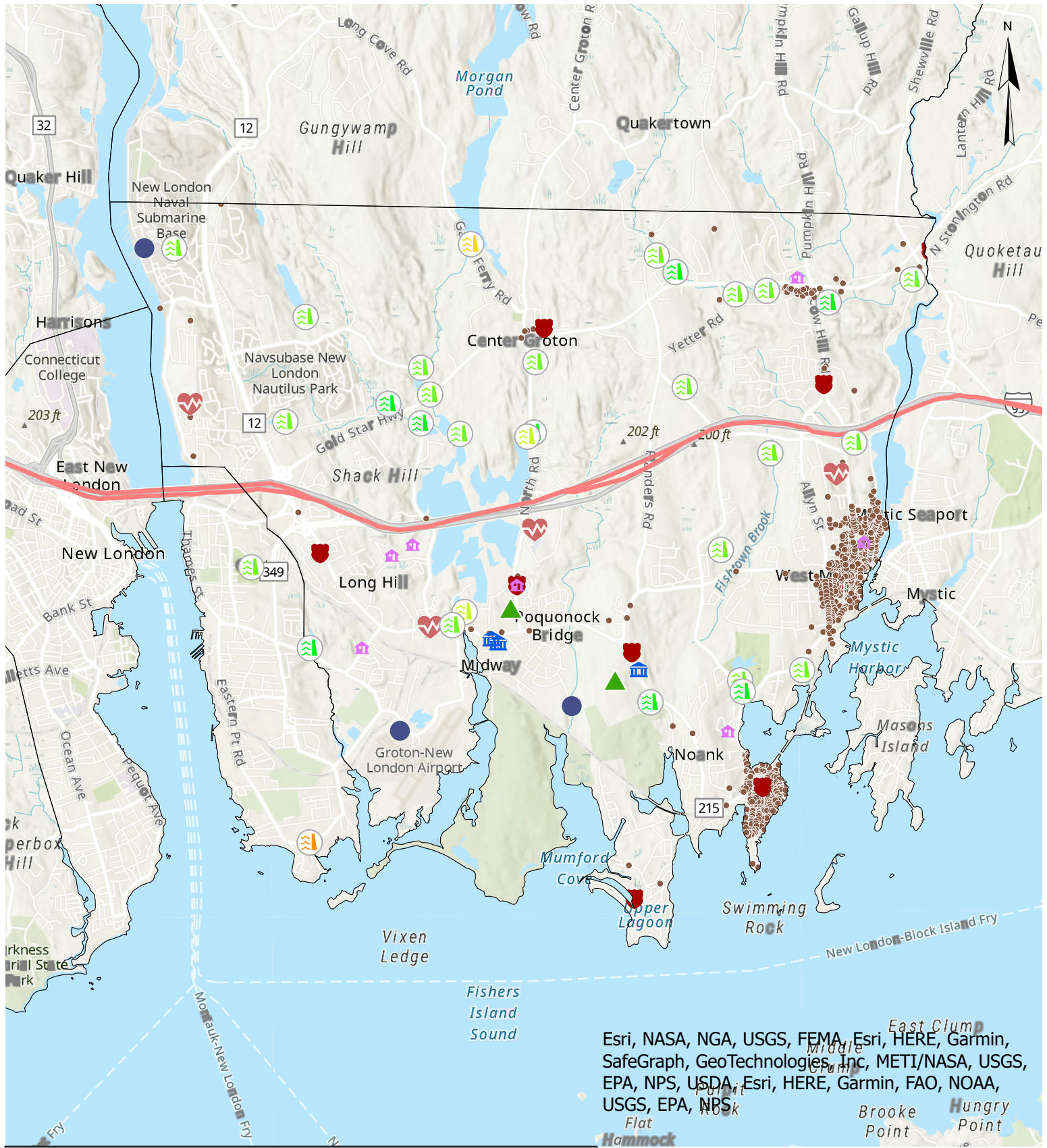
Groton Utilities owns another reservoir and dam located upstream of the Ledyard Reservoir and Poquonock Reservoir. This is the Morgan Pond Dam, located in central Ledyard. The Morgan Pond Dam is a Class B dam whose failure would impact the Town of Groton. Morgan Pond is the most upstream of the Groton Utilities water supply reservoirs. Water passing over the Morgan Pond Dam spillway flows into Ledyard Reservoir, eventually discharging to Great Brook into the Poquonock Reservoir. Morgan Pond receives water from the Billings Avery diversion. According to a 1987 inspection by Lenard Engineering, the Morgan Pond dam is an earthen embankment with a concrete spillway having a length of 1,500 feet and a maximum height of 45 feet. The spillway is located 600 feet from the right embankment contact area and is 40 feet long with an ogee crest. Installation of crest gates was completed in March 1992, which effectively raised the pond elevation by three feet. A Dam Failure Analysis (DFA) was completed as part of the 1987 inspection, and utilized a ½ PMF of 1,726 cfs.

While dams upstream in the Thames River basin could potentially cause a rise in water levels in the Thames River if they failed, their failure is expected to have a minimal effect on the Town of Groton due to the distance involved and the significant ability of Long Island Sound and the Thames River to absorb flood waters.

Hyde Pond Dam on Whitford Brook at Route 184 / the new London Turnpike was removed in 2016, thereby removing any low risks associated with this dam.



5.4.3.1 Hazard Losses

There are no reported losses for the Town of Groton related to dam failure. Downscaled losses from the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi Jurisdiction document.



