
TOWN OF LEDYARD ANNEX DOCUMENT

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

March 2023



PREPARED FOR:
Town of Ledyard
741 Colonel Ledyard Highway
Ledyard, CT 06339
www.ledyardct.org

PREPARED BY:
Resilient Land and Water, LLC
With Assistance from
Connecticut Institute for Resilience and
Climate Adaptation (CIRCA)

1. INTRODUCTION	4
1.1. PURPOSE OF ANNEX.....	4
1.2. HAZARD MITIGATION AND CLIMATE ADAPTATION GOALS	5
2. COMMUNITY PROFILE	6
2.1. PHYSICAL SETTING	6
2.2. DRAINAGE BASINS AND HYDROLOGY	8
2.3. LAND COVER	9
2.4. POPULATION, DEMOGRAPHICS, AND DEVELOPMENT TRENDS.....	9
2.5. GOVERNMENTAL STRUCTURE.....	10
2.6. REVIEW OF EXISTING PLANS AND REGULATIONS	11
2.7. CRITICAL FACILITIES, SHELTERING CAPACITY, AND EVACUATION	14
2.8. REPETITIVE LOSS PROPERTIES.....	17
2.9. EXPOSURE TO CLIMATE-AFFECTED NATURAL HAZARDS	17
2.10. COMMUNITY CLIMATE CHANGE CHALLENGES	17
3. EXTREME AND SEVERE STORMS	18
3.1. CLIMATE CHANGE IMPACTS	18
3.2. HURRICANES AND TROPICAL STORMS	18
3.2.1 <i>Setting and Recent Occurrences</i>	18
3.2.2 <i>Existing Capabilities</i>	19
3.2.3 <i>Vulnerabilities and Risk Assessment</i>	21
3.2.3.1 Hazard Losses	22
3.3. TORNADOES AND HIGH WIND EVENTS	24
3.3.1 <i>Setting and Recent Occurrences</i>	24
3.3.2 <i>Existing Capabilities</i>	24
3.3.3 <i>Vulnerabilities and Risk Assessment</i>	24
3.3.3.1 Hazard Losses	25
3.4. SEVERE WINTER STORMS.....	25
3.4.1 <i>Setting and Recent Occurrences</i>	25
3.4.2 <i>Existing Capabilities</i>	26
3.4.3 <i>Vulnerabilities and Risk Assessment</i>	27
3.4.3.1 Hazard Losses	27
4. SEA LEVEL RISE	28
4.1. CLIMATE CHANGE IMPACTS	28
4.2. COASTAL FLOODING.....	28
4.2.1 <i>Setting and Recent Occurrences</i>	28
4.2.2 <i>Existing Capabilities</i>	29
4.2.3 <i>Vulnerabilities and Risk Assessment</i>	30
4.2.3.1 Hazard Losses	30
4.3. SHORELINE CHANGE.....	32
4.3.1 <i>Setting/Historic Record</i>	32
4.3.2 <i>Existing Capabilities</i>	32
4.3.3 <i>Vulnerabilities and Risk Assessment</i>	32
4.3.3.1 Hazard Losses	32
5. CHANGING PRECIPITATION	33

5.1. CLIMATE CHANGE IMPACTS	33
5.2. RIVERINE AND PLUVIAL FLOODS	33
5.2.1 <i>Setting and Recent Occurrences</i>	33
5.2.2 <i>Existing Capabilities</i>	34
5.2.3 <i>Vulnerabilities and Risk Assessment</i>	35
5.2.3.1 Hazard Losses	40
5.3. DROUGHT	40
5.3.1 <i>Setting/ and Recent Occurrences</i>	40
5.3.2 <i>Existing Capabilities</i>	41
5.3.3 <i>Vulnerabilities and Risk Assessment</i>	41
5.3.3.1 Hazard Losses	41
5.4. DAM FAILURE	41
5.4.1 <i>Setting and Recent Occurrences</i>	41
5.4.2 <i>Existing Capabilities</i>	42
5.4.3 <i>Vulnerabilities and Risk Assessment</i>	42
5.4.3.1 Hazard Losses	44
6. RISING TEMPERATURES	46
6.1. CLIMATE CHANGE IMPACTS	46
6.2. EXTREME HEAT	46
6.2.1 <i>Setting/Historic Record</i>	46
6.2.2 <i>Existing Capabilities</i>	47
6.2.3 <i>Vulnerabilities and Risk Assessment</i>	47
6.2.3.1 Hazard Losses	47
6.3. WILDFIRES	49
6.3.1 <i>Setting/Historic Record</i>	49
6.3.2 <i>Existing Capabilities</i>	49
6.3.3 <i>Vulnerabilities and Risk Assessment</i>	50
6.3.3.1 Hazard Losses	50
7. EARTHQUAKES	51
7.1. CLIMATE CHANGE IMPACTS	51
7.2. EARTHQUAKES	51
7.2.1 <i>Setting/Historic Record</i>	51
7.2.2 <i>Existing Capabilities</i>	51
7.2.3 <i>Vulnerabilities and Risk Assessment</i>	51
7.2.4 <i>Hazard Losses</i>	52
8. MITIGATION STRATEGIES AND ACTIONS	53
8.1. STATUS OF MITIGATION STRATEGIES AND ACTIONS	53
8.2. PRIORITIZATION OF SPECIFIC ACTIONS	54

LIST OF FIGURES

FIGURE 2-1 TOWN OF LEDYARD LOCATION IN THE SCCOG REGION7
FIGURE 3-1 HURRICANE ISAIAS FUNDING CATEGORIES.....22
FIGURE 4-1 FOUR LOCALIZED SEA LEVEL RISE SCENARIOS FOR CONNECTICUT.....28
FIGURE 4-2 COASTAL STORM SURGE ZONES FOR THE TOWN OF LEDYARD31
FIGURE 5-1 CCVI FLOOD VULNERABILITY FOR THE TOWN OF LEDYARD37
FIGURE 5-2 TOWN OF LEDYARD FEMA SPECIAL FLOOD HAZARD AREAS39
FIGURE 5-3 DAMS REGISTERED WITH DEEP IN THE TOWN OF LEDYARD.....45
FIGURE 6-1 CCVI HEAT VULNERABILITY FOR THE TOWN OF LEDYARD48

LIST OF TABLES

TABLE 2-1 TOWN OF LEDYARD LAND COVER.....9
TABLE 2-2 TOWN OF LEDYARD CRITICAL FACILITIES.....14
TABLE 2-3 TOWN OF LEDYARD EXPOSURE ANALYSIS17
TABLE 3-1 HAZUS-MH HURRICANE RELATED ECONOMIC IMPACTS22
TABLE 3-2 HAZUS-MH HURRICANE RELATED BUILDING DAMAGE.....22
TABLE 3-3 HAZUS-MH HURRICANE RELATED DEBRIS AND SHELTERING NEEDS.....23
TABLE 5-1 HAZUS-MH RIVERINE FLOOD RELATED ECONOMIC IMPACTS.....40
TABLE 5-2 DAMS REGISTERED WITH DEEP IN THE TOWN OF LEDYARD42
TABLE 6-1 DAILY MAXIMUM TEMPERATURES FROM MAY TO SEPTEMBER SINCE 2017.....46
TABLE 7-1 HAZUS-MH EARTHQUAKE RELATED ECONOMIC IMPACTS.....52
TABLE 8-1 TOWN OF LEDYARD ACTIONS AND STAPLEE AND PERSISTS SCORES56

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.

The purpose of this HMP annex is to provide an update to the hazard risk assessment and capability assessment provided in the previous HMP, and to evaluate potential hazard mitigation measures and prioritize hazard mitigation projects specific to mitigating the effects of hazards on the Town of Ledyard. Background information and the regional effects of pertinent hazards are discussed in the main body of the Multi-Jurisdictional Hazard Mitigation and Climate Adaptation Plan. Thus, this annex is designed to

supplement the information presented in the Multi-Jurisdictional HMCAP with more specific details for Ledyard and is not to be considered a standalone document.

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:

- 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

Ledyard is a town of approximately 40 square miles that is situated in central New London County approximately seven miles southeast of the City of Norwich. The town is bordered by the Town of Preston to the north, the Town of North Stonington to the east, the United States Naval Submarine Base and the Town of Groton to the south, and the Thames River to the west. The most significant surface water bodies include the Thames River / Poquetanuck Cove which straddle the town's western boundary, Joe Clark Brook which discharges into Poquetanuck Cove, and Whitford Brook (including Whitford Pond) in the south and southeastern part of Ledyard. The three major transportation routes through town includes Route 12 which runs north-south along the Thames River on the western edge of town, Route 214 which transects the town across the center in an east-west orientation, and Route 117 which is oriented north-south and stretches from the Town of Preston to the north to the Town of Groton to the south.

2.1. Physical Setting

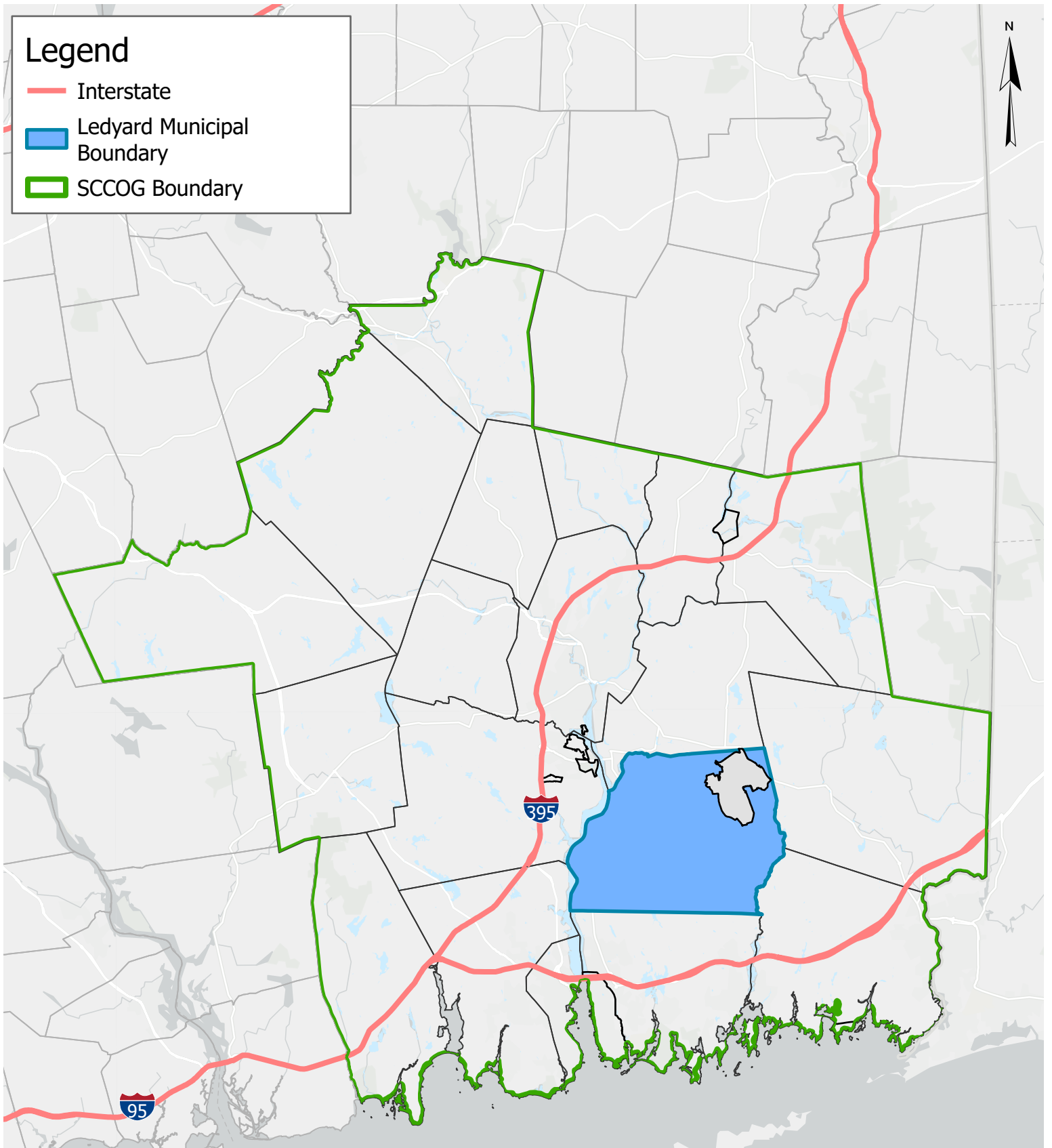
Ledyard is located in the center of the SCCOG planning area (Figure 2-1). Elevations range from approximately 470 at the top of Ayer Hill in the northeast corner of town near the town line with North Stonington and Preston to sea level along the Thames River. The most densely populated areas of town include the Route 12 corridor in the southwest portion of town between the United States Naval Submarine base and the Allyn Point area, and along Route 117 between Route 214 and the Colonel Ledyard Highway. While a majority of outlying areas are rural, the town contains a number of suburban neighborhoods.

The short stretch of Route 2 in the northeastern corner of town near the Preston and North Stonington town lines is associated with the Mashantucket Pequot Tribal Nation and includes some land uses ancillary to the Foxwoods Resort and Casino development on the tribal lands.

