HAZARD MITIGATION AND CLIMATE ADAPTATION PLAN

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

March 2023

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with contributions from
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Representatives from the 22 municipalities and two tribes that comprise the SCCOG were involved in plan development. The following individuals led the efforts of each municipality. Their time and knowledge were indispensable in preparing this plan update. Additional personnel from each municipality and tribes also involved in plan development are listed in the plan annex for each municipal or tribal entity.

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The consulting firm of Resilient Land and Water, LLC prepared the subject plan update, with contributions from the Connecticut Institute for Resilience and Climate Adaptation, building upon the initial work completed by DELTA Environmental Services, Inc. and Wilbur Smith Associates in 2005 and the plan update prepared by Milone & MacBroom in 2012 and 2017. Over time, there have been many changes regarding planning requirements for local, multi-jurisdictional, and tribal hazard mitigation plans. Thus, this plan has been reformatted and updated from the original plan. The following individuals at Resilient Land and Water should be contacted prior to plan adoption with questions or comments regarding the plan:

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Table of Contents

List of Figures

List of Tables

LIST OF ACRONYMS

AEL	Annualized Earthquake Losses	LOTCIP	Local Transportation Capital Improvement Program
AICP	American Institute of Certified Planners	MPO	Municipal Planning Organization
ARC	American Red Cross	MPTN	Mashantucket Pequot Tribal Nation
ARPA	American Rescue Plan	MRG	CIRCA Municipal Resilience Grant
ASDSO	Association of State Dam Safety Officials	NAFSMA	The National Association of Flood & Stormwater Management Agencies
ASFPM	Association of State Floodplain Managers	NAP	Noninsured Crop Disaster Assistance Program
BCA	Benefit-Cost Analysis	NCDC	National Climatic Data Center
BCR	Benefit-Cost Ratio	NCEI	National Centers for Environmental Information
BFE	Base Flood Elevation	NDRC	National Disaster Resilience Competition
BRIC	Building Resilient Infrastructure and Communities	NECCOG	Northeast Connecticut Council of Governments
CAFM	Connecticut Association of Floodplain Managers	NEHRP	National Earthquake Hazards Reduction Program
CAM	Coastal Area Management	NEMA	National Emergency Management Association
CCM	Connecticut Conference of Municipalities	NESEC	Northeast States Emergency Consortium
CCVI	Climate Change Vulnerability Index	NESIS	Northeast Snowfall Impact Scale
CDBG	Community Development Block Grants	NETAC	National Earthquake Technical Assistance Contract
CDC	Centers for Disease Control and Prevention	NFIP	National Flood Insurance Program
CEQ	Connecticut Council on Environmental Equity	NHMP	Natural Hazard Mitigation Plan
CERT	Citizens Emergency Response Team	NIDIS	National Integrated Drought Information System
CFM	Certified Floodplain Manager	NOAA	National Oceanic and Atmospheric Administration
CIRCA	Connecticut Institute for Resilience and Climate Adaptation	NPDP	National Performance of Dams Program
COG	Council of Governments	NPU	Norwich Public Utilities
CRCOG	Capitol Region Council of Governments	NRI	National Risk Index
CRS	Community Rating System	NWS	National Weather Service
DCRF	DEEP Climate Resilience Fund	OLISP	Former Office of Long Island Sound Programs
DEEP	Connecticut Department of Energy and Environmental Protection	PA	Public Assistance
DEMHS	Department of Emergency Management and Homeland Security	PDM	Pre-Disaster Mitigation
DESPP	Department of Emergency Services and Public Protection	PDSI	Palmer Drought Severity Index
DMA	Disaster Mitigation Act	PERSISTS	Permittable Equitable Realistic Safe Innovative Scientific Transferrable Sustainable
DOAG	Connecticut Department of Agriculture	POCD	Plan of Conservation and Development
DOT	Connecticut Department of Transportation	PURA	Public Utilities Regulatory Authority
DPH	Connecticut Department of Public Health	RiverCOG	Lower Connecticut River Valley Council of Governments
DPW	Department of Public Works	RL	Repetitive Loss
DRF	Disaster Relief Fund	RLP	Repetitive Loss Property
EAP	Emergency Action Plan	RPC	Regional Planning Commission
EJ	Environmental Justice	RSI	Regional Snowfall Index

ELAP	Emergency Assistance for Livestock, Honey Bees & Farm-Raised Fish
EMS	Emergency Medical Services
EO	Executive Order
EOP	Emergency Operation Plan
ESF	Emergency Support Function
FBFM	Flood Boundary and Floodway Maps
FEMA	Federal Emergency Management Agency
FHBM	Flood Hazard Boundary Maps
FIRM	Federal Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FPMS	Floodplain Management Services Program
GC3	Governor's Council on Climate Change
HMA	Hazard Mitigation Assistance
HMCAP	Hazard Mitigation and Climate Adaptation Plan
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HMTAP	Hazard Mitigation Technical Assistance Program
HUD	U.S. Department of Housing and Urban Development
HURDAT	NOAA's Hurricane Database
IA	Individual Assistance
IBHS	Insurance Institute for Business and Home
IDW	Interagency Drought Workgroup
ISTEA	Intermodal Surface Transportation Efficiency Act
LFP	Livestock Forage Disaster Program
LID	Low-Impact Development
LIP	Livestock Indemnity Program
RWIS	Roadway Weather Information System
SAFR	State Agencies Fostering Resilience
SBA	Small Business Association
SBC	State Building Code
SCCOG	Southeastern Connecticut Council of Governments
SCEL	Stream Channel Encroachment Line
SEAT	Southeast Area Transit District
seCTer	Southeastern Connecticut Enterprise Region
SFHA	Special Flood Hazard Area
SHPO	State Historic Preservation Office
SI	Substantial Improvement
SLOSH	Sea, Lake, and Overland Surges from Hurricanes
SPI	Standardized Precipitation Index
SRL	Severe Repetitive Loss
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, and Environmental
STEAP	Small Town Economic Assistance Program
SURE	Supplemental Revenue Assistance Program
TAC	Technical Assistance Contracts
TNC	The Nature Conservancy
TOD	Transit-Oriented Development
TVCCA	Thames Valley Council for Community Action
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WAWTAC	Wind and Water Technical Assistance Contract
WUCC	Water Utility Coordinating Committee
WUI	Wildland-Urban Interface

1. Introduction

1.1. Authority, Purpose, and Background

The goal of emergency management activities is to prevent loss of life and damage to property. The four traditional phases of emergency management include Mitigation, Preparedness, Response, and Recovery. Hazard mitigation tends to eliminate or reduce the need to respond by reducing the potential for losses. The term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. In the context of disasters, hazard mitigation is commonly defined as any sustained action that reduces or eliminates long-term risk to people, property, and resources from hazards and their effects.

The primary purpose of a hazard mitigation plan (often stylized as "HMP") is to identify natural hazards and risks, existing capabilities, and activities that can be undertaken by a community to prevent loss of life and reduce property damages associated with the identified hazards. Public safety and property loss reduction are the driving forces behind the elements of any HMP. Additionally, careful consideration is often given to the preservation of history, culture, and the natural environment.

This Multi-Jurisdiction Natural Hazard Mitigation Plan update was prepared specifically to identify hazards and potential mitigation measures in the municipalities and tribes of Southeastern Connecticut Council of Governments (SCCOG). SCCOG's initial HMP was approved by the Federal Emergency Management Agency (FEMA) in October 2005 and a subsequent update with the same communities was approved in 2012. A subsequent update of the plan was developed in 2017 and approved in 2018, incorporating two new communities that joined SCCOG from the former Windham Region Council of Governments.

SCCOG is working with the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) to identify unmet climate-related needs related to flooding and extreme heat through participation in the *Resilient Connecticut* program, with a duration of about 18 months from April 2022 through September 2023. SCCOG therefore elected to align the *Resilient Connecticut* planning process with this update of the region's Hazard Mitigation Plan. This alignment has resulted in development of a combined Hazard Mitigation and Climate Adaptation Plan ("HMCAP"). The alignment of the planning efforts, and the adoption of this combined Hazard Mitigation and Climate Adaptation Plan, will help position local hazard mitigation, climate adaptation, and resilience efforts for the State's "resilience project pipeline."

1.1.1 The Disaster Mitigation Act

The Disaster Mitigation Act of 2000 (DMA), commonly known as the 2000 Stafford Act amendments, was approved by Congress and signed into law in October 2000, creating Public Law 106-390. The purposes of the DMA are to establish a national program for pre-disaster mitigation and streamline administration of disaster relief. The DMA requires local communities to have a FEMA-approved mitigation plan in order to be eligible to apply for and receive Hazard Mitigation Assistance (HMA) grants.

The HMA "umbrella" contains three competitive grant programs designed to mitigate the impacts of natural hazards. This HMCAP update was developed to be consistent with the general requirements of

the HMA program as well as the specific requirements of the Hazard Mitigation Grant Program (HMGP) for post-disaster mitigation activities, as well as Flood Management Assistance (FMA) and Building Resilience Infrastructure and Communities (BRIC). *Note that HMA programs are funded at the discretion of Congress.* These programs are briefly described below.

1.1.2 Hazard Mitigation Grant Program (HMGP)

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. In Connecticut, the HMGP is administered by the Connecticut Department of Emergency Services and Public Protection (DESPP), formerly known as the Department of Emergency Management and Homeland Security (DEMHS) until its consolidation with another agency 2011.

The HMGP provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster. Several SCCOG municipalities applied for HMGP grants subsequent to Superstorm Sandy in 2012.

1.1.3 Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). In Connecticut, the FMA program is administered by the Connecticut Department of Energy and Environmental Protection (DEEP).

FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the National Flood Insurance Program (NFIP). The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities. Three types of grants are available under FMA. These are planning, project, and technical assistance grants. FMA funds have not been utilized in the SCCOG communities over the past two years.

1.1.4 Building Resilient Infrastructure and Communities (BRIC)

The BRIC program was established as a result of an amendment to Section 203 of the Stafford Act by the Disaster Recovery Reform Act of 2018. As of this amendment, FEMA discontinued the Pre-Disaster Mitigation (PDM) program which was described in previous editions of this plan.

Funding is distributed under the BRIC program to support effective and innovative projects that promote partnerships and high-impact investments, promote equity, support strong building codes, and those that reduce future losses and minimize impacts on the Disaster Relief Fund (DRF).

1.1.5 Changes Since 2017

FEMA instituted the BRIC program, described above, to provide an upgraded pre-disaster funding mechanism for more meaningful funding opportunities. The program increased the total available

federal pre-disaster funds to $1 billion, with an increase to a $1 million allocation per applicant, and an increased maximum of $500,000 for planning. The set-aside for federally recognized tribal nations was also increased from $20 to $25 million.

In 2022 FEMA announced an alternative cost-effectiveness methodology for the benefit-cost analysis (BCA) required for HMA grant programs. The BCA, which compares the benefits of a hazard mitigation project to its costs, is typically considered effective when the benefit-cost ratio (BCR) is at least 1.0 when using a 3% discount rate. However, under the new methodology, a project may be considered cost-effective when the BCR is at least 0.75 using a 7% discount rate, and the BCR is at least 1.0 at the 3% rate. FEMA hopes this change will benefit underserved communities which often find it challenging to meet the BCA requirements.

Table 1-1 presents potential mitigation project and planning activities allowed under each FEMA grant program described above as outlined in the most recent HMA Unified Guidance document (2015). In general, those identified under PDM are now eligible for BRIC, however FEMA have released specific information on activity eligibility under Mitigation Assistance: Building Resilient Infrastructure and Communities FEMA Policy[1].Many of the strategies and actions developed in this plan fall within the above list of eligible activities.

Effective September 2021 acquisitions and elevations will be considered cost-effective if the project costs are less than $323,000 and $205,000, respectively. Structures must be located in Special Flood Hazard Areas (the area of the 1-percent-annual-chance flood). The benefit-cost analysis (BCA) will not be required.

Table 1-1 Eligible Mitigation Project Activities by Program

Eligible Activities	HMGP	PDM	FMA
1. Mitigation Projects	✓	✓	✓
Property Acquisition and Structure Demolition	✓	✓	✓
Property Acquisition and Structure Relocation	✓	✓	✓
Structure Elevation	✓	✓	✓
Mitigation Reconstruction	✓	✓	✓
Dry Floodproofing of Historic Residential Structures	✓	✓	✓
Dry Floodproofing of Non-residential Structures	✓	✓	✓
Generators	✓	✓	
Localized Flood Risk Reduction Projects	✓	✓	✓
Non-localized Flood Risk Reduction Projects	✓	✓	

[1] https://www.fema.gov/sites/default/files/documents/fema_bric-policy-fp-008-05_program_policy.pdf

Structural Retrofitting of Existing Buildings	✓	✓	✓
Non-structural Retrofitting of Existing Buildings and Facilities	✓	✓	✓
Safe Room Construction	✓	✓	
Wind Retrofit for One- and Two-Family Residences	✓	✓	
Infrastructure Retrofit	✓	✓	✓
Soil Stabilization	✓	✓	✓
Wildfire Mitigation	✓	✓	
Post-Disaster Code Enforcement	✓		
Advance Assistance	✓		
5 Percent Initiative Projects	✓		
Miscellaneous/Other (1)	✓	✓	✓
2. Hazard Mitigation Planning	✓	✓	✓
Planning Related Activities	✓		
3. Technical Assistance			✓
4. Management Cost	✓	✓	✓

Source: Table 3 – HMA Unified Guidance document, February 27, 2015

Per the Addendum to the Hazard Mitigation Assistance Guidance: Program Administration by States Pilot, Hazard Mitigation Grant Program, a new non-disaster option has been created for the delegation of local mitigation plan approvals. States can request delegation of local mitigation plan approvals outside of a disaster declaration. Local mitigation plan reviews and approvals will be conducted in accordance with 44 CFR Section 201.6(d) and applicable FEMA policies.

1.2. Incorporation of Climate Change

The consideration of climate change was incorporated into the HMCAP planning process and therefore directly into this HMCAP through a number of steps:

- The planning process directly incorporated outcomes of the Governor's Council on Climate Change (GC3)
- The planning process directly incorporated the *Resilient Connecticut* expansion.
- The planning process directly incorporated climate planning resources developed by UConn and CIRCA
- The plan adds extreme heat and drought as hazards.
- Goals were modified and changed to include climate adaptation.
- The plan references new climate-aligned funding sources like the DEEP Climate Resilience Fund (DCRF) and BRIC

- Local communities were directly asked "What are your greatest climate-driven challenges?" whereas previous iterations of the planning process in 2012 and 2017 posed the question "What projects would you complete if you had funding?"

A few of these points are addressed below.

The Governor's Council on Climate Change (GC3)

The GC3 was originally established in 2015 by Governor Dannel P. Malloy's Executive Order No. 46. The GC3 was formally tasked with examining the effectiveness of existing policies and regulations designed to reduce greenhouse gas emissions and identify new strategies to meet the state's greenhouse gas emissions reduction target of 80% below 2001 levels by 2050. The GC3 submitted its recommendations on December 18, 2018. On September 3, 2019, Governor Ned Lamont issued Executive Order No. 3, re-establishing and expanding the membership and responsibilities of the GC3. The GC3's membership now includes more than 20 members from state agencies, quasi-public agencies, businesses, local governments, and nonprofits; and is tasked with two primary objectives:

1. Monitor and report on the state's implementation of the greenhouse gas emissions reduction strategies set forth in the inaugural GC3's December 2018 report Building a Low Carbon Future for Connecticut: Achieving a 45% GHG Reduction by 2030.
2. Develop a statewide Adaptation and Resilience Plan for Connecticut that encompasses the most current and locally-scaled scientific information and analysis available with respect to the effects of climate change and provide updated recommendations for adapting to and improving the state's resilience to such changes in areas such as infrastructure, agriculture, natural resources, and public health.

GC3 objective #2 provides the impetus for adding climate adaptation to this HMCAP. The GC3's report Phase 1 Report: Near-Term Actions (2021, https://portal.ct.gov/-/media/DEEP/climatechange/GC3/GC3_Phase1_Report_Jan2021.pdf) lists 61 individual actions. Many of these are reflected in the goals and actions found in this HMCAP. Refer to Appendix A for a crosswalk of the GC3's near-term actions and the content of this HMCAP.

Resilient Connecticut Expansion

"Resilient Connecticut 2.0" (stylized as *Resilient Connecticut*) is described below under Section 1.4 (Planning Process). The program was initially piloted in Fairfield County and New Haven County using Superstorm Sandy appropriations through U.S. Department of Housing and Urban Development (HUD) and the National Disaster Resilience Competition (NDRC). The NDRC awarded funds to the State of Connecticut to advance flood protection efforts in Bridgeport and to develop a regional coastal resilience plan for southwest Connecticut.

Recognizing the unmet needs in southwest Connecticut, CIRCA expanded the NDRC-funded planning effort in 2019 to include all communities in Fairfield and New Haven Counties with an emphasis on fostering resilience of regional assets and infrastructure, Transit-Oriented Development (TOD), and key transit corridors which could then be considered resilient corridors. With the GC3 efforts underway in the backdrop, extreme heat was added as a primary consideration, and *Resilient Connecticut* was re-

focused to consider multiple impacts of climate change. Resilience opportunity areas were identified through a vulnerability assessment completed in 2020-2021, and seven areas are proceeding to additional study and concept design in 2023. The "2.0" was added to denote the Statewide program expansion using State funds.

Climate Planning Resources Developed by UConn and CIRCA

UConn and CIRCA published the Connecticut Physical Climate Assessment Report in 2019 to help the State and its municipalities plan for the effects of climate change. Additionally, CIRCA developed the sea level rise planning thresholds adopted by the State of Connecticut and required for use in municipal planning and in the design of State-funded projects. This HMCAP is the first edition of the SCCOG HMP to be developed since these tools were issued.

Extreme Heat and Drought

Extreme heat and drought were not included as hazards in previous editions of the SCCOG HMP. This HMCAP is the first edition of the region's plan to directly include them as profiled hazards. Additionally, extreme heat is the central theme of one of the goals of the HMCAP.

HMCAP Goals

This edition of the SCCOG includes new goal statements that are aligned with *Resilient Connecticut* and the efforts of the GC3. The primary goal of the previous edition of the HMP was to "*prevent or minimize the loss of or damage to life, property, infrastructure, and natural, cultural, and economic resources from natural disasters. This includes the reduction of public and private damage costs. Limiting losses of and damage to life and property will also reduce the social, emotional, and economic disruption associated with a natural disaster."* The five new goals developed for this HMCAP are:

- 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.

Additional detail is provided in Section 5.1.

1.3. Document Overview

The Multi-Jurisdictional plan and each community annex are similarly laid out, with the Multi-Jurisdictional plan discussing each hazard from a regional perspective and each community annex taking a more detailed look at each natural hazard for that particular community. The HMCAP and its annexes include a general discussion of the SCCOG region and each community, including the physical setting, demographics, development trends, governmental structure, and sheltering capacity. Next, each chapter of this HMCAP and its annexes is dedicated to a particular climate change stressor, with relative

hazards within that section. For example, the extreme and severe storms category includes tropical events, winter storms, tornadoes and high wind events. Within each hazard there are three different parts: *Setting/Historic Record; Existing Capabilities; Vulnerabilities and Risk Assessment.* These are described below.

- ***Hazard Assessment*** describes the specifics of a given hazard, including general characteristics and associated effects, extent of the hazard, and the location of impact. Also defined are associated return intervals, probability and risk, and relative magnitude.
- **Historic Record** is a discussion of past occurrences of the hazard and associated damages when available.
- ***Existing Capabilities*** gives an overview of the measures that SCCOG or its member communities has undertaken in the past or is currently undertaking to mitigate the given hazard. These may take the form of ordinances and codes, home elevations and acquisitions, structural measures such as dams, or public outreach initiatives.
- ***Vulnerabilities and Risk Assessment*** focuses on the specific areas at risk to the hazard. Specific land uses in the given areas are identified. Critical buildings and infrastructure that would be affected by the hazard are identified. Hazards of a regional nature, such as hurricanes, have a risk assessment specifically addressed in the Multi-Jurisdictional plan, while the risk assessment for hazards that are more community specific, such as inland flooding, are discussed in more detail within each community annex.

The plan wraps up with implementation strategy for the HMCAP, including a schedule and program for monitoring and updating the plan, potential mitigation strategies and actions, the specific regional strategies identified by SCCOG. There is also discussion of technical and financial resources included in a reference section at the end of this Multi-jurisdictional plan.

1.4. Planning Process

1.4.1 Local Coordination

The planning process for the multi-jurisdiction hazard mitigation plan update commenced in April 2022 and ended in February 2023, spanning a period of eleven 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 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
- Direct incorporation of new Environmental Justice (EJ) mapping developed by CIRCA in 2022-2023 (although the draft maps were not available for public review until spring 2023, the same CIRCA professionals participated in the EJ mapping and the planning process for this HMCAP)
- Positioning of the 24 jurisdictions for new funding sources in Connecticut such as the new DEEP DCRF
- Consistency with the 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 primarily ended on July 8, 2022, although additional meetings were held in January and February 2023 as needed. Meeting notes were prepared to document the meetings and the status of prior mitigation actions. Because some local planning team members were unable to convene, the consultant provided a set of questions to these municipal contacts for future follow-up.

Specific Opportunities for Input to the Planning Process

Following the local planning team meetings, the planning process primarily consisted of four types of efforts/events:

1. Workshops for the local and tribal coordinators:
    - A virtual workshop with active participation methods (for example, a matching game) was conducted for the coordinators, chief elected officials, and their designers on July 21, 2022. The theme of the workshop was to present risk assessment findings and gather input.
    - A virtual workshop with active participation methods (polling/voting with Zoom) was conducted for the local and tribal coordinators, chief elected officials, and their designers on September 28, 2022. The theme of the workshop was to present State, regional, and shared hazard mitigation and climate adaptation strategies and actions.
2. Public engagement:
    - The StoryMap was deployed along with a web-based survey.
    - Press releases and web links were distributed.
    - An in-person public meeting was held on August 2, 2022. Mentimeter was used to record answers to questions that were asked during the polling segment of the meeting.
    - A hybrid in-person and virtual public meeting was held on August 3, 2022. Mentimeter was used to record answers to questions that were asked during the polling segment of the meeting, allowing people at home and people present at the meeting to respond together in real-time.

3. Targeted engagement:
    - Letters were distributed to the regional planning agencies in Connecticut, Rhode Island, and New York (Suffolk County on Long Island) that surround the SCCOG region. These letters described the HMCAP and invited comments and participation. This resulted in staff from the Capitol Regional Council of Governments (CRCOG) attending a public meeting.
    - Direct personalized emails were sent to the non-municipal water utilities and regional wastewater and water utilities serving SCCOG communities (Aquarion Water Company, Groton Utilities, Jewett City Water Company, Southeastern Connecticut Water Authority, New London Public Utilities, Norwich Public Utilities, Windham Water Works, and Westerly Water Department).
    - Meetings were held with Windham Water Works (in person, 8/18/22) and Aquarion Water Company (virtual, 9/26/22) to discuss appropriate hazard mitigation and climate adaptation strategies and actions.
    - The consultant and CIRCA presented to the Eastern Connecticut Water Utility Coordinating Committee (WUCC) to further enhance collaboration with water utilities in southeastern Connecticut. WUCC meeting attendees included Connecticut Department of Public Health (DPH), DEEP, Town of Preston, Groton Utilities, Jewett City Water Company, Southeastern Connecticut Water Authority, and Aquarion Water Company.
    - Mystic Seaport Museum was engaged through email, and the consultant and CIRCA attended an in-person meeting with the organization and the Town of Stonington to discuss appropriate strategies and actions for flood and erosion risk reduction at the Mystic Seaport Museum facilities.
    - The Sewer and Electric divisions of Norwich Public Utilities (both serving multiple communities) were engaged in February 2023, resulting in the addition of actions to the plan for both divisions.
4. COG Coordination:
    - The consultant and CIRCA attended the SCCOG board meeting of April 20, 2022, as noted above.
    - The consultant and CIRCA attended the SCCOG board meeting of September 21, 2022, to provide a brief update of the planning process and next steps.
    - The consultant and CIRCA attended the SCCOG board meeting of January 18, 2023, to provide a brief update and ask for any final comments on the draft plan and proposed HMCAP actions.

In summary, the key meeting dates memorializing the above planning process are as follows; CIRCA staff attended all meetings with the consultant to ensure that key feedback was incorporated into both the HMCAP and *Resilient Connecticut*.

- SCCOG Council of Governments (COG) meeting – 4/20/22
- Local Planning Team meetings – 5/23/22 through 7/8/22
- Workshop #1 for Local and Tribal Coordinators and Planning Teams – 7/21/22
- Public Meeting #1 – 8/2/22
- Public Meeting #2 – 8/3/22
- Mystic Seaport Museum – 8/17/22
- Windham Water Works – 8/18/22

- SCCOG COG meeting – 9/21/22
- Aquarion Water Company – 9/26/22
- Workshop #2 for Local and Tribal Coordinators and Planning Teams – 9/28/22
- Eastern Connecticut WUCC – 11/16/22
- SCCOG COG meeting – 1/28/23
- Public Meeting #3 to present Draft HMCAP – TBD

Finally, other organizations were present for COG updates on 4/20/22, 9/22/22, and 1/28/23 and therefore were provided with an opportunity for input. These included:

- U.S. Navy Base: Steve Sadlowski, Community Planning Liaison Officer; and Captain Ken Curtin
- Eversource: Teresa Jackman and T.J. Magnoli
- Southeast Area Transit District (SEAT): Mike Carroll and Thailisa Clark
- Thames Valley Council for Community Action (TVCCA): Deborah Monahan
- Connecticut Department of Transportation: Jennifer Pacacha
- Southeastern CT Enterprise Region (seCTer): Mark Oefinger and Paul Whitescarver
- Ledge Light Health District: Steve Mansfield
- New London Parking Authority: Carey Redd
- Eastern Connecticut Tourism District: Jim Bellano
- Community Foundation of Eastern Connecticut: Maryam Elahi and Carl Asikainen
- Southeastern Connecticut Cultural Coalition: Wendy Bury

All local and tribal coordinators were involved in multiple coordination and HMCAP related events including municipal planning meetings, workshops, and Resilient Connecticut Efforts. A summary of participation can be found in Table 1-2.

Table 1-2 Local and Tribal Coordinator Participation

Municipalities and Tribes	Kickoff presentation April 20, 2022 (also for Resilient CT)	Local Planning Team Meetings	Supplemental Assistance	Local/Tribal Coordinators Workshop on July 21, 2022	Public Meetings in August 2022	SCCOG Meeting of September 21, 2022 (also for Resilient CT)	Local /Tribal Coordinators Workshop on September 28, 2022	SCCOG Meeting of January 18, 2023 (also for Resilient CT)
Bozrah	Glenn Pianka	5/26/2022	--	--	--	Glenn Pianka	--	Glenn Pianka
Colchester	--	6/27/2022	--	Andreas Bisbikos	--	--	--	--
East Lyme	Kevin Seery	6/8/2022	--	Alex Klose, Matt Garneau	--	Kevin Seery	--	Kevin Seery
Franklin	Charles Grant	8/16/2022 and 1/26/23	--	--	--	Charles Grant	--	Charles Grant
Griswold	Dana Bennett	6/15/2022	--	Dana Bennett	--	--	Dana Bennett	Dana Bennett
City of Groton	--	5/25/2022	--	Joe Summers, Leslie Creane, Cierra Patrick, Keith Hedrick, Heidi Comeau	--	--	Leslie Creane, Heidi Comeau, Keith Hedrick, Eric Jenkins, Bill Robarge	Keith Hedrick
Town of Groton	John Burt	6/6/2022	Meeting with new sustainability coordinator on 10/4/22; and meeting to coordinate with Mystic planning on 2/3/23	Greg Hanover	Kevin Fitzgerald, ARPA Coordinator	John Burt	Greg Hanover, Deborah Jones, Megan Granato, Jon Reiner, David Prescott	--
Jewett City	--	6/15/2022	--	--	--	Timothy Sharkey	--	Timothy Sharkey
Lebanon	Kevin Cwikla	6/20/2022	--	--	--	Kevin Cwikla	--	--
Ledyard	--	6/1/2022	--	Fred Allyn III	--	Fred Allyn III	--	Fred Allyn III
Lisbon	Thomas Sparkman	--	--	Thomas Sparkman	--	--	Thomas Sparkman	--
MPTN	--	6/8/2022	--	Rahiem Eleazer	--	Bob Hayward	Floyd Chaney	Bob Hayward
Mohegan Tribe	--	6/15/2022	--	--	--	--	Jonathan Montey	--
Montville	Ron McDaniel	6/2/2022	--	Ron McDaniel	--	Ron McDaniel	Ron McDaniel, Liz Burdick	Ron McDaniel
New London	Michael Passero	5/23/2022	--	Adriana Reyes, Elizabeth Nocera	--	Michael Passero	Joe Lanzafame, Elizabeth Nocera	Michael Passero

Municipalities and Tribes	Kickoff presentation April 20, 2022 (also for Resilient CT)	Local Planning Team Meetings	Supplemental Assistance	Local/Tribal Coordinators Workshop on July 21, 2022	Public Meetings in August 2022	SCCOG Meeting of September 21, 2022 (also for Resilient CT)	Local /Tribal Coordinators Workshop on September 28, 2022	SCCOG Meeting of January 18, 2023 (also for Resilient CT)
North Stonington	Robert Carlson	6/13/2022	First Selectman emailed additional info to supplement meeting	--	--	Robert Carlson	Bob Carlson	Bob Carlson
Norwich	--	5/31/2022	--	Mark Waters, Richard Shuck, Dan Daniska, Deanna Rhodes, Pat McLaughlin, Brian Long	--	--	Deanna Rhodes, Chief Tracy Montoya	--
Preston	Sandra Allyn-Gauthier	6/16/2022	11/17/22 phone meeting about all actions and general approach for implementation	Could not attend but viewed slides	--	Sandra Allyn-Gauthier	Could not attend but viewed slides	Sandra Allyn-Gauthier
Salem	Ed Chmielewski	1/18/23	Justin LaFountain provided critical facilities and cooling centers; and he forwarded additional information on 8/25/22; all was verified on 1/18/23	--	--	--	Justin LaFountain attended for the Town	Ed Chmielewski
Sprague	--	6/20/2022	--	--	--	Cheryl Blanchard	--	Cheryl Blanchard
Borough of Stonington	Jeff Callahan	6/2/2022	--	Could not attend but viewed slides	--	Staff present	--	Jeff Callahan
Town of Stonington	Danielle Chesebrough	6/14/2022 and 2/14/23	Staff replied to emails with some meeting follow-up	Keith Brynes, Danielle Chesebrough, Chris	--	Danielle Chesebrough	Keith Brynes	Danielle Chesebrough

Municipalities and Tribes	Kickoff presentation April 20, 2022 (also for Resilient CT)	Local Planning Team Meetings	Supplemental Assistance	Local/Tribal Coordinators Workshop on July 21, 2022	Public Meetings in August 2022	SCCOG Meeting of September 21, 2022 (also for Resilient CT)	Local /Tribal Coordinators Workshop on September 28, 2022	SCCOG Meeting of January 18, 2023 (also for Resilient CT)
			information; Stonington WPCA provided information on 8/10/22; meeting with First Selectman on 2/14/23 was to review priorities	Greenlaw, plus a couple callers from DPW				
Waterford	Rob Brule	6/14/2022	--	Abby Piersall	--	Rob Brule	--	Rob Brule
Windham	Thomas DeVivo	7/8/2022 (call with Town Engineer Bryan Tarbell) and 8/18/2022 (Windham Water Works and Town personnel)	Staff replied to emails with some follow-up information; meeting with Windham Water Works on 8/18/22 provided additional information	--	--	--	Bryan Tarbell, Christian Perez, Michael Turgeon	--
U.S. Navy Base	Steve Sadlowski, Community Planning Liaison Officer; and Captain Ken Curtin	--	--	--	--	Steve Sadlowski and Captain Ken Curtin	--	Steve Sadlowski and Captain Ken Curtin
U.S. Coast Guard Academy	--	--	--	--	--	Lieutenant Commander Samuel Andriessen	--	Lieutenant Commanders Samuel Andriessen and Craig Johnson

1.4.2 Communication and Messaging

Correspondence with the chief elected officials, local planning teams, surrounding planning agencies, and the public included a sustained messaging about the development of a combined hazard mitigation and climate adaptation plan. For example, the initial email correspondence with the chief elected officials after the COG meeting of April 20, 2022, described the approach for incorporating climate adaptation into the hazard mitigation plan update:

> *Dear Chief Elected Officials and Local Coordinators:*
>
> *The Southeastern Connecticut Council of Governments is working with the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) to identify unmet climate-related needs related to flooding and extreme heat through participation in the Resilient Connecticut program. CIRCA introduced this program at the April 20, 2022, COG meeting. Information can be found on the attached flyer.*
>
> *SCCOG has elected to align the Resilient Connecticut planning process with the update of the region's Multi-Jurisdiction Natural Hazard Mitigation Plan, which will result in development of a combined Hazard Mitigation and Climate Adaptation Plan. Ideally, this will help position local resilience efforts for the State's "resilience project pipeline."*
>
> *The good news is that we have combined the local Resilient Connecticut meetings with the local hazard mitigation plan update meetings. The consultant for the hazard mitigation plan will work directly with CIRCA staff in a unified manner to reduce your time commitments.*
>
> *To get started, please use the poll (link below) to choose one date and time for a meeting with your local planning committee. The goal of this meeting is to review local natural hazard risks and capabilities with your staff, review the status of past mitigation actions, and develop initial ideas for new activities. You may remember participating in the last hazard mitigation plan cycle, which concluded in 2017.*
>
> *We will rely on you to invite your colleagues to this meeting. Staff from planning/land use, public works, building, emergency management, and the office of the mayor/first selectman/tribal council should be present. Once you have selected a date and time, it will be unavailable to other communities, so please choose only one option.*

The meeting invitation for the first workshop continued with this messaging:

> *Dear Chief Elected Officials and Local Coordinators:*
>
> *Thanks for all your help in May and June with the local planning meetings for the Hazard Mitigation and Climate Adaptation Plan. As we discussed, this is your community's fourth hazard mitigation plan, and we are incorporating the "Resilient Connecticut" program administered by the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) to expand the scope of the plan and align with State and Federal grant programs.*
>
> *Our first regional workshop is scheduled for July 21. A draft agenda is:*
>
> - *A brief explanation about the alignment of the Hazard Mitigation and Climate Adaptation Plan and "Resilient Connecticut"*

- *Lessons from other SCCOG and State resilience efforts*
- *Feedback from the municipal and tribe meetings in May and June*
- *Summary of the major climate-driven needs in southeastern Connecticut*
- *Risk assessment:*
    - *Initial exposure analysis for critical facilities, historic resources, etc.*
    - *Loss estimates summary from NFIP, FEMA Public Assistance, National Oceanic and Atmospheric Administration (NOAA), etc.*
- *Progress on the Zones of Shared Risk mapping*
- *Initial thoughts on where we see risks and needs overlapping*

Please join us on July 21. You may forward this to your colleagues.

Finally, the meeting invitation for the second workshop continued with this messaging:

Dear Chief Elected Officials and Local Coordinators:

Thanks for all your help with the local planning meetings for the Hazard Mitigation and Climate Adaptation Plan. As we discussed, this is your community's fourth hazard mitigation plan, and we are incorporating the "Resilient Connecticut" program administered by the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) to expand the scope of the plan and align with State and Federal grant programs.

Our second regional workshops is scheduled for September 28. A draft agenda is:

- *A brief reminder about the alignment of the Hazard Mitigation and Climate Adaptation Plan and "Resilient Connecticut"*
- *Updates on the planning meetings with the municipal and tribe teams (if needed) and from the August public meetings.*
- *Summary of the major climate-driven and hazard mitigation needs in southeastern Connecticut.*
- *Adaptation and hazard mitigation strategies of Federal, State, and regional interest that we will "shop from"*
    - *Critical facilities resilience*
    - *Cooling centers for extreme heat respite*
    - *Droughts*
    - *Water supply issues (water supply watersheds, harmful algal blooms, water quality challenges, etc.)*
    - *Wastewater/sewer infrastructure such as WWTPs/WPCFs and pumping stations*
    - *Agricultural interests/livestock/chickens*
    - *Toxic releases during floods (from DEEP program)*
    - *Historic resources (repeats from 2017 HMP; from SHPO program)*
    - *Dams*
- *Next steps*

Press releases employed the same narrative. The main press release for the project was issued on July 14, 2022, to ensure that all local planning team meetings had occurred, giving all local planning teams an opportunity to express their needs and concerns before public engagement.

July 14, 2022 – While southeastern Connecticut has enjoyed a period of relative calm over the last five years, the tropical systems of 2021 (Elsa, Fred, Henri, and Ida) were a strong reminder of the risks posed by natural disasters. The region's communities – towns, cities, boroughs, and the two federally recognized tribal nations – have shared in the development and adoption of a natural hazard mitigation plan for two decades, with updates incorporated every five years. The region's communities are again working with the Southeastern Connecticut Council of Governments (SCCOG) to update the plan, and this time the challenges associated with climate change will be incorporated directly into the plan to produce a "Hazard Mitigation and Climate Adaptation Plan" for southeastern Connecticut. The plan will outline a set of actions that can be taken to reduce losses of property and life due to natural disasters like floods, severe wind events, winter storms, wildfires, droughts, extreme heat events, and earthquakes; and will outline a set of actions to reduce impacts of these events when made worse by the effects of climate change.

The hazard mitigation and climate adaptation planning effort is leveraging close coordination with the Connecticut Institute for Resilience and Climate Adaptation (CIRCA), which is located nearby at UConn's Avery Point Campus. CIRCA is expanding its "Resilient Connecticut" program from a narrow pilot region to the entire state, with a strong focus in southeastern Connecticut.

People living and working in and near southeastern Connecticut have several opportunities to provide input to the planning process. An online, internet-based experience called a "story map" has been developed and can be accessed at https://tinyurl.com/yv7zck7h. An optional survey is embedded in the story map.

For those who would like to participate in a public information meeting, two opportunities are coming up in early August:

- *The first meeting will be held at the Groton Public Library (52 Newtown Rd, Groton) at 6:30 PM on August 2, 2022. The Groton Public Library is located on the SEAT bus routes 11 and 108.*
- *The second meeting will be held at the SCCOG offices (5 Connecticut Avenue, Norwich) at 6:30 on August 3, 2022. SCCOG offices are located on SEAT bus route 5. This second meeting will incorporate a virtual component for people wishing to join remotely. Virtual participation instructions will be posted to www.seccog.org/meetings at least one week prior to August 3. Participation by telephone (audio only) will also be possible.*

Finally, comments about the Hazard Mitigation and Climate Adaptation Plan for southeastern Connecticut can be sent directly to SCCOG at office@seccog.org.

The Hazard Mitigation and Climate Adaptation Plan for southeastern Connecticut will continue to make the region's communities eligible for seeking hazard mitigation assistance from the Federal Emergency Management Agency (FEMA) and the State of Connecticut. The plan will also help align the region with new State funding programs that are expected in the latter half of 2022.

The narrative used in the letters to surrounding planning agencies and entities is provided below:

July 7, 2022 – The Southeastern Connecticut Council of Governments (SCCOG) is in the process of updating the Multi-Jurisdiction Hazard Mitigation Plan for its member municipalities and two tribal governments. SCCOG is leveraging its participation in the Resilient Connecticut program

administered by the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) to more directly incorporate climate adaptation into the hazard mitigation plan. The goal is to develop the first "Hazard Mitigation and Climate Adaptation Plan" in Connecticut.

We invite you and your member communities to participate in the planning process by providing comments regarding the update of the Multi-Jurisdiction Hazard Mitigation Plan and its transition to a Hazard Mitigation and Climate Adaptation Plan. The current plan can be found at http://seccog.org/2017-hmp. Some questions to consider are:

- *Are any hazard mitigation and climate adaptation efforts being planning in your communities that might affect downstream, adjacent, or nearby communities of southeastern Connecticut?*
- *Have any hazard mitigation or climate adaptation needs been identified in your communities that might benefit from participation and support from SCCOG communities?*
- *Are any hazard mitigation or climate adaptation needs evident or apparent for critical facilities, critical infrastructure, transportation routes, or regional assets that are shared among your communities and those of southeastern Connecticut? For example, Windham Water Works serves southern Mansfield (CRCOG region) and western Windham in the SCCOG region; and sanitary sewers in Old Lyme (RiverCOG region) are directed to East Lyme and eventually New London.*

We invite you to provide comments directly to Sam Alexander at SCCOG (salexander@seccog.org) and the undersigned. Other opportunities to participate include a set of public meetings scheduled for August 2, 6:30 PM at the SCCOG office in Norwich (hybrid in-person and virtual) and August 3, 6:30 PM in the Town of Groton Public Library (in-person). Finally, a project Story Map is available at https://tinyurl.com/yv7zck7h.

These letters were emailed to:

- State of Rhode Island Office of Planning
- Washington County (RI) Regional Planning Council
- Suffolk County (NY) Office of Planning
- Lower Connecticut River Council of Governments (RiverCOG)
- Northeastern Connecticut Council of Governments (NECCOG)
- Capitol Region Council of Governments (CRCOG)

In response to the correspondence to surrounding planning entities, Maureen Goulet from CRCOG attended the public meetings virtually in August 2022 and provided feedback via the Mentimeter platform.

1.4.3 Regional Workshops

As mentioned above in Communication and Messaging, two regional workshops were held with the Chief Elected Officials, local and tribal coordinators, and other community staff.

The first workshop, the "Vulnerability and Risk Assessment" workshop, was held on July 21, 2022. The workshop was held virtually using the Zoom platform. There were three presenters from the consulting team and UConn CIRCA that touched on six different topics.

- Background on the HMCAP and *Resilient Connecticut*
- Lessons about risks learned from other efforts
- Recap of "what we heard" in May and June
- Vulnerability and risk assessment progress
- Regional climate-driven risks
- *Resilient Connecticut* vulnerability assessment progress

A total of 31 participants from the region joined the hour-long workshop. The consulting and CIRCA staff provided background information to the audience on the HMCAP and insight into the *Resilient Connecticut* program and the significance of the joint effort taking place for the HMCAP. A high level overview was then provided on several State and Regional efforts that would play a role in the development of the HMCAP including the regional Critical Facilities Assessment, wastewater management planning efforts, historic resource resiliency planning, and the GC3.

The focus then shifted to reviewing the findings of the local meetings conducted in May and June with each community. As this point in the workshop, attendees were able to participate in a matching game that ultimately made them revisit their "top climate change vulnerability" or challenge. Members from each community were asked to identify which on the screen they thought was their top concern. Ultimately the discussion results (Figure 1-1) either reinforced some community's top challenge, or made others consider some of their other vulnerabilities and risks in the community.

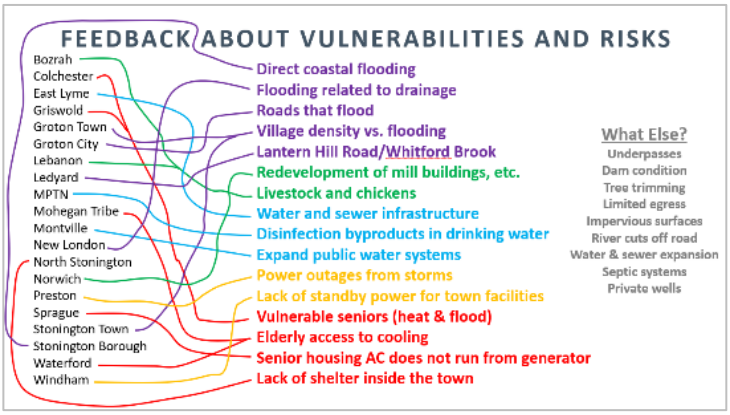


Figure 1-1 Regional Workshop Match Game Results

Preliminary findings from the vulnerability and risk assessment were then presented. This included NFIP statistics, FEMA Public Assistance (PA) losses, NOAA National Centers for Environmental Information (NCEI) losses, and exposure analysis findings. Finally, UConn CIRCA staff presented a little more detail on some of the specific climate-driven risks in the region, and how this ties into the *Resilient Connecticut* progress.

Participants were given the opportunity to ask questions after being reminded of the ESRI Story Map for the project, that there were public meetings in the near future, and that there was going to be another workshop in the fall.

The second workshop, which was the "Hazard Mitigation and Climate Adaptation Actions" workshop, was held on September 28, 2022. The workshop was held virtually on the Zoom platform, and the agenda included:

- The HMCAP and *Resilient Connecticut*
- Updates on municipal meetings and engagement

- Climate-driven and hazard mitigation needs
- Climate adaptation and hazard mitigation strategies
- Action and strategy “shopping” (a polling exercise)

The workshop had a total of 32 participants, in addition to the three from the consultant and UConn CIRCA team. To start, the team gave a similar overview of the HMCAP and *Resilient Connecticut* as the first workshop. Next, the consultants gave an overview of what the climate concerns were throughout the region according to the local community meetings, provided an updated on the public outreach and engagement efforts, and presented main points from additional stakeholder engagement. Next, participants were briefed on the status of some of the 2017 HMP actions that were drafted from State and regional efforts.

The bulk of the workshop was spent on a “shopping exercise” that was developed to gauge where communities stood on various hazard mitigation and climate adaptation actions pertaining to different assets and hazards. Participants were given three to five sample actions under eleven categories, all varying in degree of implementation and goals. The categories included:

- Community shelters
- Critical facility resilience
- Cooling center resilience
- Drought resilience
- Water supply needs
- Wastewater and sewer needs
- Agriculture/livestock
- Toxic release during floods
- Stormwater infrastructure
- Dams
- Redevelopment in flood zones

This exercise helped the team to understand the community's priorities and perspectives on staffing and implementation capabilities.