Dams and Dam Failure Inundation Areas
 Southeastern Connecticut Council of Governments
 Town of Groton
 Date: 2/23/2023

0 0.4 0.8 1.2 1.6 Miles

Legend

	Unknown/Unclassified		Senior Housing
	A		Emergency Services
	AA		Municipal
	B		Other Infrastructure and Facilities
	Historic Resources		Shelter or Cooling Center
			Care and Medical Facility

6. Rising Temperatures

6.1. Climate Change Impacts

On average, the annual temperature across the U.S. has increased by 1.8 degrees Fahrenheit when looking at the entire period of record (1895-2016). Accelerated warming patterns between 1979 and 2016 have been observed with satellite and surface data, and paleoclimate records show that some of the recent decades have been the warmest in the past 1,500 years.³

In general, periods of freeze and frost have decreased, therefore lengthening the period of time between the first winter freeze and spring thaw, since the early 1900's. These warming temperatures impact snowfall and accumulation, alter seasonal patterns, and can disrupt certain natural processes. In addition, warming temperatures can act as fuel for other natural hazards such as wildfires, droughts, hurricanes and severe storms, and also play a role in changing precipitation patterns.

In addition to exacerbating some natural hazards, extreme heat waves are becoming more frequent, which can also have a serious impact on public health. In recent years, the region has experienced numerous heat waves, with several consecutive days of extremely hot temperatures and high heat indexes. Infrastructure can also be at risk during heat waves as some components, such as roadways or bridges, have not been designed to withstand ongoing, extreme temperatures.

6.2. Extreme Heat

6.2.1 Setting and Recent Occurrences

An extreme heat event can occur at any time during warmer months and can be defined as temperatures that hover 10 degrees or more above the average high temperature for the region. These events typically last for a prolonged period of time and are accompanied by high humidity. A heat wave typically lasts three or more days with temperatures over 90 degrees for those days.

Since 2012, 480 days over 85 degrees have been recorded at the Norwich Public Utilities weather stations, 165 of which were over 90 degrees. During the summer of 2022, 45 days over 85 degrees were recorded, 21 of which were at least 90 degrees. A majority of these high temperature days occurred in July and August, with some of these extreme temperatures occurring outside summer months in May and October. Table 6-1 presents the daily maximum temperatures recorded at the Groton New London Airport and Norwich Public Utilities weather stations. Those values that are bold are above 90 degrees.

Table 6-1 Daily Maximum Temperatures from May to September Since 2017

	May		June		July		August		September	
	GNL	NPU	GNL	NPU	GNL	NPU	GNL	NPU	GNL	NPU
2017	85	93	89	94	88	92	87	89	86	89
2018	80	91	87	90	89	101	91	94	90	92
2019	83	85	88	91	94	96	88	91	87	84
2020	75	81	82	91	92	96	89	92	87	87
2021	88	87	86	96	86	94	88	96	82	85
2022	93	92	85	92	91	96	91	94	94	85

GNL = Groton New London station & NPU = Norwich Public Utilities station

³ <https://nca201758.globalchange.gov/chapter/2/>

6.2.2 Existing Capabilities

Similar to the monitoring methods used for hurricanes, severe storms, and winter storms, the Town monitors National Weather Service and local forecasts for anticipated extreme heat event, and also monitors for NWS heat warnings and advisories. The Town of Groton has identified the Senior Center and the Library as an unofficial cooling center in town. The library does not stay open past normal business hours therefore the Senior Center would need to be opened in the event of extended need. In the event of a projected heat event or heat wave, the Town is prepared to open up the Senior Center for cooling.

In addition to weather alerts and cooling centers, the town has also implemented specific zoning regulations to combat heat island effects throughout town. Section 8 in the Town of Groton zoning regulations, which is for site standards, states that one of the sections specific purposes is to reduce excessive heat in town. The subsequent regulations promote the planting of drought tolerant and native plants, and those plants and trees that are suitable for urban areas.