Geology is important to the occurrence and relative effects of natural hazards such as earthquakes. Thus, it is important to understand the geologic setting and variation of bedrock and surficial formations in lands underlying Ledyard. Ledyard lies above ten bedrock formations which largely trend east-west. The formations are interrupted by several inactive faults. The formations branch to the south in the southeastern corner of town. The majority of the town (27%) is underlain by the Potter Hill Granite Formation. The Potter Hill Granite Formation consists of light to medium-grey or light pink to grey, tan weathering or spotted, fine-to medium grained well-foliated gneiss.

Legend

- Interstate
- Ledyard Municipal Boundary
- SCCOG Boundary

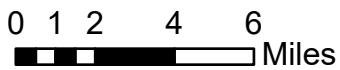


Regional Location of Ledyard

SCCOG Hazard Mitigation and Climate Adaptation Plan

Town of Ledyard

Date: 7/22/2022



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

The town's surficial geologic formations include glacial till (approximately 74% of town) and stratified drift. Refer to the Multi-Jurisdictional HMP for a generalized view of surficial materials. Till contains an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. Areas underlain by sand, sand and gravel, fines, alluvial sediment, or gravel include an extensive region mostly within the Mashantucket Pequot Tribal Nation (associated with Cedar Swamp); land surrounding tributaries to the Thames River such as Joe Clark Brook, Billings Avery Brook, and Flat Brook; and other streams such as Williams Brook, Whitford Brook, Rose Hill Brook. The amount of stratified drift present is important as areas of stratified materials are generally coincident with floodplains. In Ledyard a substantial amount of the built landscape has been built on land defined as stratified drift. Furthermore, the amount of stratified drift also has bearing on the relative intensity of earthquakes and the likelihood of soil subsidence in areas of fill.

2.2. Drainage Basins and Hydrology

As previously stated, the Thames River / Poquetanuck Cove, Joe Clark Brook, and Whitford Brook are the major water bodies in Ledyard. Their locations are described in Section 1.2. Aside from the Thames River, Joe Clark Brook, and Whitford Brook, there are approximately 16 named flowing watercourses and many unnamed small tributaries in Ledyard. Named streams include Billings Avery Brook, Great Brook, Haleys Brook, and Williams Brook. Significant impoundments include the Ledyard Reservoir, and Morgan Pond in south-central Ledyard on Great Brook and Long Pond and Lantern Hill Pond along the North Stonington town line just north of Lantern Hill Road in northeastern Ledyard.

There are a total of seven subregional watershed basins in Ledyard. The subregional basins are Great Brook, Haleys Brook, Poquetanuck Brook, Shewville Brook, Thames River, Whitford Brook, and Williams Brook. The Thames River subregional drainage basin dominates Ledyard covering approximately 25% of town, while Williams Brook, Great Brook, Shewville Brook, and Haleys Brook cover between 15.5% with Williams and Great Brook to approximately 11% coverage by Haleys Brook. Whitford Brook, the smallest subregional drainage basin in Ledyard covers almost 7% of town.

The extreme northwest corner of Ledyard drains to the Poquetanuck Brook subregional drainage basin and the extreme northeast corner drains to the Shewville Brook drainage basin, while the Thames River drainage basin extends from below the Poquetanuck Brook basin to the southwestern corner of town and the Whitford Brook basin stretches from below the Shewville Brook basin in the northeast corner along the eastern town line to the southeast corner. The Williams Brook basin is situated in the east-central section of town while the Great Brook and Haleys Brook basins cover the south-central portion of town to the town line with Groton.

The two dams with the most significant classifications are the Long Pond Dam (Class C) and the Morgan Pond Dam (Class B). In addition to these two dams, according to the DEEP Dam Safety Program, additional dams in town include two unclassified, nine Class A and AA dams, and one Class BB dam. Ten dams, the most in any drainage basin in town, are within the Thames River subregional basin in the western portion of Ledyard. The ten includes four unclassified dams, four Class A dams, and two Class BB dams. Section 10.0 provides more information about dams.

2.3. Land Cover

According to the 2016 1-meter resolution land cover developed by the NOAA Office of Coastal Management, Ledyard (excluding the Mashantucket Pequot Tribal Nation lands) is predominantly comprised of mixed forest, with approximately 68.32% of the town classified as such. The second largest land cover type is developed open space, which covers about 6.63%, and next is developed impervious which is about 6.14% of land cover. All land covers and their percent coverage can be found in Table 2-1.

Table 2-1 Town of Ledyard Land Cover

Land Cover Type (2016)	% Coverage
Barren Land	0.48
Cultivated Crops	0.59
Developed, Impervious	6.14
Developed, Open Space	6.63
Estuarine Emergent Wetland	0.01
Grassland/Herbaceous	2.57
Mixed Forest	68.32
Open Water	4.91
Palustrine Aquatic Bed	0.33
Palustrine Emergent Wetland	0.60
Palustrine Forested Wetland	5.58
Palustrine Scrub/Shrub Wetland	0.33
Pasture Hay	2.41
Scrub/Shrub	1.03
Unconsolidated Shore	0.06

2.4. Population, Demographics, and Development Trends

As of the 2020 Decennial Census, the population for the town is 15,405, which equates to about 404 people per square mile. After being initially settled in 1653 as part of the New London colony, then part of the Town of Groton, Ledyard was incorporated in 1836. By the 1950s and 1960s, Ledyard was one of the fastest growing communities in Connecticut, attributable largely to the combination of national growth in population and the substantial increase in defense manufacturing jobs located in Groton and New London. The population and the number of homes grew in town as the cities of Norwich, New London, and Groton grew in commercial and industrial scale. Although the town is characterized as a suburban community, Ledyard continues to retain a rural feel.

The large presence of wetlands, ledge, and the lack of infrastructure limits density of development in different parts of town. According to the 2020 *Plan of Conservation and Development* (POCD), residents value the rural characteristics of the town and wish to protect and preserve that quality. The POCD also discusses the town's Capital Improvement Program (CIP) which is prepared annually by the Mayor. The POCD identified three future areas of focus for long-range capital expenditures: water pollution control authority, facilities, and public schools.

The most significant areas of development in Ledyard include the Route 12 corridor from the town line with Groton to the Village of Gales Ferry, Ledyard Center, and the land near Foxwoods Resort and Casino (some of it located within the Mashantucket Pequot Tribal Nation) in the northeast corner of town. These areas include substantial commercial and industrial development with residential development mixed in.

The lack of sewer and/or water service in a few notable areas of town limits the intensity of the commercial and industrial development. Although the POCD states that maintaining the rural aspect of Ledyard is important to residents, it also states that the encouragement of economic growth and diversification and expansion of the nonresidential tax base is also desired. The town is reportedly extending the sewer main from the Ledyard High School to Ledyard Center, ultimately allowing for increased development in the area.

According to town officials, small-scale subdivisions of 10 to 12 acres with eight to ten housing units are commonly proposed or pending in town. These are largely scattered throughout town. The housing stock in Ledyard consists primarily of single family homes on larger building lots. According to the POCD, as of 2018, 85% of the town is comprised of single-family residences, with slow development between 2008 and 2018. It is reported in the POCD that 153 units were developed during that time; 139 of which were single-family units. Nearly all new development in Ledyard over the previous ten years since the last POCD included larger lot subdivisions or individual, large-lot single family homes.

It is likely that Ledyard will continue to be a largely suburban yet partially rural community in the future, with less intense industrial and commercial development than residential development and a large amount of undeveloped land remaining.

The 2020 American Community Survey 5-year estimates identified the annual average median income for Ledyard to be \$93,703, with an average of 37.7% of the population holding a Bachelor's Degree or higher, and an average unemployment rate of 4.9% throughout the town.

2.5. Governmental Structure

Ledyard is governed by a Mayor-Council form of government. The authority of town officials is granted by Connecticut General Statutes. The Mayor is the full-time Administrator and Chief Executive elected to a four year term. The nine-member Council and nine-member Board of Education are elected for two year terms in accordance with state statutes.

The Town of Ledyard has boards and commissions that can take an active role in hazard mitigation, including the Inland Wetlands and Watercourses Commission, the Planning and Zoning Commission (formerly two separate commissions combining in October 2012), the Zoning Board of Appeals, the Economic Development Commission, and the Conservation Commission. Departments and commissions common to all municipalities in SCCOG are described in Section 2 of the Multi-Jurisdictional HMP. More specific information for the departments and commissions of the Town of Ledyard is noted below:

- The Building Official reviews plans for new development and inspects the work to ensure it meets current building codes.
- The Ledyard Fire Company and the Gales Ferry Volunteer Fire Company provide fire suppression, fire prevention, rescue, and hazardous materials response services to the town.

The Mashantucket Fire Department serves the Mashantucket Pequot Tribal Nation (MPTN) land in the northeast corner of Ledyard. More information on their services can be found in the MPTN update annex of the SCCOG HMP.

- The Emergency Management Department in Ledyard is charged with ensuring that Ledyard Emergency Services are ready to respond in times of emergency to assist and restore services to normal as soon as possible following emergency conditions. The Department is staffed by volunteers and key town department heads. Personnel are involved in the development of emergency plans and the operation of the EOC.
- The Inland Wetlands and Watercourses Commission is the Inland Wetlands Regulatory Agency for the Town of Ledyard and reviews plans for compliance with said regulations and maintains the town's inland wetlands map.
- The Planning & Zoning Commission is responsible for reviewing and approving subdivision plans and the capital improvement program, updating and overseeing the implementation of the *Plan of Conservation and Development*, and reviewing commercial, governmental, institutional, non-profit, and residential developments for compliance with local and state land-use regulations. These duties are performed with the assistance of the Department of Planning & Development along with the Zoning Department. The Planning & Zoning Commission encourages mutually beneficial development with the Mashantucket Pequot Tribal Nation.
- The Zoning Board of Appeals considers requests from property owners who wish to use their property in a manner prohibited by the Zoning regulations.
- The Economic Development Commission is responsible for expanding the tax base of Ledyard and for advocating, facilitating, promoting, and advising on economic development issues within the town.
- The Conservation Commission is an advisory body for the matters of development, conservation, supervision, and regulation of natural resources. Resources include water, within the territorial limits of Ledyard.
- Since the previous edition of the HMP in 2012, the Town has established a Public Safety Commission that regularly meets to discuss emergency management decisions. This Commission includes members of a number of different Town departments.

These town departments enable Ledyard to be technically, financially, and legally capable of implementing mitigation projects for natural hazards to the extent that funding is available.

2.6. Review of Existing Plans and Regulations

Ledyard has different plans and regulations that suggest or create policies related to natural hazard mitigation. These policies and regulations are outlined in the *Emergency Operations Plan (2006)*, *Plan of Conservation and Development (Rev. 2020)*, Zoning Regulations, Subdivision Regulations, and Inland Wetlands and Watercourses Regulations. The Zoning Regulations incorporate the NFIP requirements.

Emergency Operations Plan

The town has an Emergency Operations Plan (EOP) that provides general procedures to be instituted by the Mayor, or anyone legally administering as the Chief Executive Officer, to manage large-scale emergency situations, mobilize resources, and order large-scale evacuations.

The Emergency Management Director serves as staff assistant to the Chief Executive Officer and is responsible for:

- organization and management of the Emergency Operations Center (EOC)
- establishment of communications facilities in the EOC
- coordination between departments
- coordination of all emergency activities
- collection, analysis, and reporting of information

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.

The EOP is reviewed and submitted by the Emergency Management Director, and certified by the Mayor, annually. Updates are made as needed during the review process, with the previously most recent notable updates occurring in 2013. The EOP was more thoroughly revised for January 1st, 2017, in order to meet new State requirements for local EOP templates.

Plan of Conservation and Development (Rev. 2020)

The most recent *Plan of Conservation and Development* (POCD) was adopted in February 2020. The POCD was developed through contributions from local boards and commissions, citizens, and citizen groups. The POCD is a guiding framework for the future conservation and development of the community and is an important tool in the land use decision making process of the town.

The POCD includes the following goals relevant to hazard mitigation:

- Improve and support expansion of infrastructure to protect groundwater and surface water in environmentally sensitive areas
- Increase public water supply through an interconnected regional water supply system.
- Protect water quality and implement a source protection strategy through 1) proactive zoning; 2) natural resource-based planning and site design; 3) use of best management practices; and 4) water company review of proposed development projects located within designated source protection areas.
- Identify methods and locations for extending underground utilities.
- Continue to revise land use regulations to be pro-business without sacrificing a commitment to environmentally sound development.
- Conduct a vulnerability assessment of critical facilities to identify threats to community facilities such as schools, police departments, Fire departments, and emergency shelters. Retrofit properties with wind-proofing and water proofing as needed to prepare for the effects of climate change.
- Acquire, protect, conserve, and manage high value open space to protect and sustain habitats, natural resources, and recreation areas. Work cooperatively with private non-profit organizations and private landowners to acquire high value open space parcels through purchase, gifts, easements, and other strategies.
- Protect wetlands, watercourses, and vernal pools from pollution and minimize the impact of

impervious surfaces which accelerate run-off and pollution. Protection of these resources benefits both natural habitat as well as critical water supplies.