Finally, the workshop was closed out with the next steps, and the floor was opened for discussion and questions.

Workshop materials including PowerPoint slides can be found in Appendix B.

1.4.4 Public Information and Outreach

In order to involve the public throughout the planning process, two public meetings were held, a public survey was launched and promoted for five months, and the public was able to provide comments to SCCOG throughout the planning process. A summary of the meetings and findings from the survey are outlined below.

Public Meetings

Two public meetings were held during the planning phase of the HMCAP. The meetings were publicized by SCCOG, and materials were distributed to each community to publicize to their residents. SCCOG developed various iterations of a flyer (Figure 1-4), in which it was then posted on the SCCOG Facebook Page (Figure 1-2), and a Facebook header (Figure 1-3) was developed to ensure that the information was more readily seen by visitors.

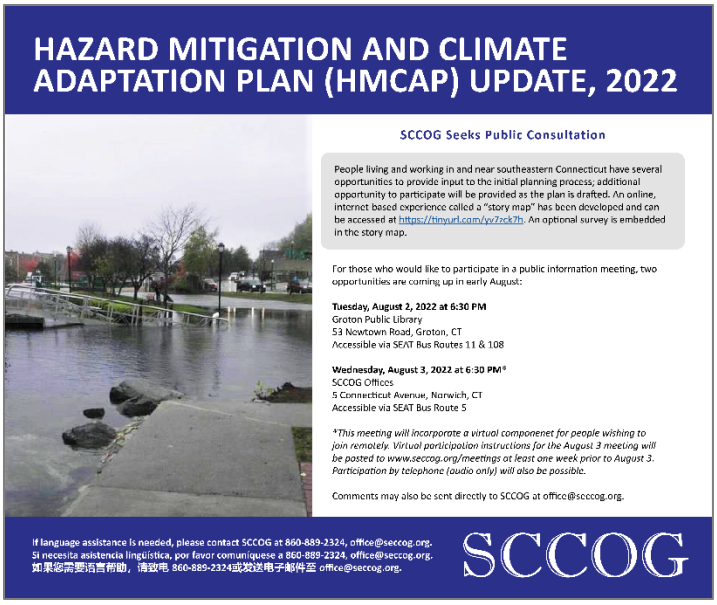


Figure 1-2 Public Meeting SCCOG Facebook Post

The first was held in person on August 2, 2022, at the Town of Groton Public Library. There were two members from the consultant team, one from the CIRCA team, two COG representatives, and two attendees from the public. The consultant presented on what the HMCAP is, what some of the natural hazards and climate impacts are that the region is facing, the types of mitigation actions and strategies their communities may identify, and some of the ways the public can provide input. Throughout the presentation, the audience was also polled using Mentimeter on natural hazards and climate change. At the conclusion of the present the floor was open for questions and comments. Below are the questions posed by the members of the public.

1. Who in a community is in charge of implementing and tracking the actions and strategies in the plan?
2. Is there a way to track or identify areas that have had a higher number of power outages during past events?
3. Is there a way to audit evacuation routes?
4. How much does the plan recommend on future development in high flood risk areas?
5. Can American Rescue Plan Act (ARPA) funds that have partially expended be used for HMGP match?
6. What is the common response from communities in regard to hazards?

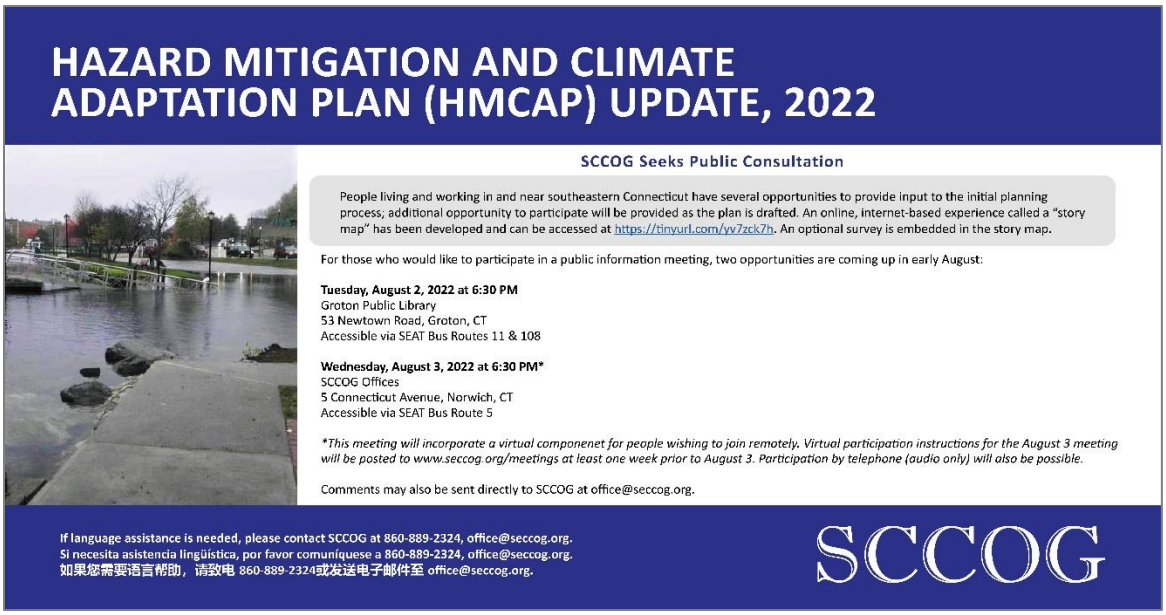


Figure 1-3 Public Meeting SCCOG Facebook Banner

The second public meeting was held the following day on August 3, 2022, with a hybrid in-person/virtual format. The meeting was hosted in Norwich at the SCCOG offices, but an online option to join was available via Zoom. There were two attendees from the public, including a representative of the CRCOG, the neighboring COG. The consultant gave the same presentation as the previous meeting, and at the end the floor was opened for questions. A discussion was had surrounding public outreach and some of the ways it could be conducted to better distribute hazard mitigation information to local communities.

A full display of the PowerPoint presentation and Mentimeter polling results can be found in Appendix C.

Figure 1-4 Public Meeting Flyer Developed by SCCOG

Public Survey

As part of community outreach, a public survey was open to the public from July to December 2022. This survey was embedded into the SCCOG HMCAP Esri Story Map, the link was distributed to all community local and tribal coordinators for local promotion, and SCCOG staff created materials to promote the survey to residents throughout the region (Figure 1-5). The 24 question survey was designed to allow residents to provide input on natural hazard events, past impacts, and preparedness; climate change considerations were also incorporated.

Figure 1-5 SCCOG Public Survey Promotional Media

The first section of the survey allowed respondents to voluntarily provide a little demographic information such as which community they live or work in, how long they have done so in the region, and whether they rent or own their properties. In total there were ten respondents from six different communities (Figure 1-6). Most respondents also shared where they work or live more specifically. Locations include:

- Work at Fitch High School/Live in Noank
- Wintechog Hill Road
- Union/State Street
- Sablewoods
- Mystic
- Laurel Crest Drive
- Downtown Norwich
- Flanders
- Central Groton

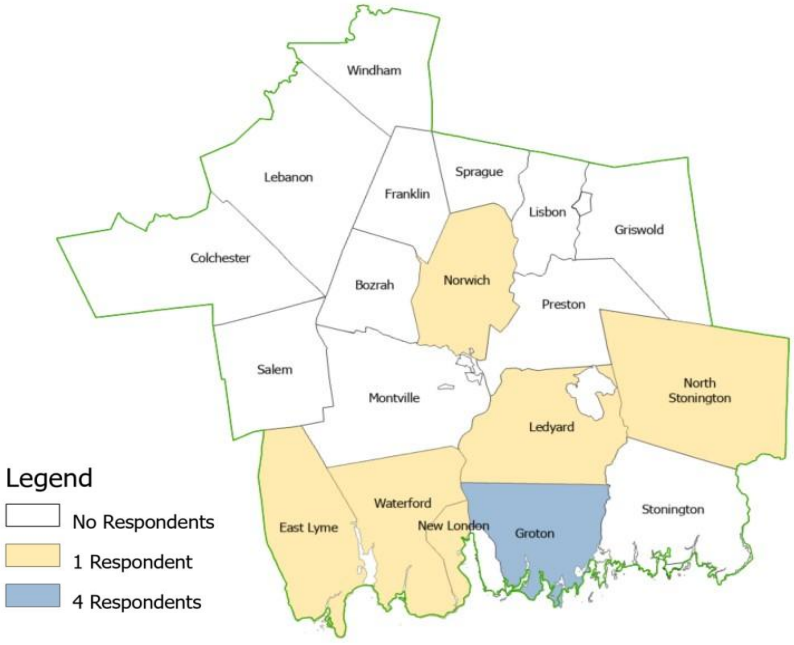


Figure 1-6 Survey Respondent Distribution in the Region

Seven of the respondents have lived or worked in the region for ten or more years, with one respondent being in the area less than a year, another between one to five years, and the last between six and nine years. Eight of the ten individuals own their property, with the remaining two renting.

Respondents were also asked how natural hazards have impacted their properties in the past. Some of the responses included wind and tree damage, flooding from tropical events like Gloria and Isaias, flooding from the 2010 rain event, power outages, and loss of access/egress from flooding.

The following section focused on natural hazards events and their experiences. In Question 7, respondents were asked to simply identify which of the 11 hazards identified have they experienced or not experienced in the past Figure 1-7. At least half of those who answered have experienced a tropical storm, tornado/wind event, winter storm, drought, and an extreme heat event. None of the respondents have directly experienced a wildfire event in the SCCOG region. Question 10 then asked respondents to identify whether they felt these events have increased, decreased, or have not changed in frequency or intensity in the past ten years (Figure 1-8). At least half of those that responded felt that tornado/high winds, coastal flooding, riverine flooding, erosion, extreme heat, and wildfires have increased in the past ten years. None of the respondents felt that any of these events have decreased in the past ten years, however several felt that some events have not changed.

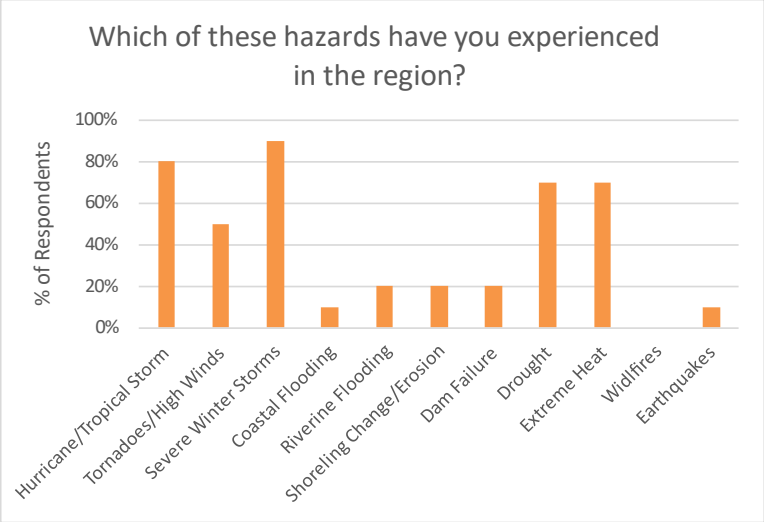


Figure 1-7 Survey Results Question 7, Natural Hazard Experiences

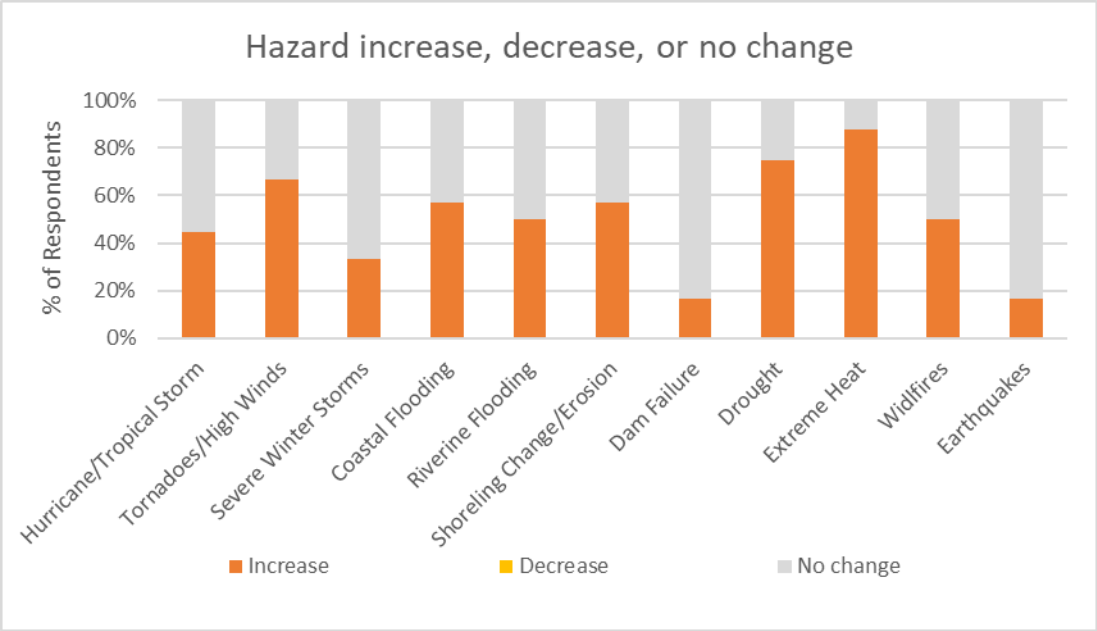


Figure 1-8 Survey Response Question 10, Event Frequency Changes

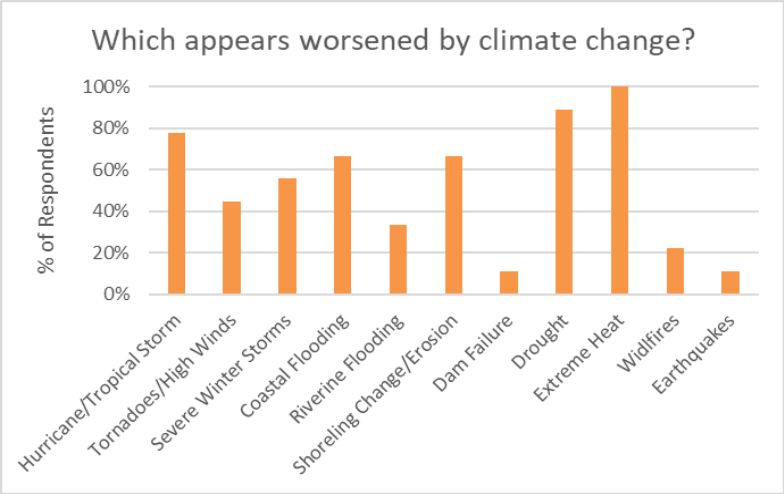


Figure 1-9 Survey Response Question 11, Hazards Worsened by Climate Change

The following question then asked respondents to identify which of the same hazards appear to be worsened by climate change. Of the responses, extreme heat was the only hazard that all nine felt was worsened by climate change. At least half of the individuals felt that tropical storms, winter storms, coastal flooding, shoreline change, and drought were all worsened by climate change.

The next section focused on past impacts. Question 12 asked about how the 2021 storms impacted their home/property/place of employment whether it was wind impacting the property or roadways, loss of power, of flooding at the property or impeding access and egress (Figure 1-10). Most reported wind damage to their property and wind affecting roads and power lines. Responses also indicated that flooding reportedly impacts roadways and properties.

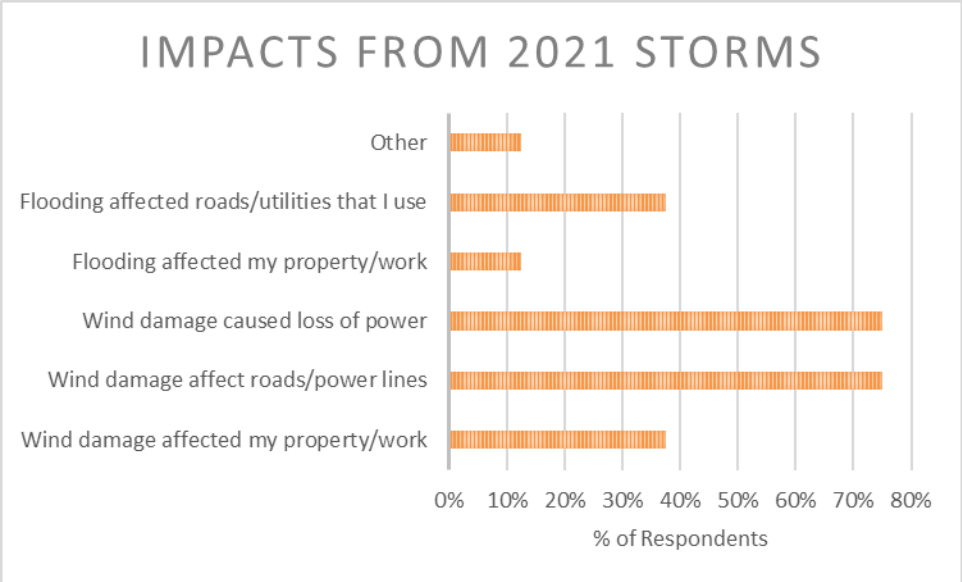


Figure 1-10 Survey Results Question 12, Impacts from 2021 Storms

To better gauge how heat events have impacted respondents, question 13 then asked which resources were available to them for respite or relief (Figure 1-11). Most respondents agreed their house with air conditioning was an option in addition to their place of employment, a retail establishment, a cooling center, or recreational area with shade or water access. One individual identified a public pool as an option, while another felt extreme heat is unlikely to affect them.

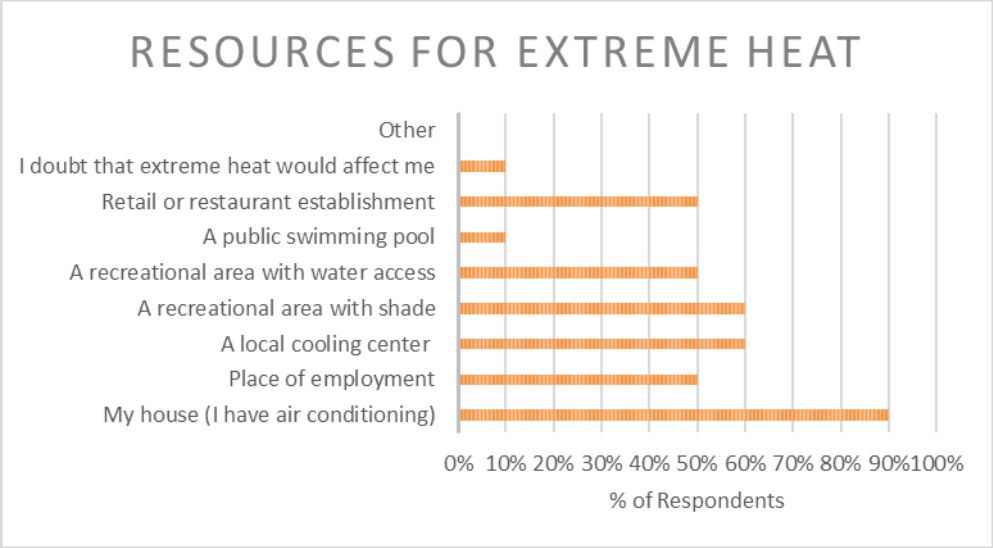


Figure 1-11 Survey Response Question 13, Extreme Heat Resources

Question 14 asked the respondents how future droughts could affect them as these events are predicted to become flashier with rapid onset (Figure 1-12). Most respondents felt that the public water system that serves their home or place of work will enact water use restrictions. In addition, 40% of the respondents were also concerned with the impacts to local produce availability. Other respondents felt their fire suppression may be impacted, their private well could be impacts, or their agricultural or business operations could be impacted by drought. One respondent felt drought was likely not affect them.

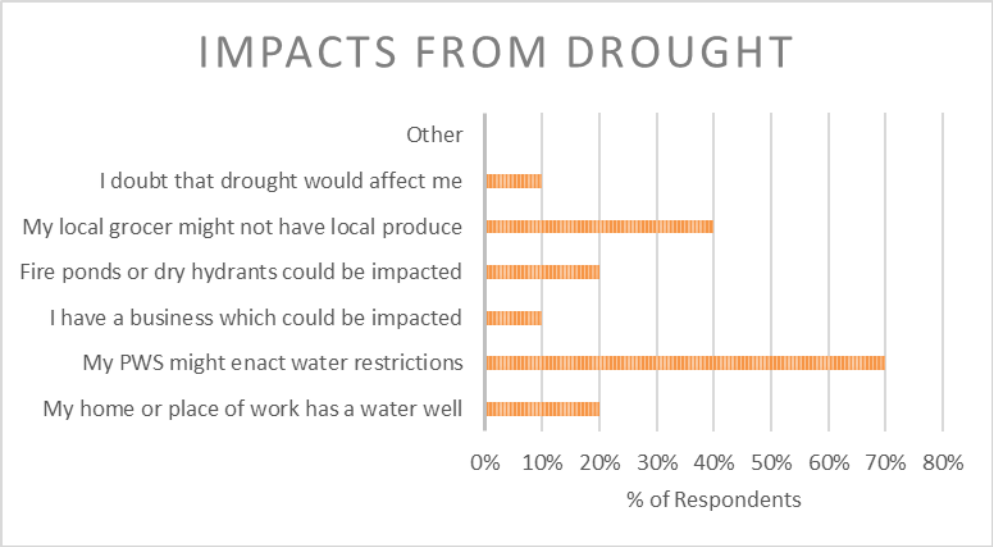


Figure 1-12 Survey Response Question 14, Drought Impacts

Section four of the survey focused on both personal and community preparedness. The first question in this section, question 15, asked respondents to first tell us how concerned they were with each of the identified hazards. At least half of those that responded are most concerned about tropical storms, severe winter storms, coastal and riverine flooding, shoreline change, and drought. About 40% are concerned about extreme heat, and tornadoes or high wind events, with only a few most concerned about wildfires, dam failure, or earthquakes. Most are *not* concerned about dam failure or earthquakes.

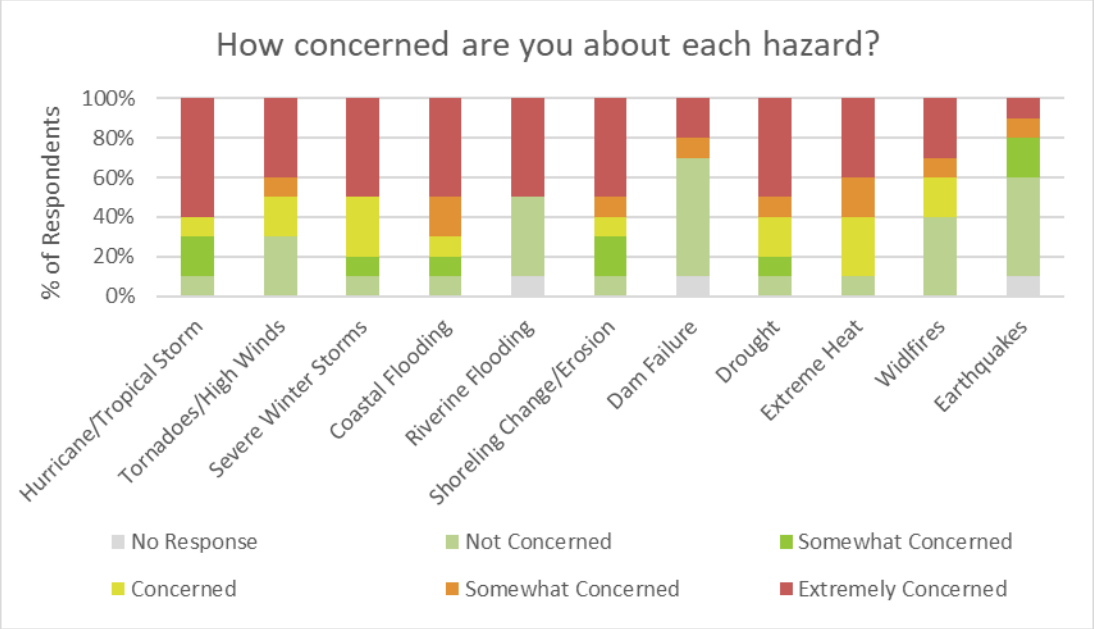


Figure 1-13 Survey Response Question 15, Natural Hazard Level of Concern

Next, respondents were asked in question 16 to identify their level of preparedness for each of the hazards. No one felt "very prepared" for any of the hazards, while a small percentage felt well prepared

for hurricanes, winter storms, or flooding. Most felt sufficiently or somewhat prepared for all hazards, with the exception of shoreline change, dam failure, wildfires, and earthquakes, where multiple individuals were unsure of how to prepare for these events.

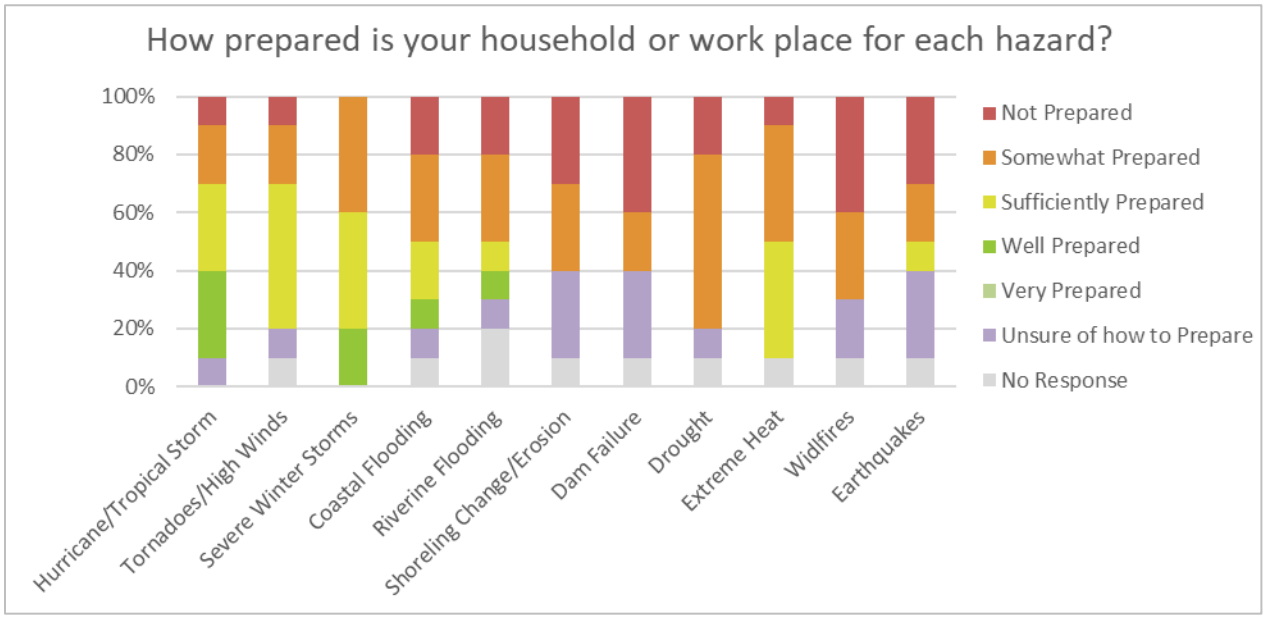


Figure 1-14 Survey Response Question 16, Hazard Preparedness

Question 17 asked how prepared the respondents felt they were to cope in the event of a power, natural gas, or other utility outage (Figure 1-15). A majority felt they were only somewhat prepared, with the others being well or sufficiently prepared. No one thought they were very prepared for an outage. Question 18 (Figure 1-16) then asked how prepared they felt their community was to deliver emergency notifications. Only 10% thought their community was very prepared, with a majority feeling the community is somewhat prepared.

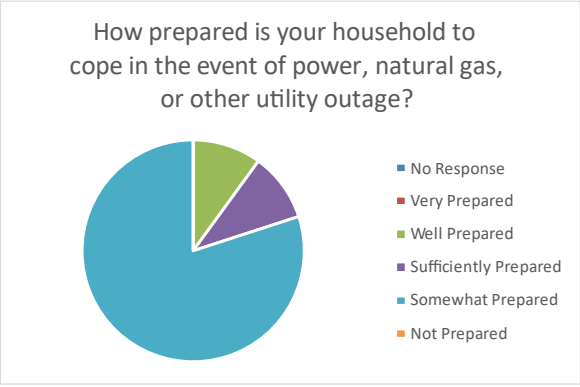


Figure 1-15 Survey Response Question 17, Utility Outage Preparedness

Figure 1-16 Survey Response Question 18, Community Emergency Notification Preparedness

Question 19 then asked respondents to provide more detail on why they felt they, or their community, were prepared or unprepared for a utility outage or to deliver emergency information. Some of the responses included:

- Power outages occur frequently making it tough to get information or alerts. The warning tower can only be heard when the wind is just right.
- Their community does their best, however there is such a large population it is challenging to take care of every single resident.
- North Stonington is a "tight-knit" community, and the fire department volunteers communicate efficiently and effectively.
- It appears that the lack of staffing in one community makes it challenging for the community to respond to daily emergencies, therefore making the respondent concerned about the community's capacity to respond to larger events.
- Waterford has strong communication skills due to Millstone requirements, and it is known where shelters are located.
- Emergency kits in house with water, flashlights, portable stove, emergency blankets, and non-perishable items.
- Having a generator and own water supply.

Respondents were then asked in question 20 (Figure 1-17) which media outlet do they think is most effective in helping to withstand natural hazards. More than half felt that television, radio, newspapers, and social media are the most effective. Other resources such as public meetings, emails, outdoor advertisements, and public awareness events were useful to about 10 to 20% of the respondents. No one felt that brochures were effective. Question 21 then asked how they had received emergency information in the past. More than half have received information from the internet or television, 44% from phone, 33% via social media, and 11% said other outlets. Question 23 asked is respondents have signed up for emergency alerts in their community; 70% have signed up alerts, while 30% have not. The final question, question 24, asked if the respondent knew where their local shelter is in their community; 60% of respondents know where their shelter is, while the remaining 40% do not.

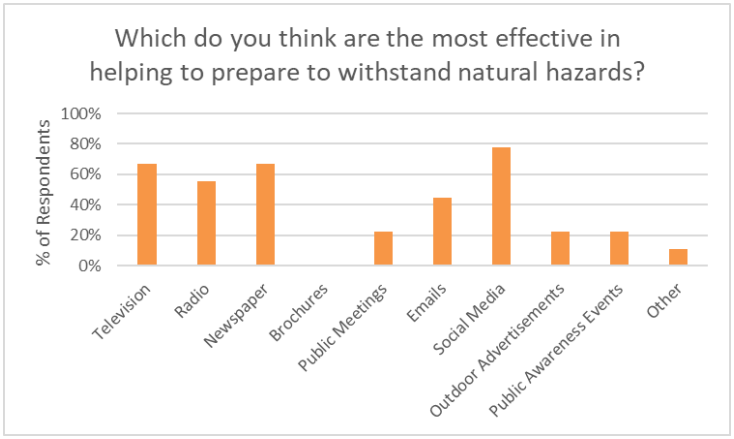


Figure 1-17 Survey Response Question 20, Effective Methods of Information Distribution

Lastly, respondents were asked to provide any additional comments or concerns about natural hazards. Responses included:

- "We have animals that we must care for. We don't shelter (except in place)."
- "My concern would be if a large event impacts the general region. Local manpower resources are not sufficient enough to deal with a large scale, widespread event. This is especially true if all of CT is suffering from the same impacts. A better model would be regional Fire/EMS and Police agencies, with a robust command structure and assets that can be shared throughout the region. If these agencies worked on a regional basis daily, it would be much more seamless for

these agencies to operate effectively during a disaster. Standardization of equipment, policies/procedures, communications, asset management, and information sharing are just a few areas where regionalization would drastically improve the response aspect to a natural disaster. Obviously, these improvements would also benefit local communities during manmade disasters and more routine day-to-day emergencies, such as highway incidents, hazmat emergencies, mass casualty events and even larger fires that require mutual aid."

- "I believe that Towns and businesses are ready for the short term recovery from events but not for the long range recovery from a major disaster. Most businesses do not have time for a long term recovery plan and Towns are not ready to handle all of the permits and inspections that would be required during a recovery from a major disaster."

Supplemental *Resilient Connecticut*/HMCAP Outreach

CIRCA convened a series of meetings with southeastern Connecticut communities where the HMCAP was a component of the agendas but not the primary topic. These meetings included:

- City of Groton
- Town of Groton with the Town's planning staff
- Town of Groton with the Town's new Resilience and Sustainability Coordinator

Furthermore, the HMCAP was discussed during some of the meetings where *Resilient Connecticut* was an agenda item during the year 2022. These included:

- CIRCA weekly staff meetings – updates about *Resilient Connecticut* and the shared planning process with the SCCOG HMCAP
- State Agencies Fostering Resilience (SAFR) – monthly meetings with updates about *Resilient Connecticut* and the shared planning process with the SCCOG HMCAP
- Statewide EJ Mapping Tool meetings – CIRCA staff in the process of developing a statewide environmental justice mapping tool for Connecticut discussed the necessity of including EJ maps in hazard mitigation and climate adaptation planning efforts and provided geospatial data (EJ Map Version 1.1) to be included in the SCCOG HMCAP.

Public Comment Period

The draft HMCAP was released to the public for comment from March 7 to March 27. All local and tribal coordinators were informed of availability and encouraged to share the plan with their communities. Several comments were received during the public comment period between March 7 and March 27, 2023:

The Nature Conservancy

In response to The Nature Conservancy (TNC) reaching out to CIRCA about its new lead planner for southeastern Connecticut (Timothy Clark), Resilient Land And Water reached out to Mr. Clark of TNC to ensure that he was aware of the HMCAP. In response, TNC reminded SCCOG and Resilient Land And Water that the findings and recommendations from its work in southeastern Connecticut should be incorporated into the HMCAP.

- Final Southeastern Connecticut Regional Resilience Guidebook (2017): https://tnc.box.com/s/d1fbdte4eiqmgld2jxp47v29phu02f55
- Final Niantic River Resilience Vision (2017): https://tnc.box.com/s/3kna25ywtb5hwxg5rnhsbgw29h43wjny
- Final Southeastern Connecticut Regional Vision – Summary of Findings (2017): https://tnc.box.com/s/schbpnbre6591xai5pnaqkekzxcs1h22
- Final Southeastern Connecticut Regional Framework for Coastal Resilience (2019): https://tnc.box.com/s/vexzprlpfecu37iums5jcye0rmbrh7zk

The 2017 documents were previously incorporated into the 2017/2018 edition of the hazard mitigation plan. Resilient Land And Water checked to ensure that recommendations from the 2019 document were in the HMCAP, and they were this is because the 2017/2018 edition of the hazard mitigation plan was one source of information for the TNC's work. In general, the recommendations from TNC's 2019 document were either directly reflected as individual actions; or they were grouped into single actions. A good example of the latter is with the Town of Salem, which elected to group previous stream crossing actions into one action about all crossings ("Conduct an inventory of stream crossings to determine if any should be upsized to reduce risks of flooding or washouts").

Town of Ledyard

During the public comment period, the Town of Ledyard issued a Request for Qualifications for an engineering study of dams and roads in the Whitford Brook/Lantern Hill Road corridor. If this study is awarded and proceeds sometime in the latter half of 2023, it may satisfy portions of actions TG21, TG27, LD9, LD11, LD12, LD13, MP6, NS7, NS8, TS25, TS27, TS28, and COG3. These actions will remain in the HMCAP because they help characterize some of the tasks that may be completed as well as tasks that can be undertaken in later years.

Southeastern Connecticut Enterprise Region (seCTer)

Subsequent to the public comment period, seCTer completed a study to position the region for undertaking a comprehensive small business risk and resilience study (including but not limited to natural hazards). seCTer's consultant reached out to SCCOG about the potential for including an action in the HMCAP. Resilient Land and Water worked with seCTer's consultant to determine that the appropriate approach would be to add one action to SCCOG's list of actions. A new action, COG8, is "Support seCTer in its evaluation of risks to small businesses and determine appropriate actions for the HMCAP, which can be amended to the HMCAP in 2024-2025."

Alliance for the Mystic River Watershed

The Alliance for the Mystic River Watershed contacted SCCOG on March 13, 2023, to introduce itself and articulate its goals. According to the Alliance, "Our main purpose is to engage human communities around the Mystic River in protecting and regenerating the watershed that protects and sustains us, through both education and collaborative civic participation. We hope to generate a multi-age, multi-agency collaborative culture, with a sense of belonging and shared purpose rooted in this spectacular place we all call home. One of our near term projects is to work with the Lantern Hill Valley Association and Eastern Pequot Tribal Council, in conjunction with the municipalities involved, to continue the

flooding resilience work along Whitford Brook and finally secure an open passageway for the herring's full migratory life cycle." The Alliance was provided with links to the draft HMCAP and did not return any comments. Future collaboration is planned. Because The Lantern Hill Valley Association and Eastern Pequot Tribal Council were specifically mentioned, along with Whitford Brook, the Alliance will connect with the Town of Ledyard about its pending work in the stream corridor.

1.4.5 Coordination with Neighboring Communities

SCCOG and its member communities have coordinated with neighboring municipalities both within and without the SCCOG region in the past relative to hazard mitigation and emergency preparedness and continue to do so. The following is a list of the communities that lie outside of the SCCOG region but adjacent to SCCOG municipalities.

Table 1-3 Non-SCCOG Municipalities Adjacent to SCCOG Communities

City / Town	Hazard Mitigation Plan Status
Adjacent Connecticut Municipalities	
Town of Old Lyme	Multi-Jurisdictional Plan through RiverCOG (2021)
Town of Lyme	
Town of East Haddam	
Town of East Hampton	
Town of Marlborough	Multi-Jurisdictional Plan through CRCOG (2019)
Town of Hebron	
Town of Columbia	
Town of Coventry	
Town of Mansfield	
Town of Chaplin	Multi-Jurisdictional Plan through NECCOG (2015)
Town of Scotland	
Town of Canterbury	
Town of Plainfield	
Town of Voluntown	
Adjacent Rhode Island Municipalities	
Town of Hopkinton	Single Jurisdiction Plan (2018)
Town of Westerly	Single Jurisdiction Plan (2017)

Communities outside of the region were included in the development of the annexes to the extent practicable, including having the option to attend the public meetings and participate in the online survey. In addition, neighboring communities were directly contacted and provided information on how to provide comments. The email narrative they received can be found in Section 1.4.2, and letters sent to neighboring planning jurisdictions can be found in Appendix D. However, SCCOG communities generally do not have shared hazard mitigation interests with their immediate neighbors that require direct coordination without facilitation by SCCOG. As noted in Section 1.4.4, a representative of CRCOG

attended the second public meeting to address any concerns raised for those adjoining communities, especially given that they will begin their plan update in 2023.

The planning meetings with Windham Water Works included robust discussions about the Town of Mansfield, which is in the Capitol Region. The Windham Water Works source (Willimantic Reservoir) and water treatment plant are located in southern Mansfield.

SCCOG communities were given ample opportunity to review and comment on the Multi-Jurisdictional plan and community annexes during plan development. Specifically, SCCOG member communities within the southeastern Connecticut region were invited to review the entire list of hazard mitigation and climate adaptation actions formulated by their neighboring SCCOG member municipalities. This is a change from previous editions of this plan, when each local and tribal coordinator was directly provided only with its own community's list.

1.4.6 Outreach to Local Stakeholders

The SCCOG region encompasses many important stakeholders; several were directly contacted to make them aware of the HMCAP and the opportunity to participate. The water utilities in the region were all contacted, and two meetings were held with a utility to discuss appropriate hazard mitigation strategies and climate adaptation strategies and actions. Those contacted included:

- Aquarion Water Company (meeting held virtually 9/26/2022)
- Groton Utilities
- Jewett City Water Company
- Southeastern Connecticut Water Authority
- New London Public Utilities
- Norwich Public Utilities (Electric, Water, and Sewer)
- Windham Water Works (meeting held in person on 8/18/2022)
- Westerly Water Department

In addition to water utility companies, the consulting and CIRCA team presented to the Eastern Connecticut WUCC to further enhance collaboration with water utilities in the region. The team presented what the HMCAP is, and how stakeholders can get involved. WUCC meeting attendees included DPH, DEEP, Town of Preston, Groton Utilities, Jewett City Water Company, Southeastern Connecticut Water Authority, and Aquarion Water Company.\

Lastly, the Mystic Seaport Museum was engaged through email, and the consultant and CIRCA attended an in-person meeting with the organization and the Town of Stonington to discuss appropriate strategies and actions for flood and erosion risk reduction at the Mystic Seaport Museum facilities.

The University of Connecticut, a major university in the region and the State, contributed to the HMCAP development. UConn CIRCA, as discussed above in Section 1.4.1, played an important role in developing this edition as a climate adaptation plan and ensuring consistency with the *Resilient Connecticut* program and other state efforts. UConn also has a campus in the SCCOG region located in Groton at Avery Point.

1.4.7 State and Regional Efforts

Several State and Regional planning efforts have been considered and incorporated into the HMCAP where appropriate. Those that have been incorporated are described below.

Resilient Connecticut

Resilient Connecticut is CIRCA's chief climate adaptation and resiliency planning program. As noted above, 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 planning process was piloted in Fairfield County and New Haven County in 2020-2021, relying on four COGs for community engagement. The ultimate goals of the *Resilient Connecticut* program are to develop vulnerability assessments that would not otherwise be completed (i.e., the flood and heat CCVI tools) and to identify and advance complex projects that address unmet needs. These complex projects fundamentally address types of flooding (whether coastal or riverine or related to stormwater) but some of them also address extreme heat vulnerabilities. Because two of the COGs in the pilot area (WestCOG and NVCOG) were developing hazard mitigation plan updates at the same time, the timing was not ideal for incorporating *Resilient Connecticut* outcomes into the hazard mitigation plan actions. Instead, the municipalities were provided with generic actions such as "Continue to collaborate with CIRCA about *Resilient Connecticut*." Unfortunately, this proved challenging for the municipalities to manage.

This experience contributed to some of the changes in the *Resilient Connecticut* program. With the expansion into southeastern Connecticut and other parts of the State, the planning process was likewise expanded, and it now relies on direct engagement with the COGs and with the member municipalities. The CCVI was completed for southeastern Connecticut in January 2023. However, identification of climate adaptation and resilience "opportunity areas" will occur while this plan is under review by FEMA. Notwithstanding the challenge related to timing, the direct participation of municipalities and tribal planning teams in the HMCAP/*Resilient Connecticut* planning process has avoided the need to include generic actions such as "Continue to collaborate with CIRCA about *Resilient Connecticut*." **Instead, CIRCA's *Resilient Connecticut* program is listed as a funding source for approximately 25 individual actions.** This will help position potential projects for the *Resilient Connecticut* program to advance through CIRCA-funded studies and concept designs.

Historic Resources Resiliency

This initiative repeats from the previous edition of this plan, as its completion was several months after the adoption of the previous edition of this plan. Recognizing that historic and cultural resources are increasingly at risk to natural hazards and climate change, the State Historic Preservation Office (SHPO) executed a resiliency planning study for historic and cultural resources from 2016 through 2018. Working with the State's Councils of Government and municipalities throughout the planning process, numerous examples were identified where historic and cultural resources were specifically at risk now, could be at risk in the future, and could help generate consensus for resiliency actions. Historic resources are difficult to floodproof, elevate, or relocate without potential loss of their historicity. Therefore, a thorough understanding of the site-specific options for each set of historic resources is

necessary prior to disasters that could damage these resources, in order to avoid damage during recovery.

SCCOG hosted a historic resources resiliency planning meeting in June 2016, with several SCCOG communities attending. During winter 2016-2017, individual meetings were held with the shoreline SCCOG communities of East Lyme, Waterford, New London, Groton City, Groton Town, Stonington Town, and Stonington Borough. Reports were issued to these communities in August 2017. These reports outline eight strategies that can be employed to make historic and cultural resources more resilient. They are:

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

A best practice guide for planning techniques to make historic resources more resilient was distributed in 2017. This guide can be used by all jurisdictions in Connecticut when undertaking development of hazard mitigation plans.

Several actions were incorporated into the previous edition of this plan to memorialize its goals and spur local progress in resilience for historic and cultural resources. The most common action was **"In accordance with the recommendations of the historic and cultural resources resiliency planning effort in 2016-2017, determine if any at-risk structures that are not yet eligible for historic designation will be eligible in the future. This may take the form of a historic resources survey."** Only one community (the City of Norwich) completed this action. Therefore, the action has been carried forward for communities that remain concerned about historic and cultural resources at risk.

"Chemical Management and Climate Resilience" – Toxic Releases During Floods

This risk reduction awareness and mapping program was funded by EPA from approximately 2017 through 2021 through CT DEEP and therefore post-dated the opportunity for incorporation into the previous edition of this plan. Information can be found at https://portal.ct.gov/DEEP/P2/Chemical-Management-and-Climate-Resilience/Chemical-Management-and-Climate-Resilience, and a link to the map viewer "Toxics Users and Climate Resilience Map" is available via the same link. One cost-free action has been given to each community: **"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."**

Critical Facilities Resiliency

Critical facilities have always been important in hazard mitigation planning, but their importance was highlighted through the rollout of the BRIC program (with the "lifelines" concept) and through the

State's GC3 planning process. Therefore, all communities participating in this plan have been provided with actions related to critical facilities. This is not a change from previous editions of this plan. However, rather than focusing on standby power, concepts related to accessibility and transit/transportation have been added to the actions.