Summary

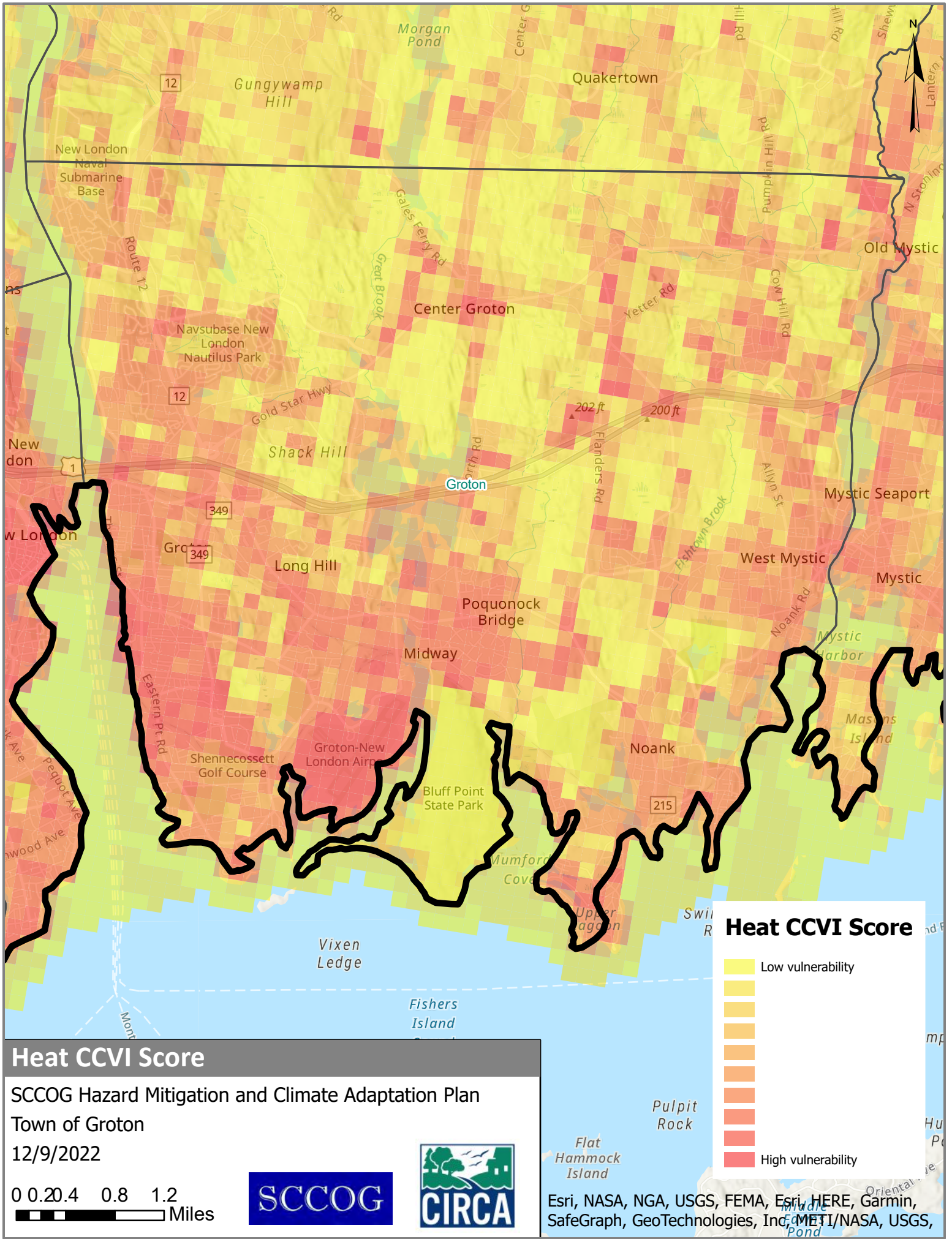
In general, the capabilities of mitigating extreme heat have increased since the 2017 edition of this plan as the town is working toward implementing regulations that promote greening and reducing heat emissivity.

6.2.3 Vulnerabilities and Risk Assessment

While the entire town is at risk of an extreme heat event, vulnerability can widely vary based on age, health, or the type of property owned in Groton. The elderly populations in town are more vulnerable to extreme heat events, particularly when in home cooling is not available. The town is also concerned about residents in low-income housing during extreme heat events. It was noted however that while not all residents may have cooling, the library and the senior center are located in close proximity to the housing locations. Also, those in town with certain health conditions may also be more vulnerable to the health factors associated with extreme temperatures.

UConn CIRCA has developed a tool to aid in understanding extreme heat vulnerability for communities across the state. This tool, known as the Climate Change Vulnerability Index (CCVI), is comprised of dozens of factors that contribute to a community's heat sensitivity, exposure, adaptive capacity, and ultimately the overall heat vulnerability. The CCVI has been used as a tool to characterize heat vulnerability for Groton. The distribution of heat vulnerability throughout the community can be seen in Figure 6-1.

Heat exposure varies across the Town of Groton, reaching high exposure in areas with impervious surfaces and clustered development such as the Naval Submarine Base, West Mystic, Long Hill, and Midway. Heat sensitivity is relatively low across much of the Town, with some pockets of higher sensitivity due to both social and built factors in West Mystic and Noank. Adaptive capacity is robust across most of the Town due to ample access to coastal waters and multiple potential cooling centers. Therefore, the overall heat vulnerability for the Town of Groton is moderate.



Heat CCVI Score

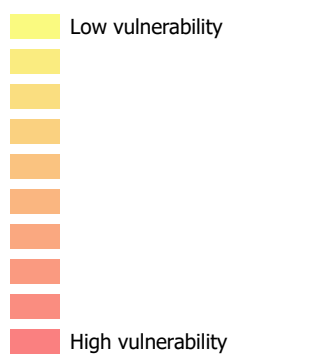
SCCOG Hazard Mitigation and Climate Adaptation Plan
Town of Groton
12/9/2022

0 0.2 0.4 0.8 1.2 Miles



Esri, NASA, NGA, USGS, FEMA, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS,

Heat CCVI Score



6.2.3.1 Hazard Losses

There are no reported losses for the Town of Groton related to extreme temperatures. Future editions of this plan will revisit this topic.

6.3. Wildfires

6.3.1 Setting and Recent Occurrences

Wildfires are considered to be highly destructive, uncontrollable fires. The most common causes of wildfires are arson, lightning strikes, and fires started from downed trees hitting electrical lines. Thus, wildfires have the potential to occur anywhere and at any time in both undeveloped and lightly developed areas of the town.

Four acres of forested land burned off Route 184 near Center Groton about three years ago. An additional four acres of land burned near Bluff Point and the airport a few years ago. These are the only notable wildfires since the preparation of the last HMP.

6.3.2 Existing Capabilities

Monitoring of potential fire conditions is an important part of mitigation. The Connecticut DEEP Forestry Division uses the rainfall data recorded by the Automated Flood Warning system to compile forest fire probability forecasts. This allows the DEEP to monitor drier areas to be prepared for forest fire conditions. The Town can access this information over the internet. The Town also receives "Red Flag" warnings via local media outlets.