With respect to flood hazard areas, the POCD recognizes that existing Zoning Regulations consider FEMA flood zones as one of the primary factors in development. The POCD additionally states that the town should conduct a vulnerability assessment on critical facilities and focus on retrofits.

Ledyard has actively revised and updated its POCD since it was adopted, with a formal amendment in 2020. Information from the first iteration of the HMP has already been incorporated into recommended revisions and additions. The Ledyard POCD is considered somewhat consistent with the current goals and actions of the hazard mitigation plan. It does not directly address several of the hazards such as winter storm hazards, earthquake hazards, and wind hazards. The next update to the POCD should incorporate more elements of the hazard mitigation and climate adaptation plan. Future updates of the POCD will incorporate information from this and future updates of the HMCAP.

Zoning Regulations (Revised to 2022)

The most recent edition of Ledyard's Zoning regulations was made effective October 11, 1963 and has been revised to February 28, 2022.

Regulations regarding floodplain management are found in Section 12.3 of the Zoning Regulations. These regulations are applied during the permitting process for new construction and during substantial improvement of existing structures. Ledyard's Zoning Regulations define substantial improvement cumulatively over a one-year period. Ledyard does not require any freeboard.

Subdivision Regulations (Amended 2013)

Hazard prevention includes identification of risks and the use of land-use regulatory and other available management tools to prevent future damage. Section 5.3 of the Subdivision Regulations addresses stormwater requirements maintaining that systems must be designed in accordance with the Drainage Ordinance.

The Subdivision Regulations specify that sixty-percent of new developments over two lots must be set aside as open space. A recent development at 800 Long Cove Road created a large amount of open space.

Ordinance Amending an Ordinance Regulating the Addition of Any New Street or Highway to the Highway System of the Town of Ledyard (1988)

The Road Ordinance (a.k.a. Ordinance #45) was adopted on December 14, 1988. The ordinance has language throughout which references drainage design and its place in the town's regulatory process. For instance, Part II discusses the application process for acceptance of a proposed street as a public street and speaks to the town's involvement in the process, including in respect to drainage system design.

Ordinance Regulating the Management of Stormwater Runoff (1995)

The Drainage Ordinance (a.k.a. Ordinance #44) regulates the management of stormwater runoff and was adopted on February 22, 1995. The ordinance requires adherence to the Connecticut Guidelines for Soil Erosion and Sediment Control. The ordinance requires a zero percent increase in discharge characteristics in certain cases where existing downstream land use or property is shown to be subject to flooding.

Inland Wetland and Watercourses Regulations (2021)

The most recent Inland Wetlands and Watercourses Regulations in the Ledyard were made effective on January 25, 2021. The Regulations define "regulated activities" as being any operation within or use of a wetland or watercourse involving removal or deposition of material, or any obstruction, alteration or pollution of such wetlands or watercourses, not including activities in Section 22a-40 of the Connecticut General Statutes (CGS). Additionally, the town regulates additional activities within 100 feet of any wetland or watercourse boundary. These regulations build on the preventative flood mitigation provided in the CGS.

2.7. Critical Facilities, Sheltering Capacity, and Evacuation

Ledyard considers several facilities to be critical to ensure that emergencies are addressed while day-to-day management of the town continues. Critical facilities are presented on figures throughout this annex and summarized in Table 2-2. No critical facilities are located within a Special Flood Hazard Area (SFHA). These facilities are described in more detail below.

Table 2-2 Town of Ledyard Critical Facilities

Facility	Address or Location	Emergency Power	Shelter	Cooling Center	In SFHA
Emergency Services					
Police Department	737 Colonel Ledyard Highway	✓			
Ledyard Fire Company**	11 Fairway Drive	✓			
Gales Ferry Volunteer Fire Company	1772 Route 12	✓			
Municipal Facilities					
Town Hall	741 Colonel Ledyard Highway	✓			
Town Hall Annex	741 Colonel Ledyard Highway				
Public Works Garage	889 Colonel Ledyard Highway	✓			
High School*	24 Gallup Hill Road		✓		
Middle School	1860 Route 12		✓		
Highlands Wastewater Treatment Facility	80 Town Farm Road	✓			
Bill Library	718 Colonel Ledyard Highway			✓	
Gales Ferry Library	18 Hurlburtt Road, Gales Ferry			✓	
Senior Center	12 Van Tassel Drive, Gales Ferry			✓	

Care Facilities				
Kings Corner Manor	60 Kings Highway, Gales Ferry			

* Emergency Operations Center (EOC)

** Backup EOC

Town of Ledyard Police Department

The Ledyard Police Department is located in a building next to the Town Hall. The building serves as a backup Emergency Operations Center (EOC) and has a new emergency power generator.

The Ledyard Police Department's mission is to provide service and protection to its citizens and visitors by maintaining a highly trained force consisting of Patrol and Detective divisions in addition to the assistance from its Emergency Telecommunications and Animal Control Divisions.

The Police Chief functions as the department head and is responsible for the Department's operations. The Department's Executive Officer provides direct supervision to the Patrol, Detective, Emergency Telecommunications, and Animal Control Divisions. The Police Department maintains a generator. The Police Department maintains use of both Facebook and Twitter social platforms to get information to residents as fast as possible.

Town Hall and Annex

The Town Hall and Annex, which are located on the same property and house many of the municipal departments, are considered a critical facility. A generator at this location can provide emergency power supply for the Town's backup dispatch equipment and the Town Hall, but cannot provide power to the annex. As of summer 2022, the Town Hall generator was being replaced.

Public Works & Transfer Stations

The Public Works Garage houses equipment to maintain the town's infrastructure and transfer municipal and bulky wastes for residents and property owners. The Department works to help ensure public and environmental health and safety.

The transfer station has been identified as a brush-disposal location for the town. Debris from severe storms and wind events can be brought to the transfer station where debris reduction is done. Chipping can be done on-site as well.

Ledyard Fire Company

The Ledyard Fire Company was established in 1951. The Fire Company provides fire, rescue, emergency medical services, and hazardous material response to the residents of Ledyard and surrounding towns on a mutual aid basis. The company most recently moved from its old headquarters next to Town Hall to its new facility on Fairway Drive where the Ledyard Fire Marshall's Office is also located. The Company is comprised of 25 volunteer firefighters, fire police, cadets and administrative members.. The Company has three fire engines in addition to three rescue and support vehicles, equaling six trucks in total.

Gales Ferry Volunteer Fire Company

The Gales Ferry Volunteer Fire Company was organized in 1942 to safeguard the residents and property of the Village of Gales Ferry and the Town of Ledyard. The Company includes a ladder truck with a 65' ladder and a 500 gallon water tank, a rescue-pumper with a 750 gallon poly water tank, a tanker truck

equipped with a 3,000 gallon poly water tank and a 3,000 gallon portable water supply tank, a rescue truck, a forestry truck, and a 20 foot "special operations" service trailer.

Shelters and Emergency Operations Center

The High School is the town's primary shelter and the EOC. In case of an emergency, the High School Gymnasium is planned to be used as the town's central evacuation point for severe weather problems. The High School shelter is certified by the American Red Cross. The High School also has a bomb shelter.

The Ledyard Middle School is the secondary shelter and, when needed, a regional shelter in Groton or Norwich may be used depending on the weather issues. The Middle School was recently renovated and now has its own generator and heating/cooling system. The town considers the school to be well-positioned as a backup shelter for the community.

The Bill Library in Ledyard, the Gales Ferry Library, and the senior center in Gales Ferry are the cooling centers in town. All three have air conditioning and can accommodate 150 people each. These have been activated as cooling centers in recent years. None of these three facilities have generators. The senior center has natural gas, multiple bathrooms, and a commercial kitchen. The town would like to acquire a back-up generator for this facility.

Highlands Wastewater Treatment Facility

The Wastewater Treatment Facility (WWTF) recently underwent major upgrades to modernize the facility's equipment, including the installation of a solar panel array.

Communications

The town is registered to the CT Alert "Everbridge" Emergency Notification System for Reverse 9-1-1. The town has a link which is listed on the Gales Ferry Volunteer Fire Company web site and the town web site. Sign-ups have been advertised through the Police Department's social media tools.

Internal emergency communications are performed over radio. The Town has upgraded its radio towers to utilize microwave bandwidths. This has increased the reliability of their radio communications.

Evacuation Routes

The three major transportation routes through town includes Route 12 which runs north-south along the Thames River on the western edge of town, Route 214 which transects the town across the center in an east-west orientation, and Route 117 which is oriented north-south and stretches from the Town of Preston to the north to the Town of Groton to the south.

Annex E of Ledyard's EOP describes the town's evacuation plans. Section V, Part A entitled "Administration" states that the Evacuation Coordinator is responsible for maintaining up-to-date evacuation route maps which depict designated primary and alternate evacuation routes. In addition, the Ledyard Emergency Management web site's "Contents" page includes explanations of the town's evacuation procedures for those buildings one mile from the Allyn's Point Complex. The Complex is currently occupied by the Dow Chemical Company and could be a large source of contamination of the area if equipment were to malfunction.

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 Ledyard has three RL properties. Payments made toward these properties total \$35,226.66.

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 Ledyard Exposure Analysis

Hazard	At-Risk Parcels		At-Risk Facilities		At-Risk Historic Assets	
	Value	Number	Value	Number	Value	Number
Hurricane/Tropical Storm	\$1,127,072,782	6,732	\$18,876,830	11	\$19,532,274	68
Severe Thunderstorm	\$1,127,072,782	6,732	\$18,876,830	11	\$19,532,274	68
Severe Winter Storm	\$1,127,072,782	6,732	\$18,876,830	11	\$19,532,274	68
Tornado	\$1,127,072,782	6,732	\$18,876,830	11	\$19,532,274	68
Drought	\$531,464,672	3,438	\$12,924,590	6	\$2,808,800	12
Flood						
1% Annual Chance	\$169,788,416	849	-	-	\$6,324,614	10
0.2% Annual Chance	\$191,156,864	984	-	-	\$6,774,924	12
Storm Surge						
Category 1	\$65,367,786	130			\$5,722,414	7
Category 2	\$69,061,155	157			\$5,722,414	7
Category 3	\$74,912,860	197			\$6,105,944	9
Category 4	\$80,135,281	229			\$6,105,944	9
Earthquakes	\$1,127,072,782	6,732	\$18,876,830	11	\$19,532,274	68
Wildfire	\$403,424,944	2,393	\$12,924,590	6	\$2,735,090	11

2.10. Community Climate Change Challenges

As is with all of the SCCOG communities, the Town of Ledyard 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 Ledyard

What are the Town's Top Climate Change Concerns?

Flooding: The Town is concerned with flood and flood-related risks downstream of Long Pond Dam along Whitford Brook and Lantern Hill Road. The road crosses the stream and is located in various flood zones. It provides important access among several communities such as Ledyard, North Stonington, and Stonington.

Extreme Heat: Cooling centers in Ledyard do not have standby power such as generators.

Others: The Town center includes a cluster of several critical facilities and key businesses. A microgrid could help reduce power outage risks and impacts.

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

Flooding: Work with SCCOG and CIRCA to scope a corridor study for Lantern Hill Road that evaluates its capabilities and flood/scour risks relative to providing access between and among MPTN, Ledyard, North Stonington, the Eastern Pequots, Stonington, and Groton.

Extreme Heat: Acquire standby power (generators) for the Senior Center, the Bill Library, and Gales Ferry Library and identify transit or transportation options to reach them, to make them more viable as a cooling centers.

Others: Consider undertaking a microgrid feasibility study for Ledyard Town Center, where several critical and essential facilities are located.

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 mean an increase in risk throughout 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 or tornado winds, heavy rains, and flooding. Flooding hazards are discussed in Section 5.2 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 impacted the region in August 2011. Branches and entire trees fell throughout the town and the region causing power outages that lasted at least seven days and, in some cases, as many as nine days in Ledyard. Connecticut Light & Power (CL&P) is the electrical utility in Ledyard that worked to restore power following Irene.

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

On October 29th, 2012, Super Storm Sandy impacted the region with rains and high winds. Ledyard suffered power outages due to the wind toppling trees onto power lines. The town received approximately \$70,000 of federal assistance to cover the damages.

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.

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.

Neither Isaias or the storms of 2021 resulted in remarkable damage. The 2021 storms caused town-wide debris in which the public works department responded to for clean-up. A majority of the clean-up was for “nuisance” debris and nothing major.

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, 2012. The code specifies the design wind speed for construction in all the Connecticut municipalities. The basic design wind speed for Ledyard is between 120 and 140 miles per hour, and ultimate design wind speed for Ledyard

is 126 miles per hour; speeds used depends 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. Ledyard has adopted the Connecticut Building Code as its building code.

Tree Maintenance

Parts of trees (limbs) or entire tall and older trees may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. In Ledyard, the Public Works Director is the Tree Warden who can post notification and schedule tree removal. The Town's utility provider is Eversource. Following the major regional outages caused by Tropical Storm Irene, Hurricane Sandy, and Winter Storm Nemo, Eversource has instituted an aggressive tree-trimming regime and has built redundancies into the grid. Eversource is also expanding a local substation. The Town reports improved resilience of the electric grid. Communication between the electric utility and the Town has also improved since the previous HMP.