Parts of this critical facilities initiative repeat from the previous edition of this plan, as communities have not made sufficient progress with the recommendations in the *Southeastern Connecticut Critical Facilities Assessment* (http://seccog.org/wp-content/uploads/2018/05/SCCOG-CriticalFacilities_FinalReport20171127.pdf and http://seccog.org/wp-content/uploads/2018/05/SiteAssessmentSheets_SCCOG_CF.pdf). However, in lieu of repeating the actions as worded five years ago, the actions are worded specifically as needed to help encourage progress. For example, "Eliminate basement of Yantic Fire Engine Co. No. 1 building" could not be completed because the City of Norwich cannot compel Yantic Fire Company to complete this action. The action has been changed to "Annually provide FEMA grant information to Yantic Fire Company to ensure they are aware of opportunities to reduce flood risk to the building. This action replaces full execution of the recommendations in the Southeastern Connecticut Critical Facilities Assessment." Similar changes have been made to approximately 15 other actions.

Cooling Centers for Extreme Heat Respite

Cooling centers have not been addressed in previous editions of this plan. Their importance was highlighted through the rollout of the BRIC program (with the "lifelines" concept) and through the State's GC3 planning process. Therefore, all communities participating in this plan have been provided with actions related to cooling centers. This is a major change from previous editions of this plan. New actions address the existence of cooling centers as well as their accessibility and transit/transportation needed to reach cooling centers.

Water Supply and Drought

Three major planning initiatives were completed in 2018. They were the:

- State Water Plan (https://portal.ct.gov/Water/Water-Planning-Council/State-Water-Plan) completed through consultant services secured by the Connecticut Water Planning Council.
- Coordinated Water System Plans for the Western, Central, and Eastern Connecticut Water Supply Management Areas (https://portal.ct.gov/DPH/Drinking-Water/WUCC/Water-Utility-Coordinating-Committee) completed through consultant services secured by the CT DPH, with the WUCCs as the plan developers. The WUCCs consist of all water utilities and the State's COGs.
- Drinking Water Vulnerability Assessment and Resiliency Plan (DWVARP) (https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/05/DWVARP_Public.pdf) completed through consultant services secured by the CT DPH, with CIRCA serving as the chief consultant.

The third plan listed above (the DWVARP) was developed, in part, specifically to ensure that the goals of the State Water Plan and Coordinated Water Supply Plans would not be lost in the State's advancement of climate adaptation and resiliency. With the completion of these major planning efforts and the addition of drought as a hazard in this edition of the plan, opportunities were available to leverage community needs related to water supply. Some of the water supply issues addressed in this plan

include flooding in water supply watersheds, harmful algal blooms, water quality challenges (i.e., Total Trihalomethanes (TTHMs) in the Mashantucket Pequot Tribal Nation water system), and extension of water systems to address private wells harmed by flashy droughts.

Wastewater Management

SCCOG completed a wastewater management plan in 2019. The document can be found at http://seccog.org/wp-content/uploads/2020/08/SCCOG_RWMP_final_adopted_071719.pdf. The planning process considered wastewater management needs related to climate adaptation and resiliency. With the completion of this plan, opportunities were available to leverage community needs related to septic systems and sanitary sewers. Actions were developed to address needs related to sewer infrastructure such as wastewater treatment plants (WWTPs)/water pollution control facilities (WPCFs) and pumping stations.

Stormwater Authorities/Stormwater Utilities

The State of Connecticut passed legislation in 2021 that makes it easier for municipalities to form stormwater authorities and implement stormwater utilities. One southeastern Connecticut municipality (New London) formed a stormwater utility during the five-year timeframe of the previous edition of this plan and has been utilizing the utility to generate revenues for projects that have addressed chronic flooding challenges in New London. Subsequently, the State of Connecticut passed legislation in 2021 that makes it easier for municipalities to form stormwater authorities and implement stormwater utilities. Specifically, the Connecticut legislature passed Substitute House Bill 6441, authorizing the creation of municipal stormwater authorities pursuant to Section 22a-498 of the Connecticut General Statutes. This bill allows any Connecticut multiplicity to establish a stormwater authority, which assesses and collects scaled user fees from property owners, for the purpose of maintaining.

SCCOG applied for, and received, a Municipal Resilience Grant from CIRCA in 2022 to develop a stormwater utility feasibility study for four of its municipalities (Preston, Ledyard, Stonington, and Waterford). With completion of the study in December 2022, the action developed for the SCCOG municipalities is **"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."**

Design Criteria for Increasing Precipitation Intensities

During the development of the 2012 and 2017 editions of this plan, some of the participating communities expressed concerns about stormwater infrastructure, culverts, and bridges being undersized relative to increasing precipitation intensities. As a result, previous editions of this plan have included actions for some municipalities that suggested formalizing best practices (i.e., "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.").

In lieu of carrying these actions forward, municipalities with remaining concerns have been given the new action **"Develop formalized methodology for stormwater infrastructure, culvert, and bridge construction and replacement that requires utilization of the most up-to-date extreme rainfall data from NOAA Atlas 14 as it is updated to become NOAA Atlas 15."** This memorializes the existence of

the new Atlas 15, which will be released after approval of this plan. The Connecticut Stormwater Manual is being updated in 2023 and will speak to the use of the revised NOAA atlas, as well.

Agricultural Interests/Livestock/Chickens

Agricultural interests including chickens and livestock are not a current Statewide resiliency planning concern. However, the SCCOG municipalities raised these concerns during the planning process. The concern merges a few issues including extreme heat, loss of power needed for cooling and water supply (i.e., drawing water from wells), and droughts causing water supplies to be impaired or limited. A dire situation could occur if a livestock or chicken facility experiences loss of water and power during an extended extreme heat event. **Two actions were provided to a limited number of communities in the plan:**

- Partner with chicken farms and related facilities to develop reliable, drought-resilience water supplies and standby power that is capable of operating cooling equipment.
- Partner with chicken farms and related facilities to develop emergency response plans that describe how to manage extreme heat events, droughts, power outages, and avian flu outbreaks.

Dams

Connecticut's dam safety program was significantly strengthened in 2014-2015 with adoption of new regulations and development of templates and forms for dam inspections and dam Emergency Action Plans (EAPs) or Emergency Operations Plans (EOPs). Nevertheless, local communities continue to experience some concern about the condition of dams in their borders and upstream. In lieu of repeating previous actions such as "obtaining copies of EOPs/EAPs" and "including dam failure inundation areas in the Reverse 911 or Alert CT database" (which have been largely completed), new actions were developed for specific dam-related concerns raised by local planning teams and chief elected officials.

Small Business Resilience

The entity known as seCTer is developing strategies for small businesses to become more resilient to natural hazards and climate change as well as stresses such as pandemics, cyber threats, and supply chain challenges. seCTer began the planning process in December 2022 and intends to complete its work in late 2023. seCTer provides updates on all its activities each month at the SCCOG meeting and will continue to provide updates throughout 2023. The results of the planning effort will be incorporated into future updates of this plan.

Stormwater authority fact sheet

SE CT water system response plan fact sheet

2. Regional Profile

2.1. Physical Setting

The SCCOG is a regional planning organization consisting of 22 municipalities in the southeastern corner of Connecticut. The planning region comprises all but three municipalities in New London County and includes one town in Windham County. The member communities include the towns, cities and boroughs of: Bozrah, Colchester, East Lyme, Franklin, Griswold, City of Groton, Town of Groton, Jewett City, Lebanon, Ledyard, Lisbon, Montville, New London, North Stonington, Norwich, Preston, Salem, Sprague, Stonington, Stonington Borough, Waterford, and Windham. Two federally recognized Native American tribes, the Mashantucket Pequot Tribal Nation and the Mohegan Tribal Nation, are affiliate members of the SCCOG.

The communities of Waterford, East Lyme, City and Town of Groton, New London, Stonington, and the Borough of Stonington are bordered by Long Island Sound to the south. Refer to Figure 2-1 for a map showing the regional location of SCCOG.

Coastal towns including East Lyme, Waterford, New London, Groton and Stonington lie almost entirely in the region of Connecticut called the "Coastal Slope," a zone that begins approximately 12 miles north of the coastline and extends toward the continental shelf. In this zone, the plane of hilltop elevation decreases at a slope of about 50 feet per mile, about twice the slope of zones further inland. The topography in the SCCOG region generally increases in elevation moving from the shoreline of Long Island sound inland to the north. Many areas remain below 200 feet above sea level, while higher hills can reach over 500 feet; the highest point in the region is the peak of Gates Hill in Lebanon at 660 feet. Major rivers, including the Thames, the Quinebaug, and the Shetucket, create further hydrographic divides in the region necessitating major bridge crossings.

Figure 2-1 Regional Location of SCCOG

The location of SCCOG communities in southeastern Connecticut places its residents at risk of damage from a variety of natural hazards. SCCOG communities are at risk of experiencing inland flooding, hurricanes, summer storms, tornadoes, hail, severe winds, lightning, heavy snow, earthquakes, dam failure, and wildfires similar to other communities in the region. While the presence of Long Island provides a buffer against wave action from the open Atlantic Ocean, storms approaching from the southeast can bypass Long Island and cause a direct hit on the SCCOG coastline. Thus, coastal flooding and erosion are major concerns for the coastal SCCOG communities and the shoreline along the tidal Thames River estuary.

2.2. Geologic Setting

Geology is important to the occurrence and relative effects of natural hazards such as earthquakes and coastal erosion. Thus, it is important to understand the geologic setting and variation of bedrock and surficial formations in the SCCOG region. Geologic information discussed in the following section was acquired in Geographic Information System (GIS) format from the United States Geological Survey and the Connecticut DEEP.

In terms of North American bedrock geology, the region is located in the northeastern part of the Appalachian Orogenic Belt, also known as the Appalachian Highlands, which extend from Maine southward to Mississippi and Alabama. The Appalachian Highlands were formed when Pangaea assembled during the late Paleozoic era. The region is generally characterized by deformed sedimentary rocks cut through by numerous thrust faults.

Bedrock Geology

Connecticut bedrock geology is comprised of several "terranes". Terranes are geologic regions that reflect the role of plate tectonics in Connecticut's natural history.

The SCCOG region contains a number of different bedrock formations that have been extensively mapped by the State of Connecticut Geology and Natural History Survey. These formations are aligned in tight, alternating bands trending west to east along the coastline and extending approximately 16 miles inland from the coast. The bedrock formations then transition into wider, north-south trending bands throughout the northern towns in the region. The area in northwestern Windham is part of the Willimantic Window, an area where underlying rocks of the Avalonian Terrane are exposed beneath the surrounding Iapetos Terrane.

There are numerous faults within the SCCOG region. The two most significant fault lines are the Honey Hill Thrust fault and the Lake Char Fault which comprise the Lake Char-Honey Hill Fault complex in southeastern Connecticut. This fault system is composed of the north-south trending Lake Char and the east-west trending Honey Hill Fault. These two faults meet and conjoin around a sharp 90° bend north of Ledyard. The Willimantic Window is also bounded by a thrust fault. Refer to Figure 2-2 for a depiction of mapped fault lines in the SCCOG region.

Figure 2-2 Fault Lines in the SCCOG Region

The Honey Hill Thrust Fault runs west-east through Salem, along the boundary between Bozrah and Montville, and along the boundary between Preston and Ledyard. The Lake Char fault is oriented north-south and crosses through the center of Griswold, and curves to the southwest through the northwest corner of North Stonington where it connects to the Honey Hill Thrust Fault near a series of intercrossed minor fault lines along the western boundary of North Stonington. The Lake Char Fault is a diagonal line formed by the collision of two Paleozoic land masses and is one of the oldest fault lines on Earth.

Glaciers have formed in the northern hemisphere several times over the past few million years, with the most recent occurrence being approximately 12,000 years ago. The southernmost portion of the more recent glaciations covered the area that is now the SCCOG region. The result of the recent glacial recession is that the SCCOG region is covered by a variety of sand and gravel deposits. As the glaciers receded, mineral deposits were left behind by the melting ice forming glacial till, and meltwaters carved valleys and left stratified deposits behind when they receded. These stratified deposits were called stratified "drift" for decades and the term is sometimes found today.

Till areas contain an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine, while surficial materials in stratified drift areas are more homogenous. Refer to Figure 2-3 for a generalized depiction of surficial materials in the SCCOG region.

The surficial geology of the SCCOG region is important to natural hazard mitigation for several reasons:

- First, areas of stratified materials are generally coincident with current and historical floodplains. These materials were deposited at lower elevations by glacial streams, and these valleys were later inherited by the larger of our present day streams and rivers.
- Second, stratified drift areas are often important aquifers, and therefore sometimes sources of public water supply are necessary to fight wildfires and other fires caused by natural hazards such as lightning or earthquakes.
- Third, areas of glacial till typically contain materials that are less susceptible to erosion.
- Finally, the amount of stratified drift also has bearing on the relative intensity of earthquakes and the likelihood of soil subsidence in areas of fill.

Figure 2-3 Surficial Geology in the SCCOG Region

2.3. Hydrology and Drainage Basins

The SCCOG region lies within 16 regional watersheds as defined by the Connecticut DEEP. The majority of these regional basins drain to the Thames River as shown on Figure 2-4. The remaining basins drain either to the Connecticut River, the Pawcatuck River, or directly to Long Island Sound. Table 2-1 presents the characteristics of the regional basins.

Table 2-1 Regional Drainage Basins in the SCCOG Region

Regional Basin	Basin Number	Drains To
Pawcatuck River	1000	Long Island Sound
Wood River	1100	Pawcatuck River
Southeast Shoreline	2000	Long Island Sound
Southeast Eastern Complex	2100	Long Island Sound
Southeast Western Complex	2200	Long Island Sound
Thames River	3000	Long Island Sound
Willimantic River	3100	Shetucket River
Natchaug River	3200	Shetucket River
Moosup River	3500	Quinebaug River
Pachaug River	3600	Quinebaug River
Quinebaug River	3700	Shetucket River
Shetucket River	3800	Thames River
Yantic River	3900	Thames River
Connecticut River	4000	Long Island Sound
Salmon River	4700	Connecticut River
Eightmile River	4800	Connecticut River

The Southeast Shoreline includes primarily minor streams near the coast of Long Island Sound. The two Southeast Complex areas include slightly larger streams such as the Four Mile River, Pattagansett River, Jordan Brook, the Mystic River, Copps Brook, and Anguilla Brook, although these streams are not as large as those listed in Table 2-1. Watercourses are discussed in more detail in each community annex. The SCCOG region has approximately 40 miles of shoreline along Long Island Sound, and numerous additional miles of shoreline along its many tidal estuaries. As a result of the presence of both coastal and riverine floodplains, the southeastern region is faced with significant flood hazards.

Figure 2-4 Regional Drainage Basins in the SCCOG Region

2.4. Land Use and Development Trends

2.4.1 Land Use

The land area of the region is 616.6 square miles based on GIS town boundary data available from the Connecticut DEEP. Nearly 85% of the SCCOG area is largely undeveloped, consisting of forests, wetlands, lands in agricultural use, active and passive recreation, and dedicated open space. Table 2-2 presents the 2016 land cover data for the SCCOG region as hosted by the University of Connecticut's Center for Land Use Education and Research (CLEAR) and prepared by the NOAA Office of Coastal Management.

Table 2-2 2016 Land Cover in the SCCOG Region

Category	Area (acres)	Percentage
Barren Land	3,027.38	0.77
Cultivated Crops	7,649.22	1.94
Developed, Impervious	28,550.77	7.23
Developed, Open Space	32,507.87	8.24
Estuarine Emergent Wetland	1,317.76	0.33
Estuarine Scrub/Shrub Wetland	39.74	0.01
Grassland/Herbaceous	12,585.65	3.19
Mixed Forest	252,221.05	63.91
Open Water	12,518.63	3.17
Palustrine Aquatic Bed	1,274.42	0.32
Palustrine Emergent Wetland	3,559.89	0.90
Palustrine Forested Wetland	18,962.50	4.80
Palustrine Scrub/Shrub Wetland	1,435.84	0.36
Pasture Hay	13,099.55	3.32
Scrub/Shrub	5,386.45	1.36
Unconsolidated Shore	489.56	0.12
Grand Total	**394,653.78**	**99.99**

Source: UConn CLEAR, NOAA

Figure 2-5 presents generalized land cover based on the 2016 NOAA land cover data. Areas shown as turf and grass are maintained grasses such as residential and commercial lawns or golf courses.

Figure 2-5 NOAA 2016 Land Cover for the SCCOG Region

The coastal areas and regions adjacent to major watercourses are predominantly developed, whereas the outer regions are characterized by mixtures of forest, wetland, and agriculture. The highest developed density in the region is located along the Quinebaug River and the Thames River corridor. Jewett City in the Town of Griswold, Norwich, New London, and the City of Groton were the municipalities with the highest development density in the region, although Windham also has a heavily developed section in Willimantic.

The majority of region's land cover is designated as mixed forest, with developed open space accounting for the next largest percentage of land use, with developed impervious. State forests are found throughout the region and include the Pachaug State Forest in Griswold, the Salmon River State Forest in Colchester, Rocky Neck State Park and Nehantic State Forest in East Lyme, and the Hopeville State Forest in Griswold. The northeastern corner of the SCCOG region is particularly undeveloped and is dominated by the Pachaug State Forest.

2.4.2 Development Trends

As noted in Section 2.4.1, past development in the SCCOG region is concentrated near major rivers and Long Island Sound, with the highest population densities occurring near the mouth of the Thames River (New London and the City of Groton). The more densely populated and developed areas near Long Island Sound and the Thames River comprise the commercial and industrial center of the region, while residential uses are spread in various densities throughout the remaining SCCOG communities. As shown in Table 2-3, the region has grown by just over 4,000 housing units since 2011.

The Southeastern Connecticut region has a strong economic base for commercial and industrial development that includes businesses in defense technology, healthcare, biotechnology, marine research, and tourism. Examples of some of the larger employers in the region include the Foxwoods Resort Casino, General Dynamics Electric Boat, Mohegan Sun Casino, Pfizer, Lawrence & Memorial Hospital, William W. Backus Hospital, Millstone Power Station, Connecticut College, Mystic Seaport Museum, United States Coast Guard Academy, and York Correctional Institution.

Tourism plays a large role in the region's economy. Major commercial developments that have a significant impact on the regional economy include Foxwoods Resort Casino in Mashantucket, the Mohegan Sun Resort in Mohegan, and the Mystic Seaport, Mystic Aquarium, and Olde Mistick Village in Stonington. Other tourist attractions in the region include the Nautilus Memorial/Submarine Force Library and Museum in Groton, the Lyman Allyn Art Museum in New London, the Slater Memorial Museum in Norwich, the Eugene O'Neill Theater Center in Waterford, and the Mashantucket Pequot Museum in Mashantucket.

Table 2-3 Net Gain in Housing Units in the SCCOG Region Since 2011

Community	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
Bozrah	2	3	1	2	-1	1	0	95	2	2	1	108
Colchester	18	25	29	28	30	63	34	31	12	17	17	304
East Lyme	28	30	27	349	91	6	24	21	68	77	28	749
Franklin	1	1	2	3	0	2	3	5	1	5	7	30
Griswold	1	7	4	5	3	6	3	25	83	14	38	189
Groton	11	15	53	33	17	17	36	113	57	15	39	406
Lebanon	3	-2	-1	0	-3	13	7	3	2	4	6	32
Ledyard	11	24	43	12	6	18	13	14	10	2	36	189
Lisbon	7	5	4	4	5	6	5	11	15	12	16	90
Montville	-7	10	12	2	0	4	10	8	10	20	16	85
New London	28	32	38	36	41	39	35	36	36	37	45	403
North Stonington	4	3	5	8	7	12	8	8	10	9	6	80
Norwich	-1	46	15	36	-5	20	18	26	1	68	4	228
Preston	7	7	9	0	7	3	7	14	9	17	12	92
Salem	7	5	2	16	8	9	9	3	8	7	51	125
Sprague	1	2	6	0	0	0	2	-1	3	0	1	14
Stonington	17	24	25	14	211	26	21	170	40	80	27	655
Waterford	9	6	9	9	5	12	20	26	100	20	23	239
Windham	7	0	6	5	5	-5	-3	-1	3	4	1	22
Total	154	243	289	562	427	252	252	607	470	410	374	4,040

Source: Connecticut Department of Economic and Community Development

The SCCOG prepared a proposed development map as part of its 2017 Regional Plan of Conservation and Development (POCD). This map is reprinted here as Figure 2-6. The map shows that future urban/high intensity uses will continue to be concentrated along the Thames and Yantic Rivers, the shoreline of Long Island Sound, the Pawcatuck River, and downtown Colchester, Jewett City, and Willimantic. Low and medium-density suburban uses will abut the urban uses and branch out along established State and local primary roads. Many areas, particularly along inland watercourses and water bodies, are denoted as proposed conservation areas. More information regarding growth in individual communities is presented in each community annex.

The presence of sewers and water systems can serve as a predictor of growth patterns in rural and suburban areas; where sewers are built, development typically follows. The absence of public water and sewer systems is a major factor in the dispersed development patterns seen in the region. Jewett City, Norwich, Montville, New London, and the City of Groton have wastewater treatment plants along the Quinebaug and Thames Rivers, and Windham has a facility on the Shetucket River. East of the Thames River, only Pawcatuck (Stonington), the Borough of Stonington, the Town of Groton, and Mystic have municipal sewage treatment facilities. East Lyme and Waterford have areas of sewer service that direct flow to New London's wastewater treatment plant.

The 2017 Regional POCD noted that sewer planning has traditionally been conducted at the municipal level in the region. Responding to this challenge, SCCOG developed a Regional Wastewater Management Plan (RWMP) in 2018-2019. The RWMP describes community needs and priorities both spatially and also relative to technical and funding capacity challenges.

Like other parts of Connecticut, the need for new housing units has influenced development trends in southeastern Connecticut. Apartment developments are proposed in parts of Stonington (Town), Groton City and Town, New London, Waterford, Montville, and Norwich. Even rural communities such as Lebanon are experiencing activity among large landowners considering new or expanded uses. For the most part, these new developments are not placing people in areas of risk. For example, the residential parts of the new development at Fort Trumbull are outside the FEMA SFHA. However, the communities of southeastern Connecticut will need to pay close attention to the lifelines that support new development. In the case of Fort Trumbull, the two roads accessing the area must pass under the Amtrak rail line, and these underpasses are at risk of flooding caused by coastal storm surge and stormwater runoff.

To help address some of the flood risks related to historical development as well as new development, the City of New London has implemented a stormwater utility, which is the first in the State of Connecticut. It is expected other communities will follow suit. The City's stormwater utility collects user fees from developed properties and utilizes these funds for stormwater improvement projects that reduce flooding.

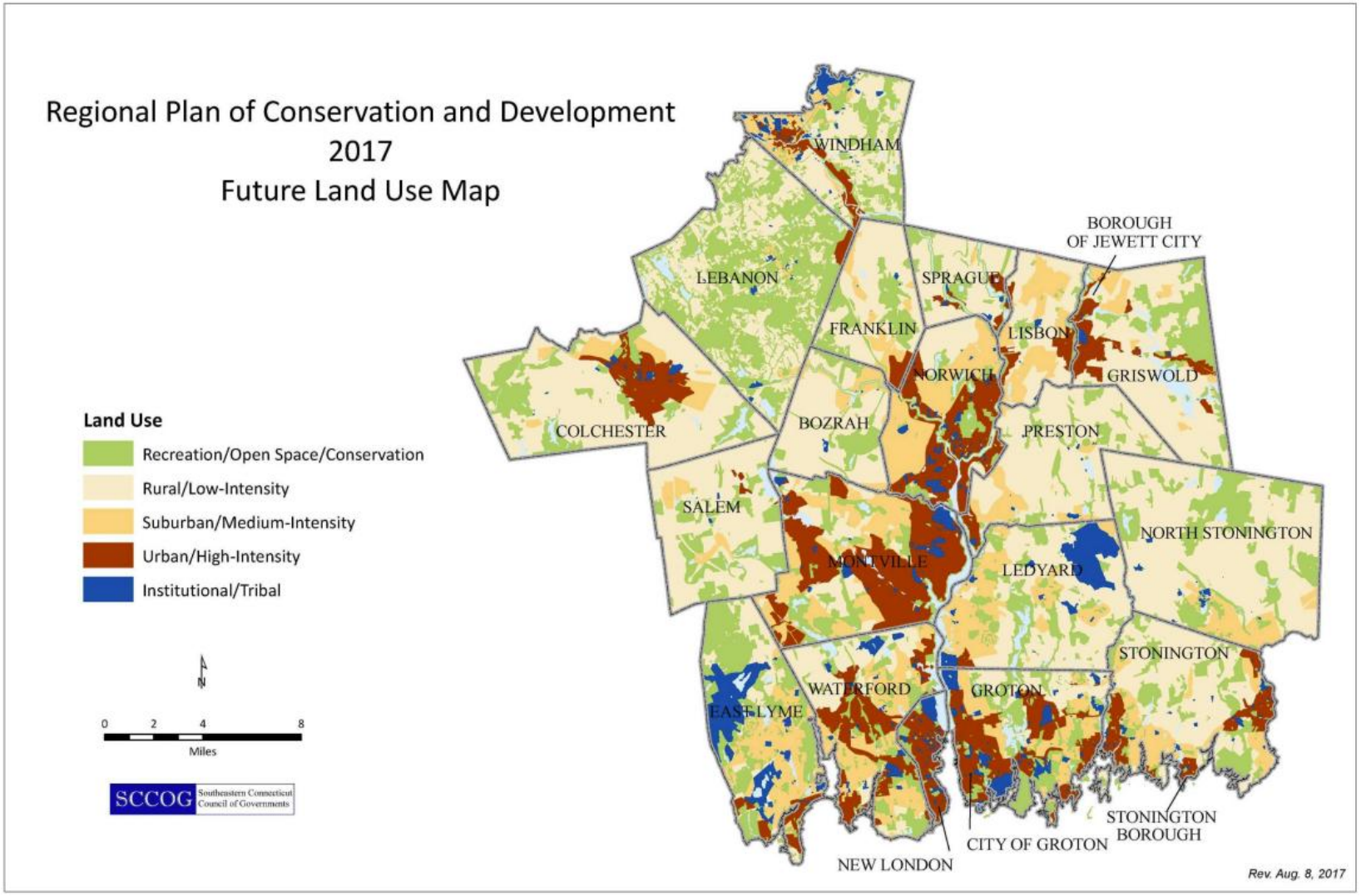


Figure 2-6 Regional Plan of Conservation and Development 2017 Future Land Use Map

2.5. Population and Demographic Setting

According to the 2020 U.S. Census, the SCCOG region's population is 278,607 persons, a decrease of 8,104 persons over the 2010 U.S. Census value of 286,711 persons. These figures include all municipalities falling within the 2022 boundaries of the SCCOG region but exclude the relatively small permanent populations of the Mohegan Tribe and Mashantucket-Pequot Tribal Nation. The City of New London has the highest population density of the region's independent municipalities, and North Stonington has the lowest. Table 2-4presents the 2010 and 2020 U.S. Census populations for the SCCOG region, the 2020 land area of each jurisdiction based on U.S. Census Bureau, and the resulting 2020 population density for each jurisdiction.

Table 2-4 2010-2020 Population of the SCCOG Region

Geographic area	2010 Population	2020 Population	Population Change	% Change	Land area (sq mi, 2020)	Population Density per square mile of land (2020)
Bozrah	2,627	2,429	-198	-7.54	19.96	121.69
Colchester	16,068	15,555	-513	-3.19	48.98	317.58
East Lyme	19,159	18,693	-466	-2.43	34.00	549.79
Franklin	1,922	1,863	-59	-3.07	19.49	95.59
Jewett City	3,487	3,328	-159	-4.56	0.70	4754.29
Griswold	8,464	11,402	-549	-4.59	34.00	328.59
Groton city	10,389	9,146	-1,243	-11.96	3.08	2,969.48
Groton	29,726	27,450	-2,276	-7.66	27.95	982.11
Lebanon	7,308	7,142	-166	-2.27	54.10	132.01
Ledyard	15,051	15,405	354	+2.35	38.22	403.06
Lisbon	4,338	4,195	-143	-3.30	16.29	257.52
Montville	19,571	18,387	-1,184	-6.05	41.95	438.31
New London	27,620	27,367	-253	-0.92	5.62	4,869.57
North Stonington	5,297	5,149	-148	-2.79	54.25	94.91
Norwich	40,493	40,125	-368	-0.91	28.06	1,429.97
Preston	4,726	4,788	62	+1.31	30.82	155.35
Salem	4,151	4,213	62	+1.49	28.92	145.68
Sprague	2,984	2,967	-17	-0.57	13.25	223.92
Stonington Borough	929	976	47	+5.06	0.35	2,788.57
Stonington	17,616	18,335	-210	-1.13	38.31	474.26
Waterford	19,517	19,571	54	+0.28	32.77	597.22
Windham	25,268	24,425	-843	-3.34	26.70	914.79
Total SCCOG	**286,711**	**278,607**	**-8,104**	**-2.83**	**597.77**	**466.08**
New London County	274,067	268,555	-5,512	-2.01	665	403.84
Windham County	118,593	116,418	-2,175	-1.83	521	223.45

Notes: Individual areas do not necessarily add to totaled value due to rounding.
Stonington and Griswold populations include respective Boroughs.
Source: U.S. Census Bureau

Demographic trends for the SCCOG region are similar to many other areas in Connecticut and are closely tied to the State's economy. The suburbanization that characterized the United States after World War II from the late 1940s through the 1970s, with the construction of new roads and the enhanced availability of the automobile and federally funded housing programs, yielded a boost in population size. The completion of Interstate 95 in Connecticut in 1956 and of Interstate 395 in 1958 played a major role in the increase of the region's year-round population. This increasing population trend has been and continues to be evident in many areas subject to metropolitan expansion along the eastern seaboard since the 1940s.

2.5.1 Socially Vulnerable Populations

Certain populations throughout the SCCOG region are more vulnerable to the impacts of natural hazard events and climate change than others. Factors increasing this vulnerability could include age, socioeconomic status, minority status, and health or disabilities. The DEEP Connecticut Environmental Justice (EJ) Community mapping (November 2022)[2] is one resource which incorporates some of these factors, and was used to identify those areas throughout the region that are considering an EJ community (Figure 2-7). According to the DEEP mapping, seven communities in the region are considered to be an EJ community because they are designated distressed municipalities, and another seven communities encompass EJ block groups.

- Distressed municipalities are designated by the Connecticut Department of Economic and Community Development (DECD) based on the fiscal capacity of the municipality using the tax base, personal income of residents, and the residents' need for public services. Distressed municipalities often include EJ block groups, but this is not always the case.
- An EJ block group, which is located outside of a distressed municipality, has been identified because 30% or more of the population lives below 200% of the federal poverty level.

The EPA EJScreen tool was used to verify locations of State-identified EJ communities throughout the region. The EJScreen takes both environmental and socioeconomic data into consideration to reflect 13 EJ indicators. Socioeconomic factors include race and income, similar to that of the DEEP EJ tool. EPA's tool identified EJ block groups in nine SCCOG communities including Cities of Groton, New London, and Norwich; and the Towns of East Lyme, Groton, North Stonington, Sprague, Stonington, and Windham. All of these communities were already identified in the DEEP EJ mapping as either a distressed municipality or containing an EJ block group.

Working with a team of State agencies, CIRCA developed new EJ mapping in 2022-2023. Public-facing map products were not available during the HMCAP planning process, but draft maps were prepared in June 2023. A map for the region is included below as Figure 2-8. The new mapping tool (https://connecticut-environmental-justice.circa.uconn.edu/) verifies the areas previously identified as socially vulnerable and living in an EJ community.

Separate from the new EJ mapping, CIRCA developed a tool to aid in understanding extreme heat and flood vulnerabilities for communities across the state. This tool, known as the CCVI, is comprised of dozens of factors that contribute to a community's sensitivity, exposure, adaptive capacity, and

[2] https://ctdeep.maps.arcgis.com/apps/webappviewer/index.html?id=d04ec429d0a4477b9526689dc7809ffe

ultimately the overall vulnerability. Many of the demographic factors used for EJ mapping are used for the sensitivity and adaptive capacity scores in the CCVI. In fact, in some communities, these factors dominate the CCVI calculation (which is based on ranking methodologies found in climate science) and the flood and heat vulnerabilities have a similar profile as the EJ mapping. Individual flood and heat CCVI maps can be found in each annex document.

The public engagement component of the planning process included tools to reach socially vulnerable and EJ populations in an equitable manner. For example, social media posts included tips for accessing messages in Spanish and Chinese (which is common amongst employees of the casinos in the region). While it is impossible to know how many socially vulnerable people viewed social media or press releases, people who participated in the survey live in at least three EJ communities based on the locations they entered (downtown New London, downtown Norwich, and central Groton). The public meetings in Groton and Norwich were located along bus routes, and these routes were cited in the social media and press releases.

Notwithstanding the efforts already undertaken, SCCOG believes that continued engagement directed at socially vulnerable, traditionally underserved populations will help enhance the plan. Working with CIRCA, SCCOG developed a list of organizations that are best equipped to reach socially vulnerable, traditionally underserved populations in the region. Appendix I includes the list, along with specific messages and a straightforward flier that will be annually distributed to these organizations for physical posting and their social media.

Figure 2-7 CT DEEP Environmental Justice Communities (2021)

Figure 2-8 CT DEEP Environmental Justice Communities Version 1.5 (2023)

2.6. Critical Infrastructure

Aspects of emergency services typically addressed in hazard mitigation include the following:

- Emergency communication;
- Emergency warning and response;
- Emergency sheltering; and
- Critical facilities protection.

Hazard mitigation capabilities related to emergency services can be combined with other types of capabilities and measures to form successful projects, or remain as stand-alone projects. Emergency communication is a critical aspect of the hazard response programs currently in place in the SCCOG region. In the event of an emergency, the municipalities within the region establish an Emergency Operations Center (EOC) within each town and mobilize their response agencies.

Interagency communications among the communities, State agencies and independent utilities in the SCCOG region requires continued coordination to establish and maintain the critical communication links. A need for improved and continued coordination has been identified during this study. Many municipalities within the region expressed interest in a reverse 9-1-1 emergency communication system at the time of the 2005 HMP and have since worked to increase reverse communication systems capabilities. The State of Connecticut operates a "CT Alerts Everbridge" reverse 9-1-1 system for emergency communication and response. This reverse 9-1-1 system can automatically call telephones in affected areas throughout participating municipalities, efficiently replaying important information. This type of system is increasingly considered an effective tool in warning and instructing residents during the event of an emergency. Tribal governments are not officially part of the State system. The Mashantucket Pequot Tribal Nation, for example, currently utilizes its own reverse 9-1-1 system on tribal lands although it has access to the State system through employees who work for other municipalities in the region.

Inter-municipal cooperation is an important aspect of emergency services within the region. Mutual aid agreements as well as regional dispatch centers allow for successful assistance between communities in the region in the event of emergencies. While some improvements have been made, many municipalities continue to seek ways to upgrade systems.

Emergency response cannot be successfully conducted without proper training and equipment. Police, fire fighters, and paramedics maintain emergency response training. This includes maintaining and updating emergency equipment and emergency response protocols. Fire hydrant surveys are regularly conducted in each community to ensure that they are working properly. All communities, particularly inland and rural communities utilize dry hydrants and seek areas where additional dry hydrants may be installed.

The use of fire and rescue boats are necessary in several SCCOG communities (particularly along the coast). In addition to offering additional protection of certain critical facilities, structures, and other assets, (such as the commercial fishing fleet in Stonington) which are located in geographically isolated

areas along the coastline, access to such specialized equipment may allow for additional lives to be saved in an emergency.

2.6.1 Critical Facilities

Numerous "critical facilities" including hospitals, medical centers, fire and police departments, and municipal buildings are located throughout the region. Critical facilities include William W. Backus Hospital in Norwich, Lawrence & Memorial Hospital in New London, Pequot Medical Center in Groton, Windham Hospital in Windham, and medical centers in the surrounding towns such as East Lyme, Ledyard, North Stonington, and Colchester. Every jurisdiction has a fire department, and most jurisdictions have a police department, however, several of the smaller rural towns have resident troopers through the Connecticut State Police. Other critical facilities include public water and sewer infrastructure and treatment plants, electrical and natural gas transmission lines and the Millstone Power Station, regional airports, ferries, and major highways in the region.

Some of the SCCOG region's critical facilities have been identified as being located in flood hazard areas. Facilities that may not be accessible during emergency situations include the Griswold Firehouse on Route 138 (Voluntown Road), the Town of Stonington's Sewer Plant, the Yantic Village Fire Station and Department of Public Works in Norwich, and the Mystic Fire Department, Quiambaug Fire Department, Mystic Post Office, and Mystic Train Station in Stonington. Critical facilities in each jurisdiction are discussed within each annex of this plan.

Health care, assisted living, and senior living facilities that are located in flood zones are often good candidates for flood mitigation projects. In addition, the facilities in flood zones and those that may be cut off from flooding are recommended to develop site-specific evacuation plans. Specific locations of these vulnerable populations are detailed in the individual community annexes.

In 2017, SCCOG conducted an analysis of 19 critical facilities located in or adjacent to areas of flood risk to determine methods of making them more resilient to flood, snow, and wind risks under climate change. This discussion was captured in the previous edition of this plan. The following facilities were included in the assessment:

Table 2-5 Facilities Included in SCCOG Critical Facility Resiliency Assessment

Municipality	Facility	Address	In FEMA Zone	Adjacent FEMA Zone
Stonington Borough	Fire House and EOC	100 Main St	AE	VE-14
	Borough Hall and Public Works	26 Church St	AE	500-yr
Stonington Town	Old Mystic FD	21 North Stonington Rd	500-yr	AE
	Quiambaug FD	50 Old Stonington Rd	AE	X
	Mystic FD	34 Broadway	AE	X
Groton Town	GLP Police and Fire	5 Atlantic Ave	AE	X
	Town Hall	45 Fort Hill Road	X	500-yr
Groton City	City Hall	295 Meridian St	X	500-yr
	Public Works	295 Meridian St	500-yr	X
New London	Fire HQ and EOC	289 Bank St	500-yr	AE/VE
Waterford	Quaker Hill Fire Co.	17 Old Colchester Rd	500-yr	AE
Montville	Chesterfield Fire Co.	1606 Hartford New London Tpke	X	AE
Norwich	Yantic Fire Co. No. 1	151 Yantic Rd	AE	Floodway
	Occum FD	44 Taftville Occum Rd	AE	500-yr
	Public Works	50 Clinton Ave	500-yr	AE
Preston	Public Works	423 Route 2	X	A
Sprague	Town Hall	1 Main St	AE	Floodway
	Public Works	1 Main St	AE	Floodway

Results of the assessment were discussed in the previous editions of the annexes for Stonington Town, Stonington Borough, Groton Town, Groton City, New London, Waterford, Montville, Norwich, Preston, and Sprague. For the most part, these discussions have been carried forward to this update.

2.6.2 Shelters

Emergency shelters are considered to be an important subset of critical facilities as they are needed in emergency situations. These are not to be confused with safe rooms or individual storm shelters, such as designated rooms in certain buildings that are meant to provide increased levels of protection from winds. A primary shelter should have the ability to operate with a standby source of power such as an emergency generator.

The American Red Cross (ARC) has published a guidebook entitled "Standards for Hurricane Evacuation Shelter Selection" (ARC Publication #4496). The publication provides guidelines for selecting shelters relative to resilience from storm surges, flooding, and hurricane winds. While the publication recognizes that not all communities are able to identify an ideal shelter, it urges communities to consider as many of the criteria as possible. The ARC also has formal standards for shelters regarding space and internal facilities, but these standards are unrelated to structural resilience. The organization of shelter staff, supplies and notification is described in the community EOPs, along with responsibilities of each individual involved in emergency response. Shelters in SCCOG communities are listed in Table 2-6 based on communication with local officials and/or other available information. Note that in most cases the "capacity" represents a seated capacity and not bedding-down capacity.

Table 2-6 Shelters in the SCCOG Region

City / Town / Tribe	Number of Local Shelters	Capacity of Local Shelters
Bozrah	3	>100
Colchester	2	800
East Lyme	3	2,300
Franklin	3	318
Griswold	4	525
Groton, City of	2	250
Groton, Town of	2	1,400
Lebanon	1	*
Ledyard	2	>100
Lisbon	1	150
Mashantucket Pequot Tribal Nation	2	400
Mohegan Tribe	1	50
Montville	1	>100
New London	2	3,750
North Stonington	1	>100
Norwich	14	33,000
Preston	1	100
Salem	2	>100
Sprague	2	600
Stonington, Borough of	0	0
Stonington, Town of	2	1,300
Waterford	5	5,500
Windham	2	*
Total Capacity		**50,943**

* Sheltering capacities are not immediately available for Lebanon and Windham Number of shelters may have fluctuated since the previous HMP, however capacities are as of the 2017 HMP.

Note that the Mashantucket Pequot Tribal Nation has mutual aid agreements through SCCOG to house regional shelterees in the casino or hotel. This additional shelter space is not listed in Table 2-6. The Mohegan Tribe can also provide additional regional sheltering space during a widespread emergency although no agreements are currently in place.

Upgrading emergency shelters is an important hazard mitigation measure that includes contacting the local ARC or other local emergency aid groups for technical assistance and updating supplies. Supplies include the number of emergency beds, food, and clothes. Communication equipment should be updated and working properly. Emergency shelters should not be sited within the floodplain. Community officials should take steps to relocate existing emergency shelters within the floodplain, or to properly protect the shelter with measures such as flood proofing or elevating the structure if possible.

The U.S. Army Corps of Engineers (USACE) prepared the Connecticut Hurricane Evacuation Study and Technical Data Report in 1994. The primary purpose of the study was to provide the state, local

emergency management agencies, and evacuation decision-makers with data necessary to plan for and evacuate areas vulnerable to hurricane flooding. The study focused on coastal communities. The study estimated that there were more than 150,000 residents living in Categories One and Category Two hurricane evacuation zones and a total of more than 280,000 residents living in Categories Three and Category Four hurricane evacuation zones. These numbers reflect the number of residents in 25 coastal communities located in Fairfield, New Haven, Middlesex and New London counties.

The 1994 study provides data for each of these coastal communities regarding vulnerable populations, medical/institutional facilities, and shelter needs. Although the study is outdated, it still provides useful data regarding the extents of hurricane impacts within a given community. In general, estimated shelter capacities for individual communities were inadequate for the estimated evacuees. In some cases, jurisdictions in the SCCOG region have added shelters to address these shortfalls, but in others there remain gaps between shelter space and number of evacuees.

During the planning process for this update, several SCCOG communities expressed a shift in the DEMHS sheltering philosophy from hyper-local to a more regional approach. This has resulted in a few cases where people would need to leave their community to use a shelter in an adjacent community. This challenge has contributed to a set of proposed actions about shelters.

Cooling Centers

Each community in the SCCOG region has identified at least one facility that could be used for cooling during an extreme heat event. These facilities are typically opened at the local level and can be utilized by any member of the community seeking a cool refuge from the heat. Most communities identify a local library as the first option for cooling as these locations are typically open seven days a week, are cool, and are available to access during the warmest parts of the day. Some communities have also identified facilities such as fire departments, town hall, or schools. Some of these facilities have additional capabilities such as food preparation, device charging, or showers.

Any community in the region also has the opportunity to publicize the opening of this center during a heat event by way of community communication methods, or through United Way-211. The United Way develops a list during extreme heat events of cooling center locations and hours on their website. Specific details on each community's cooling center can be found in their respective annex.

2.6.3 Transportation

Southeastern Connecticut possesses a transportation network of highways, rail lines, bus service, air service, passenger ferry service, and shipping corridors. Major highways throughout the region include Interstate 95, Interstate 395, Route 2, and Route 32. Interstate 95 serves the east/west corridor in the region and is the most heavily traveled thoroughfare in the region. It is the main highway for travelers along the Atlantic coast from Florida to Maine, and the volume to capacity ratio of the highway is slowing approaching 1.0 indicating the need for improvements to mitigate congestion (SCCOG Fiscal Year 2015 Long Range Regional Transportation Plan). I-395 serves a north-south corridor in the region, with the highest traffic volumes concentrated in the Montville section due to the development and expansion of the Mohegan Sun Casino and Hotel complex. Throughout the region many roadways are

affected by flooding due to roads being within floodplains, having poor drainage, and/or inadequate culvert sizes. Individual community annexes identify such problem areas.

Rail lines extend to several of the communities allowing people to travel via train. Amtrak provides passenger rail service with stops at New London and Mystic. The Amtrak rail line travels east-west from Boston to New York. Freight service is offered by the New England Central Railroad and the Providence and Worcester Railroad. The New England Central Railroad is located on the west side of the Thames River and offers north-south freight service.

The southeastern region has a public bus system, SEAT, which serves the municipalities of East Lyme, Griswold, Groton, Ledyard, Montville, New London, Norwich, Stonington, and Waterford. SEAT runs routes throughout the region including to the two area casinos. Many community members as well as casino employees rely on this public transportation.

Air service throughout the region is offered by the state owned Groton-New London Airport and Windham Airport, private airports in Griswold and Stonington, a heliport in Colchester, and two military airports. Groton-New London Airport is in a flood zone which may pose a potential impact on the arrival and departure of aircraft during a significant storm event.