Existing mitigation for wildland fire control is typically focused on building codes, public education, Fire Company training, and maintaining an adequate supply of equipment. The Fire companies go to fires as quickly as possible in the Town. Groton Utilities provides fire protection water. Fire pumps are tested and are considered to provide excellent pressure. Each hydrant is banded such that the Fire Company knows how much pressure is available. The Town has few dry hydrants since public water service is available throughout the town. Installation of dry hydrants and cisterns is not required by regulations.

The level of fire protection afforded by the existing public water service and other water sources in outlying areas is considered to be good for the development level of the Town. The Fire Companies will continue to evaluate the level of risk and the need for additional public water system hydrants or other water sources in the future.

The Connecticut DEEP has recently changed its Open Burning Program. It now requires individuals to be nominated and designated by the Chief Executive Officer in each municipality that allows open burning and to take an online training course and exam to become certified as an "Open Burning Official." Permit template forms were also revised that provide permit requirements so that the applicant/permittee is made aware of the requirements prior to, during, and after burn activity. The regulated activity is then overseen by the Town.

Summary

In general, municipal capabilities to mitigate wildfire damage have remained consistent since the 2012 edition of the hazard mitigation plan was adopted.

6.3.3 Vulnerabilities and Risk Assessment

The risk for wildfire in the Town is low for several reasons. First, with the exception of Groton Utilities watershed land, the Town is largely developed such that there are few outlying areas where a wildfire could advance undetected. Secondly, developed areas of the Town have public water service provided by Groton Utilities. This public water service provides sufficient water volume and pressure to fight nearly any fire. Third, the Thames River and Fishers Island Sound are nearby if additional firefighting water was necessary. Fourth, there are few notable dead ends or one-way roads that are difficult to access in the Town. Finally, the Town has very extensive coverage from its many Fire Companies. Thus, if a wildfire did occur, it would likely be contained to within only a few acres. This was true of the two recent four-acre fires noted above.

6.3.3.1 Hazard Losses

There are no reported losses for the Town of Groton related to wildfires. Downscaled losses from the 2019 Connecticut Natural Hazard Mitigation Plan using WUI acreage are developed in the Multi-Jurisdictional document.

7. Earthquakes

7.1. Climate Change Impacts

Earthquakes are not a climate related hazard, therefore there are no expected impacts as a result of climate change. There are however secondary impacts that could be a concern and amplify the damages of an earthquake. The deterioration of infrastructure from extreme heat or salt water as a result of coastal flooding or sea level rise may weaken certain components making them more prone to damage or collapse during an earthquake event. Flooding events can also leave some landscapes at a higher risk of landslides; an earthquake could potentially prompt a landslide in post-flooded areas.

7.2. Earthquakes

7.2.1 Setting and Recent Occurrences

An earthquake is a sudden rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Earthquakes can cause buildings and bridges to collapse; disrupt gas, electric, and telephone lines; and often cause landslides, flash floods, fires, avalanches, and tsunamis. Earthquakes can occur at any time and often without warning. Detailed descriptions of earthquakes, scales, and effects can be found in Section 3.3.5 of the Multi-Jurisdictional HMCAP. Despite the low probability of an earthquake occurrence, earthquake damage presents a potentially catastrophic hazard to the town. However, it is very unlikely that the town would be at the epicenter of such a damaging earthquake. No major earthquakes have affected the town since the last HMP.

7.2.2 Existing Capabilities

The Connecticut Building Codes include design criteria for buildings specific to each region as adopted by Building Officials and Code Administrators (BOCA). These include the seismic coefficients for building design in the Town. The Town has adopted these codes for new construction, and they are enforced by the Zoning and Building Department.

Due to the infrequent nature of damaging earthquakes, Town land use policies do not directly address earthquake hazards. However, the potential for an earthquake and emergency response procedures is addressed in the Town's EOP. In general, municipal capabilities to mitigate earthquake damage have not increased since the 2017 edition of the hazard mitigation plan was adopted. This is because the hazard continues to pose a low risk of damage to the Town.

7.2.3 Vulnerabilities and Risk Assessment

Surficial earth materials behave differently in response to seismic activity. Unconsolidated materials such as sand and artificial fill can amplify the shaking associated with an earthquake. As noted in Section 2.1, a several areas of the town (particularly near watercourses and underlying the entire Groton-New London airport) are underlain by stratified drift. These areas are potentially more at risk for earthquake damage than the areas of the town underlain by glacial till. The best mitigation for future development in areas of sandy material is the application of the most stringent standards in the Connecticut Building Code, exceeding the building code requirements, or, if the Town deems necessary, the possible prohibition of new construction. The areas that are not at increased risk during an earthquake due to unstable soils are the areas underlain by glacial till.

Two faults are mapped within the eastern section of the town, trending north-south. Although they are believed to be inactive, they are associated with the Honey Hill/Lake Char fault system that extends west to east through Salem, Montville, and Preston. The west-east portion of the fault system is considered moderately active by the Connecticut Department of Emergency Services and Public Protection and has been linked with recent small earthquake activity in East Haddam, on the order of 1 to 2 on the Richter scale. Towns that are intersected by this fault zone are considered at moderate risk for very low-intensity earthquakes such as those experienced in East Haddam. Groton may have slightly lower risk due to its position to the south of the main fault zone.

Unlike seismic activity in California, earthquakes in Connecticut are not associated with specific known active faults. However, bedrock in Connecticut and New England in general is typically formed from relatively hard metamorphic rock that is highly capable of transmitting seismic energy over great distances. For example, the relatively strong earthquake that occurred recently in Virginia was felt in Connecticut because the energy was transmitted over a great distance through such hard bedrock.