The Tree Warden is allotted an extremely limited budget to allocate towards proactive tree trimming; most trimming in Town is performed by Eversource. The Town sometimes contracts private companies to help with tree trimming.

Debris Management

The Ledyard DPW collects debris following a storm and deposits it at the Town Transfer Station, where they convert it to mulch for reuse within the Town. Town staff are discussing additional debris collection and disposal sites in case they run out of room at the transfer station, which has about six acres of storage space. Private companies are contracted to assist with debris removal as necessary.

Warnings and Communication

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 can access National Weather Service forecasts via the internet as well as listening to local media outlets (television, radio) to receive information about the relative strength of the approaching storm. This information provides the resources needed to determine whether or not to activate its EOP and encourage residents to take protective or evacuation measures if appropriate.

Residents are currently able to sign up to receive warnings from the CT Alert "Everbridge" Emergency Notification System to receive critical information specific to different areas within Ledyard. Although hurricanes that have impacted Ledyard have historically passed in a day's time, additional regional shelters could be outfitted following a storm with the assistance of the American Red Cross on an as-needed basis for long-term evacuees.

Education and Preparation

The Fire Marshal performs regular building inspections, and encourages building owners to prepare emergency response plans during those inspections.

The DPW surveys Town owned buildings to detect weaknesses with regards to snow and wind loading as part of the department's standard activities. Engineering level studies are not performed.

Summary

In general, municipal capabilities to mitigate hurricane damage has 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 winds of Tropical Storm Irene in 2011 and Hurricane Sandy in 2012 and have operated at this level since.

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). Of particular concern are the blockage of roads and the damage to the electrical power supply from falling trees and tree limbs. There was a town-wide seven to nine day power outage following Tropical Storm Irene in 2011, and additional power outages following Hurricane Sandy in 2012, due to tree damage to utility lines.

Many structures built in town do not meet current wind load building codes and are particularly susceptible to roof and window damage from high wind events. This risk to structures will be reduced with time as these buildings are remodeled or replaced with buildings that meet current codes. Those newer structures put in place since the 1990s are less vulnerable to damage from hurricanes and/or tropical storms.

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

3.2.3.1 Hazard Losses

The Town of Griswold received \$25,748 in FEMA Public Assistance (PA) funds in the wake of Hurricane Isaias. These funds are the federal share of the eligible costs associated with the hurricane, which were a total of \$34,331. All of these federal funds were received for townwide debris removal (Figure 3-1). Since 2012, the town has received \$78,395 in FEMA PA funds (including Isaias) for project costs of \$94,778.

In addition to PA, FEMA offers Individual Assistance (IA) to property owners and renters. In the wake of Hurricane Ida, one property renter in Ledyard received IA in the amount of \$300.

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. presents hurricane related damages for the Town of Ledyard. 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.

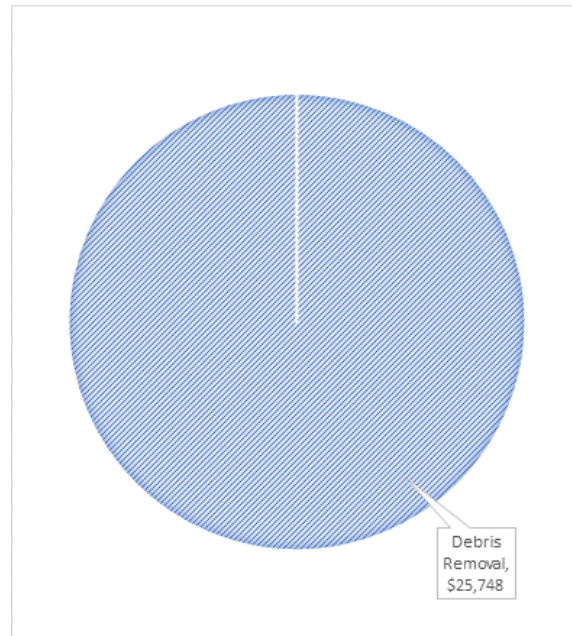


Figure 3-1 Hurricane Isaias Funding Categories

Table 3-1 HAZUS-MH Hurricane Related Economic Impacts

Ledyard	Return Period	Residential	Commercial	Industrial	Others	Total
	10-year	\$58,500	\$0	\$0	\$0	\$58,500
	20-year	\$2,031,160	\$82,380	\$4,590	\$77,000	\$2,195,130
	50-year	\$11,347,410	\$906,290	\$41,060	\$574,600	\$12,869,360
	100-year	\$23,151,570	\$3,586,230	\$139,460	\$7,262,360	\$34,139,620
	200-year	\$43,894,590	\$8,868,300	\$377,450	\$19,198,490	\$72,338,830
	500-year	\$90,437,230	\$19,109,480	\$999,560	\$40,076,880	\$150,623,150
	1,000-year	\$128,127,160	\$30,947,760	\$1,483,660	\$42,855,350	\$203,413,930

Table 3-2 HAZUS-MH Hurricane Related Building Damage

Ledyard	Return Period	Minor	Moderate	Severe	Destruction	Total
	10-year	2	0	0	0	2

	20-year	19	1	0	0	20
	50-year	275	21	0	0	296
	100-year	658	78	3	1	740
	200-year	1,101	196	13	6	1,316
	500-year	1,594	421	51	27	2,093
	1,000-year	1,821	571	86	46	2,524

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

Ledyard	Return Period	Debris Generated (Tons)	Households Displaced	Individuals Seeking Temporary Shelter
	10-year	8	0	0
	20-year	236	0	0
	50-year	2,790	0	0
	100-year	4,627	0	0
	200-year	8,436	5	2
	500-year	15,725	30	10
	1,000-year	21,395	60	24

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 Ledyard. 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 summer 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. No tornadoes have occurred in the town since the last HMP.

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 the Pawcatuck section of Stonington, and another further north 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 can access National Weather Service forecasts via the internet as well as listen to 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, additional methods of mitigation for wind damage are employed by the town as explained in Section 3.2.2 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, with the exception of some of the changes described in Section 3.2.2.

3.3.3 Vulnerabilities and Risk Assessment

Summer storms 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 area 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 many were constructed prior to current building codes, and many campgrounds offer little structural protection from the elements.

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 Connecticut. 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 report event associated with a severe thunderstorm and wind event. The event on September 6, 2017 resulted in trees down throughout town. Damages reported from these events totaled \$5,000. 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 summer storms, 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.

Winter storm events of 2010 and 2013 were some of the most impactful events in the past decade. The year 2013 featured exceptional snow events that severely taxed snow removal abilities of towns in the region. The blizzard of 2013 in early February dumped one to two feet of snow on the region. Another snowstorm struck the region in mid-March, 2013 dumping upwards of one to two feet of snow in some parts of the county.

- The winter of 2010-2011 produced significant snowfall in Ledyard. Gales Ferry School was closed temporarily while the roof's snow load was evaluated and was ultimately deemed safe. One residential roof collapsed. Winter Storm Alfred in late October 2011 caused only minor tree damage and no loss of power in town.
- A low pressure zone rapidly intensified while moving northeast to a position east of Cape Cod by 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 3 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 23.6 inches in Old Lyme. Winds also gusted as high as 60 mph at Groton Airport. Snowfall totals were 22 inches in Ledyard Center.
- Winter Storm Juno, or the Blizzard of 2015, dropped 19 inches of snow on Ledyard from January 26-27. Blizzard conditions were experienced, and schools canceled.

Some of the more recent significant 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. The Connecticut Department of Transportation (DOT) plows the State roadways, while the town employs 11 plow trucks and three small plow trucks to clear town roads and facilities. The Department has prioritized routes for the 11 large plow trucks. Each route is approximately ten miles in length. The town uses treated salt for the de-icing of the roadways. The Town believes that its snow removal capabilities are sufficient.

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. This specification is adhered to by the town. The DPW removes snow from the roofs of Town-owned buildings, while the Board of Education oversees removal of snow from the school buildings. The Building and Grounds Department of the Town Hall campus, which includes the Town Hall, the Town Hall Annex, the DPW, and the new Police Department, has a plan for snow removal from campus driveways and roofs.

Information related to protecting Town residents during cold weather, and for mitigating icing and of pipes at residences, is posted on the Town website.

Summary

In general, municipal capabilities to mitigate snowstorm damage have increased slightly 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, microclimates, 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.

Warning and education can prevent most injuries from winter storms. 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.

In general, there are few steep slopes such that extra sanding and salting of the roadways in necessary locations alleviates any trouble spots. Town officials did not indicate this to be a major issue, rather an issue that deserves priority when town staff begins their treatment of roads. These areas are usually treated first by town staff during and following winter storms. Also, there are no issues with ice jams on any of the streams in the town.

3.4.3.1 Hazard Losses

There have been no reported winter storm losses for the Town of Ledyard since 2017. In the past decade, the town has received FEMA PA funds in the amount of \$119,946 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).

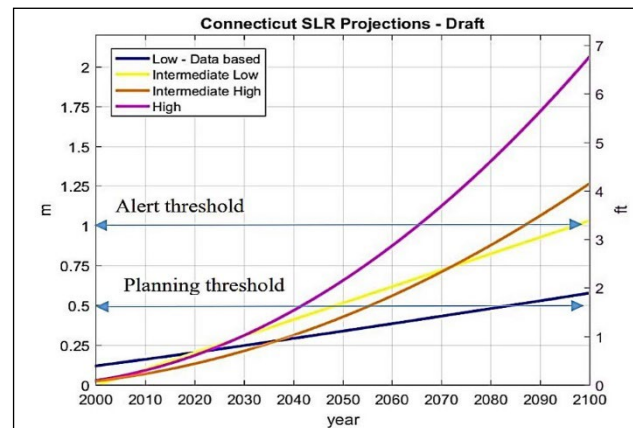


Figure 4-1 Four Localized Sea Level Rise Scenarios for

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 also 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

Despite being located inland from the Connecticut shoreline, Ledyard has coastal resource areas that are tidally influenced along the Thames River. The shoreline of Ledyard contains a combination of undeveloped and developed shorefront with estuarine embayments at Long Cove, Mill Cove, and elsewhere. The coastal resources found in Connecticut and described by DEEP are listed in the Multi-Jurisdictional HMP.

Homes, businesses, and industry are located in close proximity to the shorefront along the coastal area. However, the Town's inland location places many properties at higher elevations than typical coastal low-lying areas adjacent to Long Island Sound. As such, the town does not typically experience coastal flooding. While coastal flooding is relatively infrequent, hurricanes and tropical storms have the potential to induce coastal flooding and storm surge that can impact structures. The town may be concerned with the potential long-term effects of sea level rise and its potential to exacerbate coastal flooding conditions in the future.

The last major hurricane or tropical storm wind event to affect the Town was Hurricane Sandy in October 2012. Sandy brought high winds and coastal flooding to the entire Connecticut coastline; however no significant coastal flooding occurred within Ledyard along the tidal Thames River.

Neither Tropical Storm Isaias nor the events of 2021 caused any coastal flooding impacts on the town. 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, just downstream in the Thames River, was reportedly the sixth highest on record. Numerous roads and structures experienced flooding in coastal southeastern Connecticut.

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 and the coastal management area, 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 5.2.2) are also applicable to coastal flood mitigation, and additional programs were listed in Section 2.6.

The shoreline of Ledyard contains many flood and erosion control structures. Private bulkheads can be found in many of the residentially, commercially and industrially developed coastal neighborhoods. The Riverside Place neighborhood is a good example of residential properties with shoreline protection structures. The shorelines of the Dow Chemical site and the Navy Base are developed with riprap and bulkheads. The railroad line parallel to Route 12 forms an embankment along parts of the Thames shoreline. In particular, the railroad embankment separates Mill Cove and Clark Cove from the Thames River.

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) including floodway areas. As noted by the Zoning Regulations, building activities in the floodplain are restricted and new construction or substantial redevelopment must prove that the lowest horizontal member of the new construction will be above the base flood elevation. In addition, the town requires the submission of a coastal site plan for any project located within the coastal area management boundary.

Like many communities, the Town lacks existing policies and mitigation measures that are specifically designed to address sea level rise. The Town participated in a resiliency planning initiative with SCCOG and TNC in 2016-2017². However, the Town has not yet embarked on detailed coastal hazard planning to the degree that nearby communities like Waterford and the Town of Groton have done. Although the Town of Ledyard does not currently have a specific plan to address sea level rise, important pieces are in place in the form of the codes and regulations cited in this HMCAP that have been enacted to minimize storm, erosion, and flood damage to structures.

Summary

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

In general, municipal capabilities to mitigate coastal flood damage have remained flat since the 2017 edition of the hazard mitigation plan was adopted. This is likely because the coastal flood risks are minimal along the tidal portion of the Thames River. However, the Town must continue to monitor changes occurring along the Thames River and plan accordingly.

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. Historic record coastal flooding typically only occurs due to storm surge. Refer to Figure 4-2 for a depiction of areas susceptible to storm surge.

Note that *HAZUS-MH*, FEMA's hazard loss estimation software, was utilized to calculate the potential damages to the Town of Ledyard from a combined 1% annual chance riverine and coastal flood. Results were presented in Section 3.3.2.1 of the Multi-Jurisdictional HMP.