Significant marine transportation exists in Long Island Sound, comprising passenger ferries, commercial shipping, and pleasure boating. The Admiral Shear State Pier in New London, which is adjacent to the Central New England Railroad pier, functions as the region's most important commercial marine facility. The State Pier is Connecticut's only major deep-water seaport within a multi-use Foreign Trade Zone. In an effort to reduce congestion on I-95, the State Pier may be utilized in the future to ship non-time sensitive goods along the Connecticut coast to the port of New Jersey. As of 2020, the Connecticut Port Authority (CPA) announced a major project to improve and upgrade the pier, making it a modern port which will also support the offshore wind industry. Ferry service out of New London becomes increasingly busy during the summer months and is available to Long Island, Fishers Island, Martha's Vineyard, MA, and Block Island, RI. Long Island Sound and Fishers Island Sound have numerous harbors and inlets that are used extensively by pleasure craft during the summer months. A few of the harbors along the southeastern region's coastline that offer protection during storms include Stonington Harbor, Mystic Harbor, the Thames River, and the Niantic River.

2.6.4 Evacuation Routes

Most SCCOG communities do not have a specific evacuation route map during emergencies. In general, local emergency personnel direct traffic from local roads to primary highways such as Interstate 95, Interstate 395, Route 2, Route 32, Route 49, Route 85, and Route 169. Evacuation routes should not include roads that can become submerged during coastal storms and riverine flooding. Any changes in shelter status, shelter locations, or roadway routing may require modifications to the evacuation map. Many of the coastal communities have installed evacuation signs in strategic locations that direct residents out of coastal flood zones. Refer to Figure 2-7 for a depiction of major roadways.

The State of Connecticut's DESPP (Emergency Management & Homeland Security) website provides an Evacuation Route Map to Host Communities that is applicable to the southeast region of Connecticut.

The map was last updated in July 2011 and was created to address how evacuation should proceed if necessitated by an emergency at the Millstone Power Generation Facility in Waterford. The map was again being updated at the time of this report. Host Communities for affected regions of East Lyme, Waterford, Montville, New London, Ledyard, Town of Groton and City of Groton include New Haven, Storrs, Windham, Stonington and Norwich. Many of the affected communities include areas susceptible to coastal flooding and/or flooding from storm surge, suggesting that a similar plan could be used to address a large scale evacuation due to a major hurricane.

Figure 2-9 Major Roads in the SCCOG Region

2.7. Historic and Cultural Resources

Recognizing that historic and cultural resources are increasingly at risk to natural hazards and climate change, SHPO embarked on a resiliency planning study for historic and cultural resources beginning in 2016. Working with the State's Councils of Government and municipalities throughout the planning process, numerous examples were identified where historic and cultural resources were specifically at risk now, could be at risk in the future, and could help generate consensus for resiliency actions. Historic resources are difficult to floodproof, elevate, or relocate without potential loss of their historicity. Therefore, a thorough understanding of the site-specific options for each set of historic resources is necessary prior to disasters that could damage these resources, in order to avoid damage during recovery.

SCCOG hosted a historic resources resiliency planning meeting in June 2016, with several SCCOG communities attending. During winter 2016-2017, individual meetings were held with the shoreline SCCOG communities of East Lyme, Waterford, New London, Groton City, Groton Town, Stonington Town, and Stonington Borough. Reports were issued to these communities in August 2017. These reports outline eight strategies that can be employed to make historic and cultural resources more resilient. They are:

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

A best practice guide for planning techniques to make historic resources more resilient was distributed in September 2017. This guide can be used by all jurisdictions in Connecticut when undertaking development of hazard mitigation plans.

SCCOG has already taken steps toward the strategy "Strengthen Recovery Planning." Specifically, SCCOG developed a model municipal ordinance for disaster recovery. The model ordinance mentions historic resources and buildings.

To build upon SCCOG's involvement in the historic resource's resiliency planning process, several actions were given to many of the participating jurisdictions and appeared in the previous edition of this plan. Progress was made in Norwich (where a local inventory was developed to protect historic structures in areas of flood risk) but few other communities. The actions were carried forward for only some of the communities (those with a higher percentage of historic and cultural resources in areas of potential flood risk).

2.8. Governmental Structure

This section provides an overview of SCCOG, as well as a general description of the types of local agencies that handle hazard mitigation in the region.

SCCOG

The Southeastern Connecticut Council of Governments (SCCOG) is a public agency. It was formed through local initiative to provide a basis for intergovernmental cooperation in dealing with a wide range of issues facing southeastern Connecticut. The Council was organized in October 1992 through the adoption of ordinances for this purpose by the twenty towns, cities, and boroughs of the region. It succeeded its predecessor agency, the Southeastern Connecticut Regional Planning Agency (SCRPA), which had been in existence since January 1961.

SCCOG is the second largest of Connecticut's fifteen regional planning organizations. It is the only regional planning organization in the state which counts two federally recognized Native American Tribes as non-voting affiliate members. SCCOG also has liaison representation from the United States Naval Submarine Base and the United States Coast Guard Academy.

SCCOG operates under the provisions of Sections 4-124i through 4-124p of the Connecticut General Statutes. Duties assigned to councils of government include making a plan of conservation and development for the region; assisting municipalities within the region, as well as state and other public and private agencies; and performing a variety of advisory review functions. Under federal transportation law, SCCOG functions as the region's Metropolitan Planning Organization (MPO), responsible for coordinating transportation planning in southeastern Connecticut. In addition to its statutorily assigned duties, SCCOG's functions include providing a basis for intergovernmental cooperation, aiding in the solution of regional issues, serving as a technical resource to its member municipalities, and providing a collective voice for the region.

The policy board of the SCCOG consists of the municipal chief elected officials from its 22 member municipalities. The Regional Planning Commission (RPC) functions as a subunit of the Council and is composed of one representative from the planning commission of each member municipality. In addition to the RPC, the Council has several standing committees including the Executive Committee, the Legislative Committee, and the Nominating Committee. The Council's Bylaws allow other committees to form as needed.

SCCOG funding is derived from several sources. SCCOG annually receives dues from each of its municipal members assessed on a per capita basis. The Council receives federal and state funds to conduct planning and transportation studies for the region. SCCOG also offers technical assistance to local planning commissions in its member municipalities and tribal governments on a fee basis.

In addition to the regional council of governments, the municipalities and tribal governments in the region have various departments and commissions responsible for overseeing development and coordinating hazard response. In particular, these governments are tasked with making information available to the public. The following sections briefly describe typical municipal departments which are involved with natural hazard mitigation.

Emergency Management Office

The typical mission of the local Emergency Management Office is to maximize survival of people, prevent and/or minimize injuries, and preserve property and resources in its jurisdiction by making use of all available manpower, equipment, and other resources in the event of natural or technological disasters or national security threats. In addition to coordinating activities during disasters, the Emergency Management Office typically coordinates all early warning activities and is involved in educating the public on how to react during emergency situations.

Department of Fire / Rescue / EMS

Local governments in the region have either full-time or volunteer fire companies. Larger cities or towns generally have several fire houses in different areas of the city or town to assure rapid emergency response. All municipalities have municipal offices where elected officials help maintain order during emergency situations. The Fire Department is one of the primary agencies involved with hazard mitigation through emergency services and public education.

Police Department

Police departments are found in most of the suburban and urban municipalities and tribes but not in all rural towns. Day-to-day duties of a Police Department include crime prevention, criminal investigations, traffic enforcement, motor vehicle accident investigations, and patrols. Duties related to natural hazard mitigation include planning and coordination of personnel, equipment, shelters, and other resources necessary during an emergency. Communication and coordination with the Fire Department is critical before, during, and after natural hazard emergencies. Many of the less-populated SCCOG towns have resident state troopers in lieu of a municipal police department.

Public Works / Highway Departments

All of the SCCOG region's communities have a Public Works Department or Highway Department whose responsibilities include construction and maintenance of roadways, sidewalks, and drainage systems; maintenance of all parks and school properties; street sweeping, sanding, and snow removal; the preservation, care and removal of trees within the Town's rights-of-way and/or public places; and maintenance of Town vehicles and equipment.

As is common throughout Connecticut, Public Works Departments are often charged with implementing numerous structural projects that are related to hazard mitigation. Specifically, roadway/infrastructure maintenance and complaint logging/tracking are the two primary duties of the Public Work Department. The Public Works Department also typically tracks, plans, prepares for, and responds to flooding, inundation, and/or erosion of roads and infrastructure such as the sewer pumping station and the wastewater treatment plants. The Public Works Department also conducts snow removal and deicing on roads; tree and tree limb removal in rights-of-way; and maintains and upgrades storm drainage systems to prevent flooding caused by rainfall.

Because of the duties described above, the Public Works Department is often one of the first responders during emergencies. The Public Works Department must maintain access for the Police and Fire Departments to respond to emergencies.

Building Departments

Local Building Departments administer a building inspection program adhering to and enforcing all code requirements of the State of Connecticut relating to building construction. The tribal governments also have building departments who utilize the international building code. Additional responsibilities include administering and enforcing all related codes for the safety, health, and welfare of persons and properties in the jurisdiction, supervising departmental policies and procedures, and providing technical assistance to local officials.

The Building Official has a unique responsibility when it comes to hazard mitigation, they are responsible for overseeing a number of codes such as those related to wind damage prevention as well as those related to inland and coastal flood damage prevention. Although other departments and commissions may review development plans and develop or revise regulations, many important types of pre-disaster mitigation are funneled through and enforced by the Building Department. For example, the Building Department enforces A- and V-zone standards for floodproof construction and building elevations, maintains elevation certificates, and enforces building codes that protect against wind and fire damage. Thus, the types of mitigation that are administered by the Building Department include prevention and property protection. Typically, the building department provides hazard mitigation assistance at the time of the building permit application.

The primary role of the Building Department during disaster situations is to provide damage assessment, inspect damaged buildings and issue permits for temporary structures and actions necessary to maintain safety standards.

Engineering Department

Many towns have Engineering Departments and/or a Town or City Engineer who plans, directs, and coordinates engineering contracts and construction projects, including bridges, sanitary, and marine development. As such, the Engineer will often need to review issues related to drainage, flood conveyance, and flood mitigation and related elements of structural hazard mitigation, and the Engineer usually works closely with Public Works and Highway personnel. Typically, either the Engineer or the Public Works / Highway Superintendent will have a list of floodprone areas in the community.

Planning and Zoning / Land Use Department

The Planning and Zoning or Land Use Department of a jurisdiction enforces the local zoning and subdivision regulations, provides staff assistance to the planning and Zoning Commission, and performs long term planning activities related to land use and community development. This department typically drafts, updates and implements the goals and objectives of the local Plan of Conservation and Development. The planning office provides assistance to local Health Departments and Building and Engineering Departments.

In most cases, the local planning department includes the administrator of the local flood regulations under the NFIP. This person also has access to map information showing the location and extent of FEMA Special Flood Hazard Areas (SFHAs) in the community. This mapping is important in raising the public's awareness of natural hazards in the community.

Because the Planning Department typically directly assists the applicable commissions with administration of the Zoning Regulations, Subdivision Regulations, and Inland Wetland Regulations, the department is responsible for elements of almost all six facets of mitigation (prevention, property protection, natural resource protection, structural projects, emergency services, and public education). For example, wetlands preservation is one of the purest forms of hazard mitigation due to the natural functions and values of wetlands including stream bank and shoreline stabilization and flood water storage.

In coastal communities, the Planning and Zoning / Land Use Department typically assists the local Harbor Management Commission in administering any Waterway Protection Line Ordinances, as well as reviewing coastal site plan applications for certain development types within the coastal management area defined by the State.

Flood and Erosion Control Board

These boards can be created pursuant to the authority of Public Act No. 509 of the General Assembly, now Sections 25-84 through 25-94 of the Connecticut General Statutes. Typically, the Flood & Erosion Control Board's role in hazard mitigation is very important. They are authorized to "plan, lay out, acquire, construct, reconstruct, repair, supervise, and manage a flood or erosion control system" meaning "any dike, berm, dam, piping, groin, jetty, sea wall, embankment, revetment, tide-gate, water storage area, ditch, drain, or other structure or facility" that is useful in preventing or reducing damage from floods or erosion.

Significant changes in Connecticut in 2022 have resulted in the ability of Flood and Erosion Control Boards to serve as resiliency agencies or boards in municipalities. A municipality outside the SCCOG region is considering whether to merge its Coastal Resiliency Commission into its Flood and Erosion Control Board. This is a model that the SCCOG may wish to monitor.

Parks and Recreation Department

The Parks and Recreation Department typically oversees town open space parks. This responsibility includes the properties acquired by the town for hazard mitigation purposes and converted to open space.

Attorney

A jurisdiction's Attorney's office plays a critical role in hazard mitigation. The office typically reviews and helps to administer grant applications and projects under the HMA programs such as HMGP and BRIC.

Citizen Volunteer Organizations

Many SCCOG communities have a Citizens Emergency Response Team (CERT). The members of these teams have received training in many areas involving disaster situations such as first aid, sheltering management, and traffic control and commodities distribution along with other related tasks. These groups fill voids that exist especially during large scale incidents where standard public safety staffing cannot fulfill all the necessary operations.

Additional Groups

In addition to Town offices, the American Red Cross (ARC), the Salvation Army and the local health districts provide services related to mitigation and emergency management. The ARC and the Salvation Army help provide shelter and vital services during disasters and participate in public education activities. The local Health Districts become involved with water supply and sanitation issues that may arise during and after emergencies and natural disasters.

2.9. Review of Existing Plans, Public Information, and Regulatory Structures

Public Information is one of the most important types of hazard mitigation measure which, like prevention and resource protection, can be most effectively implemented in conjunction with other hazard mitigation projects. This section discusses regional plans prepared by SCCOG that are pertinent to natural hazard mitigation. A review of local jurisdiction plans may be found in the respective community annexes. Each of the regional plans is freely available on the SCCOG website.

Land Use – 2011 – Southeastern Connecticut Region (2012)

The SCCOG region completed a land use study in May 2012 that analyzed parcel data from all member municipalities. Much of these data were discussed in Section 2.4.1. The study concluded that the amount of developed land and designated open space in the region have been steadily increasing over the last three decades, while the amount of undeveloped land has been steadily decreasing over the same period.

Regional Plan of Conservation and Development (2017)

The SCCOG region has an established Regional Plan of Conservation and Development (POCD), which was assembled with contributions from local boards and commissions, citizens, and citizen groups. The purpose of the POCD is "to promote with the greatest efficiency and economy the coordinated development of its area of operation and the general welfare and prosperity of its people." Large scale development projects are required to reference the regional and State Plan of Conservation and Development to ensure consistency with established planning guidelines. The Regional POCD discusses natural hazard threats to the region (winter storms, hurricanes, flooding, wind, climate change, and rising sea level) and presents resiliency goals for the region. Specifically, the Regional POCD recommends that SCCOG develop data for use by the region's towns that identify areas of future risk and develop a plan for near- and mid-term actions to adapt to the effects of climate change. The Regional POCD also recommends that its member municipalities facilitate the elevation of at-risk properties by re-calibrating zoning regulation height limits and that they discourage new development in floodprone areas.

According to the 2017 Regional POCD, the SCCOG region has numerous historical sites. The highest concentrations of historic sites occur in Norwich, New London, and Mystic, and many are located near water such as Mystic Seaport. SHPO recently conducted an analysis of historic properties in shoreline communities with regard to vulnerability to natural hazards. More information on historic resources is presented within each municipal annex.

Regional Resilience Guidebook and Regional Resilience Vision Project (2017)

The Nature Conservancy, in conjunction with SCCOG and SeCTer developed a Regional Resilience Vision, which seeks to help southeastern Connecticut residents prepare for disaster events and a changing climate. The project was funded by a 2015 grant from the Connecticut Community Foundation, and focused on the towns of East Lyme, Groton, Montville, New London, Norwich, Ledyard, Salem, Stonington, and Waterford.

The vision for the project was assembled in conjunction with municipal staff, land use and economic planners, public and private utilities, major employers, academic institutions, and other stakeholders. In order to prioritize major focus areas of the project, the core project team recruited a team of planners representing each municipality and boroughs within the planning area. This team then derived six planning sectors which would for the framework of the resilience workshops. The six sectors identified are water, food, ecosystem services, transportation, energy, and regional economy. All of these sectors were deemed important areas in which to focus the resiliency efforts.

The Nature Conservancy held two workshops, which were used to derive the challenges facing the region, as well as possible solutions. In the first workshop, participants were given six planning sectors, listed above, and were asked to identify challenges associated with each planning sector caused by weather events, climate change, and other factors. Dialogue between the various stakeholders listed above ensured that various interests were considered when identifying challenges. In the second workshop, stakeholders were tasked with providing potential solutions to each of the challenges identified in each planning sector. The potential solutions were then consolidated into "overarching" solutions, which could have broader application.

The table below is a summary of the solutions presented in the Southeastern Connecticut Regional Resilience Guidebook. Potential mitigation actions relevant to all-hazards or individual hazard mitigation are noted as such. In some cases, the solution can be used to inform mitigation actions.

Table 2-7 SCCOG Regional Resilience Guidebook Summary Solutions

Category	Solutions	Potential Direct or Indirect Mitigation Action?
Water	Assess current public and private water supply and distribution capacity	Yes
	Build upon past projects and foster future opportunities across the region to utilize green infrastructure and improve gray infrastructure to enhance capture and infiltration of runoff	Yes
	Develop a regionally specific decision support process to help municipalities assess and plan for flooding, efficient water use/reuse, and nonpoint source pollutions, simultaneously	Yes
Food	Explore cooperative funding, sourcing, and distribution models to meet demands for local foods among area residents, schools, and other institutions	No
	Scope feasibility of large scale municipal composting, regional processing facility, and cooperative distribution system	No
	Look to streamline regulatory requirements across multiple state agencies	No
	Create greater housing opportunities in currently developed areas and take steps to promote agricultural careers among the next generation	No
	Explore ways to accommodate the uncertainty of future environmental conditions in farm planning	No
	Reduce flood risk to farmers through dam removal, soil erosion control measures, and watershed management	Yes
	Conduct a food-shed mapping effort across the region to determine sources and quantities of locally produced food	No
Ecosystems	Strengthen collaborative leadership that champions benefits of ecosystem services from municipal to regional scale	No
	Catalogue financial mechanisms and incentives for property owners to maintain and enhance natural infrastructure and associated services	No
	Monetize services provided by natural assets when making economic growth and development decisions across the region	No
	Define ways to incorporate ecosystem services directly into permitting requirements for MS4 and other initiatives	Yes
	Integrate natural infrastructure into zoning codes to reduce conflicts between development and community resilience	Yes
	Conduct outreach and education for residents and business owners on where and what natural alternatives could be considered alongside standard hard engineering approaches	Yes
Transportation	Prioritize state and local funding for infrastructure improvements that contribute to overall community resilience	Yes
	Collaborate on largest regional transportation vulnerabilities and share planning, engineering, and monetary resources across municipalities to enhance regional resilience	Yes
	Integrate green infrastructure and natural assets into transportation upgrades and retrofits through design standards and codes	Yes
	Establish mutual aid agreements with nearby urban centers (Hartford, Worcester) to reduce risk to transit-dependent residents during emergencies	No
Energy	Identify steps to further strengthen and possibly redesign the distribution system in partnership with municipalities	Yes

	Improve communications among stakeholders within the energy system	No
	Target and incentivize consumer behavior to improve overall energy resilience	No
	Routinely update state building codes with energy efficiency standards	Yes
	Update existing response plans with a specific emphasis on speeding up the recovery of energy infrastructure	Yes
Economy	Conduct fiscal impact study of extreme weather and sea level rise scenarios to strengthen commitments from community leaders and elected officials	Yes
	Improve coordination of disaster recovery between public and private stakeholders	Yes
	Reduce long-term over-reliance on high value, residential property for tax revenue	No
	Prioritize compact mixed use areas by infilling downtown and village centers outside of flood hazard areas	Yes
	General diversification of the economy to increase collective revenue streams and reduce the demands on local ecosystems	No
Cross-Sector Resilience	Develop a regionally specific decision support process to help municipalities assess and plan for flooding, efficient use/reuse, and nonpoint source pollution, simultaneously	Yes
	Integrate natural infrastructure into zoning codes to reduce conflicts between development and community resilience	Yes
	Collaborate on largest regional transportation vulnerabilities and share planning, engineering, and monetary resources across municipalities to enhance regional resilience	Yes
	Conduct fiscal impact study of extreme weather, drought, and sea level rise scenarios to strengthen commitments from community leaders and elected officials	Yes
	Build upon past projects and foster future opportunities across the region to utilize green infrastructure and improve gray infrastructure to enhance capture and infiltration of runoff	Yes
	Conduct a food-shed mapping effort across the region to determine sources and quantities of locally produced food	No
	Monetize services provided by natural assets when making economic growth and development decisions across the region	No
	Prioritize state and local funding for infrastructure improvements that contribute to overall community resilience across the region	Yes
	Identify steps to further strengthen and possibly redesign energy distribution system through partnerships across multiple municipalities	No

Regional Water Priority Planning Document (2010)

This map depicts critical areas where development of new water sources or infrastructure needs to occur in the SCCOG region. The eight priority projects include:

- Thames River interconnection (completed, activated 2008);
- New source development in Windham to service Franklin, Sprague, Lisbon, Preston, Bozrah, Mohegan Tribe, and Colchester (near term, high priority);
- New London supply development including a lower level intake in Lake Konomoc and new source development to service Waterford, East Lyme, Montville, and Salem (near term, high priority);

- East Lyme / New London operable interconnection (completed, activated 2015);
- New source development in North Stonington to service Stonington, Westerly Water Department, and Mashantucket Pequot Tribal Nation (near term, high priority);
- Groton / Aquarion Water Company emergency interconnection (completed, activated 2013);
- Ledyard / Preston emergency interconnection (mid-term, medium priority); and
- Mohegan-Pequot Bridge crossing between Preston and Mohegan Tribe (long term, medium priority).

Individual community annexes will have more information regarding local water needs, as this can affect emergency response to natural hazard damage.

Regional Emergency Support Plan (2011)

The SCCOG region coordinates with the Northeastern Connecticut Council of Governments (NECCOG) for regional emergency response. Together, these entities and their member communities have developed an emergency support plan that outlines regional emergency support functions for its members. The plan provides a basis for jurisdictions to collaborate in planning, communication, information sharing, and coordination before, during, or after an emergency of regional significance. The document is intended to support local Emergency Operations Plans that are critical to local emergency response and are strategic in scope. Much of the document consists of an all-hazards risk assessment which analyses the impacts of natural hazards such as blizzards, ice storms, ice jams, heat waves, drought, flooding, tornadoes, land subsidence, landslides, dam failure, and hurricanes could contribute to a regional emergency and provides guidance for members to coordinate regionally regarding a variety of support functions, including in the absence of a declaration of a State of Emergency by the Governor of Connecticut.

SCCOG also conducted a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis in 2008 in coordination with the Northeastern Region Council of Governments and the Windham Region Council of Governments. The major weaknesses in emergency response in eastern Connecticut were found to be the lack of intra-district long-distance communication due to radio and cell phone dead zones; general communication issues between municipalities, social service agencies, and non-profits; an inability to directly notify various disciplines, and lack of funding for emergency preparedness.

Local Plans of Conservation and Development

Each Connecticut municipality is required to prepare a POCD every ten years. The POCD requirements are similar to those described above for regional POCDs. One of the recommendations in each annex of the 2012 HMP was for the local municipality to incorporate elements of the 2012 HMP Update into its local planning efforts. Note that such incorporation was suggested in the 2015 HMP Update for Lebanon and Windham but was not specifically listed as a strategy or action. Several communities have since the 2012 and 2017 HMP incorporated natural hazards into their POCD. Some communities have yet to extensively incorporate hazards, however, all do have hazard narrative to a certain degree. Table 2-8 summarizes the status of incorporation of natural hazard information into local POCDs:

Table 2-8 Status of Incorporation of Natural Hazards into Local POCDs

Geographic area	Year of Current POCD	Year of Next POCD	Current POCD Incorporates Natural Hazard Information?
Bozrah	2015	2025	Partially. Only addresses flooding.
Colchester	2015	2025	Yes.
East Lyme	2020	2030	Partially. Only addresses flooding, sea level rise, and wildfires.
Franklin	2013	2023	Partially. Only addresses poor drainage flooding.
Griswold	2018	2028	Partially. Only addresses flooding.
Groton, City of	2018	2028	Yes.
Groton, Town of	2016	2026	Yes.
Lebanon	2010	2020	Partially. Actions geared toward flooding.
Ledyard	2010	2020	Partially. Only addresses flooding and wildfires.
Lisbon	2016	2026	Partially. References 2012 HMP strategy.
Montville	2010	2020	Partially. Only addresses impediments to development.
New London	2017	2027	Partially. Only addresses flooding and sea level rise
North Stonington	2013	2023	Partially. Only recognizes need for resiliency.
Norwich	2013	2023	Partially. Only addresses sea level rise.
Preston	2014	2024	Partially. Only addresses wildfires.
Salem	2012	2022	Partially. Only addresses wildfires.
Sprague	2012	2022	Partially. Only addresses flooding.
Stonington, Borough of	2012	2022	Partially. Only addresses flooding.
Stonington, Town of	2015	2025	Yes.
Waterford	2015	2025	Yes.
Windham	2017	2027	Partially. Only addresses flooding.

More information on local POCDs can be found in each municipal annex. Based on Table 2-8, five communities have met the incorporation of natural hazards requirement in their POCDs, and with the remaining communities only partially incorporating certain aspects of hazard mitigation. The 2017 Regional POCD provides an excellent example of how to incorporate natural hazard information into a POCD. This requirement has been incorporated into the strategies and actions of the 18 SCCOG jurisdictions as appropriate.

Statewide Public Information

Many State government websites contain information pertinent to natural hazards. The Connecticut DEEP also hosts the State Hazard Mitigation Plan online at (https://portal.ct.gov/DEMHS/Emergency-Management/Resources-For-Officials/Hazard-Mitigation) which provides additional information on the effects of natural hazards in the State. The CT NHMP was updated in 2019, with a new update schedule to begin in 2023.

Local Public Information

During the preparation of the original HMP in 2004-2005, the Hazard Mitigation Committee identified the need for a continued and expanded program of public information. Such a program could include

providing educational information to the homeowners and business owners in the flood hazard areas. A public education and information component should be included in all hazard mitigation projects undertaken in the region. The availability of information and increasing public awareness continues to be a goal of member communities in the SCCOG region.

Libraries can be an effective location of a hazard information center. Town Halls and other public facilities can also serve as information centers. A wide range of hazard mitigation documentation should be compiled for public review. Making available free pamphlets on preparedness for natural hazards is a relatively inexpensive way to ensure that the public is informed about basic preparedness measures.

Real estate disclosure is another method where localized hazards are identified. This is a procedure where sellers of real estate are compelled to provide notice to buyers of known hazards affecting the property to be conveyed. Most mortgages require the purchase of flood insurance if the property is located within the FEMA SFHA. This extra expense may dissuade some buyers from purchasing the property, but also provides an additional level of assurance to the owner that they will have assistance recovering from a flood event.

FEMA and CitizenCorps have published disaster planning guides known as the "Are You Ready?" series (https://www.ready.gov/sites/default/files/2021-11/are-you-ready-guide.pdf). These are considered among the best of the planning guides that are available from disaster-related planning and response organizations. Key publications from the series should be available to all region residents. In addition, public and private school and adult education programs can offer education classes that include hazard identification and hazard mitigation components.

Review of Regulatory Standards

The SCCOG, as a regional planning organization, does not have or administer any regulations. Instead, members voluntarily agree to abide by regional recommendations when possible.

Hazard prevention includes identification of risks and the use of land-use regulatory and other available management tools to prevent future damage. The municipalities in the southeast region have planning and zoning tools in place that incorporate floodplain management. Planning and zoning regulations, inland wetlands and watercourses regulations, harbor management regulations and building departments' enforcement of Building Codes are all important existing regulatory mechanisms that address hazard prevention and incorporate floodplain management. Additional details for each of the communities can be found in the respective annexes. The following are examples of how hazard prevention can be accomplished through existing programs:

Planning and Zoning

Planning and Zoning Regulations or similar land use regulations can be tailored to be consistent with hazard mitigation planning. Establishment of Flood Overlay Districts, Coastal Resource Zones, and River Corridor Preservation Zones are all techniques that can potentially be employed to limit additional development in hazardous locations.

Open Space Preservation

Community planning that includes open space acquisition and preservation can be established or revised in a manner that is consistent with hazard mitigation planning. For example, acquisition of floodplain and river corridor properties should be encouraged as a municipal priority.

Floodplain Development Regulations

The modification of floodplain management regulations to include more restrictive development standards is consistent with hazard mitigation planning. The NFIP Community Rating System gives credit to communities that exceed the minimum floodplain management requirements of the NFIP. Requirements include elevating structures higher than the 1-percent annual-chance base flood elevation, which is an example of a more stringent standard. Many jurisdictions have incorporated NFIP regulations into their standard Zoning or Subdivision Regulations. A full review of each community's regulations is presented in the respective community annex.

Stormwater Management

Stormwater management regulations that limit any potential increase in the discharge of stormwater and that preserve floodplain storage are examples of the use of stormwater management in a manner consistent with hazard mitigation planning. Communities should conduct catch basin surveys in order to identify and prioritize potential replacements of catch basins and overall stormwater drainage improvements. The identification and improvement of drainage systems and culverts that have inadequate capacity helps reduce flooding risks and also prevents further damage to roadways.

In response to a recommendation from the Connecticut Governor's Council on Climate Change (GC3), SCCOG has launched a pilot program in 2021 to help municipalities take steps to launching a stormwater authority. SCCOG plans on working directly with four communities, Stonington, Waterford, Ledyard, and Preston.

Wetlands Protection

Wetlands areas generally serve as critical flood storage areas. By limiting wetlands development not only are important natural resource areas protected but additional floodplain development is also limited. All SCCOG members have wetland regulations of some type.

Erosion and Sediment Control Regulations

Effective implementation of Sediment and Erosion controls include utilization of detention basins and use of other Best Management Practices to slow the velocity and limit increase in runoff. Strict adherence to the requirements is an effective hazard mitigation tool. Some municipalities do not have separate erosion and sediment control regulations and instead require compliance with the 2002 State of Connecticut Sedimentation and Erosion Control guidelines.

Coastal resilience plan fact sheet

3. Hazard Identification and Risk Assessment

3.1. Climate Change

It has been observed that global climate change is occurring more rapidly than that of the historic natural variations throughout earth's history. Observations include average global temperature increases, sea level rise, shifting precipitation trends, ocean acidification, and changes in severe storm occurrences. These observed changes are predominantly attributed to human activities such as emission of greenhouse gases from fossil fuel combustion, deforestation, and extensive land-use changes. Many of these climate changes have severe, direct impacts on natural hazards.

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] It is expected that annual average temperatures will increase by about 2.5 degrees Fahrenheit by the end of the century regardless of future emissions.

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.

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, in addition to 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 3-1). 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).

[3] https://nca201758.globalchange.gov/chapter/2/

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.

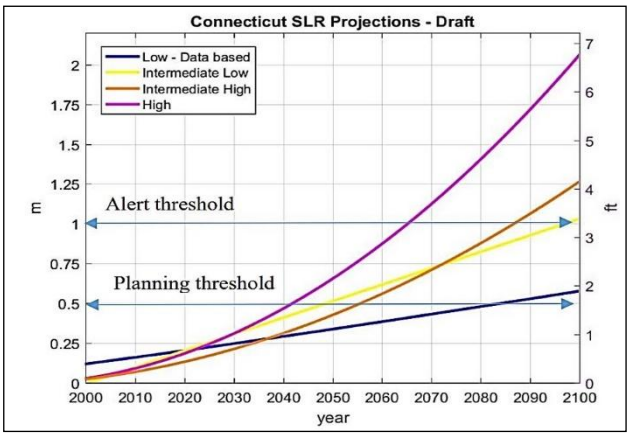


Figure 3-1 Four Localized Sea Level Rise Scenarios for Connecticut

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.

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.[4] 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.

The SCCOG region has an agreeable climate characterized by moderate but distinct seasons. The mean annual high temperature is approximately 60.5 degrees Fahrenheit as reported by NOAA for the period 1956-2022 and the NPU station, and 59.3 from 1957-2021 in Groton. Summer temperatures rise in the mid-80s, and winter temperatures dip into the upper 20s to mid-30's Fahrenheit. Extreme conditions can raise summer temperatures to near 100 degrees and winter temperatures to below zero.

Additionally, according to NOAA, mean snowfall inland (NPU) is approximately 14.9 inches per year and coastal (Groton) is approximately 22.9 inches per year. Mean annual precipitation is 46.8 inches per year as measured in Norwich and 44.6 in Groton. Precipitation is typically evenly distributed throughout the year.

3.2. Climate Drivers and Natural Hazards

As global warming increases, and the climate changes as a result of anthropogenic and natural reasons, these various reasons drive certain types of climatic events to shift in frequency, intensity, and location.

The continued increase in precipitation only heightens the need for hazard mitigation planning as the occurrence of floods may change in accordance with the greater precipitation.

Extreme and severe storms such as hurricanes, summer storms and tornadoes, and winter storms, are all expected to shift in intensity and frequency to varying degrees. As the climate warms and ocean temperatures rise, and atmospheric circulation patterns change, weather patterns change, and these warmer conditions provide "fuel" for more intense tropical events. Extreme storms can also exacerbate coastal flooding and shoreline change events, particularly as a result of **sea level rise.** Rising sea levels, caused by warming waters and melting ice sheets, can increase the frequency and intensity of coastal flooding storm surge, and erosion of shoreline change. Severe storms can also experience **changing precipitation patterns**. Annual precipitation amounts have increased across the northern and eastern United States in since the beginning of the last century. These changes are projected to continue, with the most notable shifts during winter and spring months. In addition to more precipitation, drought conditions are also expected to increase due to longer periods

[4] https://nca2018.globalchange.gov/chapter/2/

of time between heavy rainstorms and a reduction in surface soil moisture due to warmer temperatures. As temperatures increase, **extreme temperature** events will also become more frequent. Global temperatures across the United States have increased by 1.2 degrees over the past few decades. These small increases have lead to increase in heat wave events, ultimately increasing pubic health challenege, decresaing air quality, and promoting dry, drought coditions. These dry conditions are also conducive to wildfires. Over the past few decades, wildfire occurrences have increased in frequency in western areas of the United States.

As these storms and hazards shift in intensity and frequency as a result of climate change, so will the vulnerability and susceptibility throughout the SCCOG region. One critical componenet of hazard mitigation and climate adaptation is to prepare to future, larger storms, above and beyond what is typically experienced in a communtiy.

In general, changes in flooding and extreme heat events tend to be the most concerning for many of the SCCOG communities. All SCCOG jurisidictions have specifc concerns related flooding, heat, and other climate driven hazards such as drought. In order to succinctly identify these top community concerns, and their actions to address the hazard, cliamte change summary sheets have been developed to present the information. These sheets can be found in Appendix E, with each community having their own sheet in their annex.

3.3. Hazards Impacting the Region

The term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. The 2012 and 2017 HMP determined that the most significant hazard in the SCCOG region is flooding, with winter storms, hurricanes, and earthquakes also presenting significant concerns. Wildfires, landslides, and coastal erosion were concerns in particular communities but not considered to be region-wide threats. Drought was also a minor concern in 2012 as the relative abundance of rainfall and ample water supply in SCCOG communities has made serious droughts a rare occurrence. Drought has since become an increasing concern in certain parts of the region.

Additional hazards were reviewed in full to bring the updated plan into concurrence with the State of Connecticut HMP and other local HMPs in Connecticut. Based on a review of the 2019 Connecticut Natural Hazard Mitigation Plan and other local plans in Connecticut. The hazards identified for the region have also been grouped by their respective climate change stressor to better realize how climate change may exacerbate these hazards. The list of hazards includes the following:

- Extreme and Severe Storms
    - Hurricanes and Tropical Storms
    - Tornadoes and High Winds
    - Severe Winter Storms
- Sea Level Rise
    - Coastal Flooding
    - Shoreline Change
- Changing Precipitation Patterns
    - Riverine and Pluvial Floods
    - Drought

    - Dam Failure
- Rising Temperatures
    - Extreme Heat
    - Wildfire
- Non-Climate Drive
    - Earthquake

These are the same hazards that were addressed in the previous SCCOG Hazard Mitigation Plan, with the expansion of coastal flooding, and the addition of extreme heat and drought. They were reviewed during the development of the *2019 Connecticut Natural Hazards Mitigation Plan* (CT NHMP - adopted January 2019), and the 2017 SCCOG HMP contributed to the Hazard Identification and Risk Assessment (HIRA) presented in that document. Thus, the plans are consistent.

This document has been prepared with the understanding that a single *hazard effect* may be caused by multiple *hazard events*. For example, flooding may occur as a result of frequent heavy rains, a hurricane, or a winter storm. Thus, Table 3-1 and Table 3-2 on the following pages provide summaries of the hazard events and hazard effects that impact the SCCOG region and include criteria for characterizing the locations impacted by the hazard, the frequency of occurrence of the hazard, and the magnitude or severity of the hazards. In order to better identify current vulnerabilities and potential mitigation strategies associated with other hazards, each hazard has been individually discussed in a separate section in this plan. Specific community details are discussed in each individual community annex.

Table 3-1 Effects of Natural Hazards

Natural Hazard	Extreme and Severe Storms			Sea Level Rise		Changing Precipitation Patterns			Rising Temperatures	
	Hurricanes and Tropical Storms	Summer Storms and Tornadoes	Winter Storms	Coastal Flooding	Shoreline Change	Riverine and Pluvial Floods	Drought	Dam Failure	Extreme Heat	Wildfire
Inland Flooding	X	X		X		X		X		
Flooding from Poor Drainage	X	X			X					
Coastal Flooding	X		X		X					
Storm Surge	X		X	X		X				
Coastal Erosion	X		X		X					
Wind	X	X	X							
Falling Trees/Branches	X	X	X							
Lightning	X	X								
Hail		X								
Snow			X							
Blizzard			X							
Ice			X							

Fire/Heat									X	X
Smoke										X
Shaking										
Dam Failure						X		X		
Power Failure	X	X	X						X	X

Table 3-2 Hazard Event Ranking

Natural Hazards	Location 1 = small 2 = medium 3 = large	Frequency of Occurrence 0 = unlikely 1 = possible 2 = likely 3 = highly likely	Magnitude/ Severity 1 = limited 2 = significant 3 = critical 4 = catastrophic	Rank
Hurricanes and Tropical Storms	3	3	2	8
Summer Storms and Tornadoes	3	1	3	7
Winter Storms	2	3	2	7
Coastal Flooding	3	1	2	6
Shoreline Change	1	2	1	4
Riverine and Pluvial Floods	2	3	3	8
Drought	3	2	2	7
Dam Failure	1	1	4	6
Extreme Heat	3	3	2	8
Wildfire	2	1	2	5
Earthquake	3	0	2	5

- Each hazard may have multiple effects; for example, a hurricane causes high winds and flooding.
- Some hazards may have similar effects; for example, hurricanes and earthquakes may cause dam failure.

Location
1 = small: isolated to specific area during one event
2 = medium: multiple areas during one event
3 = large: significant portion of the region during one event

Frequency of Occurrence
0 = unlikely: less than 1% probability in the next 100 years
1 = possible: between 1 and 10% probability in the next year; or at least one chance in next 100 years
2 = likely: between 10 and 100% probability in the next year; or at least one chance in next 10 years
3 = highly likely: near 100% probability in the next year

Magnitude/Severity
1 = limited: injuries and/or illnesses are treatable with first aid; minor "quality of life" loss; shutdown of critical facilities and services for 24 hours or less; property severely damaged < 10%
2 = significant: injuries and/or illnesses do not result in permanent disability; shutdown of several critical facilities for more than one week; property severely damaged <25% and >10%

3 = critical: injuries and/or illnesses result in permanent disability; complete shutdown of critical facilities for at least two weeks; property severely damaged <50% and >25%
4 = catastrophic: multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

3.3.1 Disaster Declarations

An important part of identifying natural hazard that can affect the SCCOG region is utilizing the past record of federally declared disasters and emergencies. According to information on the FEMA website, Connecticut has received 29 Major Disaster or Emergency Declarations since 1954. Table 3-3 presents information related to recent declarations in New London and Windham County. Recent disasters include three tropical storms, a severe storm that produced widespread inland flooding, and the Covid-19 Pandemic.

Table 3-3 Disaster and Emergency Declarations in SCCOG Region

Disaster Number	Event	Date of Event(s)	Individual Assistance	Public Assistance	HMGP
FEMA-DR-4629	Remnants of Hurricane Ida	9/1 – 9/2/2021	X		X
FEMA-EM-3564	Hurricane Henri	8/21 – 8/24/2021		X	
FEMA DR-4580/EM3535	Tropical Storm Isaias	8/4/2020		X	X
FEMA-DR-4500/EM-3439	Covid-19 Pandemic	1/2020 – Ongoing	X	X	X
FEMA-DR-4410	Severe Storms and Flooding	9/25 – 9/26/2018		X	X
FEMA-DR-4213	Severe Winter Storm and Snowstorm	1/26 -1/29/2015		X	X
FEMA-DR-4106	Severe Winter Storm and Snowstorm	2/08 - 2/12/2013		X	X
FEMA-DR-4087	Hurricane Sandy	10/27 - 11/08/2012	X	X	X
FEMA-DR-4046 / EM-3342	Winter Storm Alfred	10/29 – 10/30/2011		X	X
FEMA-DR-4023	Tropical Storm Irene	8/27 – 9/1/2011	X	X	X
FEMA-DR-1958	Snowstorm	1/11 – 1/12/2011		X	X
FEMA-DR-1904	Severe Storms and Flooding	3/12 – 5/17/2010	X	X	X
FEMA-DR-1700	Severe Storms and Flooding	4/15 – 4/27/2007	X		X
FEMA-EM-3266	Snow	2/11 – 2/12/2006		X	
FEMA-DR-1619	Severe Storms and Flooding	10/14 – 10/15/2005		X	X
FEMA-EM-3200	Snow	1/22 – 1/23/2005		X	
FEMA-EM-3192	Snow	12/5 – 12/7/2003		X	
FEMA-EM-3176	Snowstorm	2/17 – 2/18/2003		X	
FEMA-DR-1092	Blizzard	1/7 – 1/13/1996		X	
FEMA-EM-3098	Severe Winds, Blizzard, Record Snowfall	3/13 – 3/17-1993		X	

FEMA-DR-916	Hurricane Bob	8/19/1991		X	
FEMA-DR-747	Hurricane Gloria	9/27/1985		X	
FEMA-DR-661	Severe Storms, Flooding	6/14/1982	X	X	
FEMA-EM-3060	Blizzards and Snowstorms	2/7/1978		X	
FEMA-DR-42	Hurricane, Torrential Rain, Floods	8/20/1955			
FEMA-DR-25	Hurricanes	9/17/1954			

Notes: *Individual Assistance* includes assistance to individuals and households.
Public Assistance includes assistance to State and local governments and certain private non-profit organizations for emergency work and the repair or replacement of disaster-damaged facilities.

3.3.2 NCEI Events

The NOAA National Centers for Environmental Information (NCEI) is another resource for hazard identification and event analysis. The NOAA NCEI database is a compilation of reports and information related to natural hazard and weather events. The database often includes details on an event and the impacts, economic related damages, and any injuries or loss of life. While not every event includes these details, the reporting database is integral for understanding regional and localized impacts.

The NCEI identified both episodes, and events. An episode refers to the overall storm system, while events can be several associated hazards with one episode. Table 3-4 and Table 3-5 show all hazard events reported under NCEI since 1950 including reported property damages, injuries, and deaths. While crop damages can be reported, there has been no reported damages to crops in either county since 1950.

Table 3-4 NCEI Hazard Events for New London County

Hazard	Events	Property Damage	Injuries	Deaths
Blizzard	14	$0	0	0
Coastal Flood	8	$0	0	0
Cold/Wind Chill	2	$0	0	0
Drought	6	$0	0	0
Excessive Heat	2	$0	0	0
Extreme Cold/Wind Chill	4	$0	0	0
Flash Flood	75	$806,240	0	0
Flood	45	$6,560,000	0	0
Funnel Cloud	2	$0	0	0
Hail	60	$500	1	0
Heat	6	$0	0	0
Heavy Rain	18	$7,500	0	0
Heavy Snow	72	$0	0	0
High Wind	50	$1,992,000	1	0
Ice Storm	2	$0	0	0
Lightning	14	$34,000	19	1

Storm Surge/Tide	1	$0	0	0
Strong Wind	23	$830,000	0	0
Thunderstorm Wind	118	$333,000	1	2
Tornado	4	$63,500	0	0
Tropical Storm	9	$3,008,000	0	0
Winter Storm	26	$0	0	0
Winter Weather	30	$0	0	0
Grand Total	**591**	**$13,634,740**	**22**	**3**

Table 3-5 NCEI Hazard Events for Windham County

Hazard	Events	Property Damage	Injuries	Deaths
Drought	7	$0	0	0
Excessive Heat	3	$0	0	0
Flash Flood	8	$168,000	0	0
Flood	17	$754,000	0	1
Hail	31	$0	0	0
Heat	2	$0	0	0
Heavy Rain	3	$0	0	0
Heavy Snow	46	$71,000	0	0
High Wind	18	$724,000	1	0
Lightning	6	$44,500	2	0
Strong Wind	17	$59,500	0	0
Thunderstorm Wind	136	$864,100	0	0
Tornado	7	$2,570,250	0	0
Tropical Storm	2	$20,562,000	0	0
Winter Storm	22	$615,000	0	0
Winter Weather	24	$60,700	0	0
Grand Total	**349**	**$26,493,050**	**3**	**1**

Because the NCEI database is primarily based on spotter and media reports, losses reported may be inaccurate for certain events. However, this database is a good indicator for which hazards tend to impact each county more.

3.3.3 Exposure to Climate-Affected Natural Hazards

Properties, people, historic resources, and critical facilities in the region 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 3-6.