The built environment in the town primarily includes some more recent construction that is seismically designed. However, most buildings were built before the 1980s and therefore are not built to current building codes. Thus, it is believed that most buildings would be at least moderately damaged by a significant earthquake. Those residents who live or work in older, non-reinforced masonry buildings are at the highest risk for experiencing earthquake damage.

Areas of steep slopes can collapse during an earthquake, creating landslides. The town has several areas with steep slopes greater than 15% located throughout the town and these areas have already prevented significant development. While landslides are not a particular concern in the town, areas beneath steep slopes could be vulnerable to landslide damage during a major earthquake.

Seismic activity can also break utility lines such as water mains, gas mains, electric and telephone lines, and stormwater management systems. Damage to utility lines can lead to fires, especially in electric and gas mains. Dam failure can also pose a significant threat to developed areas during an earthquake. For this HMP, dam failure has been addressed separately in Section 10.0. As noted previously, most utility infrastructure in the town is located above ground. A quick and coordinated response with CL&P, Groton Utilities, and other providers will be necessary to inspect damaged utilities following an earthquake, to isolate damaged areas, and to bring backup systems online. This is covered in the EOPs for these entities.

7.2.4 Hazard Losses

There are no reported losses for the Town of Groton related to earthquakes. Downscaled losses from the 2019 Connecticut Natural Hazard Mitigation Plan are developed in the Multi-Jurisdictional document. In addition, a *HAZUS-MH* analysis of the potential economic and societal impacts to the SCCOG region from earthquake damage is detailed in the Multi-Jurisdictional HMCAP. The analysis addresses a range of potential impacts from any earthquake scenario, estimated damage to buildings by building type, potential damage to utilities and infrastructure, predicted sheltering requirements, estimated casualties, and total estimated losses and direct economic impact that may result from

various earthquake scenarios. Potential economic impacts can be seen in Table 7-1, with additional information developed in the Multi-Jurisdictional document.

Table 7-1 HAZUS-MH Earthquake Related Economic Impacts

Groton	Residential	Commercial	Industrial	Others	Total
	\$359,420,000	\$338,760,000	\$45,940,000	\$137,720,000	881,840,000

8. Mitigation Strategies and Actions

8.1. Status of Mitigation Strategies and Actions

A total of 30 hazard mitigation actions were developed in the previous edition of this plan. The status of each is listed below.

#	Mitigation Actions and Strategies for Groton 2016 - 2021	Status	Status Details
1	Expand the availability of standby power in the Town's critical facilities particularly the Senior Center	Carry Forward	The senior center has a generator, but it cannot power the whole building, so this is still needed if the center is to be used as a cooling center.
2	Work with the City of Groton to create an open space corridor along Birch Plain Creek	Carry Forward	Still a potential but has not happened yet.
3	Equip the new middle school with a standby generator that is sufficiently powerful to serve the entire building, and designate this building as an emergency shelter	Carry Forward	The middle school has a generator, but it is unknown whether it can power the whole building. Needs follow-up.
4	Install air-conditioning units in emergency shelters so that they can be used safely during summertime emergencies	Carry Forward	No new air-conditioning units have been added.
5	Upgrade the standby generator at the High School so that it is capable of powering the entire building	Carry Forward	This has not yet been done. Still an interest.
6	Pursue the acquisition of the Tilcon land, which is traversed by Fort Hill Brook.	Complete	The state now owns this land.
7	Groton Long Point Police/Fire Facility: Complete additional utility room dry floodproofing and expanded wet floodproofing.	Carry Forward	No additional floodproofing has yet occurred.
8	Consider flexible yard requirements and regulatory incentives to allow for and encourage larger separations of buildings from coastal high hazard areas and encourage or require property owners to build as far back from eroding shorelines and vulnerable beach areas as possible.	Carry Forward	Nothing new has occurred but this is still an interest.
9	Consider a study to determine if improvements are necessary to control flooding on Birch Plain Creek near Poquonnock Road since the former Electric Boat Dam has been removed.	Remove	No new studies have been conducted; not much flooding has been reported since the removal of the dam.
10	Provide technical assistance to owners of non-residential structures that suffer flood damage regarding floodproofing techniques such as wet and dry floodproofing.	Carry Forward	No progress
11	Develop a protocol to address redevelopment of buildings severely damaged or destroyed after a major coastal storm.	Carry Forward	No progress. Not much severe damage has occurred in recent years. Keep this action in case of future damage.
12	Conduct beach nourishment and vegetation as needed to keep up with erosion.	Carry Forward	The Town is adding vegetation to Esker Point Beach and doing annual monitoring of sand. Ongoing, keep in.