Vulnerability Analysis of Areas along Coastal Waters

The area potentially flooded by storm surge is not as extensive as the 1% annual chance floodplain. In general, the coastal area affected by storm surge is limited to areas immediately adjacent to the Thames River. The area of Mill Cove off of the Thames has been pointed to by Town personnel as somewhat vulnerable to tidal flooding, but waters must rise eight to ten feet above normal high tide before it will affect the road there.

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.

Vulnerability Analysis of Private Properties

The coastal areas of the Town of Ledyard have properties that are inhabited year-round. This intensifies risk to life and property in coastal areas. Waterfront properties are very susceptible to damage from storm surge although FEMA has not established any coastal velocity zones in Ledyard.

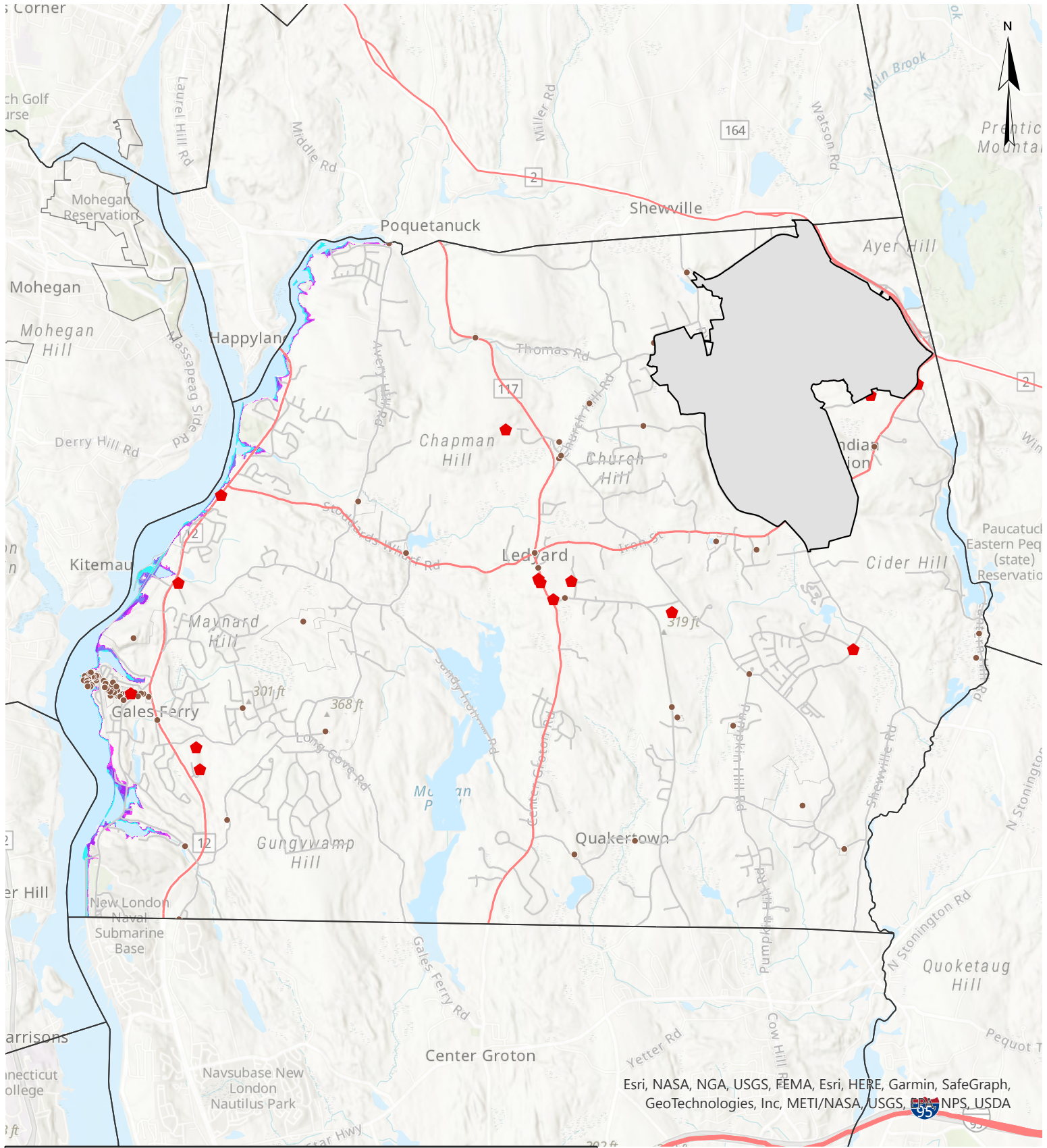
Buildings located in flood hazard areas are primarily commercial or industrial but also include some residential and critical facility structures as noted in Section 4.3.1. Most of the structures that are threatened by flooding are also located within the 1% annual chance floodplain.

Vulnerability Analysis of Critical Facilities

As shown on Figure 4-1, critical facilities are not located within potential storm surge areas.

4.2.3.1 Hazard Losses

There are no reported losses for the Town of Ledyard related to coastal flooding.



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

Hurricane Storm Surge Inundation Areas

SCCOG Hazard Mitigation and Climate Adaptation Plan

Town of Ledyard

Date: 8/3/2022

0 0.4 0.8 1.2 1.6 Miles

Legend

- Historic Resources
- ⬠ Critical Facilities

Hurricane Category

- 1
- 2
- 3
- 4

4.3. Shoreline Change

4.3.1 Setting/Historic Record

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

Many of the shoreline capabilities are similar to those mentioned in Section 4.2.2. The flood and erosion control structures throughout the coastal area of town that protect against coastal flooding can also help to limit impacts from erosion.

4.3.3 Vulnerabilities and Risk Assessment

Coastal erosion is generally not an issue in the Town of Ledyard since much of the shorefront is either fully developed (particularly along the Navy Base and Dow industrial area) or characterized by high bedrock. However, as sea level rises, the effectiveness of these structures could be undermined such that erosion will be able to occur landward of riprap, bulkheads, and embankments, thus necessitating expansion of the structures.

4.3.3.1 Hazard Losses

There are no reported losses for the Town of Ledyard related to shoreline change.

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 totals and intensity are believed to have increased, and are 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 frequency and severity 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, damage 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 edition of this plan. While riverine flooding along watercourses is a concern, shallow nuisance flooding and poor drainage have also caused flooding 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 during pluvial and riverine floods.

The March 2010 storms continue to be considered the event that caused the most widespread flooding in Ledyard since the town began participating in the multi-jurisdiction hazard mitigation plan. These flood events caused roadway flooding and a significant amount of nuisance flooding as noted below. Structures in one area were directly affected by overbank flooding.

- At the Ledyard and North Stonington town line, Lantern Hill Road at the Lantern Hill Brook crossing was washed out during the March 2010 heavy rains and flooding. Both towns and the Mashantucket Pequot Tribal nation are collectively working to resolve the issue at this crossing.
- Other sections of Lantern Hill Road are also considered at high risk of flooding. This includes the area near Homestead Road, Bush Pond, and Whitford Brook.
- Where Flat Brook crosses under Baldwin Hill Road, the watercourse flows under a non-residential building which has had historical issues becoming inundated.
- Lambtown Road Extension crosses through a wetland and the road forms a "dam" of Lamb Brook near Haleys Brook. This situation, along with beaver activity in the area has brought about flooding and a scouring of a 300-foot stretch of the road.

- The Shewville Road Bridge at the Shewville Brook/Indiantown Brook crossing is in need of replacement as it has been historically associated with flooding. Replacement of this bridge is in the final stages of State approval and will be undertaken as soon as approvals are granted and funding is finalized.

The Williams Brook Bridge at Town Farm Road has experienced inundation during significant storms. This bridge should be considered to be elevated and/or replaced.

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, maintaining drainage systems, through education and outreach, and by utilizing warning systems. Town staff are prepared to offer technical assistance regarding flood proofing measures to owners of non-residential structures that suffer flood damage, should they be interested. Many mitigation measures are common to all hazards and therefore were listed in Section 2.6. No structural flood control projects are located within or upstream of Ledyard, although the existing dams provide a small amount of flood mitigation.

Bridge Replacements, Drainage, and Maintenance

The Public Works Department cleans and inspects catch basins and culverts at least annually or more often if problems are noted. When flooding occurs, typically either the Mayor's Office, the Public Works Department, or either Fire Department handles complaints from residents. All are involved in some capacity in these cases. For example, the Mayor's Office may field calls regarding a flooded roadway while the Public Works Department inspects culverts, catch basins, problematic roadways and bridges and erects barricades to close roads, and the Fire Department responds to calls requesting help for pumping flooded basements. Drainage complaints are directed to the Public Works Department.

The Town has completed several minor projects since the last HMP to alleviate flooding problems caused by poor drainage. Improvements were made to the stream crossing of Shewville Road at Wiffle Brook, which is a tributary to Williams Brook. Local officials completed work with North Stonington and the Mashantucket Pequot Tribal Nation to resolve flooding issues on Lantern Hill Road at the Lantern Hill Brook crossing. The Town also worked with the Mashantucket Pequot Tribal Nation to replace, in 2016, the bridge at Shewville Road over Shewville Brook which was damaged during the March 2010 floods. The Town redirected the watercourse of Flat Brook at Baldwin Hill Road to reduce flooding.

The Town is working on an additional improvement to Lantern Hill Road, near Homestead Road, in the form of increasing the size of the culvert and improving the bridge structure over Whitford Brook. That project is expected to be completed by the end of 2017. The Town is also pursuing funding to replace and increase the capacity of the Town Farm Road Bridge over Williams Brook.

Regulations, Codes, and Ordinances

Ledyard has planning and zoning tools in place that incorporate floodplain management. The town also has subdivision regulations and a drainage and road ordinance that require adequate drainage be provided to reduce exposure to flood hazards. Retention ponds are required at new developments.

Regulations covering development in and/or near inland wetland areas and watercourses also exist within the town's Inland Wetlands and Watercourses Regulations.

Acquisitions, Elevations, and Property Protection

Approximately 289 acres of old farmland along Haley Brook, on the Groton-Ledyard border, were acquired by the Groton Open Space Association in December of 2013. The site is called Avery Farm. Lambtown Road Extension, which required upgrades at the crossings with Lamb and Haleys Brooks, has been permanently closed to traffic as part of that acquisition. This removes any risk associated with the inundation or failure of this road.

In 2020 two open space acquisitions were made by the Avalonia Land Conservancy. The Atkinson Family Preserve is a 205.8 acre preserve on Long Cover Road. The Thompson Brook Preserve is a 41.4 acre preserve on the eastern side of Long Cove Road. The preserve is also home to wetlands and vernal pools.

Flood Watches and Warnings

The Mayor and both Fire Companies access weather reports through the National Weather Service and local media. The town participates in the CT Alerts "Everbridge" Emergency Alerting and Notification Reverse 9-1-1 System and encourages residents to join through its web sites and social media. The town is encouraged to post the link for residents to join the system on the Emergency Management and Ledyard Fire Company web sites. Effective utilization of this service allows the town the ability to receive geographically specific weather warnings when storms are imminent. This service provides Ledyard with the ability to telephone warnings into specific areas, prior to or during natural hazard events.

The Town has interactive maps online that depict SFHAs and are accessible to the public.

Stormwater Management

The Town is in the early stages of potentially organizing and implementing a stormwater utility. To help understand the benefits of implementing a stormwater utility, the Town participated in a stormwater utility feasibility study in fall 2022. A final report was issued to SCCOG and the Town in 2023, and one of the proposed hazard mitigation and climate adaptation actions builds on the completion of the study.

Summary

In general, municipal capabilities to mitigate flood damage have increased slightly since the 2017 edition of the hazard mitigation plan was adopted. This is because the Town has continued to make investments in staffing, public works projects, and open space acquisition.

5.2.3 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk of inland flooding within Ledyard. Inland flooding due to nuisance flooding or poor drainage is the most common type of flooding experienced by the town, although roadway inundation also occurs during more severe events.

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 **Error! Reference source not found.** The CCVI demonstrates that flood vulnerability in Ledyard ranges from primarily low to low-moderate.