Table 3-6 SCCOG Regional Exposure Analysis

Hazard	At-Risk Parcels		At-Risk Facilities		At-Risk Historic Assets	
	Value	Number	Value	Number	Value	Number
Hurricane/Tropical Storm	$25,961,938,512	109,384	$1,582,705,980	257	$1,734,347,244	5,397
Severe Thunderstorm	$25,961,938,512	109,384	$1,582,705,980	257	$1,734,347,244	5,397
Severe Winter Storm	$25,961,938,512	109,384	$1,582,705,980	257	$1,734,347,244	5,397
Tornado	$25,961,938,512	109,384	$1,582,705,980	257	$1,734,347,244	5,397
Drought	$9,001,829,012	42,113	$854,536,220	105	$36,721,830	177
Flood						
1% Annual Chance	$6,843,058,641	15,575	$720,439,620	70	$628,579,694	1,184
Coastal (VE)	$2,051,008,506	2,683	$158,270,570	3	$258,067,120	283
0.2% Annual Chance	$8,699,102,431	22,002	$888,608,320	92	$908,586,454	1,573
Storm Surge						
Category 1	$2,616,468,688	4,741	$213,560,380	14	$482,473,984	537
Category 2	$4,113,865,812	7,101	$281,424,360	24	$648,638,649	901
Category 3	$4,667,436,187	9,237	$371,845,620	37	$755,096,129	1,188
Category 4	$4,874,604,318	10,535	$371,845,620	37	$876,569,009	1,276
Earthquakes	$25,961,938,512	109,384	$1,582,705,980	257	$1,734,347,244	5,397
Wildfire	$6,203,386,549	32,466	$760,698,260	100	$34,128,390	169

3.3.4 Hazard Datasets

The extent of the hazard identification and risk assessment depends on the type and quality of data used to determine risk and losses. Sources for these datasets range from federal, state, and local; with some being supplemented by another. Table 3-7 summarizes the type and source for the various hazard datasets.

Table 3-7 Hazard Datasets used for HIRA and Loss Estimates

Hazard	Dataset	Source
Hurricanes and Tropical Storms	NCEI Storm Events Database	NOAA NCEI
	FEMA Public Assistance (PA) & Individual Assistance (IA)	OpenFEMA Datasets
	FEMA HAZUS-MH	FEMA
Tornadoes and High Winds	NCEI Storm Events Database	NOAA NCEI
Winter Storms	NCEI Storm Events Database	NOAA NCEI
	FEMA PA	OpenFEMA Datasets

Coastal Flooding	NCEI Storm Events Database	NOAA NCEI
Shoreline Change		
Riverine and Pluvial Flooding	NCEI Storm Events Database	NOAA NCEI
	FEMA PA	OpenFEMA Datasets
	FEMA HAZUS-MH	FEMA
	NFIP Policy and Claim Information	FEMA NFIP
	CCVI	UConn CIRCA
Drought	NCEI Storm Events Database	NOAA NCEI
	USDA Disaster Assistance Programs Data	USDA
	Private Well Parcels	CT DPH
Dam Failure	Dam Location and Classification	CT DEEP
Extreme Heat	NCEI Storm Events Database	NOAA NCEI
	CCVI	UConn CIRCA
Wildfires	NCEI Storm Events Database	NOAA NCEI
	Private Well Parcels	CT DPH
	Wildfire and Wildland Urban Interface (WUI)	University of Wisconsin-Madison, Silvis Lab
Earthquake	FEMA HAZUS-MH	FEMA
	Earthquake Catalog	USGS

3.4. Risk Assessment

3.4.1 Extreme and Severe Storms

Changes in atmospheric circulation have resulted in observed shifts of extreme storms. Winter storms have shifted more northward, and future projections show an increase in frequency of these events in the northeastern United States. Human-induced warming is also having impacts on the Atlantic hurricane season. Studies have shown that the tropics have expanded poleward, ultimately expanding the geographic stretch of tropical cyclone tracks. Though it is more challenging to observe and predict the changes to tornadoes and severe thunderstorms due to their shorter time period of occurrence, there have been some indications that a warmer climate could increase the number of days that are conducive to severe storms and tornadoes.

3.4.1.1 Hurricanes and Tropical Storms

Several types of hazards may be associated with tropical storms and hurricanes, including heavy or tornado winds, heavy rains, and flooding. The region includes seven coastal jurisdictions susceptible to both coastal flooding and wind damage during such storms; inland communities are also susceptible to wind damage and inland flooding produced by heavy rainfall. A hurricane striking the region is considered a possible event each year and could cause critical damage to many of the localities and their infrastructure.

The original HMP grouped mitigation of wind hazards associated with hurricanes, tornadoes, severe thunderstorms, and winter storms. The 2012 HMP update then addressed wind hazards separately according to cause, and that format is continued herein. As hurricanes and tropical storms are regional

in nature, a regional quantitative vulnerability and risk assessment has been performed and is presented in this chapter. Individual community annexes include qualitative information regarding particular at-risk areas in local jurisdictions.

3.4.1.1.1 Hazard Assessment

Hurricanes are a class of tropical cyclones that are defined by the National Weather Service as warm-core, non-frontal, low pressure, large scale systems that develop over tropical or subtropical water and have definite organized circulations. Tropical cyclones are categorized based on the speed of the sustained (one-minute average) surface wind near the center of the storm. These categories are Tropical Depression (winds less than 39 mph), Tropical Storm (winds 39-74 mph, inclusive), and Hurricanes (winds at least 74 mph).

The geographic areas affected by tropical cyclones are called tropical cyclone basins. The Atlantic tropical cyclone basin is one of six in the world and includes much of the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. The official Atlantic hurricane season begins on June 1 and extends through November 30 of each year although occasionally hurricanes occur outside this period.

Inland Impacts

Inland Connecticut is vulnerable to hurricanes despite moderate hurricane occurrences when compared with other areas within the Atlantic Tropical Cyclone basin. Since hurricanes tend to weaken within 12 hours of landfall, far inland areas are relatively less susceptible to hurricane wind damages than coastal areas in Connecticut. However, the heaviest rainfall often occurs inland. A prime example is Tropical Storm Irene (described in Section 3.4.1.1.2). Though Irene did not occur more recently, the storm caused extensive precipitation within inland Connecticut and remains one of the more impactful events in hurricane history Extratropical Storm Ida in 2021 also produced heavy rainfall, which caused flooding across the region along roadways, and elevated river levels.

Seven of the 24 SCCOG jurisdictions are considered to have coastal areas, although Connecticut's coastal management boundary extends inland along the Thames River. Thus, the SCCOG region is susceptible to both inland and coastal flooding hazards during hurricanes and tropical storms. All areas within the SCCOG region are near enough to the coast to experience strong winds. Of particular concern are the blockage of roads and the damage to the electrical power supply from falling trees and tree limbs as was experienced during Irene.

Storm Surge

Abnormal rise of water generated by a storm over and above the predicated astronomical tides is commonly referred to as storm surge. In short, it is the difference between the observed water level and the normal astronomical tide. Storm surge is not the same as storm tide, which is the water level rise due to the combination of storm surge and the astronomical tide. Extratropical storms such as nor'easters have produced some of the highest storm surges and resultant damages on record. However, hurricanes have the potential to produce much higher storm surges because of the vast amount of energy released by these storm systems over a relatively short duration. Hurricane Katrina in 2005 is one of the nation's most infamous examples of damage and devastation caused by storm surge.

In 2011, Tropical Storm Irene struck at high tide during a perigee (full moon) tide resulting in an abnormally high storm surge causing serious coastal damage in Connecticut. The storm surge from Irene destroyed structures and flooded many coastal roads in East Haven and Milford. Superstorm Sandy in 2012 also produced a devastating storm surge along the shoreline. The tropical events of 2020 and 2021, did not produce surge levels as severe as Irene or Sandy, however, there were certainly local incidents of surge inundation and coastal flooding.

A number of factors contribute to the generation of storm surge, but the fundamental forcing mechanism is wind and the resultant frictional stress it imposes on the water surface as it forces water to move inland. The magnitude of storm surge within a coastal basin is governed by both the meteorological parameters of the hurricane and the physical characteristics of the basin. The meteorological aspects include the hurricane's size, measured by the radius of maximum winds; the intensity, measured by sea level pressure and maximum surface wind speeds at the storm center; the path, or forward track of the storm; and the storm's forward speed.

The Saffir/Simpson Scale

The "Saffir-Simpson Hurricane Scale" was used prior to 2009 to categorize hurricanes based upon wind speed, central pressure, and storm surge, relating these components to damage potential. In 2009, the scale was revised and is now called the "Saffir-Simpson Hurricane Wind Scale." The modified scale is more scientifically defensible and is predicated only on surface wind speeds. Storm surge is no longer part of the scale. The National Hurricane Center is considering offering specific warnings regarding storm surge based on Sea, Lake, and Overland Surges from Hurricanes (SLOSH) mapping for areas that could be impacted by a hurricane.

Table 3-8 lists the hurricane characteristics mentioned above as a function of category as well as the expected central pressure.

Table 3-8 Hurricane Characteristics

Category	CENTRAL PRESSURE		WIND SPEED		SURGE Feet	Damage Potential
	Millibars	Inches of Hg	MPH	Knots		
1	>980	>28.9	74-95	64-83	4-5	Minimal
2	965-979	28.5-28.9	96-110	84-96	6-8	Moderate
3	945-964	27.9-28.5	111-130	97-113	9-12	Extensive
4	920-644	27.2-27.9	131-155	114-135	13-18	Extreme
5	<920	<27.2	>155	>135	>18	Catastrophic

Hurricanes are grouped into five categories based on strength. The following descriptions are from the National Hurricane Center.

- **Category One Hurricane:** Sustained winds 74-95 miles per hour (mph) (64-82 knots (kt) or 119-153 kilometers per hour (km/hr)). *Very dangerous winds will produce some damage.* Well-constructed frame homes could have damage to the roof, shingles, vinyl siding and gutters.

Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.

- **Category Two Hurricane:** Sustained winds 96-110 mph (83-95 kt or 154-177 km/hr). *Extremely dangerous winds will cause extensive damage.* Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
- **Category Three Hurricane:** Sustained winds 111-130 mph (96-113 kt or 178-209 km/hr). *Devastating damage will occur.* Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
- **Category Four Hurricane:** Sustained winds 131-155 mph (114-135 kt or 210-249 km/hr). *Catastrophic damage will occur.* Well-built framed homes can sustain severe damage with the loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
- **Category Five Hurricane:** Sustained winds greater than 155 mph (135 kt or 249 km/hr). *Catastrophic damage will occur.* A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

3.4.1.1.2 Historic Record

Through research efforts by the National Oceanic and Atmospheric Administration's (NOAA) National Climate Center in cooperation with the National Hurricane Center, records of tropical cyclone occurrences within the Atlantic Cyclone Basin have been compiled from 1851 to present. These records are compiled in NOAA's Hurricane database (HURDAT), which contains historical data recently reanalyzed to current scientific standards as well as the most current hurricane data.

During HURDAT's period of record (1851-2016), three Category Three Hurricanes, 11 Category Two Hurricanes, 17 Category One Hurricanes, and 42 tropical storms have tracked within a 150 nautical mile radius of New London. The representative storm strengths were measured as the peak intensities for each individual storm passing within the 150-mile radius. The 31 hurricanes noted above occurred in July through October as noted in Table 3-9. Based on the historical record, the months of August and September appear to be the time of highest risk for a hurricane or tropical storm to impact the region.

Table 3-9 Tropical Cyclones by Month within 150 Miles of New London, 1851-2016

Category	July	August	September	October	Total
Tropical Storm[1]	7	14	14	7	42
One	2	6	6	3	17
Two	0	4	6	1	11
Three	0	1	2	0	3
Total	**9**	**25**	**28**	**11**	**73**

[1]One tropical storm occurred in May, one occurred in June, and one occurred in November. Hurricane Irene is counted as a Tropical Storm, and Hurricane Sandy is counted as a Hurricane in this table although both were technically extratropical systems upon approach to New London.

While the SCCOG region has experienced hurricanes and tropical storms as shown in Table 3-9, but not all of these storms were damaging events. Many passed out to sea southeast of Long Island Sound and thus produced minimal winds and surges. A description of major tropical cyclones that caused damage near the SCCOG region follows:

- An unnamed hurricane in September 1869 was a Category Three Hurricane when its center made landfall in Rhode Island. The hurricane was fairly compact without strong winds on the west side of the center. Storm surge was reported at 8 feet but mitigated by low tide. Heavy winds downed many trees and left severe damage. All telegraph lines between New York and Boston were cut by the storm.
- The most devastating hurricane to strike Connecticut and believed to be the strongest hurricane to hit New England in recorded history, is believed to have been a Category Three Hurricane at its peak. Dubbed the "Long Island Express of September 21, 1938," this name was derived from the unusually high forward speed of the hurricane (estimated to be 70 mph). As a Category Two Hurricane, the center of the storm passed over Long Island, made landfall near Milford, Connecticut, and moved quickly northward into northern New England.
- The majority of damage was caused from storm surge and wind damage. Surges up to 18 feet were recorded along portions of the Connecticut coast, and 130 mile per hour gusts flattened forests, destroyed nearly 5,000 cottages, farms, and homes, and damaged an estimated 15,000 more throughout New York and southern New England. The storm resulted in catastrophic fires in New London and Mystic, Connecticut. Totals of 14 to 17 inches of rain were reported in central Connecticut, causing severe flooding. Overall, the storm left an estimated 564 dead, 1,700 injured, and caused physical damages in excess of $38 million (1938 USD).
- The "Great Atlantic Hurricane" hit the Connecticut coast in September 1944. This storm was a Category Four Hurricane at its peak intensity but was a Category One Hurricane when its center passed over eastern Long Island and made landfall in Connecticut near New London. The storm brought rainfall in excess of six inches to most of the state and rainfall in excess of eight to 10 inches in Fairfield County. Most of the wind damage from this storm occurred in southeastern Connecticut although wind gusts of 109 mph were reported in Hartford, Connecticut. Injuries and storm damage were lower in this hurricane than in 1938 because of increased warning time and the fewer structures located in vulnerable areas due to the lack of rebuilding after the 1938 storm.
- Hurricane Carol was a Category Two Hurricane when it made landfall in Connecticut near Clinton in late August 1954. The storm arrived shortly after high tide and produced storm surges of 10 to 15 feet in southeastern Connecticut. Rainfall amounts of six inches were recorded in New London, and wind gusts peaked at over 100 mph. Near the coast, the combination of strong winds and storm surge damaged or destroyed thousands of buildings, and the winds toppled trees that left most of the eastern part of the state without power. Overall damages in the northeast were estimated at one billion dollars (1954 USD), and 48 people died as a direct result of the hurricane. Western Connecticut was largely unaffected by Hurricane Carol due to the compact nature of the storm.

- As also described in Section 3.4.3.1.2 , the year 1955 was a devastating year for flooding in Connecticut. Connie was a declining tropical storm over the Midwest when its effects hit Connecticut in August 1955, producing heavy rainfall of four to six inches across the state. The saturated soil conditions exacerbated the flooding caused by Tropical Storm Diane five days later, the wettest tropical cyclone on record for the northeast. The storm produced 14 inches of rain in a 30-hour period, causing destructive flooding conditions along nearly every major river system in the state.
- Hurricane Belle of August 1976 was a Category One Hurricane as it passed over Long Island but was downgraded to a tropical storm before its center made landfall near Stratford, Connecticut. Belle caused five fatalities and minor shoreline damage.
- Hurricane Gloria of September 1985 was a Category Three Hurricane when it made landfall in North Carolina and weakened to a Category Two Hurricane before its center passed over Long Island, New York, making landfall in Connecticut near Bridgeport. The hurricane struck at low tide, resulting in low to moderate storm surges along the coast. The storm produced up to six inches of rain in some areas and heavy winds that damaged structures and uprooted thousands of trees. The volume and spread of debris and loss of power were the major impacts from this storm, with over 500,000 people suffering significant power outages.
- Hurricane Bob was a Category Two Hurricane when its center made landfall in Rhode Island in August 1991. The hurricane caused storm surge damage along the Connecticut coast but was more extensively felt in Rhode Island and Massachusetts. Heavy winds were felt across eastern Connecticut with gusts up to 100 mph and light to moderate tree damage. The storm was responsible for six deaths in the state. Total damage in southern New England was approximately $680 million (1991 USD).
- Tropical Storm Floyd struck Connecticut in 1999. Floyd is the storm of record in the Connecticut Natural Hazard Mitigation Plan due to heavy rainfall that caused widespread flood damage throughout the state. The winds associated with Tropical Storm Floyd also caused power outages throughout New England and at least one death in Connecticut.
- Hurricane Irene peaked as a Category Three storm before it made landfall in North Carolina and tracked northward along the Delmarva Peninsula and New Jersey before the remnants of the eye crossed over New York City on Sunday, August 28, 2011. Anticipating storm surges along the Atlantic coastline, many states and municipalities issued mandatory evacuations on August 26 and 27, 2011. Many coastal towns in the SCCOG region ordered a mandatory evacuation to all residents in anticipation of Hurricane Irene's landfall on Saturday, August 27, 2011, which had been downgraded to a Tropical Storm at the time of landfall. The largest damage was done to electrical lines throughout the State of Connecticut. More than half of the State (over 754,000 customers) was without power following the storm, with some areas not having electricity restored for more than a week. A total of 10 deaths were attributed to the storm in Connecticut.
- Hurricane Sandy struck the Connecticut shoreline as a Category 1 Hurricane in late October 2012, causing power outages for 600,000 customers and at least $360 million in damages in Connecticut. Damages in southeast Connecticut were minor, with only a small number of power outages reported. The most significant damage occurred due to storm surge flooding along the coastline, as well as high winds. FEMA Public Assistance records indicate that some towns, such

as Norwich and New London, received $500,000 to $1,000,000 federal money to aid with the cleanup.

- On August 2, 2020, Tropical Storm Isaias swept through the State bringing severe winds which resulted in one of the highest outage events Connecticut has ever experienced. With over 620,000 outages reported by Eversource, 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 the typical amount of rainfall experienced during a tropical storm event, the wind damage exceeded expectations bringing down trees and power lines across the State. FEMA Public Assistance received throughout the region was over $750,000.

The State experienced four tropical storm events in 2021: Elsa, Fred, Henri, and Ida.

- Tropical Storm Elsa was the first to occur on July 9, 2021, and brought heavy rains and wind gusts of 43 mph recorded at the Groton-New London Airport. Though damage was not as severe as forecast, there were thousands of power outages throughout the SCCOG region. Rainfall totals included 2.9 inches in Quaker Hill, 2.8 inches in New London, and 1.73 in Groton. Western parts of Connecticut saw up to 5.1 inches of rainfall.
- Remnants of Tropical Storm (extratropical storm) Fred moved through the State on August 19, 2021, bringing heavy rains and concerns of tornadic activity. However, damage was not significant from the event for the SCCOG region, with only 1.5 to 2 inches of rainfall and localized flooding issues.
- Shortly after Fred, Tropical Depression Henri was expected to make landfall which included a more severe forecast. On August 22, after being downgraded from a Category 1 hurricane, Henri made landfall in Westerly, Rhode Island, just over the State border, and quickly moved through the Region. The storm was short lived, rainfall totals included 2.5 inches at Quaker Hill, and 3.6 in New London, and wind speeds rapidly weakened just before landfall. There were also thousands of power outages, with Groton reportedly being one of the hardest hit communities in the Region with approximately 4,200 customers without power during the peak of the storm. Other communities with significant outages included Stonington with over 1,200 and Ledyard, with over 1,000. Both Groton Town and City declared states of emergency as a result of Henri. In an additional response to Henri, Mohegan Sun closed several dining and retail outlets, and postponed a Sunday concert event in preparation. The Foxwoods casino also shifted and condensed their operations to accommodate staffing availability, and overall safety as the storm progressed.
- The fourth event of the 2021 season was Extratropical Storm Ida on September 1. For the first time, a statewide flash flood emergency was issued due to anticipated heavy rainfall. Several inches of rain fell across the State, with some communities seeing between 7 and 8 inches. Some communities, including the City of Norwich, warned residents to have minimal contact with surface waters after the event due to discharge of untreated sewage. Roads, bridges, and culverts were impacted across the regions, with major damage cited by CT DOT on route 63 in Watertown.

Impacts of 2021 hurricane season fact sheet

Isaias fact sheet

3.4.1.1.3 Existing Capabilities

Each community individually, and the region as a whole, have various capabilities to mitigate tropical storms and their associated hazards.

Flooding

Existing mitigation measures appropriate for flooding are discussed in Sections 3.4.2.1 and 3.4.3.1. These include the ordinances, codes, and regulations that have been enacted to minimize flood damage, as well as the aggressive programs to elevate and remove floodprone homes throughout the region. In addition, various structures exist to protect certain coastal areas, including bulkheads, seawalls, jetties, groins, and riprap.

Wind

Nearly all of the SCCOG jurisdictions utilize the Connecticut State Building Code which addresses the requirements for wind loading. The two tribal governments utilize building codes which have stricter standards in certain cases than the State Building Code. The 2022 Connecticut State Building Code was most recently amended in 2022 and adopted with an effective date of October 1, 2022. The code specifies the design wind speed for construction in all the Connecticut municipalities, with the addition of split zones for some towns to account for inland areas that are less susceptible to direct wind damage. Table 3-10 presents the basic design wind speed for SCCOG jurisdictions based on the applicable building code. Design wind speeds vary depending on the type of building construction. The 2022 State Building Code also classifies areas south of Interstate 95 as a Wind-Borne Debris Region in the communities of East Lyme, Groton, New London, Stonington, and Waterford.

Table 3-10 Ultimate Design Wind Speed in SCCOG Jurisdictions

Jurisdiction	Ultimate Design Wind Speed (mph)[1]
Bozrah	115
Colchester	115
East Lyme	120
Franklin	115
Griswold	120
Groton[2]	120
Lebanon	115
Ledyard[3]	120
Lisbon	115
Montville[3]	120
New London	120
North Stonington	120
Norwich	115
Preston	120
Salem	115
Sprague	115
Stonington[2]	120
Waterford	120
Windham	115

1. Based on three second gust in Appendix R of the State Building Code.
2. State Building Code does not separate out boroughs.
3. State Building Code does not specifically address Tribal Land.

Connecticut is located in FEMA Zone II regarding maximum expected wind speed. The maximum expected wind speed for a three-second gust is 160 miles per hour in south-central and southeastern Connecticut. This wind speed could occur as a result of either a hurricane or a tornado. The American Society of Civil Engineers recommends that new buildings be designed to withstand this peak three-second gust which is much greater than the design wind speeds noted in Table 3-10.

Jurisdictions in the SCCOG region have actively supported wind mitigation, especially along the shoreline. Typical mitigation activities include encouraging the installation of storm shutters and promoting hurricane preparedness by providing information to the public and encouraging evacuation signage and routes. In addition, the majority of SCCOG jurisdictions require all utilities in new subdivisions to be located underground whenever possible in order to mitigate storm-related wind damages.

Each SCCOG jurisdiction has designated an individual as Tree Warden and administers a tree-trimming program. Tree-trimming on municipally owned property is conducted on an as-needed basis or following complaints by residents. Most tree-trimming is conducted with clean-up activities following storms. In general, local governments maintain small trees and downed branches and contract with tree companies to deal with larger trees. Local electric companies (Bozrah Light & Power, Eversource, Groton Utilities, Norwich Public Utilities, and tribal utilities) have tree trimming maintenance programs in place.

Prior to hurricane and tropical storm emergencies, SCCOG jurisdictions will activate their local EOCs and open emergency shelters. Although hurricanes that have impacted southeastern Connecticut have historically passed in a day's time, additional shelters could be outfitted following a storm on an as-need basis for long-term evacuees. In addition, the local jurisdictions ensure that warning/notification systems and communication equipment are working properly and prepare for the possible evacuation of impacted areas.

The SCCOG region relies on the CT "Everbridge" Reverse 911 system, radio, cable television, area newspapers, and the internet to spread information on the location and availability of shelters. It is understood that several of these information sources can be cut off due to power failure, so emergency personnel can also pass this information on manually via door-to-door communication and public flyers. This was the primary method of communication during Irene, for example.

3.4.1.1.4 Vulnerabilities and Risk Assessment

NOAA issues an annual hurricane outlook to provide a general guide to each upcoming hurricane season based on various climatic factors. However, it is impossible to predict exactly when and where a hurricane will occur. NOAA believes that "hurricane landfalls are largely determined by the weather patterns in places the hurricane approaches, which are only predictable within several days of the storm making landfall."

NOAA has utilized the National Hurricane Center Risk Analysis Program (HURISK) to determine return periods for various hurricane categories at locations throughout the United States. As noted on the NOAA website, hurricane return periods are the frequency at which a certain intensity or category of hurricane can be expected within 75 nautical miles of a given location. For example, a return period of 20 years for a particular category storm means that on average during the previous 100 years a storm of that category passed within 75 nautical miles of that location five times. Thus, it is expected that similar category storms would pass within that radius an additional five times during the next 100 years.

The State Hazard Mitigation Plan (2019) presents modeled return periods for tropical events making landfall in or near Connecticut. These estimates are shown in Table 3-11.

Table 3-11 Modeled Return Periods for Various Hurricane Events

Tropical Event	Return Period
Category 1	10 to 15 years
Category 2	23 to 30 years
Category 3	46 to 74 years

Source: CT State HMP (2019)

Though the region has been impacted by multiple tropical events in the past decade, Superstorm Sandy, which occurred in October of 2012, remains a significant reminder that hurricanes track close to Connecticut, and significant damage can be inflicted even by storms that do not make direct landfall over the state. Importantly, despite major news coverage, over $360 million in damage, and four deaths, Sandy was a sub-tropical storm with its eye near Atlantic City, New Jersey, when its effects were felt in Connecticut. Therefore, the last major *hurricane* to impact Connecticut continues to be Hurricane Bob in 1991.

The 2019 *Connecticut Natural Hazard Mitigation Plan Update* has noted that in recent years, referencing the 2007 IPCC Synthesis Report, researchers have found that data shows the intensity of tropical events such as hurricanes and typhoons having increased over the last 35 years. The HMP also indicates that is likely, given the history of major storms and estimates for events in a future climate, that Connecticut should expect hurricanes of greater intensity. This could also include an increase in associated hazards such as high winds, storm surge, and flooding.

In general, as the residents and businesses of the state of Connecticut become increasingly dependent on the internet and mobile communications, the impact of hurricanes on commerce will continue to increase. A major hurricane has the potential of causing complete disruption of power and communications for up to several weeks, rendering electronic devices and those that rely on utility towers and lines inoperative. The most impactful recent event, Tropical Storm Isaias, is a good example of this when some residents went almost a week without power. Damage from these types of storms can be from several sources:

- Strong winds can cause debris such as signs, roofing material, and small items left outside become flying missiles during hurricanes. Such debris can cause direct damage to structures, vehicles, and people.

- Parts of trees (limbs) or entire tall and older trees may snap and fall during heavy wind events, potentially damaging structures, utility lines, vehicles, and people. Extensive damage to trees, towers, aboveground and underground utility lines (from uprooted trees, poles, or failed infrastructure) may cause considerable disruption for residents. This is considered the most problematic issue associated with strong winds. Following a major storm, the loss of power to the region's many traffic signals potentially causes expenditures of a great deal of manpower to control and post the intersections for duration of the power outages and creates vulnerabilities for maintaining emergency communication as many areas have insufficient backup power sources.
- Streets may be flooded or blocked by fallen branches, poles, or trees, preventing egress.
- Downed power lines from heavy winds can also start fires during hurricanes with limited rainfall.
- Some hurricanes may also spawn tornados that cause additional damage.

The SCCOG region is highly vulnerable to hurricane damage from wind and flooding and from any tornadoes accompanying the storm. Wind is considered to be the most frequently occurring natural hazard in the region and its effects can be felt nearly everywhere. All of the damage to the region from historical tropical cyclones has been due to the effects of winds, flooding, and storm surge. Factors that influence vulnerability to tropical cyclones in the region include building codes currently in place, local zoning and development patterns, and the age and number of structures located in highly vulnerable areas of each community. In addition, the coastline is home to private and municipal marinas which are vulnerable to the effects of both wind and flooding.

Recall from Section 2 that elderly and persons with disabilities reside in the region. It is possible that populations impacted by a widespread high-wind event such as a hurricane could consist of the elderly and numerous people with disabilities. Thus, it is important for local jurisdictions to be prepared to assist these special populations during wind emergencies. More information regarding these populations is presented in each community annex.

Loss Estimates

To estimate potential losses associated with hurricanes and tropical storms, the FEMA HAZUS-MH version 6.0 was utilized to model probabilistic hurricanes, and FEMA Public Assistance (PA) and Individual Assistance (IA) figures were used to evaluate past losses, and the potential for future losses.

HAZUS-MH

In order to quantify potential hurricane damage, HAZUS-MH 6.0 simulations were run for probabilistic hurricanes that could theoretically affect the region. The simulated storms estimate the potential maximum damage that would occur (based on year 2020 dollar values using year 2020 census data) based on wind speeds of varying return periods.

Note that these simulations calculate damage for wind effects alone and not damages due to flooding or other non-wind effects. Thus, the damage and displacement estimates presented below are likely *lower* than would occur during a hurricane associated with severe rainfall and storm surge. Results are presented in Appendix F and summarized below.

The FEMA default values were used for each census tract in the *HAZUS-MH* simulations. A summary of the default building counts and exposure values is shown in Table 3-12. Approximately 48.8 billion dollars of building value was estimated to exist in the region.

Table 3-12 HAZUS-MH Hurricane Scenarios Basic Information

Occupancy	Building Count	Dollar Exposure
Agriculture	200	$107,177,000
Commercial	7,821	$11,542,353,000
Education	198	$3,183,268,000
Government	1,090	$2,071,586,000
Industrial	1,385	$1,871,968,000
Religion	516	$642,742,000
Residential	74,247	$29,379,164,000
Total	**85,457**	**$48,798,258,000**

The FEMA *Hurricane Model HAZUS-MH Technical Manual* outlines various damage thresholds to classify buildings damaged during hurricanes. The five classifications are summarized below:

- **No Damage or Very Minor Damage**: Little or no visible damage from the outside. No broken windows or failed roof deck. Minimal loss of roof cover, with no or very limited water penetration.
- **Minor Damage**: Maximum of one broken window, door, or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.
- **Moderate Damage**: Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.
- **Severe Damage**: Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to the interior from water. Limited, local joist failures. Failure of one wall.
- **Destruction:** Essentially complete roof failure and/or more than 25% of roof sheathing. A significant amount of the wall envelope opened through window failure and/or failure of more than one wall. Extensive damage to interior.

Table 3-13 presents the peak wind speeds during each wind event simulated by *HAZUS-MH* for the region. The number of expected buildings to experience various classifications of damage is presented in Table 3-13, along with the total number of buildings expected to experience various classifications of damage. Minimal damage is expected to buildings for wind speeds less than 65 mph, with overall damages increasing with increasing wind speed.

Table 3-13 HAZUS Hurricane Scenarios – Number of Buildings Damaged

SCCOG	Return Period	Peak Wind Gust (mph)	Minor	Moderate	Severe	Destruction	Total
2022 Results	10-year	52 - 56	67	1	0	0	68
	20-year	71 - 74	501	28	0	0	529

	50-year	89	5,417	644	25	6	6,092
	100-year	97 - 101	12,436	2,201	157	65	14,859
	200-year	105 - 106	19,611	4,858	537	244	25,249
	500-year	112 - 114	27,090	9,421	11,955	763	49,229
	1,000-year	116 - 118	30,395	12,742	2,753	1,364	47,254

The *HAZUS* simulations consider a subset of critical facilities termed "essential facilities" that are important during emergency situations. Note that the essential facilities in *HAZUS-MH* may not necessarily be the same today as they were in 2020. Nevertheless, the information is useful from a planning standpoint. As shown in Table 3-14, minimal damage to essential facilities is expected for wind speeds less than 100 mph (100 year or smaller). Some fire stations and police stations are simulated to experience minor to moderate damage when winds exceed 100 mph. Schools are not expected to experience more than minor damage for wind speeds below those of a 200-year wind event. Relatively minor wind events were simulated as having the potential to damage the hospitals in the region, with significant damage occurring beginning with the 100-year event. Emergency operations centers (EOCs) in the region were not simulated as receiving damage under any scenario.

Table 3-14 HAZUS-MH Hurricane Scenarios – Essential Facility Damage

Return Period or Hurricane	EOC (Total of 22)	Fire Station (Total of 62)	Police Station (Total of 30)	Schools (Total of 117)	Hospitals (Total of 6)
10-Year	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use
20-Year	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use
50-Year	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use
100-Year	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use
200-Year	None or minor damage, no loss of use	None or minor damage, no loss of use	None or minor damage, no loss of use	Probability of at least 1 facility having at least moderate damage	None or minor damage, no loss of use
500-Year	None or minor damage, no loss of use	None or minor damage, no loss of use	Probability of at least 2 facilities having at least moderate damage	Probability of at least 13 facilities having at least moderate damage	Probability of at least 1 facility having at least moderate damage
1,000-Year	Probability of at least 1 facility having at least moderate damage	None or minor damage, no loss of use	Probability that 4 will be at least moderately damaged greater than 50%, no loss of use	Probability that 22 will be at least moderately damaged greater than 50%, no loss of use	Probability that 1 will be at least moderately damaged greater than 50%, 3 with loss of use > 1 day.

Table 3-15 presents the estimated tonnage of debris that would be generated by wind damage during each *HAZUS-MH* hurricane scenario. As shown in Table 3-15, minimal debris is expected for wind speeds less than the 20-year event. Reinforced concrete and steel buildings are expected to generate the least amount of debris under any conditions. The majority of the debris that is generated is tree related.

Table 3-15 HAZUS-MH Hurricane Scenarios – Debris Generation (Tons)

SCCOG	Return Period	Total Debris Generated	Brick / Wood	Reinforced Concrete / Steel	Eligible Tree Debris
2022 Results	10-year	296	36	0	260
	20-year	6,084	3,549	0	2,699
	50-year	54,624	27,479	4	27,137
	100-year	102,182	61,570	48	40,555
	200-year	176,281	113,720	210	63,351
	500-year	310,226	197,289	852	112,084
	1,000-year	424,006	274,017	1,691	148,262

Table 3-16 presents the potential sheltering requirements based on the various wind events simulated by *HAZUS-MH*. The predicted sheltering requirements for wind damage are minimal below the 100-year event.

Table 3-16 HAZUS Hurricane Scenarios – Shelter Requirements

Return Period or Hurricane	Number of Displaced Households	Short-Term Sheltering Need (Number of People)
10-Year	0	0
20-Year	0	0
50-Year	14	4
100-Year	111	36
200-Year	429	170
500-Year	1,494	695
1,000-Year	2,847	1,435

Table 3-17 presents the predicted building related economic loss due to the various simulated wind events. Building related economic loss estimates include the subcategories of property damage (Table 3-18) and business interruption (Table 3-19). Property damage estimates include damages to the building itself, contents, and inventory. Business interruption losses include loss of income, relocation, rental, and wages.

Table 3-17 HAZUS-MH Building Related Economic Losses

Return Period	Residential	Commercial	Industrial	Others	Total
10-year	$2,369,700	$22,540	$6,840	$4,430	$2,403,510
20-year	$194,824,470	$2,199,280	$298,670	$836,650	$53,441,310
50-year	$272,518,570	$29,607,590	$4,734,830	$10,518,360	$330,787,520

100-year	$522,555,870	$86,981,980	$12,507,030	$39,368,310	$691,586,600
200-year	$1,181,335,630	$246,111,420	$46,340,680	$125,272,930	$1,599,060,660
500-year	$2,294,125,580	$555,728,260	$105,180,770	$274,419,540	$3,236,623,550
1,000-year	$3,346,423,980	$888,917,530	$163,843,200	$388,355,450	$4,787,540,160

Table 3-18 HAZUS-MH Hurricane Scenarios – Property Damage

Return Period	Building Losses	Content Losses	Inventory Losses
10-Year	$1,763,510	$793,810	$0
20-Year	$48,266,280	$6,516,230	$2,290
50-Year	$265,027,500	$48,336,820	$1,583,470
100-Year	$584,073,220	$135,957,370	$3,946,120
200-Year	$1,083,332,390	$319,264,440	$11,162,660
500-Year	$2,020,304,100	$715,077,570	$28,095,090
1,000-Year	$2,896,159,310	$1,125,600,550	$45,881,540

Business interruption loss estimates in Table 3-19 include the subcategories of lost income, relocation expenses, rental expenses, and lost wages. The business interruption losses are associated with the inability to operate a business due to the damage sustained during a hurricane and also include temporary living expenses for those people displaced from their homes because of the storm.

Table 3-19 HAZUS-MH Hurricane Scenarios – Business Interruption

Return Period	Income Losses	Relocation Losses	Rental Losses	Wage Losses
10-Year	None	$7,160	$430	None
20-Year	None	$622,560	$699,710	None
50-Year	$2,905,530	$13,414,520	$9,209,830	$6,201,660
100-Year	$8,255,610	$39,074,800	$24,591,490	$23,103,210
200-Year	$14,566,140	$92,735,890	$49,250,600	$52,226,930
500-Year	$29,916,500	$203,222,320	$96,229,610	$81,987,510
1,000-Year	$45,787,530	$305,762,810	$139,058,340	$96,520,290

Table 3-20 summarizes the losses presented in Table 3-18 and Table 3-19. Losses are relatively small for storms with return periods of less than the 20-year but increase rapidly as stronger storms are considered. For example, a 100-year hurricane wind event (slightly stronger than Hurricane Carol in 1954) would cause approximately $819 million in economic losses to the region.

Table 3-20 HAZUS-MH Hurricane Scenarios – Building-Related Economic Loss

Return Period	Total Property Damage	Total Business Interruption	Total Losses	Annualized Loss Estimate
10-Year	$2,557,320	$7,590	$2,654,910	$1,469,049.25
20-Year	$54,784,790,	$1,322,270	$56,107,060	$6,041,796.00
50-Year	$314,947,790	$31,731,550	$346,679,340	$5,828,405.80
100-Year	$723,976,710	$95,025,100	$819,001,820	$6,103,852.13
200-Year	$1,413,759,480	$208,779,550	$1,622,539,030	$7,191,557.61

500-Year	$2,763,476,760	$408,355,950	$3,171,832,710	$3,913,301.54
1,000-Year	$4,067,641,390	$587,128,960	$4,654,770,360	$4,654,770.36
Total				**$35,202,732.68**

The probabilistic storm losses in Table 3-20 can be utilized to determine the annualized loss to the region due to hurricane wind. The annualized loss based on the losses incurred during storms with return periods of 10, 20, 50, 100, 200, 500, and 1000 years, is $35.2 million[5]. This includes direct property damage as well as business interruption losses. This figure is based on probabilistic hurricane events and does not address the historic hurricanes modeled in *HAZUS-MH*. Recall that *HAZUS-MH* modeled wind damage only and did not include damages from flooding caused by hurricanes.

Public Assistance

Loss estimates for hurricane wind can also be generated from the Public Assistance figures received by municipalities and other entities within the SCCOG region. According to information from the FEMA Public Assistance Funded Projects Summary (Open Government Initiative), there were two hurricane wind events (Irene and Sandy) since 2017 that resulted in federal disaster declarations in southeastern Connecticut, however only one left the SCCOG region eligible for public assistance. Tropical Storm Isaias resulted in reimbursement requests to FEMA, the other, Hurricane Ida, resulted in IA requests, described below. These expenses included debris removal, emergency protective measures, state management costs, and repairs to damaged infrastructure and buildings experienced by local governments and non-profits. A summary for the SCCOG region is presented in Table 3-21 below.

Table 3-21 Public Assistance Reimbursements Related to Hurricanes and Tropical Storms Since 2017

SCCOG Jurisdiction	Local Government Cost	Other Local Agency Cost*	Total Cost
Bozrah	None	None	None
Colchester	$94,251.30	None	$94,251.30
East Lyme	$74,746.15	$3,033.34	$77,779.49
Franklin	$10,088.75	None	$10,088.75
Griswold	$29,051.27	$3,033.34	$32,084.61
Groton, City of	None	None	None
Groton, Town of	None	$3,033.34	$3,033.34
Jewett City, Borough of	None	None	None
Lebanon	None	None	None
Ledyard	$25,748.47	$3,033.34	$28,781.81
Lisbon	None	None	None
Mashantucket Pequot Tribal Nation	None	None	None
Mohegan Tribe	None	None	None
Montville	None	$3,033.34	$3,033.34
New London	None	$3,033.34	$3,033.34
North Stonington	None	$3,033.34	$3,033.34

[5] Using an equation presented in the HAZUS-MH Technical Manual to calculate annualized loss.

Norwich	$452,543.54	$3,033.34	$455,576.88
Preston	None	$3,033.34	$3,033.34
Salem	None	None	None
Sprague	None	$3,033.34	$3,033.34
Stonington, Borough of	None	None	None
Stonington, Town of	$9,000.00	$3,033.34	$12,033.34
Waterford	$27,813.48	$3,033.34	$30,846.82
Windham	None	None	None
Total	$7,297,877.40	$36,400.13	$759,643.09

*Other agencies = Fire Districts, Schools, Housing Authorities, and other Non-Profit Agencies

Tropical Storm Isaias caused severe wind damage across the region and state, leaving thousands without power for days. It is assumed that the majority of the funds received for this event were for wind damage, however, an exact breakdown is not immediately available.

Since 2012, there have been two hurricanes that the region received PA for: Tropical Storm Isaias, and Superstorm Sandy. The funds received throughout the region for both events can be found, along with the reported project costs, and the annualized loss estimates based on these events.

Table 3-22 Hurricane Related Public Assistance Reimbursements Since 2012

Community	PA Funds Received	Reported Project Costs	Annualized Loss Estimates
Colchester	$216,155	$267,262	$26,726
East Lyme	$2,242,023	$2,972,754	$297,275
Franklin	$17,719	$23,625	$2,363
Griswold	$78,395	$90,802	$9,080
Groton City	$485,472	$575,295	$57,529
Groton Town	$612,767	$817,022	$81,702
Lebanon	$30,672	$40,896	$4,090
Ledyard	$94,778	$126,370	$12,637
Mashantucket Pequot Indian Reservation	$178,995	$238,660	$23,866
Montville	$92,079	$122,772	$12,277
New London	$764,340	$1,019,120	$101,912
North Stonington	$48,988	$65,317	$6,532
Norwich	$1,283,449	$1,483,880	$148,388
Preston	$10,810	$14,414	$1,441
Salem	$24,219	$32,844	$3,284
Sprague	$44,960	$59,947	$5,995
Stonington	$306,084	$424,628	$42,463
Stonington Borough	$97,371	$129,828	$12,983
Waterford	$324,550	$432,733	$43,273
Windham	$56,985	$75,979	$7,598
Southeastern Connecticut Water Authority (SCWA)	$20,086.39	$26,781.85	$2,678

Southern Connecticut Regional Resources Recovery Authority (SCRRA)	$120,537.90	$160,717.30	$16,072
Total	**$7,151,431**	**$9,201,645**	**$920,164**

Based on the information in Table 3-22, hurricane wind losses reimbursed through the FEMA Public Assistance Program have totaled $7.1 million for the SCCOG region since 2012. The annualized loss due to hurricane wind for the SCCOG region over the past 10 years of record in the Public Assistance report is therefore $9,201,645.

Summary

Hurricanes present a very real and potentially costly hazard to the region. Based on the historic record and *HAZUS-MH* simulations of various wind events, the entire region is at risk to wind damage from hurricanes. These damages can include direct structural damages, interruptions to business and commerce, emotional impacts, and injury and possibly death.

Based on FEMA Public Assistance reimbursements, the annualized estimated loss due to hurricanes and tropical storms is just over $900,000. This annualized estimate is for costs that each community sought reimbursement for such as debris removal, emergency operations, or road and bridge repairs. According to *HAZUS-MH* simulations, the annualized estimated loss is just over $31 million for property damage, and $3.8 million for business interruption (income loss). The HAZUS-MH estimate is utilized herein as an estimate of annualized loss for the SCCOG region as this figure likely takes into account unreported damages to private property that is not part of the Public Assistance information.

3.4.1.2 Tornadoes and High Winds

3.4.1.2.1 Hazard Assessment

The entire region is susceptible to damage from a severe thunder or summer storm (including high winds, heavy rain, flash flooding, hail, and lightning) and tornadoes. Like hurricanes and winter storms, summer storms and tornadoes have the potential to affect any area within the region. 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 a jurisdiction without harming another. Thus, these storms are considered to be less regional in nature and potential vulnerability is discussed within each community annex.

Based on the historic record, it is considered highly likely that a severe storm that includes lightning or high winds will occur each year, although lightning strikes have a limited effect. Strong winds and hail are considered likely to occur during such storms but also generally have limited effects. However, high winds typically have more of an impact than lightning strikes. A tornado is considered a possible event in New London County each year and could cause significant damage to a small area. Based on the limited historic record of significant tornadoes affecting the SCCOG region, the previous HMP gave tornadoes a lower vulnerability and mitigation priority than other hazards.

Heavy wind (including tornadoes and downbursts), lightning, heavy rain, hail, and flash floods are the primary hazards associated with severe and summer storms. Flooding caused by heavy rainfall is covered in Section 3.4.3.1 of this plan and will not be discussed here.

Tornadoes

NOAA defines a tornado as "a violently rotating column of air extending from a thunderstorm to the ground." The two types of tornadoes include those that develop from supercell thunderstorms and those that do not. While the physics of tornado development are fairly well understood, there are many unknowns still being studied regarding the exact conditions in a storm event required to trigger a tornado, the factors affecting the dissipation of a tornado, and the effect of cloud seeding on tornado development.