13	Utilize recently available extreme rainfall data to determine existing sizing of culverts. Encourage bridge replacements and culvert replacements in areas found to be undersized.	Complete	The Town is using current data supported by DEEP.
14	Continue to require that post- development rates of runoff to be no greater than pre- development conditions in most circumstances; utilize recently available extreme rainfall data as noted above when designing controls.	Capability	This is common practice for the town and has become a capability. This action does not need to be listed going forward.
15	Investigate funding sources and feasibility and prioritization of improvements to mitigate frequent and repeated flooding problems. Improvements could include elevation of roads and replacement of storm drainage systems. Work with CT DOT to facilitate these actions if State roads are involved.	Carry Forward with Revisions	Groton Long Point Rd and Groton Long Point Bridge are nearly in the final design phase. Perhaps make this action more specific for the future.
16	Study and prioritize upgrades to stormwater collection and discharge systems to keep up with rising sea level.	Carry Forward	This is ongoing. The town received funding this year to study Willow Point in Mystic.
17	Study and prioritize installation of appropriately designed flood/tide gates at locations such as Groton Long Point and Mumford Cove, with considerations for sea level rise built into the design.	Carry Forward	No progress.
18	Study and prioritize locations for use of "non-structural" erosion control measures (such as vegetated slopes and elevated foundations)	Remove	There is not much activity on this, though applications in coastal areas already take this into consideration. This is more of a capability.
19	Complete the ongoing engineering study of Groton Long Point Road Bridge and design appropriate means of protecting this important mode of egress to keep up with rising sea level and withstand coastal storms.	Carry Forward with Revisions	This is under way (see #15).
20	Evaluate and prioritize potential roadway elevation and structural protections at Groton-New London Airport, as it lies in the coastal flood hazard area.	Carry Forward with Revisions	No progress. The road that goes through the airport is a state road, so the town does not have ability to act on this.
21	Work with Amtrak to study potential bridge replacements at the Poquonnock Road and South Road underpasses to facilitate enhanced emergency transportation. Evaluate potential drainage Improvements at the South Road and Poquonnock Road underpasses to reduce flooding.	Carry Forward with Revisions	Poquonnock Road is town-owned, South Road is state-owned. This action can be revised to reflect this.
22	Work with The Nature Conservancy to identify redevelopment options for the Fort Hill homes area, which is partly located in a SFHA.	Carry Forward with Revisions	The town was previously working on a project with TNC, but none of the recommendations have been implemented. Revise this action and keep it in. Town staff will send the TNC report.

23	Determine if any at-risk structures that are not yet eligible for historic designation will be eligible in the future. This may take the form of a historic resources survey.	Carry Forward	The town may revise this after the Mystic study (see #24).
24	Conduct a pilot study in Mystic to determine how a small number of historic structures may be mitigated without loss of historicity that is connected to their location near or over water.		This is underway.
25	Encourage commercial building owners or managers of large population clusters to develop response plans and mitigation opportunities	Remove	This can be retired, not relevant.
26	Upgrade shelters and critical facilities to resist stronger winds when possible	Capability	Ongoing, as needed. The highway garage has hurricane shutters. Three schools have been upgraded in the last five years, using the state building code for wind.
27	Develop working relationships with local community organizations and encourage them to promote wise landscaping techniques	Remove	This can be retired. LID regulations in 2019 will suffice.
28	Provide information for protecting Town residents during cold weather and for mitigating icing and insulating pipes at residences	Remove	Not an issue but can be done on an as need basis.
29	Ensure that copies of EOPs for all the Groton Utilities dams are on file with the Town of Groton Office of Emergency Management.	Carry Forward	This is still needed.
30	Work with Groton Utilities to conduct a tabletop exercise (drill) that simulates a potential dam failure, as Norwich Public Utilities has done with the City of Norwich.	Carry Forward	This has not been done.

During the planning process, CIRCA and consultant staff facilitated a discussion with the Town staff to identify the greatest climate change concerns and challenges. The previous actions were re-evaluated in this context. Elements of 20 prior actions have been carried forward into the new hazard mitigation and climate adaptation actions.

8.2. Prioritization of Specific Actions

The proposed actions for the Town of Groton to undertake from 2023 through 2028 are listed in Table 8-1 on the next page. The full list of actions for the region with buildups for the PERSISTS and STAPLEE scores are available in the multi-jurisdiction document.

The actions with the highest PERSISTS score and the highest STAPLEE score are different, which is consistent with the intent of the two scores. PERSISTS scores tend to be higher for actions that maximize public safety while advancing climate science and being transferable to other communities, whereas STAPLEE scores tend to be higher for actions that are highly cost effective and technically feasible for reducing losses from hazards. The actions with the highest combined scores are:

- Provide technical assistance to owners of non-residential structures that suffer flood damage regarding floodproofing techniques such as wet and dry floodproofing.
- Advance design and seek funding for replacement of the Eccleston Brook culvert at Route 1 with a larger culvert or bridge.
- Advance design and seek funding for replacement of the Haleys Brook culvert at River Road with a larger culvert or bridge.
- Advance design and seek funding for replacement of the Haleys Brook culvert at Cow Hill Road with a larger culvert or bridge.
- Advance design and seek funding for replacement of the West Branch Red Brook culvert at Pumpkin Hill Road with a larger culvert or bridge.

The Town intends to focus on the above actions, along with the following two actions about cooling centers:

- Expand the availability of standby power in the Town's critical facilities (including but not limited to the Senior Center, which can be used as a cooling center).
- Install air-conditioning units in emergency shelters so that they can be used safely during summertime emergencies.