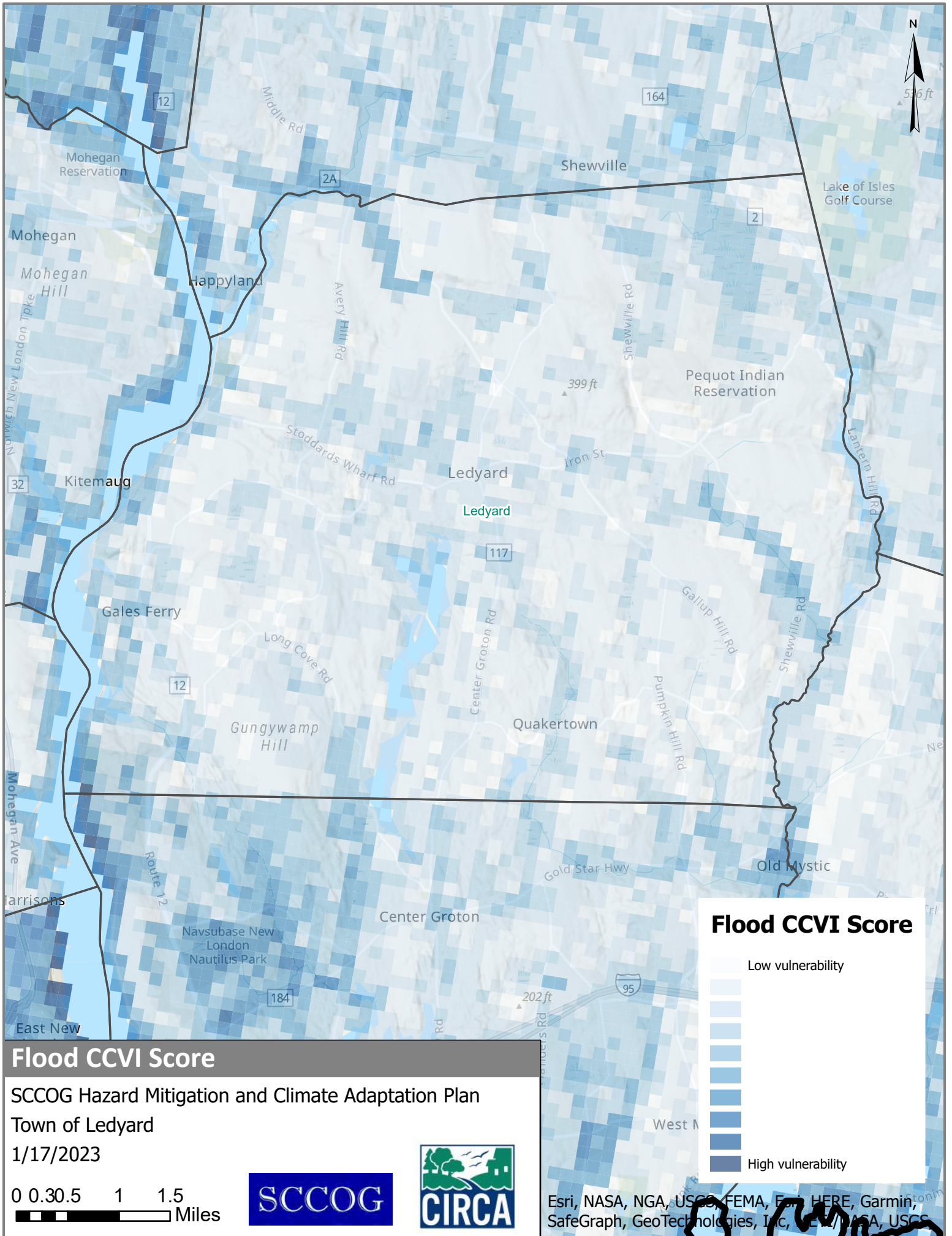
Vulnerability Analysis of Areas along Watercourses

Stretches of Thames River, Flat Brook, Pine Swamp Brook, Clark Cove, Tom Allyn Brook, Billings Avery Brook, Joe Clark Brook, Shewville Brook, and Williams Brook are designated as SFHAs defined by FEMA. These areas are designated as AE flood zones, indicating that flood elevations are available.

Additionally, a large stretch of Great Brook that includes Morgan Pond and the Ledyard Reservoir, Haleys Brook, Billings Avery Brook, Joe Clark Brook, Rose Hill Brook, Shewville Brook, Indiantown Brook, Whitford Brook, and a few others are mapped Zone A floodplains. These areas lack flood elevations. As previously discussed, there are a few areas of town where flooding is hazardous to travelers or roadways. Those areas are discussed in Section 5.2.1. Refer to Figure 5-2 for the location of SFHAs within Ledyard.

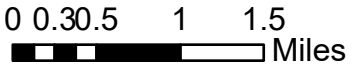
Additionally discussed previously, the three major transportation routes through town includes Route 12 which runs north-south along the Thames River on the western edge of town, Route 214 which transects the town across the center in an east-west orientation, and Route 117 which is oriented north-south and stretches from the Town of Preston to the north to the Town of Groton to the south. The DFIRM mapping suggests that all the routes can be affected by extreme flooding. Routes 12 and 214 are crossed at multiple locations by SFHAs, while Route 117 is crossed at only one location by a 0.2 percent annual chance flood hazard zone as defined by FEMA.

The Whitford Brook corridor continues to be an area of concern for the town in regard to flooding, and scour risks. Recently, funding was acquired from the State Bond Commission to replace a bridge (shared with Stonington) over the brook.

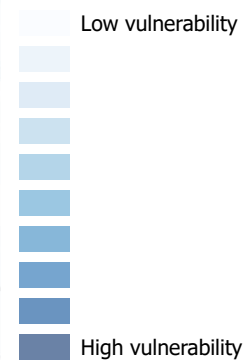


Flood CCVI Score

SCCOG Hazard Mitigation and Climate Adaptation Plan
 Town of Ledyard
 1/17/2023



Flood CCVI Score



Esri, NASA, NGA, USGS, FEMA, HERE, Garmin, SafeGraph, GeoTechnologies, Inc., etc.

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.

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. One location in Ledyard was analyzed, and recommendations were made for restoration. These are summarized below.

- **Wendell Comrie Road on Haley's Brook:** Replace with Stream Simulation Design culvert or bridge, and/or: increase hydraulic capacity, increase water depth through crossing, restore natural heterogeneous substrate, eliminate perched outlets. If replacement is not feasible, consider retrofits to increase depth (e.g., inlet weir to favor a single pipe at low flows) and eliminate perched outlet (e.g. engineered cascade or weirs).

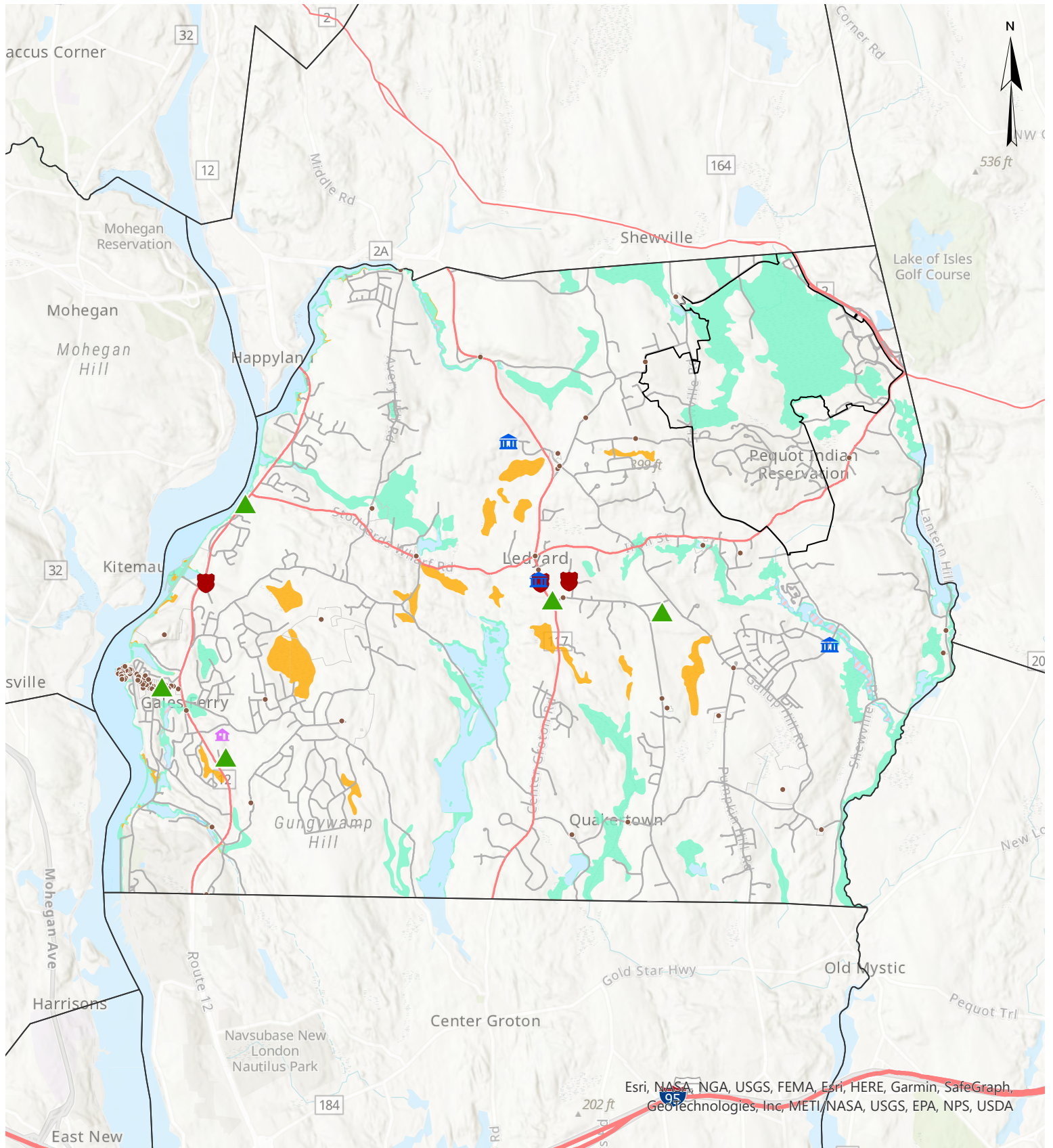
Vulnerability Analysis of Private Properties

The majority of structures located in the SFHA are in the Gales Ferry section of Ledyard with the majority of structures being residential while less are classified as commercial or industrial. Town personnel indicate that structures typically do not get damaged by riverine or overbank flooding.

There are three repetitive loss properties in town. Such properties are those which have received two or more claim payments of more than \$1,000 from the NFIP with any rolling 10-year period for the home or business. Two of the repetitive loss properties are located across a roadway from a small impoundment but are not located below the base flood elevation, as they are situated on the high points of the lots. These homes may experience drainage-related or basement flooding. The third repetitive loss property is associated with the Whitford Brook watershed, but is not located near the brook. This home might also experience poor drainage or basement flooding.

Vulnerability Analysis of Critical Facilities

As noted in Section 2.7, none of Ledyard's critical facilities are located within an SFHA flood zone. With respect to critical facilities, there are no serious concerns to the town facilities in conjunction with flooding.

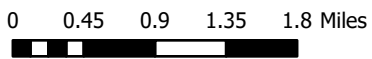


Critical Facilities and Historic Resources with Flood Zones

SCCOG Hazard Mitigation and Climate Adaptation Plan

Town of Ledyard

Date: 8/1/2022



Legend

- Historic Resources
- 🏠 Senior Housing
- 🛑 Emergency Services
- 🏛️ Municipal
- ▲ Shelter or Cooling Center
- 🌊 1% Annual Chance Flood Hazard Area
- 🌊 .2% Annual Chance Flood Hazard Area
- 🌊 Floodway

5.2.3.1 Hazard Losses

According to NFIP statistics, as of June 30, 2022, the Town of Ledyard has had a total of 24 flood related losses, with a total of \$179,662 paid towards the claims.

Since 2017 there has been no NOAA reported flood events, or FEMA PA reimbursements received for flooding. FEMA HAZUS-MH 6.0 was used to develop losses associated with the 100-year riverine flood event. Table 5-1 presents flood related damages for the Town of Ledyard. Additional HAZUS-generated losses for the town and region can be found in the Multi-Jurisdictional document.

Table 5-1 HAZUS-MH Riverine Flood Related Economic Impacts

Ledyard	2022 Results				
	Residential	Commercial	Industrial	Other	TOTAL
Direct					
Building	\$2,560,000	\$1,120,000	\$20,000	\$140,000	\$3,840,000
Contents	\$1,410,000	\$5,260,000	\$30,000	\$890,000	\$7,590,000
Inventory	\$0	\$160,000	\$0	\$0	\$160,000
Subtotal	\$3,970,000	\$6,540,000	\$50,000	\$1,030,000	\$11,590,000
Business Interruption					
Income	\$0	\$15,330,000	\$0	\$600,000	\$15,930,000
Relocation	\$1,570,000	\$2,200,000	\$0	\$370,000	\$4,140,000
Rental Income	\$590,000	\$1,750,000	\$0	\$40,000	\$2,380,000
Wage	\$10,000	\$12,420,000	\$0	\$8,130,000	\$20,560,000
Subtotal	\$2,170,000	\$31,700,000	\$10,000	\$9,140,000	\$43,020,000
Total	\$6,140,000	\$38,240,000	\$60,000	\$10,170,000	\$54,610,000

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 having occurred 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 Ledyard, like many communities, does not have specific regulations geared toward drought mitigation. One of the main purposes of the Town’s zoning regulations is however to facilitate the adequate provision of water throughout the town. Section 5.0 of the Zoning Regulations, Conservation and Open Space Subdivisions, has been designed to protect water supplies and watershed areas, and promote conservation of wetlands. The conservation and protection of these areas in town aid in groundwater conservation which could alleviate drought impacts.

In addition, public water supply systems in town increase resilience for those that are serviced by these systems. The town reports that in recent years during droughts, the town has fared relatively well, and that recent water system expansions have helped to limit drought impacts to those properties that formerly relied on private wells.

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 Ledyard 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 Ledyard is vulnerable to drought, but the degree of vulnerability varies. There are many properties in town that rely on private wells for their residential or commercial drinking water. These private well users may face challenges relative to water supply during periods of drought.