Supercell thunderstorms are long-lived (greater than one hour) and highly organized storms feeding off an updraft that is tilted and rotating. This rotation is referred to as a "mesocyclone" when detected by Doppler radar. The figure below is a diagram of the anatomy of a supercell that has spawned a supercell tornado. Tornadoes that form from a supercell thunderstorm are a very small extension of the larger rotation; they are the most common and the most dangerous type of tornado as most large and violent tornadoes are spawned from supercells.

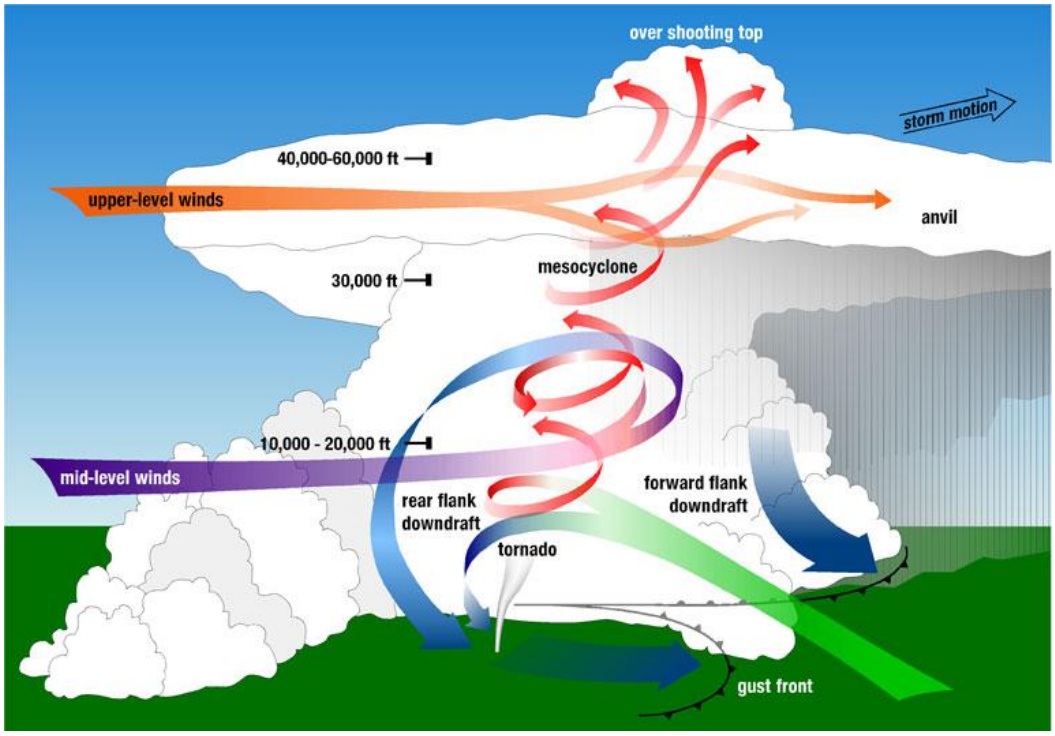


Figure 3-2: Anatomy of a Tornado. (NOAA National Severe Storms Laboratory)

Non-supercell tornadoes are defined by NOAA as circulations that form without a rotating updraft. Damage from these types of tornadoes tends to be F2 or less (see Fujita Scale, below). The two types of non-supercell tornadoes are gustnadoes and landspouts:

- A gustnado is a whirl of dust or debris at or near the ground with no condensation tunnel that forms along the gust front of a storm.
- A landspout is a narrow, ropelike condensation funnel that forms when the thunderstorm cloud is still growing and there is no rotating updraft. Thus, the spinning motion originates near the ground. Waterspouts are similar to landspouts but occur over water.

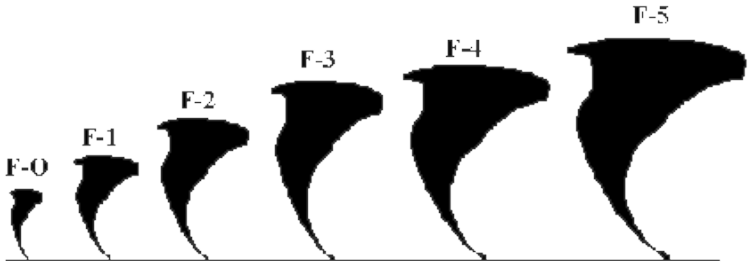
The Fujita Scale was accepted as the official classification system for tornado damage for many years following its publication in 1971. The Fujita Scale rated the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure. The scale ranked tornadoes using the now-familiar notation of F0 through F5, increasing with wind speed and intensity. A description of the scale follows in Table 3-23.

Table 3-23 Fujita Scale (National Weather Service)

F-Scale Number	Intensity	Wind Speed	Type of Damage Done
F0	Gale tornado	40-72 mph	Some damage to chimneys; branches broken off trees; shallow-rooted trees knocked over; damage to sign boards.
F1	Moderate tornado	73-112 mph	Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off for some distance; cars thrown, and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; steel-reinforced concrete structures badly damaged.

According to NOAA, weak tornadoes (F0 and F1) account for approximately 69% of all tornadoes. These tornadoes last an average of five to 10 minutes and account for approximately 3% of tornado-related deaths. Strong tornadoes (F2 and F3) account for approximately 29% of all tornadoes and approximately 27% of all tornado deaths. These storms may last for 20 minutes or more.

Violent supercell tornadoes (F4 and above) are extremely destructive but rare and account for only 2% of all tornadoes. These storms sometimes last over an hour and result in approximately 70% of all tornado-related deaths. Violent and long-lasting tornadoes have caused severe destruction to the Midwest and southern United States and are most common in these regions.



Fujita Tornado Scale. Image courtesy of FEMA.

The Enhanced Fujita Scale was released by NOAA for implementation on February 1, 2007. According to the NOAA website, the Enhanced Fujita Scale was developed in response to a number of weaknesses to the Fujita Scale that were apparent over the years, including the subjectivity of the original scale based on damage, the use of the worst damage to classify the tornado, the fact that structures have different construction depending on location within the United States, and an overestimation of wind speeds for F3 and greater.

Similar to the Fujita Scale, the Enhanced Fujita Scale is also a set of wind estimates based on damage. It uses three-second gusts estimated at the point of impact based on a judgment of eight levels of damage as compared to 28 specific indicators. These damage indicators range from some small barns to automotive service buildings, to trees and transmission line towers. Table 3-24 relates the Fujita and Enhanced Fujita Scales.

Table 3-24 Enhanced Fujita Scale

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

Official records of tornado activity date back to 1950. According to NOAA, an average of 1,000 tornadoes is reported each year in the United States. The historic record of tornadoes in the region is discussed in Section 3.4.1.2.1. Tornadoes are most likely to occur in Connecticut in June, July, and August of each year.

According to the NOAA Storm Event Database, the highest relative risk for tornadoes in each Connecticut County is Litchfield (36 events between January 1, 1950, and July 28, 2022) and New Haven (21) followed by Hartford (18 events) Counties, Fairfield (16 events), Tolland (15 events), Middlesex (7 events), Windham (7 events), and finally New London (4 events) Counties. In total, there have been 33 more tornado reports across the state since the 2017 update with several having occurred as a result of one storm cell. The same source shows the adjacent Washington County in Rhode Island as having three tornado events. The SCCOG region, covering most of New London County and including the Town of Windham, is at a minor risk for tornadoes. The pattern of occurrence in Connecticut is expected to remain unchanged according to the 2019 *Connecticut Natural Hazards Mitigation Plan*, although that documents points out that climate change is expected to increase the frequency and intensity of thunderstorms, in turn potentially increasing the risk and occurrence of associated tornadoes.

Image courtesy of NOAA.

Lightning

Lightning is a discharge of electricity that occurs between the positive and negative charges within the atmosphere or between the atmosphere and the ground. According to NOAA, the creation of lightning during a storm is a complicated process that is not fully understood. In the initial stages of development, air acts as an insulator between the positive and negative charges. However, when the potential between the positive and negative charges becomes too great, a discharge of electricity (lightning) occurs.

In-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom. Cloud-to-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom of a second cloud. Cloud-to-ground lightning is the most dangerous. In summertime, most cloud-to-ground lightning occurs between the negative charges near the bottom of the cloud and positive charges on the ground.

According to NOAA's National Weather Service, there is an average of 100,000 thunderstorms per year in the United States, with roughly 25 million lightning strikes. According to *A Detailed Analysis of Lightning Deaths in the United States from 2006 to* 2019, a total of 418 people were killed from lightning, which is an average of 32 people per year having died from lightning strikes in the United States in those 13 years. As of September 26, 2022, the NWS reported a total of 19 lightning related deaths in 2022 so far. Most lightning deaths can be attributed to leisure -related activities (54%), particularly boating and fishing which account for 14% of leisure-activity lightning deaths. In addition, daily routine activities account for 16% of deaths, work activities account for 18%, with the remaining 4% of activities being unknown. The historic record of lightning strikes in the SCCOG region is presented in Section 6.3.

Downbursts

A downburst is a severe localized wind blasting down from a thunderstorm. They are more common than tornadoes in Connecticut. Depending on the size and location of downburst events, the destruction to property may be significant.

Downburst activity is, on occasion, mistaken for tornado activity. Both storms have very damaging winds (downburst wind speeds can exceed 165 miles per hour) and are very loud. These "straight line" winds are distinguishable from tornado activity by the pattern of destruction and debris such that the best way to determine the damage source is to fly over the area.

Downbursts fall into two categories:

Microbursts affect an area less than 2.5 miles in diameter, last five to 15 minutes, and can cause damaging winds up to 168 mph.

Macrobursts affect an area at least 2.5 miles in diameter, last five to 30 minutes, and can cause damaging winds up to 134 mph.

It is difficult to find statistical data regarding frequency of downburst activity. NOAA claims that there are 10 downburst reports for every tornado report in the United States. This implies that there are approximately 10,000 downbursts reported in the United States each year and further implies that downbursts occur in approximately 10% of all thunderstorms in the United States annually. This value suggests that downbursts are a relatively uncommon yet persistent hazard. A few downbursts have occurred in the region as reported in the historic record in Section 3.4.1.2.1.

Hail

Hailstones are chunks of ice that grow as updrafts in thunderstorms keep them in the atmosphere. Most hailstones are smaller in diameter than a dime, but stones weighing more than 1.5 pounds have been recorded. NOAA has estimates of the velocity of falling hail ranging from nine meters per second (m/s) (20 mph) for a one centimeter (cm) diameter hailstone, to 48 m/s (107 mph) for an eight cm, 0.7 kilogram stone. While crops are the major victims of hail, larger hail is also a hazard to people, vehicles, and property.

According to NOAA's NCEI there have been 101 reports of hail in New London and Windham Counties, with one reported injury. There were nine reported events between 2018 and 2022 in the SCCOG region. Hailstorms typically occur in at least one part of Connecticut each year during a severe thunderstorm. Hail storms have occurred in the SCCOG region as reported in the historic record in Section 3.4.1.2.1.

3.4.1.2.2 Historic Record

Connecticut has had 124 confirmed tornado events since 1950. The most vulnerable area of the state are Litchfield County and New Haven County based on historical accounts. Only seven tornadoes have been reported in New London and Windham Counties. Inland areas are generally more vulnerable to tornadoes than coastal areas, since sea breezes have the effect of defusing tornadoes.

An extensively researched list of tornado activity in Connecticut is available on Wikipedia. This list extends back to 1648 although it is noted that the historical data prior to 1950 is incomplete due to lack of official records and gaps in populated areas. This record shows five tornadoes having occurred in the

region: one in 1799, 1918, 2002, 2018, 2021. Thus, the frequency of occurrence is very low. Details regarding these tornados are as follows:

- August 2, 1799: A tornado affected the towns of Franklin, Lebanon, and Bozrah, destroying two homes.
- September 18, 1918: A tornado cut a wide path (130 to 160 feet wide) from Groton through Mystic and out into Long Island Sound. Small buildings, roofs, trees, and telephone poles were heavily damaged, and several people received minor injuries from flying debris.
- June 16, 2002: A waterspout formed over Gardner Lake in Montville, causing F1 damage to trees, houses, and cars when it made landfall.
- October 29, 2018: An EF-0 tornado touched down in Stonington and caused several trees to uproot.
- November 13, 2021: A large storm produced four tornadoes in the state, with one touching down in the Pawcatuck area of Stonington. This event was the first record of tornadic activity in November since at least 1950.

Thunderstorms, on average, occur on 18 to 35 days each year in Connecticut. Only 4 lightning-related fatalities occurred in Connecticut between 1950 and 2022, with 68 injuries having occurred. For example, on June 8, 2008, lightning struck a pavilion at Hammonasset Beach in nearby Madison, Connecticut, injuring five and killing one. Hail is often a part of such thunderstorms as seen in the historic record for the SCCOG region. A limited selection of summer storm damage in and around SCCOG jurisdictions taken from the NCDC Storm Events database is listed in each community annex.

3.4.1.2.3 Existing Capabilities

Warning is the most viable and therefore the primary method of existing mitigation for tornadoes and thunderstorm-related hazards in Connecticut. The NOAA National Weather Service issues watches and warnings when severe weather is likely to develop or has developed, respectively. After a series of deadly tornadoes struck Litchfield and New Haven counties on July 10, 1989, killing two persons and causing millions of dollars in damage, Connecticut installed a new type of warning system. The National Oceanic and Atmospheric Administration (NOAA) Weather Radio Specific Area Message Encoder (WRSAME) system allows forecasters at three National Weather Service (NWS) offices to send watches and warnings to specific areas of Connecticut. Warnings can be sent within a few minutes of a Doppler radar indication that a tornado may be forming within a severe thunderstorm. Table 3-25 and Table 3-26 list the NOAA Watches and Warnings, respectively, as pertaining to actions to be taken by emergency management personnel in connection with summer storms and tornadoes.

Table 3-25 NOAA Weather Watches

Weather Condition	Meaning	Actions
Severe Thunderstorm	Severe thunderstorms are possible in your area.	Notify personnel and watch for severe weather.
Tornado	Tornadoes are possible in your area.	Notify personnel and be prepared to move quickly if a warning is issued.
Flash Flood	It is possible that rains will cause flash flooding in your area.	Notify personnel to watch for street or river flooding.

Table 3-26 NOAA Weather Warnings

Weather Condition	Meaning	Actions
Severe Thunderstorm	Severe thunderstorms are occurring or are imminent in your area.	Notify personnel and watch for severe conditions or damage (i.e., downed power lines and trees). Take appropriate actions listed in municipal emergency plans.
Tornado	Tornadoes are occurring or are imminent in your area.	Notify personnel, watch for severe weather, and ensure personnel are protected. Take appropriate actions listed in emergency plans.
Flash Flood	Flash flooding is occurring or imminent in your area.	Watch local rivers and streams. Be prepared to evacuate low-lying areas. Take appropriate actions listed in emergency plans.

Many SCCOG jurisdictions have weather alert radios in their EOCs. These radios are used in conjunction with the apparatus systems in coastal areas to warn residents of incoming severe weather and for evacuations when necessary.

A **severe thunderstorm watch** is issued by the National Weather Service when the weather conditions are such that a severe thunderstorm (winds greater than 58 miles per hour, or hail three-fourths of an inch or greater, or can produce a tornado) is likely to develop.

A **severe thunderstorm warning** is issued when a severe thunderstorm has been sighted or indicated by weather radar.

Aside from warnings, several other methods of mitigation for wind damage are employed in the SCCOG region as explained in Section 3.4.1.1.3 within the context of hurricanes and tropical storms. In addition, the Connecticut State Building Code and the International Building Code includes guidelines for the proper grounding of buildings and electrical boxes.

3.4.1.2.4 Vulnerabilities and Risk Assessment

According to the *2019 Connecticut Natural Hazard Mitigation Plan Update*, New London County and Windham County have the lowest risk to experience tornado damage out of all the counties in the State. However, the plan notes that, according to USDA data, Windham and New London Counties have the highest vulnerability of hail related crop loss and damage. As shown in the historic record, tornado activity in the region occurs approximately once every 15 to 20years. However, NOAA states that climate change has the potential to increase the frequency and intensity of tornadoes, so it is possible that the pattern of occurrence in southeastern Connecticut could change in the future. Most notably, the region has experienced two tornadoes since the last update, while previously events spanned several years.

Given the limited occurrence of tornadoes in Connecticut and the SCCOG region in particular, the magnitude and extent of tornado damage is not sufficient to justify the construction of tornado shelters or safe rooms. Instead, the State has provided NOAA weather radios to all public schools as well as to many local governments for use in public buildings. The general public continues to rely on mass media

for knowledge of weather warnings. Warning time for tornadoes is very short due to the nature of these types of events, so pre-disaster response time can be limited. However, the NOAA weather radios provide immediate notification of all types of weather warnings in addition to tornadoes, making them very popular with communities.

The central and southern portions of the United States are at higher risk for lightning and thunderstorms than is the northeast. However, FEMA reports that more deaths from lightning occur on the East Coast than elsewhere. This may be due to the relatively higher population density along the east coast as compared to the Midwest and southern portions of the United States. Lightning-related fatalities have declined in recent years due to increased education and awareness.

In general, thunderstorms and hailstorms in Connecticut are more frequent in the western and northern parts of Connecticut and slightly less frequent in the southern and eastern parts. Thunderstorms are expected to impact the SCCOG region at least 14 days each year. The majority of these events do not cause any measurable damage. Although lightning is usually associated with thunderstorms, it can occur on almost any day. The likelihood of lightning strikes in the SCCOG region is very high during any given thunderstorm although no particular area of the region is at higher risk of lightning strikes. The risk of at least one hailstorm occurring in the region is considered moderate in any given year.

Most thunderstorm damage is caused by straight-line winds exceeding 100 mph. Straight-line winds occur as the first gust of a thunderstorm or from a downburst from a thunderstorm and have no associated rotation. The risk of downbursts occurring during such storms and damaging the region is believed to be moderate for any given year. All areas of the region are susceptible to damage from high winds although more building damage is expected in densely populated inland areas and coastal neighborhoods.

Experience in the SCCOG region has generally shown that winds in excess of 50 mph will cause significant tree damage. The damage to buildings and electrical and cable 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. Most downed power lines in the region are detected quickly and any associated fires are quickly extinguished. Such fires can be extremely dangerous during the summer months during dry and drought conditions.

Loss Estimates

The *2019 Connecticut Natural Hazards Mitigation Plan Update* provides annual estimated losses on a countywide basis for several hazards. That Plan does not include any annualized estimated losses in New London County from tornado events, but in neighboring Windham County the annualized loss estimate is $85,329. The annualized number of tornado events in each county is very similar (0.06 in New London County, 0.04 in Windham County). For the purposes of estimated future losses, it was deemed reasonable to extrapolate the Windham County annualized losses to New London County.

Annualized losses due to tornadoes were estimated for each SCCOG community based on each community's population relative to their own county, using the countywide annualized loss estimate of $85,329 as a starting point. The annualized loss estimates for tornadoes are summarized in Table 3-27

below. Based on these figures, the annualized loss due to tornadoes in the SCCOG region is $98,948. This estimate for tornado damages is relatively low despite high costs from individual events due to the infrequency of their occurrence. The regional annualized loss was divided by the population ratio of each jurisdiction to its respective county in order to determine annualized losses to each SCCOG jurisdiction.

Annualized losses due to thunderstorms were estimated based on each community's population relative to their own county, and the annualized loss estimate presented in the 2019 CT NHMP for New London County ($49,028) and Windham County ($28,019). The annualized loss estimates for tornadoes and thunderstorms are summarized in Table 3-27 below. Based on these figures, the annualized loss due to thunderstorms in the SCCOG region is $52,445. The regional annualized loss was divided by the population ratio of each jurisdiction to its respective county in order to determine annualized losses to each SCCOG jurisdiction.

In summary, the entire region is at relatively equal risk for experiencing damage from summer storms and tornadoes. Based on the historic record, only a few summer storms or tornadoes have resulted in costly damages to the region's jurisdictions. Most damages are relatively site-specific and occur to private property (and therefore are paid for by private insurance). For municipal property, each local government's budget for tree removal and minor repairs is generally limited to handle routine summer storm damage.

Table 3-27 Estimated Annualized Losses from Thunderstorms & Tornadoes

Community	Estimated Annual Costs		
	Thunderstorms	Tornadoes	TOTAL
Bozrah	$443	$772	$1,215
Colchester	$2,840	$4,942	$7,782
East Lyme	$3,413	$5,939	$9,352
Franklin	$340	$592	$932
Griswold	$2,082	$3,623	$5,704
Groton City	$1,670	$2,906	$4,576
Groton Town	$5,011	$8,722	$13,733
Lebanon	$1,304	$2,269	$3,573
Ledyard	$2,812	$4,895	$7,707
Lisbon	$766	$1,333	$2,099
Mashantucket Pequot Tribal Nation			
Mohegan Tribe			
Montville	$3,357	$5,842	$9,199
New London	$4,996	$8,695	$13,692
North Stonington	$940	$1,636	$2,576
Norwich	$7,325	$12,749	$20,074
Preston	$874	$1,521	$2,395
Salem	$769	$1,339	$2,108
Sprague	$542	$943	$1,484
Stonington Borough	$163	$283	$446
Stonington Town	$3,347	$5,826	$9,173
Waterford	$3,573	$6,218	$9,791

Windham	$5,879	$17,902	$23,781
SCCOG TOTAL	**$52,445**	**$98,948**	**$151,393**

3.4.1.3 Severe Winter Storms

Similar to summer storms and tornadoes, winter storms have the potential to affect any part of the region. However, unlike summer storms, winter events and the hazards that result (wind, snow, and ice) have more widespread geographic extent. The entire region is therefore susceptible to winter storms and due to its location on the shoreline can have more snowfall totals during ocean-effect snowstorms. 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 region.

Extreme cold temperatures can accompany a severe winter storm, but also occur during many winters in the absence of a storm. Extreme cold can be defined as prolonged periods of time with freezing temperatures, often made worse by the impact of wind chill factors (the combined elements of air temperature and wind on exposed skin). At certain levels the human body may suffer from frostbite or hypothermia, making extreme cold a potentially severe and life-threatening hazard to people left unprotected from the elements. Freezing temperatures may cause severe damage to crops and other vegetation, and pipes may freeze and burst in structures that are poorly insulated or without heat.

3.4.1.3.1 Hazard Assessment

This section focuses on those effects commonly associated with winter storms, including those from blizzards, ice storms, heavy snow, freezing rain, and extreme cold. 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 include loss of power and heat.

According to the National Weather Service, approximately 70% of winter deaths related to snow and ice occur in automobiles, and approximately 25% of deaths occur from people being caught in the cold. In relation to deaths from exposure to cold, 50% are people over 60 years old, 75% are male, and 20% occur in the home.

The classic winter storm in New England is the nor'easter, which is caused by a warm, moist, low-pressure system moving up from the south colliding with a cold, dry high-pressure system moving down from the north. The nor'easter derives its name from the northeast winds typically accompanying such storms, and such storms tend to produce a large amount of precipitation.

Severe winter storms can produce an array of hazardous weather conditions, including heavy snow, blizzards, freezing rain and ice pellets, flooding, heavy winds, and extreme cold. The National Weather Service defines a blizzard as having winds over 35 mph with snow with blowing snow that reduces visibility to less than one-quarter mile for at least three hours. Along the coast, wind driven waves can batter the shore, causing flooding and severe beach erosion. Coupled with a high tide, the low pressure of a nor'easter can have an effect similar to a storm surge from a hurricane.

Connecticut experiences at least one severe winter storm every five years although a variety of small and medium snow and ice storms occur every winter. The likelihood of a nor'easter occurring in any given winter is therefore considered high, and the likelihood of other winter storms occurring in any given winter is very high.

Until recently, the Northeast Snowfall Impact Scale (NESIS) was used by NOAA to characterize and rank high-impact northeast snowstorms. This ranking system has evolved into the currently used Regional Snowfall Index (RSI). The RSI ranks snowstorms that impact the eastern two thirds of the United States, placing them in one of five categories: Extreme, Crippling, Major, Significant, and Notable. The RSI is based on the spatial extent of the storm, the amount of snowfall, and the juxtaposition of these elements with population. RSI differs from NESIS in that it uses a more refined geographic area to define the population impact. NESIS had used the population of the entire two-thirds of the United States in evaluating impacts for all storms whereas RSI has refined population data into six regions. The result is a more region-specific analysis of a storm's impact. The use of population in evaluating impacts provides a measure of societal impact from the event. Table 3-28 presents the RSI categories, their corresponding RSI values, and a descriptive adjective.

Table 3-28 RSI Categories

Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18.0+	Extreme

Connecticut typically experiences at least one severe winter storm every five years although a variety of small and medium snow and ice storms occur nearly every winter. The likelihood of a nor'easter occurring in any given winter is therefore considered high, and the likelihood of other winter storms occurring in any given winter is very high.

RSI values are calculated within a GIS. The aerial distribution of snowfall and population information are combined in an equation that calculates the RSI score, which varies from around one for smaller storms to over 18 for extreme storms. The raw score is then converted into one of the five RSI categories. The largest RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. Approximately 217 of the most notable historic winter storms to impact the Northeast have been analyzed and categorized by RSI through February 2022.

In addition to RSI, the snow intensity classification system, shown in Table 3-29, categorizes severe winter storms and nor'easters for the eastern and central United States. The five level hierarchy categorizes storms by snowfall amounts, rates, wind speeds, potential for drifting, disruptions, and impacts on costal and maritime activities.

Table 3-29 Snow Intensity Classification System

Intensity Index Category	Maximum Snowfall Amounts	Maximum Snowfall Rate	Potential Wind Speeds	Maximum Drifting Potential	Closings/ Delays on Communities, Schools, And Travel	Impact On Coastal and Maritime Interests	Nature Of Disruption
1	< 10 in.	Very low < 1 in./hr	Weak	Minor < 20 in.	Maybe minor (hours)	Minor	Minimal nuisance
2	10–20+ in.	Moderate 1+ in./hr	Strong	Moderate 3 ft.	Maybe moderate (hours to a day common)	Minor to moderate	Nuisance–inconvenience
3	20–30+ in.	High 2+ in./hr	Gale Force	High 4–6+ ft.	Possibly extensive/ lengthy (several days possible)	Moderate to severe	Inconvenience–crippling
4	30–40+ in.	Very High 2-3+ in./hr	Gale-force hurricane	Very High 6–10+ ft.	Probably extensive/ lengthy (up to a week may be common)	Severe	Crippling–paralyzing
5	40–50+ in.	Overwhelming > 3+ in./hr	Gale-force hurricane	Exceptional 10–15+ ft.	Extensive/ lengthy (up to a week common)	Extreme	Paralyzing

Source: Gregory A. Zielinski, Institute for Quaternary and Climate Studies, University of Maine

Extreme cold, which can either accompany a winter storm event or occur over a period of time independent of an event, can impact any part of the SCCOG region. Cold events can be exacerbated by storm events when high winds drive temperatures down, creating a wind chill effect. As shown in the wind chill index in Figure 3-3, the dangers of frostbite increase when strong winds and freezing temperatures coincide.

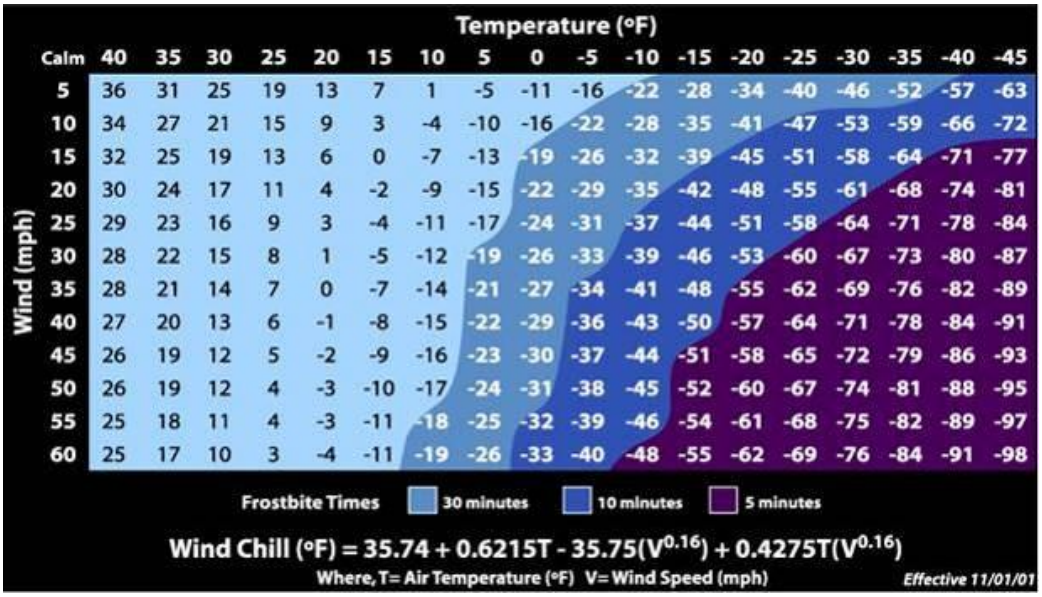


Figure 3-3 Effects of Wind Chill on the Human Body (NOAA NWS)

3.4.1.3.2 Historic Record

Thirteen major winter nor'easters have occurred in Connecticut during the past 30 years (in 1988, 1992, 1996, 2003, 2006, 2009, 2010, two in 2011, 2013, 2015, 2016, 2017, 2018). According to the NCDC, there have been over 104 heavy snow, blizzard, and ice events in New London and Windham Counties between January 2000 and February 2022, causing over $750,000 in damages. Notably, the historic Nor'easter of October 2011 (Winter Storm Alfred) caused power outages, cell-phone tower damage, air travel disruptions, loss of livestock, and an estimated $11 million in damages.

Winter Storm Ginger in 1996 caused up to 27 inches of snow in 24 hours and shut down the state of Connecticut for an entire day. Other storms have also been powerful. A 1992 nor'easter, in particular, caused the third-highest tides ever recorded in Long Island Sound and damaged 6,000 coastal homes. Inland areas received up to four feet of snow. "Winter Storm Alfred" in October 2011 caused power outages of up to ten days in northern Connecticut. Some of the SCCOG communities suffered similar damage from Winter Storm Alfred and Tropical Storm Irene within a two-month period.

According to the NCDC, there have been 134 snow and ice events in the state of Connecticut between 1993 and April 2010, causing over $18 million in damages. Heavy snowfall is relatively rare in the SCCOG region due to the relatively low elevations in the region and the close proximity of the warm waters of Long Island Sound. Similarly, catastrophic ice storms are less frequent in Connecticut than the rest of New England due to the close proximity of the warmer waters of the Atlantic Ocean and Long Island Sound. The most severe ice storm in Connecticut on record was Ice Storm Felix on December 18, 1973. This storm resulted in two deaths and widespread power outages throughout the state.

Examples of recent winter storms to affect New London County selected from the NCDC database include:

- East Coast Winter Storm, March 13-14, 1993 – A powerful storm with record low barometric pressure readings hit the state with blizzard conditions. Gale force winds accompanied by snow drifts several feet deep closed businesses, hindered travel, and forced residents to lose power. Federal aid was given to the state for snow removal.
- Heavy Snowstorm, January 6-7, 1994 – An extended period of snowfall led to a change to sleet and freezing rain along the coastline, which hindered travel, closed schools, led to a loss of power for many residents in southeastern Connecticut, and resulted in downed tree limbs and power lines.
- Ocean-Effect Heavy Snow Storm, April 10, 1996 – Heavy, wet snow fell across most of Southeastern Connecticut where numerous trees and power lines fell.
- Heavy Snow Storm, February 5, 2001 – Wet snow resulted in large-scale power outages because of downed power lines from fallen tree limbs and caused travel in southern Connecticut to become treacherous as numerous traffic accidents occurred.
- Winter Storm, March 4-7, 2001 – A slow-moving, large-scale winter storm subjected southern Connecticut to heavy wet snow and numerous power outages as snowfall totals were around 14 inches in Old Saybrook. Over $5 million in damages were reported throughout the State.
- February Heavy Snowstorm, February 16-17, 2003 – Heavy snow became widespread and was blown by northeast winds of 20 to 30 mph causing near blizzard conditions. Travel almost ceased entirely, and widespread minor tidal flooding occurred along the Connecticut shoreline as Old Saybrook saw a total of almost 16 inches of total snowfall.
- Heavy Snow, January 22-23, 2005 – An intense low produced near blizzard conditions, strong and gusty winds, and blowing and drifting snow and caused minor to moderate local tidal flooding along the shoreline.
- Winter Storm, February 14, 2007 – A mix of heavy snow, sleet, freezing rain, strong gusty winds, and minor tidal flooding occurred along the coast of the state throughout the day.
- Winter Storm Alfred (the "2011 Halloween nor'easter") struck Connecticut on October 29, 2011. This storm compounded the tree damage experienced during Tropical Storm Irene two months earlier by producing heavy winds and up to 19 inches of snow in the State. The combination of heavy snowfall and downed branches caused widespread power outages throughout Connecticut. Electrical service was lost for over a week in some locations, and over 830,000 people were left without power in Connecticut following the storm. The SCCOG region was spared the brunt of this storm, with most locations receiving only limited snow and tree damage and having power outages up to three days in length.
- 12/29/2012 – A complex low pressure system entering the Ohio Valley on December 28th transferred its energy to a secondary low along the North Carolina coast on the 29th. The secondary low intensified into a nor'easter off the Mid-Atlantic and New England coasts later on the 29th and brought heavy snow to most of southern Connecticut. Spotters and state DOT measured 8 to 9 inches of snowfall in Southern New London County and 9 to 12 inches of snowfall in Northern New London.
- February 8, 2013 – A fierce nor'easter (dubbed "Nemo" by the Weather Channel) brought blizzard conditions to most of the Northeast, producing snowfall rates of 5 to 6 inches per hour in parts of Connecticut. Three consecutive hours of blizzard conditions dropped 2-3 feet of snow. Winds also gusted over 50 mph at Groton Airport and the storm caused more than 850,000 power outages. All roads in Connecticut were closed for 2 days. This storm was ranked as a "Crippling" storm by RSI. The overall storm impacts and damages resulted in a Presidential

Disaster Declaration for Connecticut. Snowfall totals ranged from 15 inches in Stonington to 22 inches in Ledyard Center to as much as 31 inches in Colchester.

- January 26, 2015 - A strong Nor'easter (named Winter Storm Juno) brought heavy snow and strong winds to Southern Connecticut, with blizzard conditions in New London County. Trained spotters and Connecticut DOT reported snowfall of 16 to 26 inches. North winds gusted up to 45 mph at Groton-New London Airport, with blowing and drifting of snow. Groton-New London Airport experienced blizzard conditions, with 1/4 mile visibility in heavy snow and north winds gusting frequently over 35 mph, from about 4 AM until about 9 AM. Nearby Willimantic Airport experienced blizzard conditions, with 1/4 mile visibility in heavy snow and north winds gusting frequently over 35 mph, from about 630 AM until about 930 AM.
- January 23, 2016 - Low pressure moving across the Deep South intensified and moved off the Mid Atlantic coast on Saturday January 23rd, bringing heavy snow and strong winds to all of southern Connecticut, and blizzard conditions to some coastal locations. The public and Connecticut DOT reported snowfall ranging from 7 to 8 inches. Groton ASOS (KGON) reported near blizzard conditions from 9 AM until 5 PM, where winds also gusted to 45 mph. The U.S. Coast Guard Academy in New London reported strong northerly winds sustained at 39 mph and gusting to 50 mph between 9 PM and 10 PM. An automated weather station at Stonington also reported strong northeast winds, sustained at 33 mph at 10:10 AM, and gusting to 45 mph at 12:40 PM. The public and Connecticut DOT reported snowfall ranging from 5 to 14 inches. Nearby Groton ASOS (KGON) reported near blizzard conditions from 9 AM until 5 PM.
- January 4, 2018 – Unofficially dubbed Winter Storm Grayson, the rapidly intensified system was considered a “bomb cyclone” with winds similar to a Category 1 hurricane and blizzard like conditions. Snowfall rates varied throughout the northeast with reports between one to three inches per hour. Totals for the SCCOG region were up to one foot of snow, along with icy conditions and coastal flooding.
- March 2018 – There were four significant events in the month of March, however, the region, and state, experienced these storms very differently than other parts of the Northeast. From March first to the third a large system caused severe damage along the eastern seaboard, however Connecticut primarily experienced heavy rain and winds. On March 8 a Nor’Easter left over 100,000 without power across the state and drastically different snow totals with some parts of the state receiving over two feet. On March 13 a strong, banded storm hit the state with parts of western and eastern Connecticut seeing the most snow. Parts of Eastern Connecticut received up to two feet, with 18” reported in Waterford. The fourth event of the month occurred between March 20 and 22, however the impact was nominal for Connecticut while New York and New Jersey felt the brunt of the storm.
- December 16-17, 2020 – A winter storm produced strong winds, with gusts up to 48 mph, and heavy snow in some parts of the region. Totals ranged from 6 to 10 inches in New London County and 8 to 12 in Windham County. Snowfall reports were 10” in Lebanon, 11.5' in Norwich, 9.4” in Ledyard, 8” in East Lyme and Waterford, 9.5” in New London, 7.4” in Groton, and 6” in Stonington.
- February 1, 2021 – A low pressure system moved from the West Coast and stalled along the coast of New Jersey, and eventually moved out to the east. The storm did however cause

significant snowfall along the shoreline. Snowfall totals for the SCCOG region include 3" in Groton, 4.5" in East Lyme, 5" in Norwich, 5.5" in Preston, 5.8 in New London, 6.1" in Ledyard and 9" in Franklin.

- February 7, 2021 – Snowfall in New London County ranged from 5 to 9 inches in the Northern areas and 3 to 6 along the shoreline. In Windham County, snow averaged 7 to 10 inches.
- January 7, 2022 – A winter storm brought 5.3 inches of snow to Ledyard and 5.1 in Ledyard Center, and 7.0 inches in Colchester and Franklin.
- January 28 & 29, 2022 – A strong winter storm brought low visibility, and wind gusts up to 57 mph in Groton and 65 mph in New London. Some snowfall reports for Southern New London ranged from 10 to 20 inches, with reports of 21" in Groton and 20" in Niantic.

The snowfall, sleet, freezing rain, and rain that fell on Connecticut during the 2010-2011 winter season proved to be catastrophic for a number of buildings throughout the State. With severely low temperatures coupled with the absence of the removal of snow and ice buildup from roofs of buildings in Connecticut, numerous roofs collapsed during the winter season. A list of 76 roof/building collapses and damage due to buildup of frozen precipitation was compiled from various media reports from January 12, 2011, to February 17, 2011. As a result of the roof and building collapses, injury to humans, animals, and property took place. The overall storm impacts and damages resulted in Presidential Disaster Declaration #1958 for Connecticut. The winter storms of January and February 2011 are listed as the 18th and 19th storms and given a "Major" description in the NESIS ranking. These storms produced snow, sleet, freezing rain, strong gusty winds, severely low temperatures, and coastal flooding. Snowfall totals for winter 2010-2011 in Southeastern Connecticut averaged around 70 inches. Although roof collapses were limited in the SCCOG region, several were observed and recorded as noted in Table 3-30.

Table 3-30 Reported Roof Collapse Damage, January-February 2011

Municipality	Description
Bozrah	Kofkoff Egg Farm
Colchester	Butler Construction Equipment
Griswold	Residential homes and mobile homes (several)
Ledyard	Residential home
New London	575 Bank Street building (commercial/residential)
Norwich	Vacant school
Norwich	Vacant school
Norwich	Perry's Carpets
Salem	Barn
Stonington	Connecticut Castings
Voluntown	Barn
Waterford	Shell gasoline service station
Waterford	Aaron's shopping center

In addition, many structures in the SCCOG communities were in danger of collapse and were cleared to prevent collapse or damage, such as the Stop & Shop Supermarket in Montville and 12 homes in Colchester. In general, damage was more severe in the northern and western part of the region.

Temperatures have fluctuated over the years during winter months, with more recent years having warmer than average temperatures, however, there have also been many low temperatures during the winter seasons. As shown in Table 3-31 lowest temperatures along the shoreline in the past decade have reached -8 degrees Fahrenheit at the Groton New London Airport weather station, and -7 degrees at the Norwich Public Utilities weather station. Over the past decade, the Groton-New London Airport has seen an average of 96 days below freezing temperatures, and the NPU station has experienced an average of 107 days below freezing.

Table 3-31 Maximum Low Temperature and Days Below Freezing by Calendar Year (NWS)

Calendar Year	Groton-New London Airport		Norwich Public Utilities	
	Max. Low Temp	# of Days at or Below Freezing (32F)	Max. Low Temp	# of Days at or Below Freezing (32F)
2023	-4	51	-5	61
2022	2	76	2	112
2021	9	104	10	111
2020	9	93	10	94
2019	1	109	2	120
2018	-2	110	-1	116
2017	6	93	5	100
2016	-8	87	-7	105
2015	-5	110	-5	114
2014	-1	116	-1	117
2013	5	113	7	124
Average	**1.1**	**96.5**	**1.5**	**107.7**

3.4.1.3.3 Existing Capabilities

Existing programs applicable to winter storm winds are the same as those discussed in Sections 3.4.1.1 and 3.4.1.2.. 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 for municipalities to budget fiscal resources toward snow management. Each SCCOG jurisdiction ensures that all warning/notification and communications systems are ready before a storm and ensures that appropriate equipment and supplies, especially snow removal equipment, are in place and in good working order.

The Connecticut Building Code specifies that a pressure of 30 pounds per square foot (psf) be used as the base "ground snow load" for computing snow loading for different types of roofs. The International Building code specifies the same pressure for habitable attics and sleeping areas and specifies a

minimum pressure of 40 psf for all other areas. As a result of the winter of 2010-2011, it is anticipated many communities developed programs and procedures for roof snow removal.

Collectively, the Connecticut DOT and local public works departments conduct the majority of plowing in the region, with the Connecticut DOT restricted to plowing State routes. Tribal authorities maintain roads on tribal lands. Although private communities are responsible for plowing their own roads, some SCCOG municipalities provide these services where it is difficult to discern the division between private and public roads. Specific capabilities of each jurisdiction are listed in each respective community annex.

All communities throughout the SCCOG regional also have sheltering capabilities either locally or regionally that can be utilized overnight during an extreme cold event. In addition, all communities in the region have at least one cooling center available during the summer that can act as warming center during the winter months.

3.4.1.3.4 Vulnerability and Risk Assessment

Winter storm hazards in the region are potentially significant and regularly cause moderate to high levels of costs including power outages and transportation disruption. Actual direct damages are normally limited under most winter storms to impact the region as the SCCOG region receives generally less snowfall than most of the state. However, as mentioned in Sections 3.4.1.1 and 3.4.1.2., many roadways in the SCCOG region are heavily treed. Many tree limbs on roadways are not suited to withstand high wind and snow or ice loads. During extreme winters, snow loading on roofs is also an issue. Although snowdrifts do occur in the region, they are not a substantial issue.

Winter storms present some potentially unique transportation vulnerabilities. There is a high propensity for traffic accidents during heavy snow and even light icing events. Roads may become impassable, inhibiting the ability of emergency equipment to reach trouble spots as well as the accessibility to medical and shelter facilities. Stranded motorists, especially senior and/or handicapped citizens, are at a particularly high risk during a blizzard.

Recall from Section 2 that elderly and persons with disabilities reside in the region. It is almost certain that populations impacted by a winter storm in the region would consist of the elderly and numerous people with disabilities. Thus, it is important for the jurisdictions in the region to be prepared to assist these special populations during winter storms.

Regarding coastal flooding, the same vulnerable populations discussed in Section 4.5 are vulnerable to flooding caused by nor'easters. Further "flood" damage could be caused in individual homes by freezing and breaking of water pipes.

Extreme cold can impact any area of the region and any population. However, some populations and residents may be at an increased risk such as the elderly, homeless, those that work outdoors, and those living in older poorly insulated structures. These populations may have an increased level of exposure to extreme cold or may not have access to adequate warming or capacity to ensure structures are efficient enough to stay warm.

Loss Estimates

The *2019 Connecticut Natural Hazards Mitigation Plan Update* provides annual estimated losses on a countywide basis for several hazards, including winter storms. However, damages were not reported to the NCDC for winter storms affecting New London County as of 2019. The annualized loss estimate for winter storms in Windham County from the NCDC data is reported as $105,940. For the purposes of estimated future losses, it was deemed reasonable to extrapolate the Windham County annualized losses to New London County (as was done for tornadoes).

Annualized losses were estimated for each SCCOG community based on each community's population relative to their own county, using the countywide annualized loss estimate of $105,940 as a starting point. The annualized loss estimates for winter storms are summarized in Table 3-31 below. Based on these figures, the annualized loss due to winter storms in the SCCOG region is $122,914.

Table 3-32 Estimated Annualized Losses from Winter Storms Based on NCDC Data from the 2019 State Hazard Mitigation Plan

Community	Winter Storm Losses
Bozrah	$958
Colchester	$6,136
East Lyme	$7,374
Franklin	$735
Griswold	$4,498
Groton City	$3,608
Groton Town	$10,829
Lebanon	$2,817
Ledyard	$6,077
Lisbon	$1,655
Mashantucket Pequot Tribal Nation	$46
Mohegan Tribe	$19
Montville	$7,253
New London	$10,796
North Stonington	$2,031
Norwich	$15,829
Preston	$1,889
Salem	$1,662
Sprague	$1,170
Stonington Borough	$352
Stonington Town	$7,233
Waterford	$7,720
Windham	$22,227
SCCOG TOTAL	**$122,914**

Loss estimates for winter storms were also generated from Public Assistance reimbursement data. As noted in Table 3-32, there have been two winter storm events since 2012 that resulted in federal disaster declarations in the SCCOG region. A summary is presented in Table 3-32 below. Recall that federal reimbursement of PA-eligible projects is only 75% of the cost.