Table 8-1 Town of Groton Actions and STAPLEE and PERSISTS Scores

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERSISTS Score	STAPLEE Score	PERSISTS x STAPLEE =
TG1	Expand the availability of standby power in the Town's critical facilities (including but not limited to the Senior Center, which can be used as a cooling center).	Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.	Preparedness & Emergency Response	Office of the Chief Elected Official	\$100,000 - \$500,000	FEMA HMA; Other Preparedness Grants	7/2023 - 6/2025	High	16	5	80
TG2	Assess mobility constraints for accessing all emergency shelters (including cooling centers) and critical facilities.	Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.	Preparedness & Emergency Response	Office of the Chief Elected Official	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 6/2025	Medium	16	7	112
TG3	Upgrade the new middle school generator to ensure backup power capacity is sufficient to run the entire building.	Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.	Preparedness & Emergency Response	Office of the Chief Elected Official	\$100,000 - \$500,000	FEMA HMA; Other Preparedness Grants	7/2023 - 6/2025	Medium	16	6	96
TG4	Install air-conditioning units in emergency shelters so that they can be used safely during summertime emergencies	Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.	Preparedness & Emergency Response	Office of the Chief Elected Official	\$100,000 - \$500,000	Preparedness grants	7/2023 - 6/2025	High	16	6	96
TG5	Upgrade the standby generator at the High School so that it is capable of powering the entire building	Ensure that critical facilities are resilient, with special attention to shelters and cooling centers.	Preparedness & Emergency Response	Office of the Chief Elected Official	\$100,000 - \$500,000	FEMA HMA; Other Preparedness Grants	7/2023 - 6/2025	High	16	6	96
TG6	Work with the City of Groton to create an open space corridor along Birch Plain Creek to increase flood capacity.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Natural Resources Protection	Office of the Chief Elected Official	>\$1M	DEEP Open Space Grants; Land Trusts	7/2024 - 06/2028	Low	19	2	38
TG7	Seek funding to assess/study all roads/highways susceptible to storm surge, sea level rise, severe rainfall	Invest in resilient corridors to ensure that people and services are accessible during	Structural Projects	Public Works	\$100,000 - \$500,000	DEEP Climate Resilience Fund; CT DOT or LOTCIP;	7/2024 - 06/2028	Medium	17	5	85

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERSISTS Score	STAPLEE Score	PERSISTS x STAPLEE =
	flooding events, sunny day flooding, etc.	floods and that development along corridors is resilient over the long term.				Municipal CIP Budget					
TG8	For the Groton Long Point Police/Fire Facility: Partner with the jurisdiction to complete additional utility room dry floodproofing and expanded wet floodproofing as recommended in the Southeastern Connecticut Critical Facilities Assessment.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Office of the Chief Elected Official	\$50,000 - \$100,000	FEMA HMA	7/2023 - 6/2025	High	17	8	136
TG9	Consider flexible yard requirements and regulatory incentives to allow for and encourage larger separations of buildings from coastal high hazard areas and encourage or require property owners to build as far back from eroding shorelines and vulnerable beach areas as possible.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Prevention	Land Use Staff	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 6/2025	Medium	19	7	133
TG10	Provide technical assistance to owners of non-residential structures that suffer flood damage regarding floodproofing techniques such as wet and dry floodproofing.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Floodplain Manager	\$0 - \$10,000	Municipal Operating Budget	7/2024 - 06/2028	Medium	19	9	171
TG11	Develop a protocol to address redevelopment of buildings severely damaged or destroyed after a major coastal storm.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Building Official	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 6/2025	Medium	19	6	114
TG12	Conduct beach nourishment and revegetation as needed to keep up with erosion, such as Esker Point Beach and others.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Natural Resources Protection	Conservation Staff	\$500,000 - \$1M	NOAA/NFWF; LISFF; Municipal CIP Budget	7/2023 - 6/2025	Medium	13	3	39
TG13	Secure funding to construct and implement the Groton Long Point Road and Groton Long Point Bridge design upgrades to maintain emergency egress and address sea level rise and coastal storms. Work with CT DOT as needed to complete the elevations and upgrades.	Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.	Structural Projects	Public Works	>\$1M	DEEP Climate Resilience Fund; CT DOT or LOTCIP; IJIA BIP; Municipal CIP Budget	7/2024 - 06/2028	High	17	6	102

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERISTS Score	STAPLEE Score	PERISTS x STAPLEE =
TG14	Study risk of storm surge inundation in coastal floodplain areas (including Groton Long Point and Mumford Cove) - study to include assessment of critical infrastructure, homes, and businesses.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Structural Projects	Public Works	\$500,000 - \$1M	NOAA/NFWF; LISFF; Municipal CIP Budget	7/2023 - 6/2025	Medium	18	2	36
TG15	Using the process developed by CIRCA for Resilient Connecticut pilot projects in Branford and Fairfield, work with Amtrak and the State to study potential bridge replacements at town owned Poquonnock Road and state-owned South Road underpasses to facilitate enhanced emergency transportation. Evaluate potential drainage improvements at the South Road and Poquonnock Road underpasses to reduce flooding. This actions includes studies and concept design but not construction.	Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.	Structural Projects	Public Works	\$100,000 - \$500,000	DEEP Climate Resilience Fund; CIRCA Resilient Connecticut; CT DOT	7/2024 - 06/2028	High	17	6	102
TG16	Determine if any at-risk structures that are not yet eligible for historic designation will be eligible in the future. This may take the form of a historic resources survey.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Land Use Staff	\$10,000 - \$25,000	SHPO	7/2025 - 6/2026	Medium	15	6	90
TG17	Implement specific pump station resilience recommendations resulting from the feasibility study completed in 2022.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Public Works	\$500,000 - \$1M	FEMA HMA; CWSRA	7/2023 - 6/2025	High	20	6	120
TG18	Seek funding from DEEP Climate Resilience Fund to develop a Climate Action Plan (including vulnerability assessment).	More than one goal	More than one category	Sustainability Manager	\$100,000 - \$500,000	DEEP Climate Resilience Fund	4/2023 - 9/2024	High	21	5	105
TG19	Seek funding for Poquonnock Plains Park evaluation from DEEP Climate Resilience Fund.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Natural Resources Protection	Sustainability Manager	\$100,000 - \$500,000	DEEP Climate Resilience Fund	4/2023 - 9/2024	High	15	3	45