5.3.3.1 Hazard Losses

There have been no reported drought losses for the Town of Ledyard. 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 floodwater. 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 Ledyard is considered a possible event each year with potentially critical effects. Substantial scouring occurred on Lantern Hill Road downstream of Lantern Hill Pond Dam when the dam

failed during the March 2010 flood. Lantern Hill Pond Dam is presently being reconstructed in accordance with a design that will mitigate future failure and relieve chronic downstream flooding. This is the only known dam failure to have affected the town since the time of the last 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. Ledyard is home to nine registered dams. These dams are listed in Table 5-2. No Class C (high hazard) or Class B (significant hazard) dams are located within Ledyard. No Class B or Class C dams are located upstream of Ledyard whose failure could potentially lead to flooding within the town.

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

CT Dam#	Dam Name	Dam Class	Owner Type
7223	Tom Allyn Brook Dam	A	Private Corporation
7226	Lake Nova	A	Private Corporation
7228	Larrabee Pond Dam	AA	Private
7229	Glidden Pond Dam	AA	Private
7203	Whitford Pond Dam	A	Private
7213	Smith Pond Dam	BB	Private
7214	Flat Brook Pond	A	Private
7216	Tribrook Pond Dam	A	Private Corporation
7218	Rec Pond	A	Private

Dams in the region whose failure could impact Ledyard 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. The Town of Ledyard does not own any dams. The town should work with the DEEP and dam owners to ensure that EAPs remain current and on file.

Recently, the Lantern Hill Valley Association (LHVA) and McKee Farm Trust (MFT) have worked to acquire funding to repair and replace dams on Long and Bush Ponds.

Summary

In general, municipal capabilities to mitigate dam failure damage have not increased significantly since the 2017 edition of the hazard mitigation plan was adopted. However, changes in the State's regulation of dams have increased Statewide capabilities sharply.

5.4.3 Vulnerabilities and Risk Assessment

The potential impacts related to the failure of Class B dams within Ledyard are described below. Where information was available, the descriptions below are based on information available at the Connecticut

DEEP Dam Safety Section. Refer to Figure 10-1 for a location map showing the dams and potential dam failure inundation areas (where available).

- Long Pond – The Long Pond Dam is a Class B dam located at the southern end of Long Pond, located along the eastern town line of Ledyard with North Stonington. The dam is owned by the private Lantern Hill Valley Association. The dam impounds Long Pond on Whitford Brook and is a 109-acre recreational pond. Long Pond, along with Lantern Hill Pond, are the headwaters of the Mystic River, draining south into Whitford Brook, through Old Mystic, becoming the Mystic River. Long Pond and Lantern Hill Pond are both sites for Connecticut state boat launches. The pond is also used by different regional Fire Departments for equipment testing, cleaning and drills. The pond is surrounded by homes occupied year-round. A six-foot cross culvert under Lantern Hill Road connects Long Pond and Bush Pond.

An EOP was created and is maintained by the Lantern Hill Valley Association is dated May 1, 2006, and is on file with the CT DEEP. The association was formed by landowners surrounding Long and Bush Ponds to maintain the dam and spillway of Long Pond. In March 2010, significant damage occurred due to the overtopping of the dam during heavy rain flows. Town officials have noted scouring on Lantern Hill Road occurred below the dam. The dam was the discussion of a January 2012 meeting between representatives from the Lantern Hill Valley Association, the Mayor of Ledyard and the First Selectman of North Stonington. The meeting discussed options that Lantern Hill Valley Association had concerning the dam including making repairs, removing, or returning ownership to the original owners of the dam.

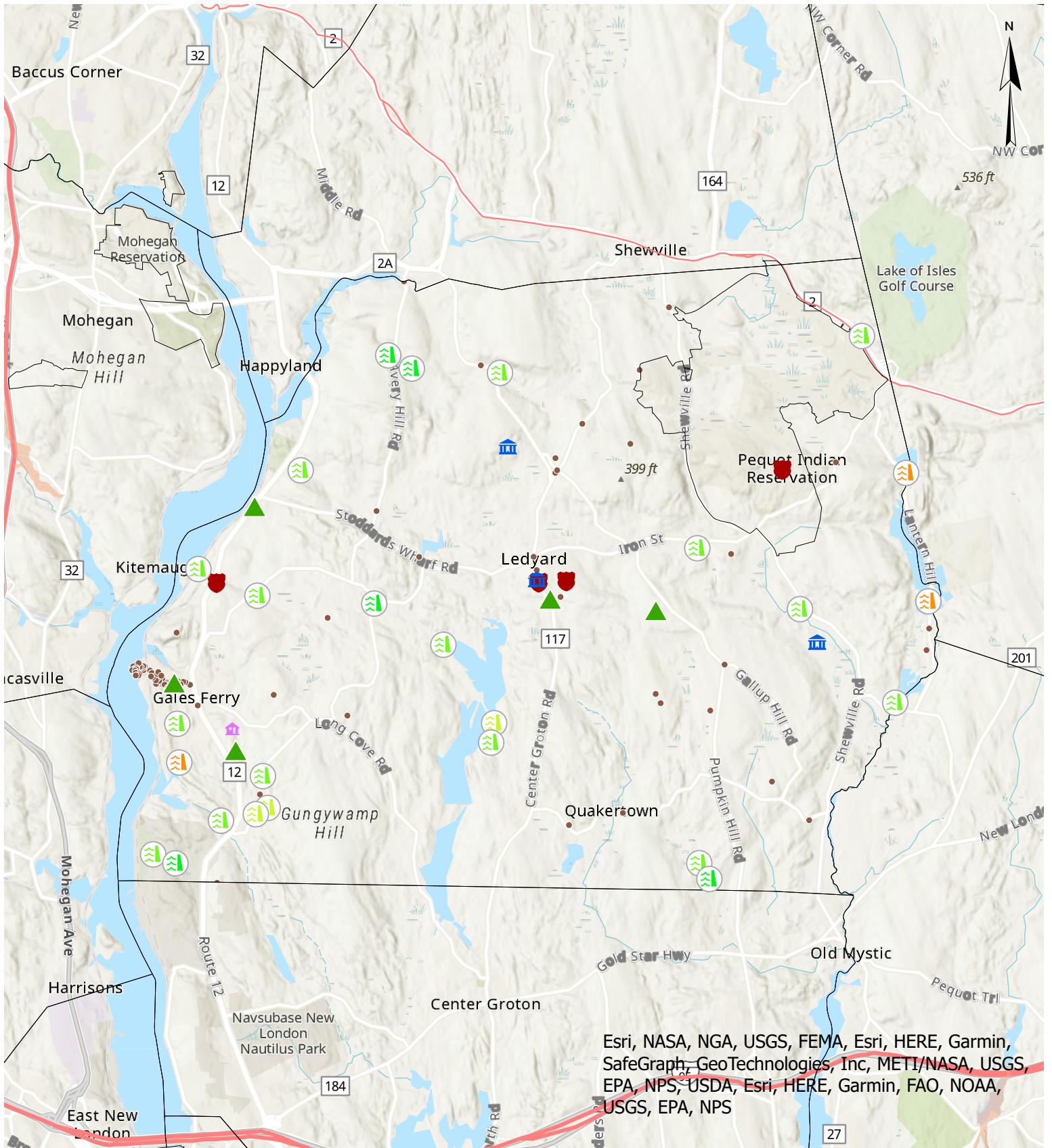
The town has been working with the CT DEEP and owners of the dam to address the state of the Long Pond / Bush Pond complex and its dams. The CT DEEP has performed a study of the potential effects of a 0.2% annual-chance storm on the dams here. The Town has not yet seen the results of those reports, and will decide on appropriate action to move forward once that report is received.

Since the previous HMP, the Lantern hill Pond Dam (one of the three dams impounding Long Pond) has been completely restructured, along with the road below it. This dam was overtopped during the floods of 2010, and the road below it was damaged.

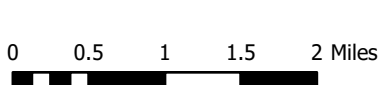
- Morgan Pond – The Morgan Pond Dam is a Class B dam located at the southern end of the Morgan Pond Reservoir. The water body is the most upstream of the Groton Utilities water supply reservoirs. Water passing over the Morgan Pond Dam spillway flows into Ledyard Reservoir, eventually discharging to Great Brook into the terminal Poquonnock Reservoir. The pond also receives water from the Billings Avery Reservoir, a registered diversion. According to a 1987 inspection by Lenard Engineering, the dam is an earthen embankment with 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. The dam is owned by Groton Utilities.

5.4.3.1 Hazard Losses

There are no reported losses for the Town of Ledyard related to dam failure. Downscaled drought 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 Ledyard
 Date: 2/23/2023



Legend

- Dams
 - Unknown/Unclassified
 - A
 - AA
 - BB
- Historic Resources
- Senior Housing
- Emergency Services
- Municipal
- Shelter or Cooling Center

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

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/Historic Record

An extreme heat event can occur at any time during the 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 is 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 Ledyard has identified the Senior Center, Bill Library, and Gales Ferry Library. The Town is prepared to open up the cooling centers for resident use.

Summary

In general, the capabilities of mitigating extreme heat have increased since the 2017 edition of this plan as the town has identified multiple cooling centers for use during an extreme heat event.

6.2.3 Vulnerabilities and Risk Assessment

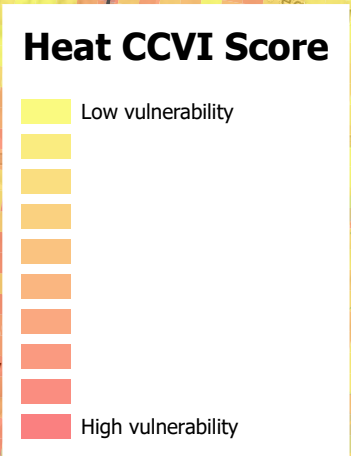
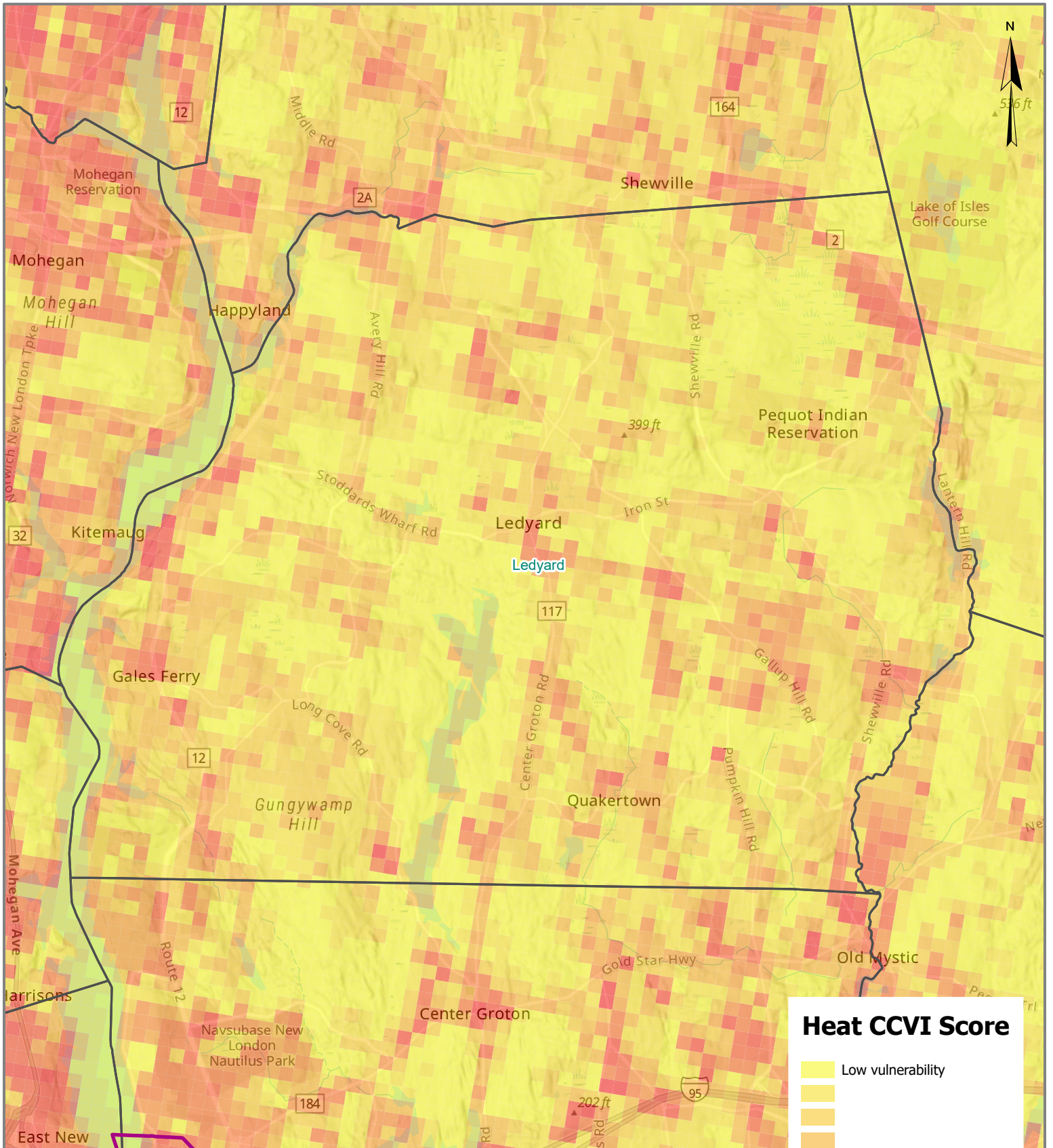
While the entire town is at risk of an extreme heat event, vulnerability can widely vary based on age, health, or the type of property owned in Ledyard. The elderly populations in town are more vulnerable to extreme heat events, particularly when in home cooling is not available. Also, those in town with certain health conditions may also be more vulnerable to the health factors associated with extreme temperatures.