Table 3-33 Public Assistance Grants Received for Winter Storm Events since 2012

SCCOG Jurisdiction	Local Government Cost	Other Local Agency Cost*	Total Cost
Bozrah	$20,315	-	$51,996.33
Colchester	$208994	$3,830	$212,814
East Lyme	$292,654	-	$537,118.59
Franklin	$52,952	$3,120	$56,702
Griswold	$144,728	-	$275,282.04
Groton, City of	$237,686	$3,438	$241,124
Groton, Town of	$290,435	$21,370	$311,805
Jewett City, Borough of	-	-	None
Lebanon	$114,705	-	$215,195.81
Ledyard	$159,929	-	$324,220.79
Lisbon	$93,010	-	$139,239.21
Mashantucket Pequot Tribal Nation	$222,592	-	$458,515.20
Mohegan Tribe	$232,555	-	$318,744.16
Montville	$300,809	$17,505	$318,314
New London	$333,681	$81,814	$410,367
North Stonington	$61,420	-	$168,088.44
Norwich	$699,938	$157,879	$852,688
Preston	$51,289	-	$130,409.40
Salem	$91,992	$3,120	$95,112
Sprague	$49,142	-	$109,433.56
Stonington, Borough of	$80,907	-	$77,477.21
Stonington, Town of	$225,081	$18,318	$225,081
Waterford	$390,496	$9,177	$399,672
Windham	$190,233	$173,504	$363,737
Total	**$4,527,223**	**$493,075**	**$5,020,297**
*Other agencies = Fire Districts, Schools, Housing Authorities, Medical Facilities, Water Utilities and other Non-Profit Agencies			

Based on this data, the total losses due to winter storms are $5,020,297 since 2012. This gives an annualized loss estimate of $502,029 for the SCCOG region. This figure does not account for most private property damage (which does not qualify for PA funding), nor for costs associated with typical winter activities (PA grants are only awarded following Presidentially Declared disasters). This figure, therefore, likely underestimates actual winter storm losses and expenditures.

Summary

The entire region is at relatively equal risk for experiencing damage from winter storms, although some areas may be more susceptible. Most damages are relatively site-specific and affect private property, and therefore are paid for by private insurance. Repairs for power outages, a common impact of winter storms, are often widespread and difficult to quantify on the municipal level. For municipal property, budgets for plowing, roof clearing, and minor repairs are generally adequate to handle winter storm damage, although plowing budgets may be depleted in severe winters.

In particular, the heavy snowfalls associated with the winter of 2010-2011 stressed local plowing budgets and raised a high level of awareness of the danger that heavy snow poses to roofs. The snow associated with Winter Storm Alfred in October 2011 and storm Nemo in February 2013 also had significant regional impacts and raised awareness of snow dangers.

Based on FEMA Public Assistance reimbursements, the annualized estimated loss due to winter storms is $502,029 per year. According to the annualized loss estimates generated by population based on the NCDC losses in the 2019 CT NHMP, the annualized estimated loss for winter storms is much lower at $122,914 per year. The FEMA Public Assistance winter storm estimates are utilized herein as an estimate of annualized loss for the SCCOG region as this value is higher.

3.4.2 Sea Level Rise

Sea level rise refers to an increase in mean sea level over time. There is strong scientific evidence that global sea level is now rising at an increased rate and will continue to rise during this century.

The 2022 NOAA Technical Report projects a rise of 10 to 12 inches in the next 30 years along the U.S. coastline, with 2 feet being likely by 2100.

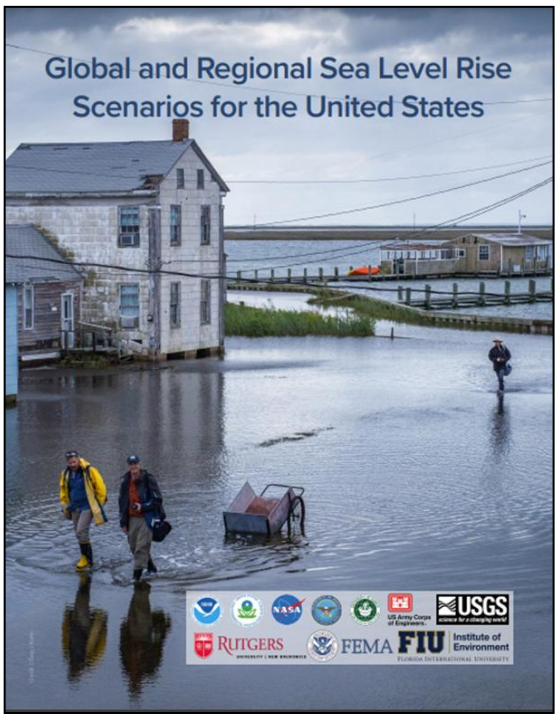
The primary causes of **global sea level rise** are:

- thermal expansion, which is caused by the warming of the oceans (since water expands as it warms);
- loss of land-based ice (such as glaciers and polar ice caps) due to increased melting from warming temperatures

In addition to global sea level rise, changes occur on smaller scales resulting **in local sea level change**, which can me more of an immediate concern to coastal communities. Local sea level change, or rise, is caused by a combination of global sea level rise, changes in local and global ocean currents, and local changes in land elevation. Weakening Atlantic currents and local land subsidence accelerate the rate of sea level rise occurring in Long Island Sound. Coastal communities experiencing increases in mean sea level are at greater risk to the effects of coastal flood hazards as natural, protective buffers such as coastal wetlands and dunes are lost, and property and infrastructure become more exposed to the frequency and severity of coastal flood and storm surge inundation.

Sea level rise is not consistent around the world, and is affected by local variations in currents, temperature, and changes in land surface elevation. It has long been expected that the rate of sea level rise in Connecticut will be slightly higher than the global projections due to the effects of regional subsidence. However, more recent studies have asserted that changes in ocean circulation will increase the relative sea level rise along the Atlantic coast even more.

In its landmark 2001 report, the Intergovernmental Panel on Climate Change (IPCC) concluded projected that global sea level may rise nine to 88 centimeters (0.30 - 2.89 ft) during the 21st century. According to the most recent update, *Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2013*, these predictions have been revised to a rise of **28 to 98 cm (0.9 to 3.2 ft)** by 2100 relative to 1986-2005 levels.



The IPCC recently published the Sixth Assessment Report which includes global mean sea level (GMSL) projections. The report predicts that by 2050, global sea levels will rise between 0.15 and 0.23 meters (0.49 to 0.75 feet) under the most optimistic greenhouse gas emission scenarios, or 0.20 to 0.30 meters (0.65 to 0.98 feet) under high emission scenarios. More long-term projections anticipate a rise of up to 3.3 feet under high emission scenarios.

The NOAA Technical Report titled Global and regional Sea Level Rise Scenarios for the United States: Update Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines (February 2022) has built upon previous efforts from the 2017 NOAA report. The 2022 edition presents an increased confidence level in proving a narrower range of global, national, and regional sea level rise projections than the previous report. The report anticipates a rise of **0.25 to 0.30 meters by 2050, with an additional 5 centimeters for the East Coast**. Longer term projections include **0.6 to 2.2 meters by 2100** along the U.S. Coastline, and up to 3.9 meters by 2150. On a global scale, mean sea level is expected to rise between 0.15 to 0.43 meters by 2050, 0.3 to 2.0 meters by 2100, and up to 3.7 by 2150. In addition to sea level rise scenarios, the NOAA report indicates the disruptive coastal flooding events may also increase from 3 to 10 events per year by 2050.

To provide more local guidance for Connecticut, The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) at the University of Connecticut has developed local sea level rise scenarios (Figure 3-3). These localized scenarios were derived from the 2012 NOAA report but modified to include the effects of local oceanographic conditions, more recent data and models, and local land motion. Based on the localized scenarios, **CIRCA recommends that Connecticut communities plan for 0.5 meters (1.64 feet) of sea level rise above 2001 levels by 2050**, and continued sea level rise beyond that date. These projections have been developed per Connecticut Public Act 18-82; the Act also requires CIRCA to update these projections no less than once every ten years to ensure communities have up to do regional projections.

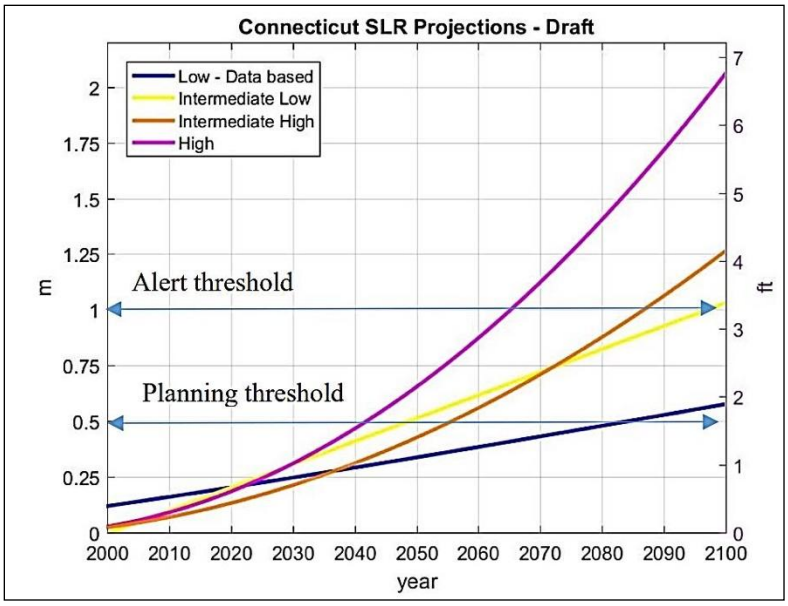


Figure 3-4 Four Localized Sea Level Rise Scenarios in Connecticut

Although erosion and shoreline change have long been recognized as coastal hazards nationwide, it is only in recent decades that the chronic problem of sea level rise has been projected to be closely connected to the acute threats of erosion and shoreline change. Indeed, continued increases in the rate of sea level rise will increase the incidence, severity, and adverse effects of erosion and shoreline change as well as flooding.

The basis for evaluating sea level rise in this HMCAP is the historic sea level rise for the Connecticut shoreline over the last 100 years as adjusted by local observations. Water level data from tide gauges (refer to Figure 3-4 below) demonstrate that in the late 19th century and early 1900s sea level was rising at a rate of one millimeter (mm) each year. Throughout most of the 20th century, the rate has been rising between 2.76 and 3.14 mm per year between Bridgeport and Newport, Rhode Island. tide gauge data was augmented by satellite altimeter readings, which indicate that between 1990 and 2008 the rate increased to three mm per year. In addition, subsidence along the Connecticut coast may have effectively caused an additional rise of three inches on a localized basis.

Scientific studies have resulted in a wide range in the projected long-term sea level rise to the year 2100. A conservative approach to determine likely "short-term" rise from the present time to 2050 can be developed by using the historic rise over the last century and assuming that the threefold acceleration rate will continue in the short term projected into the future. As noted above, the observed rate over the last century is one to three mm/year resulting in a conservative estimate of an additional nine to ten inches by 2050. Land subsidence at some local shoreline areas is 0.01 inch per year, which increases the estimated rise to eleven inches by 2050.

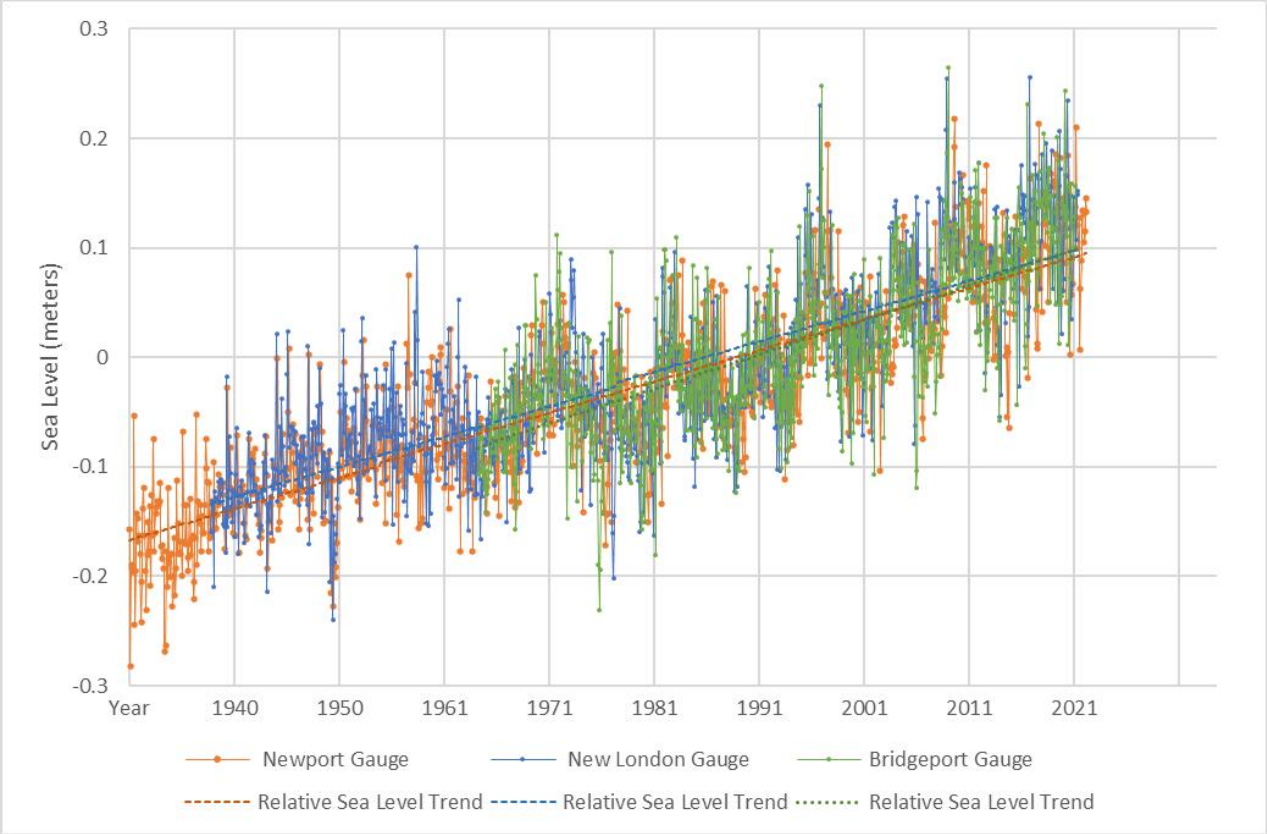


Figure 3-5: Observed Sea Level Data from Tide Gauges in Connecticut and Rhode Island

The wide range of governmental and scientific projections reflects the fact that sea level rise and climate change in general will be affected by a wide number of factors, and their combined effect and timing of impact can have a variety of possible outcomes. These averages are global averages and must be further adjusted by local conditions and factors as they become understood.

Impacts

A continued increase in the rate of rising sea levels will inundate low areas, increase erosion of beaches and tidal marshes, increase the incidence of flooding from storm surges, and enable saltwater to advance upstream and intrude further into estuaries and aquifers.

Rising sea level affects both the natural and the human-made environments. Future sea level rise could result in the disappearance of a large percentage of tidal wetlands in the SCCOG region unless they can advance as quickly as the rising level. Saltwater advancing upstream along estuaries can alter the point at which flocculation leads to sedimentation and the creation of shoals.

As sea level rises, storm surges from hurricanes and nor'easters will reach further inland as they will be starting from a higher base level. It has been projected that by the end of the 21st century, it is possible that a Category 1 hurricane storm surge will be similar to what is now mapped as a Category 3 hurricane storm surge.

Similarly, FEMA coastal base flood elevations would progressively rise along with sea level. This means that the 1% annual chance and 0.2% annual chance flood levels will affect lands that are currently at unaffected elevations. This would exacerbate the problem of coastal and near-coastal inland flooding within the region.

As sea level rises, drainage systems become less effective. Thus, rainstorms will have the potential to cause greater flooding. Many coastal areas in the SCCOG region report increased problems with inadequate storm drainage south of Interstate 95 and in several coastal areas. As sea level rises, these areas will likely continue to experience decreased drainage capacity and increased flooding.

3.4.2.1 Coastal Flooding

Coastal flooding is typically associated with hurricanes and tropical storms, nor'easters, or other storm events that are discussed elsewhere this HMCAP. It is a well-documented natural hazard that threatens the region frequently and in many locations. A review of the DFIRM in each the coastal communities of East Lyme, Waterford, New London, City of Groton, Town of Groton, Borough of Stonington, and the Town of Stonington reveals that the shoreline of southeast Connecticut consists of AE (1% annual chance flood) and VE (1% annual chance flood with wave velocity hazards) zones. The FEMA mapping implies some level of flooding for vast areas south of Interstate 95 during 100-year coastal flood events. Flooding at tidal creeks can occur where the 100-year coastal flood zones extend far inland from the shoreline and merge with inland flood zones, cutting off access via critical roadways in the process.

Sea level rise is affecting coastal and tidal areas and land areas located at elevations close to sea level. As such, the entire SCCOG shoreline is vulnerable to sea level rise and vulnerable areas extend inland along low-lying areas. The timing of the impacts from sea level rise will vary with distance from the shoreline.

3.4.2.1.1 Hazard Assessment

As shown in the figures in the annexes for East Lyme, Waterford, New London, City and Town of Groton, and the Borough and Town of Stonington, areas inundated by the 1% annual chance flood extend along the entire shoreline of the SCCOG region. As noted in Table 3-42, the 1% annual chance coastal flood inundation areas are associated with Zone AE and Zone VE floodplains. Most of the region's velocity zones are located along the immediate Long Island Sound and Fishers Island Sound shoreline, though some areas are included along the mouths of the major rivers such as the Thames River.

Significant coastal flooding is typically associated with severe storms such as hurricanes, tropical storms, and nor'easters. These storms are discussed in more detail in other chapters. The USACE and FEMA have mapped hurricane surge zones in Connecticut for Category 1, 2, 3, and 4 hurricanes (Figure 3-5). This mapping is entitled the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) mapping. Each affected shoreline community has a map in its respective community annex. In many locations, the Category 1 and 2 surge zones coincide with the coastal flood zones mapped by FEMA. However, Category 3 and 4 storms are believed to have the potential to drive surges further inland. Hurricanes are discussed in detail in Section 3.4.1.1 of this Plan.

Figure 3-6 SCCOG Hurricane Surge Inundation Areas

Even without the occurrence of hurricanes, tropical storms, nor'easters, or other storm events, astronomical higher tides and "king tides" will cause shallow flooding of different parts of coastal communities every single year. Meanwhile, sea level rise (discussed below) is already known to be exacerbating coastal flooding, and erosion of the shoreline will allow it to affect populations and structures that previously enjoyed a higher degree of protection.

In summary, coastal flooding can occur as a result of astronomical higher tides acting alone or concurrent with storms; as a result of nor'easters, hurricanes and tropical storms; or simply as a result of persistent strong winds. In addition, coastal flooding will increase in frequency and magnitude as sea level rises.

3.4.2.1.2 Historic Record

The SCCOG region experiences coastal flooding associated with astronomical high tides and coastal storms such as nor'easters, tropical storms, and hurricanes. Low pressures and strong winds that cause tidal flooding frequently accompany these weather events. Detailed discussions of hurricanes and nor'easters are provided in Sections 3.4.1.1 and 3.4.1.3 of this Plan, respectively. The region has shared in the devastation of all the major storms that have struck Long Island Sound in the past century. Many of these hurricanes and nor'easters have caused coastal flooding in the region.

The hurricanes of 1938 and 1954 caused some of the worst coastal flooding in the history of New London County. According to FEMA, the 1938 hurricane, which struck at high tide, resulted in the greatest disaster in Connecticut's history up to that time because of the combined effects of flooding, winds, and storm surge. The 1938 hurricane had a maximum tidal elevation of 8.8 feet in the region, just shy of the coastal base flood elevation which is between 11 and 15 feet (V Zone) and between nine and 12 feet (AE Zone). The 1954 hurricane entered Connecticut in the vicinity of New London and created storm surge almost as high as the 1938 hurricane. Both storms caused tidal surges along the Niantic and the Thames Rivers and along other smaller tributaries to these rivers and Long Island Sound. Significant tidal effects were felt upstream on the Thames River in Norwich and Montville. As noted in the community annexes, many communities experienced millions of dollars in damages from these events.

In more recent memory, flooding and winds associated with hurricanes and storm events have caused extensive shoreline erosion and related damages. Hurricanes Gloria and Bob caused very little water damage but resulted in extensive wind damage. Hurricane Gloria caused dock damage, structural damage to sea walls, retaining walls and bulkheads, and beach erosion throughout the SCCOG region. Fortunately, the hurricane struck at low tide, limiting the damage caused by storm surge. The storm surge associated with Hurricane Bob was also relatively minimal (only five feet) as measured in New London.

Tropical and extra tropical storms have produced periods of locally heavy rainfall that has resulted in the flooding of coastal areas. These events have been recorded on June 4-7, 1982, May 16, 1989, October 31, 1991, December 10-12, 1992, and May 27-June 2, 1994. Emergency Management records show that widespread street and storm drain system flooding were associated with these events producing significant basement flooding. Other nor'easters and blizzards have also resulted in coastal and river

flooding. Some of these events that resulted in multiple NFIP damage claims were in February of 1987, March of 1978, January of 1979, March of 1980 and March of 1984. Also, in December of 1992 the nor'easter storm named Beth brought high waters and damage to coastal areas.

Even during lesser storm events and high tides, coastal flooding occurs in the region. Many of the coastal roads have been identified by SCCOG communities as sites of chronic coastal-related flooding where inundation occurs at least once every year and sometimes more frequently. For example, a king tide occurring on a sunny day (October 28, 2015; refer to the picture on the right) caused water to flow onto, and inundate, many sections of roads in the Groton side of Mystic. The residents of many of these neighborhoods have become accustomed to the chronic flooding but remain very concerned, nevertheless.

Tropical Storm Irene

When Tropical Storm Irene moved up the Atlantic coast in late August 2011, it caused severe and widespread flooding in North Carolina, New York, Vermont, Massachusetts, and other states, leading to a series of federal disaster declarations. In Connecticut, the storm made landfall as a tropical storm. The USGS installed storm surge sensors along Long Island Sound in advance of the storm. Storm surges of three to five feet were experienced throughout the region, with the higher surges in the western part of the SCCOG region. These surges resulted in minor to moderate flooding of low-lying areas in the SCCOG region (such as flooding in Mystic) with most damages being as a result of tree damage and extended power outages. Ultimately, the State of Connecticut received federal disaster declaration #4023 as a result of Irene.

Superstorm Sandy

Hurricane Sandy formed in the Caribbean on October 22, 2012. The storm struck the New Jersey and New York region the hardest on October 29, 2012, and also caused extensive flooding along the Connecticut coast, where it was classified as a “superstorm”. According to the National Hurricane Center, the storm caused an estimated 147 deaths, including five in Connecticut. The most significant damage to the SCCOG region occurred due to storm surge flooding along the coastline, as well as high winds. FEMA Public Assistance records indicate that some SCCOG jurisdictions, such as Norwich and New London, received $500,000 to $1,000,000 in federal money to aid with the cleanup. The picture to the right is from the Stonington side of Mystic.

The region has also recently faced coastal flooding challenges attributed to the 2020 Tropical Storm Isaias, along with the 2021 hurricane events. While none of these had the coastal flooding impacts like Irene or Sandy, some serious coastal flooding challenges have also occurred due to strong storms and nor'easters. For example, a strong coastal storm on January 17, 2022, prompted coastal flooding in several southeastern communities, and resulted in a dramatic rescue of several individuals in East Lyme.

Since 2017, as issued from the National Weather Service, there have been:

- 2 coastal flood watches
- 3 coastal flood warnings
- 23 coastal flood advisories

Though this may seem infrequent, coastal floods can often occur without warning as they can be attributed to smaller scale storms or high tides.

3.4.2.1.3 Existing Capabilities

Many of the existing programs, policies, and mitigation measures utilized in the region for inland flood mitigation are also applicable to coastal flood mitigation. Participation in the NFIP is an important program for mitigating coastal flooding damages and was described in Section 3.4.3.1.3. Local regulations are described in Section 2 of each community annex. Sections of these codes and regulations are dedicated to flood damage prevention. The State Building Code was modified in 2016 to require additional protections for structures in coastal floodplains, essentially requiring freeboard in coastal A and VE zones even if it is not required by local flood damage prevention regulations.

As explained elsewhere in this HMCAP, the National Weather Service issues a flood watch or a flash flood watch for an area when conditions in or near the area are favorable for a flood or flash flood, respectively. A flash flood watch or flood watch does not necessarily mean that flooding will occur. The National Weather Service issues a flood warning or a flash flood warning for an area when parts of the area are either currently flooding, highly likely to flood, or when flooding is imminent.

In April 1994 FEMA, USACE, NOAA, and the Connecticut Department of Emergency Management and Homeland Security (then the Office of Policy and Management) completed the Connecticut Hurricane Evacuation Study Technical Data Report that includes an evacuation map atlas and an inundation map atlas. This study provides information on the extent and severity of potential flooding from hurricanes (based on the SLOSH mapping), the associated vulnerable population, capacity of shelters, estimated sheltering requirements, and evacuation time. The State and coastal municipalities in the SCCOG region use the study and maps to plan for possible evacuations. Note that CT DEMHS updated the State Response Framework in 2019 and the SLOSH mapping was last updated by USACE in 2012.

Many SCCOG communities have completed participation in a hurricane evacuation sign project. Gauges and signs have been installed at various locations throughout the region. The signs provide elevations above sea level from the ground up to twelve or sixteen feet above sea level. The signs indicate areas of town that would be inundated by hurricane-related flooding. Although installation of the signs will not

provide protection to structures, they will allow residents to take steps to protect their safety and movable possessions.

The shoreline of the SCCOG region contains many coastal flood control structures to prevent coastal flooding and erosion. Seawalls and bulkheads can be found in many of the residentially developed coastal neighborhoods. Specific projects include the New London hurricane barrier in Shaw's Cove (constructed by the USACE between 1978 and 1985), construction of breakwaters at Stonington Harbor, and construction of seawalls, bulkheads, and groins in multiple locations along the shoreline. Many potential structural projects have not been pursued to date, however, because it is questionable whether an acceptable cost-benefit ratio exists for the projects. The potential environmental impacts of structural projects are often also a concern.

In summary, the region primarily attempts to mitigate coastal flood damage and flood hazards by controlling and restricting activities in floodprone areas, elevating homes, maintaining hard structures in good condition, and providing signage and warning systems.

Sea Level Rise

The Nature Conservancy has released a number of Coastal Resilience tools for shoreline communities as part of its Coastal Resilience project. The purpose of the Coastal Resilience project is to provide communities, planners, businesses, and officials with easy access to information on projected changes in sea level and coastal storm impacts in order to assist in coastal planning and management decisions. This tool delineates areas likely to receive coastal flooding taking into account the potential impacts of sea level rise. This is an excellent tool for local planners to utilize when making long-term development decisions.

The TNC Coastal Resilience Tool for Shoreline Communities can be found at:

http://coastalresilience.org/tools/apps/

The CIRCA Sea Level Rise Viewer can be found at:

https://lisicos.uconn.edu/SLR/

In October 2011, the Coastal Resilience project released the Marshes on the Move tool. This tool provides modeling guidance for resource managers and planners, describing the parameters and issues involved in using wetland migration models that depict the possible responses of coastal wetlands to sea level rise. This work is a collaborative effort between the National Oceanic and Atmospheric Administration and The Nature Conservancy. The SCCOG region participated in related work that resulted in a journal article published in Environmental Research Letters entitled "Governments Plan for Development of Land Vulnerable to Rising Sea Level: Southeastern Connecticut." In general, these projects concluded that tidal wetland migration would only occur in areas that are currently undeveloped and do not have structural protection measures or are hemmed in by existing development.

CIRCA has also developed a Connecticut specific sea level rise and storm surg viewer which includes the most up to date sea level rise projections for the state. The viewer provides the user with two rise scenarios, and the 10, 30, 100, and 500 year flood events with an additional 20 inches of sea level rise.

Planners and decision makers can use this tool to better identify and visualize the potential impacts of future sea levels.

In general, the SCCOG communities have traditionally lacked existing policies and mitigation measures that are specifically designed to address sea level rise and coastal change, although this lack of capacity is shifting rapidly. Some of the most recent sea level rise and climate focused projects include:

- Groton City has recently completed a Community Resilience Plan which focuses on climate change resilience as well as sea level rise challenges.
- The Town of Waterford has completed a pump station vulnerability assessment to determine risks for critical infrastructure.
- The Town of Groton is underway with a Downtown Mystic resilience study which focuses on sea level rise impacts and climate change.
- The Mystic Seaport in Stonington is working on a Sea Level Rise Strategic Facility Plan to address the challenges being faced by the historic museum.

More information can be found in the annexes for these towns, and others. In the meantime, SCCOG anticipates that all member jurisdictions along the shoreline continue to look for ways to pursue forward-thinking coastal planning.

3.4.2.1.4 Vulnerability and Risk Assessment

Over the years, the character of the SCCOG shoreline has become more of a year-round community with the conversion of many seasonal cottages to year-round dwellings. This has intensified the risks to life and property for shoreline residents. Beachfront properties are susceptible to damage, not only as a result of flooding, but also because the dynamic nature of the beach system results in shoreline erosion in some locations. Low-lying coastal roadways can also be flooded, and the frequency of flooding will certainly increase with sea level rise. This situation can present a serious risk to the safety of certain neighborhoods, such as Mason's Island in Stonington, where only one mode of vehicular egress is available.

Damage from coastal flooding would not be limited to developed areas. With regard to undeveloped areas, all of the tidal marshes in the SCCOG region are vulnerable to sea level rise. They will continue to erode as marshes spend more time inundated. The marshes will continue to be "squeezed" where they cannot migrate inland and, even where sufficient land is available for migration, sea level rise could be too fast for migration to occur.

As noted in Section 3.4.2.1.1, TNC and several partner agencies have developed a hazard planning tool and a risk assessment process designed to help communities identify and prioritize steps to reduce risks in a community. CIRCA has also been working in the region to promote the Sea Level Rise viewer and the Resilient Connecticut products (discussed further in Section 3.4.3.1.3) which can aid in hazard planning.

Vulnerability of Private Properties

Based on correspondence with the State of Connecticut NFIP Coordinator, a total of 64 Repetitive Loss Properties (RLPs) have been identified that are located near coastal water bodies in the region, up from the 54 identified in 2012. These repeat claims demonstrate the persistent nature of the coastal flood

hazards throughout the region. Maps indicating the approximate location of the repetitive flood insurance losses are included in each community annex. A summary of the RLPs related to coastal flooding are listed in Table 3-33.

Table 3-34 Repetitive Loss Properties Affected by Coastal Flooding in the SCCOG Region (As of June 19, 2022)

Town	Number of Properties	Property Type*	Flooding Source
East Lyme	13	R	Niantic Bay, Niantic River, Long Island Sound
Groton, City of	3	R	Eastern Point Bay, Thames River
Groton, Town of	2	1 C; 1 R	Mystic Harbor, Mystic River
Groton Long Point Assoc	5	R	Long Island Sound
New London	17	1 C, 16 R	Thames River, Long Island Sound
Stonington, Borough of	2	R	Fishers Island Sound
Stonington, Town of	16	2 C; 14 R	Mystic River, Mystic Harbor, Stonington Harbor, Pequotsepos River, Quiambaug Cove, Fishers Island Sound, Pawcatuck River, Lamberts Cove
Waterford	6	R	Niantic River, Jordan Cove, Alewife Cove, Long Island Sound
Total	**64**	**4 C, 60 R**	

* R = Residential; C = Commercial

The software platform ArcGIS was utilized to determine the area of coastal floodprone areas, and the number of properties located within the various floodplains within the region, along with their property value. As noted in Table 3-34, there are 2, properties located in the 2,481 acres, with a total at risk property value of over 1.5 billion dollars. Several critical facilities also lie within hurricane surge zones and in coastal SFHAs.

Table 3-35 Number of Parcels in VE Zone and Property Values

Municipality	No. in VE Zone	Total Exposed Property Value in VE Zone
East Lyme	528	$3,568,180
Groton, City of	182	$397,967,560
Groton, Town of	540	$582,855,150
New London	168	$387,543,056
Stonington	666	$396,181,900
Stonington Borough	259	$107,650,600
Waterford	340	$175,242,060
Total	**2,470**	**$1,547,176,006**

It is recognized that many private properties may suffer coastal flood damage that is not reported because the structures are not insured under the NFIP. These residents and business owners are likely repairing structures on their own. Coastal flood mitigation as recommended in this HMP will likely help many of these property owners.

Loss Estimates

The FEMA HAZUS-MH version 6.0 was utilized to run probabilistic coastal flood scenarios independent of riverine flood events. Below are estimated loss summaries from various sources.

HAZUS-MH

HAZUS-MH is FEMA's loss estimation methodology software for flood, wind, and earthquake hazards. The software utilizes year 2020 U.S. Census data and a variety of engineering information to calculate potential damages (specified in year 2020 United States Dollars or USD) to a user-defined region. The software was utilized to perform a basic analysis to generate potential damages in the SCCOG region from a 100-year coastal flood event within each jurisdiction. The coastal flooding module of *HAZUS-MH* was not run for inland communities.

Hydrology and hydraulics for the coastal reaches, as well as depth grids, were generated using the HAZUS methodology. The model uses default hazard data, including Hydraulic Unit Codes and USGS regression equations and gage records to determine discharge frequency. Summary reports for the 1% annual chance coastal flood event in each jurisdiction are included in Appendix F. The following paragraphs discuss the results of the *HAZUS-MH* analysis.

Each jurisdiction was run separately in *HAZUS-MH*. FEMA default values were used for each census tract in each *HAZUS-MH* simulation. Note that for communities with coastal flooding areas the 1% annual chance coastal floodplain was run independently of the riverine analysis. *HAZUS-MH* distinguishes between riverine and coastal reaches, and therefore these were distinctly different scenarios. However, this does not mean that riverine and coastal flooding sources are distinctly different in each community. It is challenging to determine where exactly a riverine floodplain ends, and coastal floodplain begins. Therefore, these delineations of floodplains may vary in reality compared to what is experienced on the ground. The individual model runs are summarized throughout this section.

Table 3-50 presents the expected damages for each coastal SCCOG jurisdiction. The *HAZUS-MH* simulation estimates that during a combined 1% annual chance riverine flood event more than 900buildings will be damaged in the region from coastal flooding. It is important to note that communities along tidally influenced rivers have not been included in this analysis due to the limitation of coastal reach extent in the program.

Table 3-36 HAZUS-MH Coastal Flood Building Damages

SCCOG Jurisdiction	1-10% Damage	11-20% Damage	21-30% Damage	31-40% Damage	41-50% Damage	Substantial Damage	Total
East Lyme	67	161	97	12	3	16	**356**
Groton, City of	70	290	223	36	3	66	**688**
Groton, Town of	70	290	223	36	3	66	**688**
New London	19	49	11	4	1	1	**85**
Stonington	96	334	221	55	20	64	**790**
Stonington Borough	25	73	49	8	4	22	**181**
Waterford	55	152	66	8	1	12	**294**
Total	**332**	**1,067**	**670**	**123**	**32**	**181**	**2,405**

HAZUS-MH utilizes a *subset* of critical facilities known as "essential facilities" that are important following flooding events. These include EOCs, fire stations, hospitals, police stations, and schools. Not all SCCOG jurisdictions are expected to have damage to essential facilities following a 1% annual chance flood event. In the SCCOG coastal region, *HAZUS-MH* identified a total of 88 essential facilities. Of these 88 facilities, 19 of them are expected to have loss of use due to a 1% annual chance coastal flood.

Table 3-37 HAZUS-MH Coastal Flood Essential Facility Loss of Use

SCCOG Jurisdiction	EOC		Fire Department		Hospital		Police Department		School	
	Loss of Use	Total	Loss of Use	Total	Loss of Use	Total	Loss of Use	Total	Loss of Use	Total
East Lyme	0	1	1	3	0	0	1	2	2	6
Groton, City of	0	1	0	4	0	0	1	2	1	4
Groton, Town of	0	1	2	8	0	0	1	2	2	9
New London	1	1	1	3	0	2	1	2	0	19
Stonington	0	1	4	4	0	0	0	1	0	4
Stonington Borough	0	0	1	2	0	0	0	0	0	2
Waterford	0	1	1	5	0	0	0	1	1	8
Total	1	6	11	31	0	2	4	10	6	54

The *HAZUS-MH* software estimated the amount of debris that would be caused by flooding. Debris material includes items such as drywall and insulation, structural items include materials such as wood and brick, and foundations include materials such as concrete slabs, blocks, and rebar. Results are presented in Table 3-51. The *HAZUS-MH* simulation estimated that a significant amount of debris (over one-thousand tons) would be generated in Griswold, Lisbon, Norwich, and Windham.

Table 3-38 HAZUS-MH Coastal Flood Scenarios – Debris Generation (Tons)

SCCOG Jurisdiction	Total Debris (Tons)	Estimated Cleanup Truckloads (25 Tons / Truck)
East Lyme	50,151	2,006
Groton, City of	17,686	707

Groton, Town of	88,037	3,521
New London	25,402	1,016
Stonington	46,182	1,847
Stonington Borough	14,826	593
Waterford	31,889	1,276
Total	**274,173**	**10,967**

HAZUS-MH calculated the potential sheltering requirement for the 1% annual chance coastal flood event. Results are presented in Table 3-38. The model estimates that over 27,000 individuals will be displaced due to a 1% annual chance flood affecting watercourses in the region; this is approximately 9,000 households. Displacement includes households evacuated from within or very near to the inundated areas. Of those displaced, over 2,100 will seek temporary shelter in a community or regional shelter.

Table 3-39 HAZUS-MH Flood Scenarios – Shelter Requirements

SCCOG Jurisdiction	Short-Term Sheltering Need (Number of People)	Displaced Population	Sheltering Capacity
East Lyme	245	4,207	2,300
Groton, City of	213	1,137	250
Groton, Town of	528	6,915	1,400
New London	673	3,986	3,750
Stonington	245	7,478	1,300
Stonington Borough	36	975	0
Waterford	278	3,729	5,500
Total	**2,182**	**27,452**	**14,500**

The predicted sheltering requirements for coastal flood damage (Table 3-38) have been compared to the shelter information described in Section 2.11 to determine adequacy. In general, communities have sufficient sheltering capacity based on the comparison of *HAZUS-MH* shelter requirements and existing shelter capacities, however, these are the requirements for a 1% annual chance coastal flood. If this event were to coincide with a riverine flood event, or tropical storm or hurricane, sheltering needs may be higher than stated in this table. Emergency managers within these communities have worked to identify sheltering capacities that are believed appropriate for accommodating the populations that are understood to likely require shelter during a flood event.

HAZUS-MH also calculated the predicted economic losses due to the 1% annual chance flood event. Economic losses are categorized between building-related losses and business interruption losses. Building-related losses (damages to building, content, and inventory) are the estimated costs to repair or replace the damage caused to the building and its contents. Business interruption losses are those associated with the inability to operate a business because of the damage sustained during the flood and include lost income, relocation expenses, lost rental income, lost wages, and temporary living

expenses for displaced people. Results are presented in Table 3-39, with the majority of losses occurring in Groton, Norwich, and Stonington.

Table 3-40 HAZUS-MH Estimated Direct Losses from Coastal Flooding Scenarios

SCCOG Jurisdiction	Direct Losses (Millions of Dollars)		
	Estimated Total Building Losses	Estimated Business Interruption Losses	Estimated Total Losses
East Lyme	$159,920,000	$65,730,000	**$225,650,000**
Groton, City of	$43,510,000	$61,200,000	**$104,710,000**
Groton, Town of	$545,190,000	$679,410,000	**$1,224,600,000**
New London	$150,790,000	$301,170,000	**$451,960,000**
Stonington	$875,990,000	$694,700,000	**$1,570,690,000**
Stonington Borough	$125,900,000	$78,770,000	**$204,670,000**
Waterford	$203,840,000	$249,770,000	**$453,610,000**
Total	**$2,105,140,000**	**$2,130,750,000**	**$4,235,890,000**

A 1% annual chance coastal flood, as simulated by HAZUS-MH, would generate more than $4.2 billion in coastal flooding-related damages in the SCCOG region. About half of the estimated economic losses are due to damage to buildings and the other half to business interruption. Estimated damages to business operation accounts for about 50%of all economic damage, including lost income, relocation costs, rental income, and lost wages. Although these losses account for only a small portion of total economic impacts, they can cause ripple effects throughout the economy putting small businesses at risk of closure. The regional breakdown of economic impacts from coastal flooding can be found in Table 3-40.

Table 3-41: HAZUS-MH Coastal Flooding Economic Impacts

SCCOG	2022 Results				
	Residential	Commercial	Industrial	Other	Total
Direct					
Building	$519,470,000	$152,170,000	$54,520,000	$32,870,000	$759,030,000
Contents	$461,180,000	$488,000,000	$116,750,000	$191,120,000	$1,257,050,000
Inventory	$0	$59,890,000	$15,730,000	$13,430,000	$89,060,000
Subtotal	$980,650,000	$700,060,000	$187,000,000	$237,420,000	$2,105,140,000
Business Interruption					
Income	$27,030,000	$426,400,000	$4,730,000	$79,270,000	$537,420,000
Relocation	$147,580,000	$110,450,000	$4,010,000	$50,010,000	$312,040,000
Rental Income	$102,540,000	$79,640,000	$750,000	$8,040,000	$190,950,000
Wage	$63,640,000	$452,550,000	$5,700,000	$632,290,000	$1,154,180,000
Subtotal	$340,790,000	$1,069,040,000	$15,190,000	$769,610,000	$2,194,590,000
Total	**$1,321,440,000**	**$1,769,100,000**	**$202,190,000**	**$1,007,030,000**	**$4,299,730,000**

Mystic flood modeling fact sheet

Thames river modeling fact sheet

3.4.2.2 Shoreline Change

The SCCOG coastal communities have been experiencing shoreline change, erosion and accretion, for many years due to natural, cyclic processes. These changes can be attributed to natural events such as wind, waves, tides, and storms, but also to human driven processes such as development, grading, beach armoring and nourishment. As climate change impacts hazards such as severe storms and hurricanes, and brings along rising sea levels, shorelines have the potential to change at different rates than in decades past. Rapidly changing shorelines can have an impact on coastal ecosystems (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. Coastal erosion is a concern in some locations as it generally occurs during coastal flooding events. Coastal erosion and shoreline change are generally possible anywhere along the shoreline although they have been exacerbated by increased rates of sea level rise and are occurring far more rapidly in the low-lying areas between rocky shorefronts where tidal marshes tend to be present.

Long-term erosion, which occurs as a result of daily waves, winds, and tides does not necessarily have as deleterious an impact on the shoreline as that erosion caused by episodic events like hurricanes and nor'easters. Land subsidence and sea level rise can also have long-term effects, ultimately exacerbating the impacts of erosion on the shoreline. Large events, like hurricanes, have the ability of causing severe erosion or dune depletion, causing years of erosion in just several hours.

As coastal erosion continues the shoreline moves landward, posing an increased threat of damage to adjacent property and infrastructure. Natural recovery from episodic erosion events can take months or years. If a beach and dune system does not recover quickly enough naturally, coastal and upland property may be exposed to further damage in subsequent events. Shoreline hardening techniques such as seawalls, revetments, bulkheads, groins and jetties may temporarily stave off coastal erosion, but in most cases, they worsen existing erosion or cause new erosion in adjacent areas.

3.4.2.2.1 Hazard Assessment

The Connecticut shoreline continues to erode since the end of the last glaciation approximately 12,000 years ago, slowly giving way to the advancing Atlantic Ocean. This net loss of land is due partly to active erosion of beaches and tidal marshes and partly to passive submergence caused by natural component of relative sea level rise. The erosion and submergence together cause a net loss of land resulting in shoreline change.

While erosion itself is natural, it has the potential to damage coastal property and infrastructure. Coastal erosion and shoreline change can result in significant economic loss through the destruction of buildings, roads, infrastructure, natural resources, and wildlife habitats. In addition, erosion can expose septic systems and sewer pipes, contaminating shellfish beds and other resources; release oil, gasoline, and other toxins to the marine environment; and sweep construction materials and other debris out to sea. Public safety is jeopardized when buildings collapse, or water supplies are contaminated.

According to the USGS, four possible erosional outcomes can occur during a storm and storm surge event:

- "Swash" occurs when the maximum elevation of wave runup is higher than the beach but still lower than the base of the dune or bluff, if one is present. This results in the erosion of the beach.
- "Collision" occurs when the maximum elevation of wave runup is higher than the base of the dune or bluff but lower than the top of the dune or bluff. Collision results in severe erosion of the dune or bluff.
- "Overwash" occurs when the maximum elevation of wave runup is higher than the top of the dune or bluff. Overwash can result in damage to structures behind the dune or bluff.
- Finally, "inundation" occurs when the base tide and surge level is higher than the beach and dune. This is the most hazardous of the four outcomes with regard to flood damage.

Any of these outcomes are possible in the SCCOG region. They may be expected at sandy beaches and in rockier areas. Processes are somewhat different at the marsh fronts. Erosion events in a coastal setting are dependent upon many factors including sea level rise, surrounding conditions, storm events, and human alteration of drainage and currents.

Many beaches in the SCCOG region have experienced varying rates of erosion over the years. Most of the beaches are considered generally stable, but significant erosion occurs during storm events such as Hurricane Gloria, Tropical Storm Irene, and Superstorm Sandy.