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERSISTS Score	STAPLEE Score	PERSISTS x STAPLEE =
TG20	Partner with the Town of North Stonington, Town of Ledyard, Town of Stonington, and the Native American tribes to ensure that risks downstream of Long Pond are characterized in the new Emergency Action Plan for the Long Pond Dams.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Preparedness & Emergency Response	Office of the Chief Elected Official	\$10,000 - \$25,000	Municipal Operating Budget; SCCOG Municipal Service Funds	7/2023 - 6/2024	High	21	4	84
TG21	Partner with the Town of Stonington and the Town of Ledyard to determine appropriate steps to reduce risks associated with additionally breaching of the Whitford Pond Dam; document in a report that lists potential solutions.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Structural Projects	Office of the Chief Elected Official	\$25,000 - \$50,000	NOAA/NFWF; DEEP Climate Resilience Fund	7/2024 - 6/2025	High	21	5	105
TG22	Participate in a dam failure tabletop exercise for Long Pond with the Towns of Ledyard, Stonington, and North Stonington.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Preparedness & Emergency Response	Emergency Management	\$0 - \$10,000	Municipal Operating Budget	7/2025 - 6/2026	High	21	5	105
TG23	Ensure that copies of EAPs for all the Groton Utilities dams are on file with the Town of Groton Office of Emergency Management.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Preparedness & Emergency Response	Emergency Management	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 12/2023	High	14	6	84
TG24	Work with Groton Utilities to conduct a tabletop exercise (drill) that simulates a potential dam failure.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Preparedness & Emergency Response	Emergency Management	\$0 - \$10,000	Municipal Operating Budget	7/2025 - 6/2026	Low	17	5	85
TG25	Work with CT DEEP to update the list of repetitive loss properties and ensure that errors and updates are incorporated by FEMA.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Floodplain Manager	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 12/2023	High	12	6	72

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERISTS Score	STAPLEE Score	PERISTS x STAPLEE =
TG26	Conduct direct outreach to property owners in repetitive loss areas with information about how to mitigation flood losses.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Property Protection	Floodplain Manager	\$0 - \$10,000	Municipal Operating Budget	1/2024 and annually during January	High	13	4	52
TG27	Work with SCCOG and CIRCA to scope a corridor study for Lantern Hill Road that evaluates its capabilities and risks relative to providing access between and among MPTN, Ledyard, North Stonington, the Eastern Pequots, Stonington, and the Old Mystic part of Groton.	Invest in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.	Structural Projects	Office of the Chief Elected Official	\$100,000 - \$500,000	SCCOG Special Projects; DEEP Climate Resilience Fund; CIRCA Resilient Connecticut	7/2024 - 6/2025	High	24	3	72
TG28	Secure funding to advance at least one recommendation from the Mystic resiliency study scheduled for completion in 2023.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	More than one category	Sustainability Manager	>\$1M	DEEP Climate Resilience Fund; CIRCA Resilient Connecticut	7/2023 - 6/2026	Medium	15	3	45
TG29	Apply for participation in the Community Rating System (CRS) and solicit interest in involvement from Groton Long Point and Noank Fire District.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	More than one category	Floodplain Manager	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 12/2023	Medium	14	8	112
TG30	Require floodplain manager and land use staff to take free training at https://portal.ct.gov/DEEP/P2/Chemical-Management-and-Climate-Resilience/Chemical-Management-and-Climate-Resilience to reduce risks of spills from businesses during floods.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	Education & Awareness	Land Use Staff	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 12/2023	Low	14	6	84
TG31	Advance design and seek funding for replacement of the Eccleston Brook culvert at Route 1 with a larger culvert or bridge	More than one goal	Structural Projects	Public Works	\$100,000 - \$500,000	CT DOT; LOTCIP; DEEP Climate Resilience Fund; FEMA HMA; Save	7/2023 - 6/2025	Low	19	8	152

Number	Hazard Mitigation and Climate Adaptation Actions	Hazard Mitigation and Climate Adaptation Goal	Type of Action	Responsible Department	Approx. Cost Range	Potential Funding Sources	Timeframe	Priority	PERISTS Score	STAPLEE Score	PERISTS x STAPLEE =
						the Sound; IJJA AOP					
TG32	Advance design and seek funding for replacement of the Haleys Brook culvert at River Road with a larger culvert or bridge	More than one goal	Structural Projects	Public Works	\$100,000 - \$500,000	CT DOT; LOTCIP; DEEP Climate Resilience Fund; FEMA HMA; Save the Sound; IJJA AOP	7/2023 - 6/2025	Low	19	8	152
TG33	Advance design and seek funding for replacement of the Haleys Brook culvert at Cow Hill Road with a larger culvert or bridge	More than one goal	Structural Projects	Public Works	\$100,000 - \$500,000	CT DOT; LOTCIP; DEEP Climate Resilience Fund; FEMA HMA; Save the Sound; IJJA AOP	7/2023 - 6/2025	Low	19	8	152
TG34	Advance design and seek funding for replacement of the West Branch Red Brook culvert at Pumpkin Hill Road with a larger culvert or bridge	More than one goal	Structural Projects	Public Works	\$100,000 - \$500,000	CT DOT; LOTCIP; DEEP Climate Resilience Fund; FEMA HMA; Save the Sound; IJJA AOP	7/2023 - 6/2025	Low	19	8	152