The UConn Connecticut Institute for Resilience and Climate Adaptation (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 their overall heat vulnerability. The CCVI has been used as an additional tool to characterize heat vulnerability for Ledyard. The distribution of heat vulnerability throughout the community can be seen in Figure 5-3.

Both heat exposure and sensitivity are relatively low across much of Ledyard, with pockets of higher values for both in the Gales Ferry area and along Route 12. With four possible cooling centers and a widely forested landscape, adaptive capacity is robust for the town. Therefore, the overall heat vulnerability for Ledyard is low to moderate depending on the location.

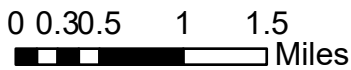
6.2.3.1 Hazard Losses

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



Heat CCVI Score

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



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

6.3. Wildfires

6.3.1 Setting/Historic Record

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 developed areas of Ledyard. Structural fires in higher density areas of the town are not directly addressed herein.

According to the town officials, no specific areas of wildfire risk or vulnerability are known. Small brush fires occur every summer, but do not typically cause significant damage. Some examples include the following:

- Summer 2016: A brushfire affected over an acre and proved to be difficult to put out because it began to burn below the ground surface.
- July 2016: a brushfire south of Whippoorwill Drive burned ten acres, and required 14 fire departments to put it out over six hours.
- May 2015: a fire on Avery Hill Road burned around eight acres; neighboring fire stations assisted.

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 Department training, and maintaining an adequate supply of equipment. The Gales Ferry Fire Company has a variety of equipment including a 280 gallon forestry truck. Additionally, new all-terrain-vehicle firefighting equipment is available from neighboring Towns through mutual aid agreements. Robust mutual aid agreements are maintained between Ledyard's Fire Department and those of neighboring towns.

The Fire Companies attack fires as quickly as possible in the town. Fire protection water is obtained through the hydrants wherever possible and different water surfaces spread throughout town. In areas located far from the dry hydrant, water is drafted from the various streams, ponds, and rivers in the town, and pump trucks carry the water to the distant area. The amount of fire protection afforded by the dry hydrants and nearby streams is considered to be adequate for the development level of Ledyard. Fire Companies will continue to evaluate the level of risk and the need for additional hydrants as development continues in the future. Dry hydrants and cisterns are not required for new developments, as tanker trucks are the preferred means of firefighting.

Several key changes to the public water system profile in Ledyard have occurred since the previous edition of the HMP in 2017. For example, public water supply has been extended into certain areas of town which allow increased development, but also provide increased fire protection for those areas.

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." Ledyard has designated 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 increased since the 2017 edition of the hazard mitigation plan was adopted, with the extension of public water systems.

6.3.3 Vulnerabilities and Risk Assessment

Forests and inaccessible tracks of land are at the highest risk for wildfires. However, according to town officials, there are no specific areas of wildfire risk or vulnerability in Ledyard. Refer to Figure 3-6 in the Multi-Jurisdictional document for a general depiction of wildfire risk areas region wide.

6.3.3.1 Hazard Losses

There are no reported losses for the Town of Ledyard 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/Historic Record

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 document. 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 Ledyard. The town has adopted these codes for new construction, and they are enforced by the Zoning Enforcement Officer.

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. The Town maintains emergency supplies in case of isolation caused by a hurricane, winter storm, or earthquake.

Summary

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, there are many areas throughout town that are underlain by stratified drift. These areas are likely 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. Those areas not at increased risk during an earthquake due to unstable soils are the areas underlain by glacial till.

Nine inactive bedrock faults largely stretch north-south through town. 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 1990s and therefore are not built to current building codes. In addition, there are areas such as town parks with recreational buildings or shelters that may not be seismically designed. Thus, it is believed that most buildings would be at least moderately damaged by a significant earthquake. Those town 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. Ledyard has areas of steep slopes and bluffs although almost all of these features occur in undeveloped areas. Thus, landslides are not a concern in the town.

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 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 Ledyard and Eversource's EOPs.

7.2.4 Hazard Losses

There are no reported losses for the Town of Ledyard 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 7-1Error! Reference source not found.**, with additional information developed in the Multi-Jurisdictional document.

Table 7-1 HAZUS-MH Earthquake Related Economic Impacts

Ledyard	Residential	Commercial	Industrial	Others	Total
	\$112,160,000	\$266,480,000	\$15,120,000	\$237,140,000	630,900,000

8. Mitigation Strategies and Actions

8.1. Status of Mitigation Strategies and Actions

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

#	Mitigation Actions and Strategies for Ledyard 2016 - 2021	Status	Status Details
1	Pursue the American Red Cross-certification of Ledyard Middle School (secondary Shelter)	Complete	Ledyard Middle School was renovated about a year and a half ago, and now has its own generator and heating/cooling. This facility is now well positioned to be a secondary shelter. This action can be considered complete. Regional shelters include Stonington High School and perhaps Fitch High School in Groton; both of these are south of I-95 so there is a concern that these would not be well-suited to a coastal hurricane.
2	Integrate additional elements of this HMP into the POCD update	Carry Forward	Two years ago, there was a light re-write of the POCD. The next update will take place in a few years and this action will be accomplished then.
3	Revise and/or update the Ordinance Regulating Management of Stormwater Runoff (Ordinance #44) with more current practices	Carry Forward	DPW has reviewed ordinances for MS4 and for meeting other requirements. The town has received a proposal from CLA Engineers for a review of ordinances related to stormwater with the goal of aligning with new MS4 requirements; not just Ordinance #44. The quoted cost was higher than anticipated and should be in the "Moderate" category instead of "Low/Minimal" in the cost scale used in the last plan. This is still a concern for the town and there is an active desire to do this, but the stumbling block is the cost. The next year will reportedly be a critical time frame for getting this done.
4	Pursue mutual aid agreements with non-profits to provide volunteer labor for response activities	Remove	Town staff are not familiar with this action; there are no official agreements with non-profits. United Way has offices in town. Organizations tend to step up as needed.
5	Pursue funding to replace/increase the capacity of the Town Farm Road bridge over Williams Brook	Remove	The town has been addressing bridges as needed and has reportedly replaced several bridges. This Town Farm Road bridge is not that old and has not presented problems during recent flooding events. On the other hand, the Whitford Brook corridor is an area of continuing concern due to flood and scour risks. Funding has been acquired from the State Bond Commission to replace the bridge (shared with Stonington) over this brook (see #8).

6	Develop formalized guidance for culvert and bridge construction and replacement that requires utilization of the most up-to-date extreme rainfall data from http://precip.eas.cornell.edu	Carry Forward with Revision	NOAA data has now superseded the Cornell Data. This could be integrated into the ordinance review mentioned in action #3.
7	Identify a location for a brush-disposal operation for dealing with debris following windstorms and determine potential reuse	Complete	The transfer station has been identified as a collection point as needed. A lot of debris reduction is done out in the field with the brush chipper. This has not yet been tested by any significant storm.
8	Work with CT DEEP and Lantern Hill Valley Association (Long Pond Dam) to ensure issues are resolved and EOP is updated	Carry Forward	Carry forward - The LHVA had an engineer conduct surveys of the dams (one is in Ledyard, two are in North Stonington). Recent bond funding (\$3 million) was allocated to repair/replace these dams plus two bridges (Including the bride mentioned above that is shared with Stonington) but the fact that two are in North Stonington is a challenge for leveraging Town of Ledyard funds. LHVA is a private 501c3 entity. The Whitford Brook bridge is the first priority, as this is closest to shovel ready. Then the funding will move onward for the other bridge and the three dams at Long Pond. More funding will be needed.

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 four 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 Ledyard 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:

- Revise and/or update the Ordinance Regulating Management of Stormwater Runoff with current practices, making them consistent with best practices and the MS4 permit; and include language on using the most up to date extreme rainfall data for stormwater infrastructure, bridge, and culvert replacement and construction guidance which will shift from NOAA Atlas 14 to NOAA Atlas 15.
- Develop locally-adopted recommendations resulting from the stormwater authority and utility feasibility study conducted by CDM Smith for SCCOG in 2022 using CIRCA's municipal resilience grant.

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

- Acquire standby power for the Senior Center, and identify transit or transportation options to reach it, to make it more viable as a cooling center.
- Acquire standby power for the Bill Library and Gales Ferry Library, and identify transit or transportation options to reach them, to make them more viable as cooling centers; or incorporate Bill Library into a Town Center microgrid.

This is consistent with the State's emphasis on cooling center resilience.

Table 8-1 Town of Ledyard 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 =
LD1	Revise and/or update the Ordinance Regulating Management of Stormwater Runoff with current practices, making them consistent with best practices and the MS4 permit; and include language on using the most up to date extreme rainfall data for stormwater infrastructure, bridge, and culvert replacement and construction guidance which will shift from NOAA Atlas 14 to NOAA Atlas 15.	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; Stormwater Utility Fees (if implemented)	7/2023 - 6/2024	High	21	10	210
LD2	Develop locally adopted recommendations resulting from the stormwater authority and utility feasibility study conducted by CDM Smith for SCCOG in 2022 using CIRCA's municipal resilience grant.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases frequency and severity of floods.	More than one category	Office of the Chief Elected Official	\$0 - \$10,000	SCCOG Special Projects; DEEP Climate Resilience Fund; CIRCA Resilient Connecticut	7/2023 - 6/2025	High	18	8	144
LD3	Integrate additional elements of this HMP into the POCD update or via amendment.	More than one goal	Education & Awareness	Land Use Staff	\$0 - \$10,000	Municipal Operating Budget	7/2023 - 6/2024	High	12	6	72
LD4	Ensure that the Middle School is viable as a local shelter, to be used when regional shelters are inaccessible.	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; STEAP	7/2023 - 6/2025	High	16	6	96
LD5	Acquire standby power for the Senior Center, and identify transit or transportation options to reach it, to make it more viable 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; STEAP	7/2023 - 6/2025	High	16	6	96
LD6	Acquire standby power for the Bill Library and Gales Ferry Library, and identify transit or	Ensure that critical facilities are resilient, with special attention to	Preparedness & Emergency Response	Office of the Chief Elected Official	\$100,000 - \$500,000	FEMA HMA; Other	7/2023 - 6/2025	High	16	6	96

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 =
	transportation options to reach them, to make them more viable as cooling centers; or incorporate Bill Library into a Town Center microgrid.	shelters and cooling centers.				preparedness grants; STEAP					
LD7	Complete final segments of planned water system expansions to address drought resiliency and make critical facilities more resilient.	Reduce losses from other hazards that are affected by climate change.	Water & Wastewater Utility Projects	Water & Sewer	>\$1M	DWSRF; Municipal CIP Budget	7/2023 - 6/2025	Medium	14	4	56
LD8	Complete final segments of planned sewer system expansions to make critical facilities more resilient.	Reduce losses from other hazards that are affected by climate change.	Water & Wastewater Utility Projects	Water & Sewer	>\$1M	CWSRF; Municipal CIP Budget	7/2023 - 6/2025	Medium	14	4	56
LD9	Working with the Town of Stonington, complete the bridge replacement for Lantern Hill Road over Whitford Brook.	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	LOTICIP; STEAP; IJJA BIP	7/2023 - 6/2024	High	16	6	96
LD10	Advance design and seek funding for replacement of the Red Brook culvert at Wendell Comrie Road	More than one goal	Structural Projects	Public Works	\$100,000 - \$500,000	CT DOT; LOTICIP; DEEP Climate Resilience Fund; FEMA HMA; Save the Sound; IJJA AOP	7/2023 - 6/2025	Low	19	8	152
LD11	Directly support the repairs to the Long Pond dams and spillway by issuing the required permits and approvals in parallel with CT DEEP approvals. Partner with the Town of North Stonington, Town of Stonington, Town of Groton, and the Native American tribes to ensure that risks are characterized in the new	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	6	126

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 =
	Emergency Action Plan for the Long Pond Dams.										
LD12	Partner with the Town of Stonington and the Town of Groton 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	4	84
LD13	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
LD14	Participate in a dam failure tabletop exercise for Long Pond with the Towns of Stonington, Groton, 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
LD15	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
LD16	Conduct direct outreach to property owners in repetitive loss areas with information about how to mitigate flood losses.	Reduce flood and erosion risks by reducing vulnerabilities and consequences, even as climate change increases	Property Protection	Floodplain Manager	\$0 - \$10,000	Municipal Operating Budget	1/2024 and annually during January	High	13	4	52

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 =
		frequency and severity of floods.									
LD17	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