As noted above, it has been documented that sea level rise has occurred at an accelerated rate over the last 100 years. Some coastal states along the eastern seaboard have reported subsidence or drowning of tidal wetlands because they can no longer accumulate peat fast enough to stay above sea level. In Connecticut, the effect of sea level rise depends on location. Sea level rise appears to be altering the zonation of plant communities in southeastern Connecticut, where the tidal range averages 0.75 meters. Studies have documented that at least two marsh systems are currently not keeping up with sea level rise. On Connecticut's western shore, with a tidal range of up to two meters, extensive areas of low marsh vegetation have been drowned (e.g., Five-Mile River, Norwalk).

Another ramification of the projected sea level rise is the tendency for marsh systems to migrate landward. As sea level rises, marshes that are able to stay above the rising water level will tend to move inland. For developed areas where seawalls, lawns, and other structures are at the very edge of the marsh, landward movement is limited.

Complicating matters, the salt marshes of the entire eastern seaboard have been faced with a dilemma that is currently being termed by some scientists as "sudden wetland dieback." Although there is dispute between scientists surrounding what exactly is occurring, it is known that the health of salt marshes and the zonation of the vegetation that resides within the marshes are threatened. Results of salt marsh dieback include the development of tidal flats and pockets of holes in the absence of the various salt marsh grasses.

In summary, erosion and shoreline change can result in significant economic and emotional loss in the current land use system of fixed property lines and ownership. However, attempting to halt the natural process of erosion with seawalls and other hard structures can shift the problem, subjecting other property owners to similar losses. The challenges are to (1) slow erosion where possible without

adversely affecting nearby resources, and (2) site coastal development in a manner that allows natural physical coastal processes such as erosion to continue.

3.4.2.2.2 Historic Record

According to the USGS National Assessment of Shoreline Change Report (2010), the average rate of long-term shoreline change for the New England coast was -0.5 meters per year with an uncertainty in the long-term trend of ±0.09 meters per year.[6] However the actual rates of erosion vary substantially along the coast as a function of shoreline type and are influenced primarily by episodic events. The Analysis of Shoreline Change in Connecticut (2014)[7] shows local short and long-term changes for the Connecticut shoreline.

Connecticut's shoreline change report provides very detailed erosion figures for each one of hundreds of segments of the shoreline. The report provides a town-by-town summary; erosion end-point rates (EPR) for SCRCOG municipalities are summarized in Table 3-41**.**

Table 3-42 Erosion End-Point Rates for SCCOG Communities

Short Term Change (1983 – 2006)		Long Term Change (1983 – 2006)	
Town	**EPR Ave (m/yr)**	**Town**	**EPR Ave (m/yr)**
East Lyme	-0.50	East Lyme	-0.01
Waterford	-0.56	Waterford	-0.08
New London	-0.60	New London	0.02
Groton – F	-0.29	Groton – F	-0.02
Groton – F & G	-0.25	Groton – F & G	-0.01
Groton – G	-0.15	Groton – G	0.02
Stonington	-0.17	Stonington	-0.05

Some episodic erosion events for the planning area have been associated with large coastal storms including hurricanes, tropical storms and nor'easters (covered under *Hurricane/Tropical Storm* and *Severe Winter Storm/Nor'easter*). The most impactful events within the past two decades include Superstorm Sandy (October 2012) and Tropical Storm Irene (August 2011). These events contributed to the rapid erosion of primary frontal dune systems, damage to seawalls and revetments, and the loss of other protective features along the immediate shoreline, which as a result significantly increases the risk of property damages to future coastal flooding events.

While communities in the SCCOG region have not had as severe an experience as those two storms, recent events have proven that erosion and shoreline change remain an increasing concern. Residents along the shoreline in Niantic have seen erosion rates increase to the point of needing to sell homes and properties as solutions and remedies are too costly. The Town of Groton has been working to increase resilience at Esker Point Beach and Palmer Cove as this town park has been impacted by erosion, tropical storms, and storm surge.

[6] Hapke, C.J., Himmelstoss, E.A., Kratzmann, M., List, J.H., and Thieler, E.R., 2010, National assessment of shoreline change; historical shoreline change along the New England and Mid-Atlantic coasts: U.S. Geological Survey Open-File Report 2010-1118.

[7] https://shorelinechange.uconn.edu/wp-content/uploads/sites/1897/2016/09/2014_CT_ShorelineChange.pdf

3.4.2.2.3 Existing Capabilities

The use of shoreline flood and erosion control structures is discouraged by the DEEP. However, as noted in the state's *Coastal Management Manual*, a structural solution may be permitted when (1) it is demonstrated that it would protect a water-dependent use, infrastructural facilities, or an inhabited structure; (2) there is a clear demonstration of the need for protection; and (3) the use of the proposed structure is unavoidable because it is demonstrated that there is no feasible less environmentally damaging nonstructural alternative. With regard to preexisting structures that were constructed to reduce coastal erosion, examples include the handful of groins, jetties, seawalls, and bulkheads along the southeastern Connecticut shoreline.

Just like coastal resilience planning, statewide capabilities have been increasing sharply relative to pursuing methods that can slow or halt erosion of the shoreline. In 2012, the Connecticut General Assembly passed Public Act 12-101, An Act Concerning the Coastal Management Act and Shoreline Flood and Erosion Control Structures. This legislation set forth initiatives to address sea level rise, revise the regulatory procedures applicable to shoreline protection, and promote living shorelines.
The CT DEEP, CIRCA, and CT Sea Grant have individually and collectively spent considerable effort over the last decade providing technical assistance and guidance on the use of living shorelines in both narrow terms[8] (constructed tidal marshes) and broad terms (constructed tidal marshes, beaches, dunes, and bioengineered banks). In June 2018, the "Living Shoreline Act" was introduced in hopes of increasing funding and applications along the shoreline. SCCOG community leaders and staff continue to participate in related activities, and some of the SCCOG communities anticipate use of living shorelines and other soft shoreline stabilization methods in the coming years and decades.

3.4.2.2.4 Vulnerability and Risk Assessment

Areas in the region that are most vulnerable to shoreline change are closely aligned with those vulnerable to coastal flooding and storm surge, particularly those that are not hardened and susceptible to severe storm damage. Homes, infrastructure, and development in general close to high wave action and surge areas are at risk of erosion, undercutting, and washouts. In addition, those existing marshes and ecosystems which currently serve as barriers, yet have no room to migrate, are also at risk of being reduced in size and capacity.

Loss Estimates

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

[8] Connecticut DEEP has developed a working definition of "living shoreline" through research of other coastal states, NOAA, and UConn. The current working definition of living shorelines according to CTDEEP is "A shoreline erosion control management practice which also restores, enhances, maintains or creates natural coastal or riparian habitat, functions and processes. Coastal and riparian habitats include but are not limited to intertidal flats, tidal marsh, beach/dune systems, and bluffs. Living shorelines may include structural features that are combined with natural components to attenuate wave energy and currents."

shoreline change events. There are however ways to track, and quantity losses associated with events; future plan updates will work to track and incorporate these losses.

For beaches, one representation of loss is the total cost of beach nourishment, even though this does not account for occasional property damage. Beach nourishment has been infrequent in the Southeastern region; however, some coastal communities have considered the option, and implementation has been infrequent.

Another measure of shoreline change loss is the total unmet need associated with living shoreline project costs, which have only recently become well-understood over the last five years. Living shoreline projects are anticipated in two parts of Stonington (Mystic Boathouse and Masons Island) and probably approach a total of $1 million to $1.5 million based on engineering opinions of probable cost. The Town of Groton recently received a grant for $750,000 in April 2022 to implement coastal resilience measures, including soft shoreline stabilization, at the Esker Point Beach and Palmer Cove area.

It is reasonable to assume that additional losses have occurred throughout the region attributed to storm related shoreline change.

3.4.3 Changing Precipitation Patterns

The Fourth National Climate Assessment states that recent trends show an increase in rainfall intensity throughout the northeast, and further intensity increase is expected during winter and spring months, with little change during summer months. There are also certain studies that show some agricultural operations may benefit from this increase in rainfall intensity and there might be greater productivity over a longer growing season. The report *also* states that droughts have also intensified across the United States and may continue to do so as global temperatures continue to rise. Though precipitation events are expected to become larger and more frequent, it is projected that the length of time between these events will also increase, resulting in lengthier dry spells. In addition, as temperatures increase, soil moisture is expected to decrease due to evapotranspiration, ultimately intensifying droughts, and reducing groundwater levels. A reduction in groundwater level, which can be attributed to lack of conservation, reduced recharge during dry spells, and saltwater inundation along the shoreline, will likely also exacerbate droughts.

According to the GC3[9], climate change is expected to shift precipitation patterns throughout the state. The average amount of precipitation is expected to increase by about 8%, or four inches per year. In addition, the number of heavy precipitation days is expected to increase from three to five, with the fraction of heavy precipitation increasing from 15% to 20%. The 1-day precipitation maximum is anticipated to rise from 2.8 to 3.5 inches, and the 3-day from 4.5 to 5.4 inches. These increases in heavy rainstorms may also increase the frequency or severity of flood events along rivers and streams in the region, and throughout urban areas that already experience drainage related, urban flooding.

3.4.3.1 Riverine and Pluvial Floods

According to FEMA, most municipalities in the United States have at least one clearly recognizable floodprone area around a river, stream, or large body of water. These areas are often outlined as SFHAs and delineated as part of the NFIP. Floodprone areas are addressed through a combination of

[9] https://resilientconnecticut.uconn.edu/wp-content/uploads/sites/2761/2020/10/CIRCA-Temperature-and-Precipitation-fact-sheet.pdf

floodplain management criteria, ordinances, and community assistance programs sponsored by the NFIP and individual municipalities.

Many communities also have localized flooding areas outside the SFHA. These floods tend to be shallower and chronically reoccur in the same area due to a combination of factors. Such factors can include ponding, poor drainage, inadequate storm sewers, clogged culverts or catch basins, sheet flow, obstructed drainage ways, sewer backup, or overbank flooding from minor streams.

Flooding (both inland and coastal) was the primary hazard addressed in the previous two editions of this HMCAP. In general, the potential for inland flooding is widespread across the SCCOG region, with the majority of major flooding occurring along established SFHAs. The areas impacted by overflow of river systems are generally limited to river corridors and floodplains. Indirect flooding that occurs outside floodplains and localized nuisance flooding along tributaries is also a common problem in different inland areas. The frequency of inland flooding in the region is considered likely for any given year, with flood damage potentially having significant effects during extreme events.

This section provides a general overview of riverine flooding as well as nuisance flooding in the SCCOG region. Coastal flooding is discussed in Section 3.4.2.1. Specific flooding details for individual towns and cities can be found in their respective annexes.

3.4.3.1.1 Hazard Assessment

Flooding is the most common and costly natural hazard in Connecticut. Flooding is typically produced as a result of other natural hazards, including hurricanes, summer storms, and winter storms. The state typically experiences floods in the early spring due to snowmelt and in the late summer/early autumn due to frontal systems and tropical storms. Localized flooding caused by thunderstorm activity during the summer months can also be significant. Flooding can also occur as a result of ice jams or dam failure and flooding may also cause landslides and slumps in affected areas. According to FEMA, there are several different types of inland flooding:

- **Riverine Flooding**: Also known as overbank flooding, it occurs when channels receive more rain or snowmelt from their watershed than normal, or the channel becomes blocked by an ice jam or debris. Excess water spills out of the channel and into the channel's floodplain area.
- **Flash Flooding:** A rapid rise of water along a water channel or low-lying urban area, usually a result of an unusually large amount of rain and/or high velocity of water flow (particularly in hilly areas) within a very short period of time. Flash floods can occur with limited warning.
- **Shallow Flooding:** Occurs in flat areas where a lack of a water channel results in water being unable to drain away easily. The three types of shallow flooding include:
    - **Sheet Flow:** Water spreads over a large area at uniform depth.
    - **Ponding:** Runoff collects in depressions with no drainage ability.
    - **Urban Flooding:** Occurs when man-made drainage systems are overloaded by a larger amount of water than the system was designed to accommodate.

Flooding presents several safety hazards to people and property and can cause extensive damage and potential injury or loss of life. Floodwaters cause massive damage to the lower levels of buildings, destroying business records, furniture, and other sentimental papers and artifacts. In addition,

floodwaters can prevent emergency and commercial egress by blocking streets, deteriorating municipal drainage systems, and diverting municipal staff and resources.

Furthermore, damp conditions trigger the growth of mold and mildew in flooded buildings, contributing to allergies, asthma, and respiratory infections. Snakes and rodents are forced out of their natural habitat and into closer contact with people, and ponded water following a flood presents a breeding ground for mosquitoes. Gasoline, pesticides, poorly treated sewage, and other aqueous pollutants can be carried into areas and buildings by floodwaters and soak into soil, building components, and furniture.

In order to provide a national standard without regional discrimination, the 1% annual chance flood, or "100-year flood", has been adopted by FEMA as the base flood for purposes of floodplain management and to determine the need for insurance. The SFHA is coincident with the base flood. This flood level has a 1% chance of being equaled or exceeded each year.

Floodplains are lands along watercourses that are subject to periodic flooding; **floodways** are those areas within the floodplains that convey the majority of flood discharge. Floodways are subject to water being conveyed at relatively high velocity and force. The **floodway fringe** contains those areas of the 100-year floodplain that are outside the floodway and are subject to inundation but do not convey the floodwaters at a high velocity.

The risk of having a flood of this magnitude or greater increases when periods longer than one year are considered. For example, FEMA notes that a structure located within a 1% annual chance flood hazard area has a 26% chance of suffering flood damage during the term of a 30-year mortgage. Similarly, a "500-year flood" has a 0.2 percent chance of occurring in a given year. The 0.2% annual chance flood hazard area indicates an area of moderate flood hazard. These areas are distributed to the public on Flood Insurance Rate Map (FIRM) panels and first became available in digital format (DIRM) in New London County in July 2011. The most recent FIRM and FIS updates for New London County were published on April 3, 2020, and reflect some minor changes from the previous HMP. Windham County FIRM panels date back to 1998. Digital representation of flood zones mapped on these panels are available as "Q3 Flood Data" and are presented in that format in this Plan. Some areas in the region are currently undergoing map revisions which are likely to be published during the life of this plan.

FEMA uses a variety of flood zones to delineate areas of annual chance flood hazard. These flood hazard zones differentiate between areas of riverine flooding and shallow flood hazards. Table 3-42 describes the various zones related to inland flooding depicted on the FIRM panels for the SCCOG region. As noted in the table, the majority of inland flooding issues in the SCCOG region result from riverine flooding.

Table 3-43 FIRM Zone Classification in SCCOG Region

Zone	Description
A	An area inundated by 1% annual chance flooding, for which no base flood elevations (BFEs) have been determined. This level of mapping is common for small inland streams in the SCCOG region.
AE	An area inundated by 1% annual chance flooding for which BFEs have been determined. This area may include a mapped floodway. This level of mapping is common for larger streams and rivers in the SCCOG region and in coastal areas.
AH	An area inundated by 1% annual chance flooding (usually an area of ponding), for which BFEs have been determined. Flood depths range from one to three feet. The only occurrence of this zone in the SCCOG region is in a headwater swamp of Sherman Brook in Colchester.
Area Not Included (Zone ANI)	An area that is located within a community or county that is not mapped on any published FIRM. Two such areas occur in the SCCOG region: A small area along Latimer Brook in Montville, and the Eastern Pequot Tribal Nation lands in North Stonington.
Open Water	An area of undesignated flood hazard. A body of open water, such as a pond, lake, ocean, etc. that is located within a community's jurisdictional limits that has no defined flood hazard. In the SCCOG region, these areas primarily occur along the Thames River.
VE	An area inundated by 1% annual chance flooding with velocity hazard (wave action). BFE's have been determined. In the SCCOG region, these areas are located along Long Island Sound and along the Thames River.
X	An area that is determined to be outside the 0.2% annual chance floodplains. This zone covers nearly all inland, non-floodprone areas in the region.
X Protected by Levee	An area that is determined to not be affected by the 0.2% annual chance flood through the presence of a functional levee system. Only one such area occurs in the SCCOG region, and it is located north of Shaw's Cove in New London.
0.2% Annual Chance Flood Hazard (Zone B or Zone X500)	An area inundated by the 0.2% annual chance flood for which elevations are determined. These areas are generally mapped adjacent to Zone AE.
1% Annual Chance Flood Hazard Contained in Channel (Zone 100IC)	A SFHA designation that in the SCCOG region only occurs along Gardner Brook in Bozrah. This indicates an area where the 1% annual chance flooding is contained within the channel banks and the channel is too narrow to show to scale. An arbitrary channel width of three meters is shown. BFE's are not shown in this area, although they may be reflected on the corresponding profile.

Flooding can occur in some areas with a higher frequency than those mapped by FEMA. This nuisance flooding occurs during heavy rain events with a much higher frequency than those used to calculate the 1% annual chance flood event and often in different areas than those depicted on the FIRM panels. These frequent flooding events occur in areas with insufficient drainage; where conditions may cause flashy, localized flooding; and where poor maintenance may exacerbate drainage problems.

During large storms, the recurrence interval level of a flood discharge on a tributary tends to be greater than the recurrence interval level of the flood discharge on the main channel downstream. In other words, a 1% annual-chance ("100-year") flood event on a tributary may only contribute to a 2% annual-

chance ("50-year") flood event downstream. This is due to the distribution of rainfall throughout large watersheds during storms and the greater hydraulic capacity of the downstream channel to convey floodwaters. Dams and other flood control structures can also reduce the magnitude of peak flood flows.

The recurrence interval level of a precipitation event also generally differs from the recurrence interval level of the associated flood. An example would be Tropical Storm Floyd in 1999, which caused rainfall on the order of a 250-year event (0.4-percent annual chance) while flood frequencies were slightly greater than a 10-year event (10-percent annual-chance) on the Naugatuck River in Beacon Falls, Connecticut. Flood events can also be mitigated or exacerbated by in-channel and soil conditions, such as low or high flows, the presence of frozen ground, or a deep or shallow water table, as can be seen in the historic record detailed in Section 3.4.3.1.2.

Figure 3-7 SCCOG Special Flood Hazard Areas

3.4.3.1.2 Historic Record

The SCCOG region has experienced various degrees of inland flooding in every season of the year throughout its recorded history. Similar to other locations in the northeast, melting snow combined with early spring rains has caused frequent spring flooding. Numerous flood events have occurred in late summer to early autumn resulting from storms of tropical origin moving northeast along the Atlantic coast. Winter floods result from the occasional thaw, particularly during years of heavy snow or periods of rainfall on frozen ground. Other flood events have been caused by excessive rainfalls upon saturated soils, yielding greater than normal runoff. Ice jams are also an issue in certain communities, such as Sprague and Norwich.

Major Historic Floods of Note

According to the 2013 FEMA FIS for New London County, the notable historical inland floods in the 20th century occurred in November 1927, March 1936, September 1938, August 1955, and June 1982. The year 1955 was a devastating year for flooding in Connecticut. Connie was a declining tropical storm (described in Section 3.4.1.1.2) when it hit Connecticut in August 1955, producing heavy rainfall of four to six inches across the state. The saturated soil conditions exacerbated the flooding caused by Tropical Storm Diane five days later, the wettest tropical cyclone on record for the northeast. The storm produced 14 inches of rain in a 30-hour period, causing destructive flooding conditions along nearly every major river system in the state. The August and October 1955 floodwaters combined caused over 100 deaths, left 86,000 unemployed, and caused an estimated $500 million in damages (1955 United States Dollars, or USD) in Connecticut. To put this damage value in perspective, consider that the total property taxes levied by all Connecticut municipalities in 1954 amounted to $194.1 million.

Effects of these notable floods in New London County are noted below:

- Tropical Storm Diane in August 1955 caused the greatest flood in recorded history along the Quinebaug River. The peak discharge caused by that storm was 40,700 cubic feet per second (cfs), greater than the 0.2% annual chance flood discharge defined in the FIS. Serious flooding was also reported along the Shetucket River.
- The hurricane of September 1938 caused some of the worst flooding in the history of New London County. According to FEMA, the 1938 hurricane, which struck at high tide, resulted in the greatest disaster in Connecticut's history up until that time because of the combined effects of flooding, winds, and storm surge. The greatest flood in recorded history on the Shetucket River occurred as a result of this storm. Flooding in Norwich had an estimated recurrence interval of 0.3% annual chance flood, while areas to the west had flooding equivalent to a 1% annual chance flood.
- A tropical storm in November 1927 caused severe flooding along the Pawcatuck River. The flood has been estimated to have been a 0.5% annual chance flood.
- The two floods of March 1936 had peak discharges of 22,800 cfs and 25,000 cfs on the Quinebaug River. A peak discharge of 2,240 cfs was recorded for the Pachaug River near Jewett City. These are greater than the 1% annual chance flood discharge defined in the FIS. These floods were caused by extra-tropical storms.
- A winter flood in 1979 was equivalent to the 1% annual chance flood in Colchester.

- A major riverine flooding event occurred in June 1982 in East Lyme and Montville. The flood was caused by heavy rainfall. This event is the flood of record for the Fourmile River.
- On January 29, 1994, a major ice jam occurred along the Shetucket River downstream of Route 97 in Baltic (a section of Sprague). Floodwaters behind the jam overtopped a local flood control berm and inundated 31 houses and four businesses. One home was seriously damaged when ice broke the foundation. The USACE estimated damages at $526,000 and estimated that the flood stages experienced would occur once every 12 years.

Significant Floods, 2007-2012

The following are descriptions of more recent examples of floods in and around the region as described in the National Climatic Data Center (NCDC) Storm Events Database and based on correspondence with municipal officials. Note that inland flooding was not necessarily limited to the described areas. Information on disaster declarations was taken from articles within FEMA's Connecticut Disaster History database.

- **April 15-16, 2007**: A Nor'easter brought heavy rain and high winds that caused widespread and significant river, stream, and urban flooding or low-lying and poor drainage areas throughout Connecticut. Significant river flooding lasted through April 23rd. While only 1.76 inches of rain was reported in Groton, heavier rainfall occurred in the northwestern part of New London County. The Yantic River rose 1.42 feet above flood stage in Norwich.
- **December 12, 2008**: A low pressure system produced a prolonged period of rain across southern Connecticut. A total of 4.5 inches of rain fell in New London County. Major flooding occurred along the Yantic River in Norwich, with the river reaching 2.82 feet above flood stage and remaining above flood stage for nearly 18 hours.
- **July 1, 2009**: Isolated severe thunderstorms produced up to 6.5 inches of rainfall that resulted in flash flooding in Groton, Ledyard, Mystic, and North Stonington. Over 100 basements were pumped out. Approximately 50-60 cars were flooded in the Mystic Aquarium parking lot. A dam in Stonington breached due to the heavy rain.
- **March 14, 2010:** A Nor'easter produced an extended period of heavy rainfall across the area that resulted in widespread flooding across portions of New London County. A total of 2.74 inches of rainfall was reported in Groton and 4.7 inches of rainfall was reported in Norwich. Moderate flooding (1.63 feet above flood stage) occurred on the Yantic River in Norwich. Numerous roads were closed in Mystic and Pawcatuck due to the flooding.
- **March 29-30, 2010:** A second Nor'easter produced an extended period of heavy rainfall across southeastern Connecticut. Major flooding occurred along the Quinebaug River at Jewett City, which crested at 23.26 feet, 5.76 feet above flood stage. Many roads were damaged in Jewett City and throughout Griswold. Floodwaters along a small tributary to Wequetequock Cove destroyed a bridge and most of the nearby road and flooded several homes. Numerous homes experienced basement flooding in Groton, Stonington, and North Stonington. Numerous roads were closed and/or washed out in Stonington and North Stonington. The Yantic River crested at 13.23 feet (4.23 feet above flood stage) on March 30, causing major flooding in Norwich. A total of 8.6 inches of rainfall was reported in Mystic. The USGS estimated that flooding ranged from the 4% annual chance flood to the 0.2% annual chance flood along rivers in the region. The Connecticut Department of Transportation noted that the 0.2% annual chance flood level was reached at eight different locations in New London County.

- **August 27-28, 2011:** As a result of Tropical Storm Irene (Federal Disaster declaration #4023), minor inland flooding occurred in coastal communities. The most significant flooding was coastal in nature and is described in Section 4.3.
- **June 25, 2012**: Heavy rainfall caused isolated flash flooding in New London County, closing route 12 at Stoddards Wharf Road in Massapeag.

Significant Floods, 2013-2017

Since adoption of the previous HMP in October 2012, a number of other flood events have occurred:

- **June 7, 2013**: The remnants of Tropical Storm Andrea tracked up the eastern seaboard resulting in a prolonged period of heavy rain, which caused flash flooding in portions of Fairfield and New London Counties. In Groton, South Road was closed at the railroad underpass due to flooding. Total reported rainfall amounts in New London County ranged from 4.12 inches in Yantic to 6.64 inches in Gales Ferry.
- **July 25, 2013**: The redevelopment of showers and storms over the same area of Southeast Connecticut led to a period of persistent heavy rain over New London County, which resulted in flash flooding. The township of Norwich was hit the hardest with WSR-88D Dual-Pol Storm Total Accumulation estimates of 5 to 8 inches, verified by observations received on the ground. During this event, a vehicle was stranded in flood waters on Huntington Avenue in Norwich; West Town Street at I-395 in Norwichtown was impassable due to flooding; a vehicle was stranded in flood waters at the intersection of White Plains Road and Hansen Road in Norwich, and an office complex at 12 Case Street in Norwich was evacuated due to flooding. Also in Norwich, the Yantic River exceeded bankfull at the intersection of Sturtevant Street and Pleasant Street, downstream of the river gauge, resulting in flooding. The public reported a storm total rainfall of 7.88 inches. Mesonets from the neighboring towns of Yantic, Oakdale and Montville reported total rainfall amounts of 5.25 inches, 3.17 inches and 1.96 inches respectively. Additionally, between 12:00 and 12:15 pm, the mesonet in Yantic reported 1.15 inches of rainfall in 15 minutes. Sholes Avenue, Pleasant Street, and West Town Street in Norwich were closed due to flooding. Residents in the area also experienced basement flooding. Several motor vehicles were stranded in flood waters as well and occupants were rescued by the local fire department. The exit ramp of I-395 at exit 82 (West Town Street) was closed due to flooding in Norwich. Golden Road near Route 32 in Norwich was closed due to flooding.
- **September 2, 2013**: Scattered thunderstorms produced between 2 and 2.5 inches of rainfall, causing flash flooding in Fairfield and New London Counties. There were six to eight inches of flowing water on portions of Route 12 from the U.S. Naval Submarine Base south to Groton. South Road at the railroad underpass in Groton was closed due to flooding.
- **March 30, 2014**: Several inches of rain fell across Southern Connecticut. Storm total rainfall reported across New London County ranged from 3.20 inches in New London to 4.90 inches in Mystic. The Yantic River at Yantic exceeded its flood stage of 9.0 feet to crest at 10.10 feet. Numerous roads in Norwich were under 2 feet of water as a result. Snake Meadow Brook overflowed its banks, flooding and ultimately closing North Sterling Road in Moosup for several hours.
- **July 4, 2014**: As a cold front slowly moved across the area, moisture from Tropical Cyclone Arthur passing to the south and east converged along the boundary resulting in heavy rain and isolated flash flooding in New London. A vehicle became trapped after 4 feet of water accumulated at the intersection of Thames Street and Eastern Point Road in Groton, resulting in

a water rescue. The lower Pawcatuck River exceeded bankfull flooding Mechanic St. in Pawcatuck Township.

- **September 10, 2015**: A wave of low pressure riding along a cold front stalled just south of Long Island. It brought heavy rain and isolated flash flooding to New London County, Connecticut. A roadway collapse was reported on Mullen Hill Road between Ellen Ward Road and Gallup Lane in Manitock Spring. Storm total rainfall from the Groton Airport ASOS was 2.53 inches. Cars were stranded on Water Street in New London due to flash flooding. Bank Street was closed due to flash flooding in New London.

Recent Significant Floods

- **September 12, 2018**: A flash flood event caused flooding throughout the region with reports of road closures in Niantic, New London, Groton, and a flooded café in downtown New London.
- **September 25, 2018**: A heavy rainstorm which produced between five to nine inches within three to four hours caused widespread flooding throughout southern Connecticut. Route 207 in Lebanon and Route 16 in Colchester were both closed due to flooding, and a flashy flood response occurred in the Yantic River basin with a flood stage of 12.53 feet. Cars were stranded in Willimantic and Lebanon, and multiple road washouts were reported. This event was a federally declared disaster (FEMA DR-4410) for New London County and resulted in over $500,000 in damages.
- **July 22, 2019**: A heavy rainstorm caused flash flooding in parts of the region which resulted in a road and retaining wall washout in Groton near Electric Boat, stranded vehicles in New London, and flooding along multiple roadways.
- **September 21, 2021**: Heavy rains pushed the Yantic River to major flood stage with a crest height of 11.71 feet, the seventh highest on record for the river in this location. Road closures were reported in Waterford, power was turned off in Norwich due to basement floodings, a hotel needed to be evacuated from basement flooding, and the Mohegan Commons on East Baltic Street were flooded and uninhabitable. It was reported that over $700,000 in uninsured damages occurred from this storm.

Federal Disaster Declarations

Three events have occurred in the SCCOG region in the last decade that have caused flood damage of sufficient extent (as well as other damages) that Presidential Disasters were declared.

- October 27 - November 8, 2012: Superstorm Sandy (Federal Disaster #4087) caused flooding that created approximately $2.6 million of damage in the SCCOG region.
- September 25 – September 26, 2018: Connecticut Severe Storms and Flooding (Federal Disaster #4410) caused statewide damage, with New London and Middlesex Counties eligible for PA. The storm caused almost $675,000 in damages in the SCCOG region.
- August 2, 2020: Tropical Storm Isaias (Federal Disaster #4580) caused flooding and severs storm damage resulting in almost $865,000 federally reported damages in the SCCOG region.

September 2018 fact sheet

3.4.3.1.3 Existing Capabilities

Jurisdictions in the SCCOG region have a variety of programs, policies, and mitigation measures that are designed to reduce or eliminate the effects of flooding. These include federal flood insurance programs, regulations, codes, and ordinances preventing encroachment and development near floodways, monitoring efforts, and emergency services. Large scale structural projects have also been constructed to reduce flooding damages. Recent and ongoing flood mitigation is described below.

Participation in the NFIP

Jurisdictions in the SCCOG region have voluntarily participated in the NFIP since 1977. These communities have incorporated the NFIP regulations into their own municipal codes, regulations, and tribal policies; plan to continue participating in the NFIP; and will continue to comply with the requirements of the NFIP.

SFHAs in New London County are delineated on a FIRM and Flood Insurance Study (FIS) published on August 5, 2013. The county-wide FIS and FIRM supersede the studies for individual towns in the county. Windham County FIS and FIRM panels date back to 1998; coverage includes the Town of Windham, the only municipality in SCCOG located outside of New London County. Some communities also participate in the Community Rating System. Table 3-43presents the history of NFIP participation in the SCCOG region including the date of identification for the initial Flood Boundary and Floodway Maps (FBFM) or Flood Hazard Boundary Maps (FHBM) that preceded each community FIRM. Each SCCOG community utilizes the current effective FIRM to delineate floodprone areas under the NFIP. Table 3-43 also lists the status of each SCCOG jurisdiction in the Community Rating System, a voluntary FEMA program for local governments which provides discounts on flood insurance for their constituents.

Table 3-44 NFIP Participation in SCCOG Jurisdictions

Community or Tribe[1]	Initial NFIP Map Identified	Initial FIRM Identified	Current Effective Map Date	Community Rating System Status[2]
Bozrah	05/31/1974	09/30/1981	07/18/2011	-
Colchester	08/02/1974	06/15/1982	07/18/2011	-
East Lyme	09/13/1974	06/15/1981	08/05/2013	Class 8
Franklin	11/01/1974	12/01/1981	07/18/2011	-
Griswold	02/28/1975	01/03/1985	07/18/2011	-
Jewett City, Borough of	12/10/1976	04/03/1985	07/18/2011	-
Groton, City of	02/21/1975	05/15/1980	08/05/2013	-
Groton, Town of	02/21/1975	04/15/1977	08/05/2013	-
Groton Long Point Association	04/11/1975	03/18/1980	08/05/2013	-
Noank Fire District	02/21/1975	09/17/1980	08/05/2013	-
Lebanon	01/24/1975	06/06/1988	07/18/2011	-
Ledyard	02/21/1975	04/01/1981	08/05/2013	-
Lisbon	01/31/1975	02/15/1985	07/18/2011	-
Mashantucket Pequot Tribal Nation	02/21/1975	04/01/1981	07/18/2011	-

Mohegan Tribe	10/18/1974	07/02/1980	07/18/2011	-
Montville	10/18/1974	07/02/1980	08/05/2013	-
New London	06/28/1974	05/02/1977	08/05/2013	-
North Stonington	09/13/1974	04/03/1985	04/03/2020	-
Norwich	05/31/1974	06/15/1978	07/18/2011	Class 8
Preston	08/16/1974	03/04/1985	07/18/2011	-
Salem	02/21/1975	02/03/1982	07/18/2011	-
Sprague	05/10/1974	01/03/1985	07/18/2011	-
Stonington, Borough of	11/29/1977	11/01/1979	08/05/2013	Class 8
Stonington, Town of*	10/18/1974	09/30/1980	04/03/2020	Class 7
Waterford	07/26/1974	02/04/1981	08/05/2013	-
Windham	04/12/1974	02/03/1982	11/06/1998	-

1 Tribal lands are identified along with their surrounding communities as initial FEMA designations occurred prior to their lands being identified as sovereign.

2 Class as of October 1, 2016. A "Class 9" rating in the CRS indicates that residents in the SFHA in that community gain a 5% discount on flood insurance, a "Class 8" rating gives a 10% discount, etc.

*The Town of Stonington is actively pursuing reinstatement into CRS

As of September 30, 2022, there were 2,642 flood insurance policies within the SCCOG communities paying a total annual premium of $3,574,949, or an average of $1,353 per policy per year. The total amount of insurance in force is $719,789,700, or an average of $272,441 per policy. The total number of paid losses (claims paid) since 1978 is 1,742 totaling $22,027,038. This information is summarized in Table 3-44

Table 3-45 NFIP Policy and Loss Statistics

Community	Total Losses (since 1/1/1978)	Total Payments (since 1/1/1978)	Policies In Force	Insurance In-Force	Premium In-Force
Bozrah	6	$6,296	3	$630,000	$2,722
Colchester	5	$6,203	14	$5,116,700	$10,814
East Lyme	246	$4,504,415	324	$97,617,400	$350,118
Franklin	14	$47,837	2	$526,000	$3,221
Griswold	5	$23,735	11	$3,009,000	$9,352
Jewett City	5	$15,557	2	$550,000	$3,775
Groton City	80	$1,016,624	83	$23,446,600	$171,127
Groton, Town of	144	$1,689,635	279	$85,834,400	$342,155
Groton Long Point Association	188	$2,109,837	223	$64,906,200	$437,496
Noank Fire District	32	$510,143	79	$23,661,900	$145,865
Lebanon	5	$49,180	15	$4,000,500	$13,980
Ledyard	24	$179,662	28	$6,961,000	$25,702
Lisbon	7	$15,576	8	$1,256,400	$14,659
Montville	15	$71,819	25	$7,091,800	$19,599
New London	180	$2,397,634	231	$56,472,400	$238,438
North Stonington	15	$173,689	21	$6,033,300	$19,602
Norwich	244	$2,375,676	226	$38,446,400	$259,003
Preston	5	$46,882	14	$3,229,600	$15,931

Salem	2	$1,627	1	$175,000	$415
Sprague	18	$128,477	22	$3,661,900	$37,683
Stonington, Borough	57	$907,626	161	$45,546,300	$220,631
Stonington	306	$3,931,005	639	$173,769,400	$937,199
Waterford	125	$1,520,355	213	$62,964,800	$262,135
Windham	14	$297,549	18	$4,882,700	$33,327
TOTAL SCCOG	**1742**	**$22,027,038**	**2642**	**$719,789,700**	**$3,574,949**

In the past, the physical alteration of a river through the construction of dams and levees was the standard response to a flooding problem. These manmade physical controls cannot always be relied upon. They are also relatively expensive, sometimes costing more to construct than the value of the property that they were intended to protect. That is why the contemporary philosophy as embodied in NFIP regulations is to prevent inappropriate development from occurring within the floodplain.

Unfortunately, many areas in the SCCOG region are somewhat problematic as development has already occurred within floodplain areas. In fact, while federal policy and regulations restrict to some extent new development in the floodplain, their overall impact has historically been to maintain the level of the existing development there through the NFIP. The NFIP will pay for repairs to a structure in floodplain area numerous times such that the payments encourage property owners to keep improving structures in the floodplains. In fact, only recently has the flood insurance pricing system begun to differentiate between the different levels of risk for pre-FIRM properties, where before a pre-FIRM property owner who was damaged by floods annually paid the same premiums as a pre-FIRM property owner who was located in a relatively low risk section of the floodplain.

The unintended consequences of these policies have been coming into greater attention lately with the unusual number of natural disasters occurring in recent years, and efforts are underway to alter these policies. As part of such efforts, FEMA is taking steps to make the NFIP more actuarially sound. The Biggert-Waters Flood Insurance Reform Act of 2012 began raising insurance premiums based on actuarial rates of risk. The Homeowner Flood Insurance Affordability Act of 2014 repealed some aspects of the initial act, modified others, and made additional changes to the NFIP. A suite of policy changes went into effect April 1 of 2016, including increased insurance rates and the addition of a surcharge to all policies. Beginning October 1, 2021, FEMA launched the first phase of Risk Rating 2.0, a new policy rating methodology. This latest programmatic change allows FEMA to set fairer rates.

Another way to discourage continued maintenance of floodplain development is for the Federal government, through FEMA, to purchase property subject to ongoing flood damage rather than pay for repairs, which may be less expensive for the Federal government over the long term. This has been done to some extent through the PDM, FMA, and HMGP programs, although funding is often limited. The effects of such programs are discussed later in this section.

Flood insurance remains the most fundamental tool available for property owners to recover from damaging flood events. Nearly 2,700 homeowners in the SCCOG region purchase flood insurance.

Although only a few communities currently participate in the CRS, one of the recommendations of this HMCAP is for communities to participate in the future.

Regulations, Codes, and Ordinances

Each community annex discusses regulations, codes, and ordinances adopted by the local governing body that are dedicated to or related to flood damage prevention. Development or alterations within the SFHA are generally restricted by local regulations and must conform with standards related to safety and the impact on floodwaters. Generally, the NFIP requires that all new construction or substantial improvements within the floodway fringe (the area of the floodplain outside of the floodway) is permitted if the building is adequately floodproofed and has the lowest floor at or above the base flood elevation (level of the 1% annual chance flood). Local freeboard requirements can require the elevation of the lowest floor or lowest structural member to be higher than the base flood elevation.

The State of Connecticut, under Public Act 18-82, has designated high standards for "critical activities". Under this legislation, critical facility and other critical infrastructure projects must use the 0.2% annual chance flood hazard area as the base flood.

Development within the floodway is more restricted and generally limited to a small list of water-dependent activities that do not result in an increase in the base flood elevation more than one foot at any place in the community. These minimum standards have been locally adopted or exceeded to be in compliance with NFIP regulations such that properties within that jurisdiction are eligible for flood insurance under the NFIP. Refer to Table 3-45 for a summary of floodplain management in the SCCOG jurisdictions.

Table 3-46 Floodplain Management in SCCOG Communities

Community	FP Management Ordinance	FP Management Zoning	Substantial Improvement Timeframe	Freeboard Requirement?
Bozrah	No	Section 10.8	1 year window	None
Colchester	Section 64	Section 9.3	1 year window	1 foot
East Lyme	Page 99	Section 15	10 year window	None
Franklin	No	Section 9.14	1-year window	None
Griswold	Section 151	Section 11.4	1-year window	None
Jewett City, Borough of	Yes	No	Unknown	Unknown
Groton, City of	Section 73	Section 4.7	50% for project, or two flood events at 25% within 10 years	None
Groton, Town of	No	Section 6.6	1-year window	1 foot (coastal only)
Groton Long Point Association	No	Section 10	50% for project, or two flood events at 25% within 10 years	1 foot
Lebanon	"Ord. on FP Management"	Section 4.11	5-year window	None
Ledyard	Section 73	Section 12.3	1-year window	None
Lisbon	No	Section 10.15	1-year window	"Above"
Montville	No	Section 16.4	1-year window	None
New London	Ch.6 Article III S:6.41-49	Section 830	10-year window	2-feet
North Stonington	10	Section 307	Project	1 foot
Norwich	Section 3.4	Section 3.4	1-year window	1.5 feet
Preston	No	Section 13.23	1-year window	None
Salem	Page 95	Section 3.13	1-year window	None
Sprague	No	Section 15.14	1-year window	None
Stonington, Borough of	No	Section 3.3.2	3-year window	1 foot
Stonington, Town of	No	Section 7.7	5-year window	1-foot
Waterford	No	Section 25.3	Life of structure	1-foot
Windham	No	Section 52	5-year window	None

Substantial Improvement (SI) is defined as any reconstruction, rehabilitation, addition, or other improvement of a structure which costs 50% or more of the market value of the structure prior to the start of construction of the improvement, without regard for the timing of the construction. Triggering this threshold requires the project to meet all current floodplain management requirements. Each community in the region has mechanisms in place to determine substantial damage, and to implement substantial improvement requirements (Table 3-46). Thus, under the minimum standard it is possible for multiple improvements to be made to a property without addressing flood risk, thereby increasing the overall risk to a property. Communities sometimes strengthen this requirement by attaching a timeframe and counting the total costs of improvements to that property within that timeframe against the substantial improvement threshold.

Table 3-47 Substantial Damage and Improvement Requirement Implementation

Community	SI and SD Implementation
Bozrah	The Planning and Zoning Commission works with the Building Official upon the submission of a permit application. These applications are then subject to Section 10.8 Special Flood Hazard Area (SFHA) Requirements in the Zoning Regulations.
Colchester	The Colchester Planning and Zoning Staff review zoning permits, and work with the Building Department to determine SI/SD. These permits are then subject to Section 9.3 in the Land Development Regulations.
East Lyme	The Building Official is authorized to review all applications and building permits to determine SI/SD, and for consistency with flood hazard regulations.
Franklin	The Building Official is responsible for reviewing all design specifications, and determining SI and whether the design is in accordance with Section 9.14 pf the Zoning Regulations building requirements.
Griswold	The Building and Zoning Enforcement Officer is tasked with reviewing all proposed structures, and determining SI/SD.
Groton, City of	The Zoning and Building Department reviews all applications for SI determination and works with Planning & Zoning to determine flood hazard area regulatory compliance.
Groton, Town of	The Planning Commission and Building Official are required to approve portions of applications that involve Special Flood Hazard Areas, therefore determining SI and ensuring flood hazard area regulatory compliance.
Jewett City	The Building Official will review all building permit applications to determine SI, and ensures proposed practices are compliant and will minimize flood damage.
Lebanon	The Planning and Zoning Commission reviews all site development plans, and works with the building department to determine SI/SD.
Ledyard	The Planning and Zoning Commission reviews all applications and potential permits to determine SI.
Lisbon	The Planning and Zoning Commission reviews all site development plans, and works with the building department to determine SI/SD.
Mashantucket Pequot Tribal Nation	The Building Code Enforcement Office and Dept. of Public Works, Community Planning and Property Management (DPWCPPM) would work together to determine SI in the community, however, there is currently no development in the SFHA.
Mohegan Tribe	The Land Preservation & Planning Department and Regulation & Compliance Department would work together to determine SI in the community, however, there is currently no development in the SFHA.
Montville	The Building Official and Enforcement Officer of Commission reviews all site plans prior to approval for permit.
New London	The Planning and Zoning Commission and Office of Development and Planning are required to review and approve portions of applications that involve structures within FEMA Special Flood Hazard Areas, including SI determination.
North Stonington	The Planning and Zoning Commission reviews all applications for a development permit which includes the required statement and supporting documentation (including costs of project and property market value) to validate whether a project is SI or not.
Norwich	The Department of Planning and Neighborhood Services works with the Building Department to review applications for SI determination. Planning then works to ensure future development is in compliance with flood hazard regulations.
Preston	The Building Official reviews building permits and the Planning and Zoning Commission review all zoning permits, and together the two departments work together to determine SD and SI. Permits are then subject to Section 16.15 in the Zoning Regulations.
Salem	The Planning and Zoning Commission reviews all zoning permits prior to the commencement of any development activities. The Commission works with the Building Department to ensure SD and SI has been determined and incorporated into the plans.

Sprague	The Building Inspector is responsible for inspecting and permitting renovations and improvements in the town and will therefore determine SD and SI in the town prior to the issuance of any permits.
Stonington	The building inspector works alongside the town planner and the zoning enforcement officer to determine SD and SI in Stonington.
Stonington Borough	The Borough Planning and Zoning Department reviews all plans before any permits are issued. The Department reviews plans to determine SD and SI, and once approved, the Town of Stonington building inspector can then issue a building permit. The Town building official then reviews plans as noted above for the town.
Waterford	The Building Official reviews building permits and the Planning and Zoning Commission review all zoning permits, and together the two departments work together to determine SD and SI.
Windham	The Building Inspector is responsible for inspecting and permitting renovations and improvements in the town and will therefore determine SD and SI in the town prior to the issuance of any permits.

Many SCCOG communities also have a policy of "no-net-increase in runoff." No zoning permits for residential or commercial construction, major additions, tennis courts, or pools are issued until the local departments review drainage and grading plans to ensure that adjacent and/or downstream properties are not adversely affected.

Stream Channel Encroachment Line Program

The 2012 HMP discussed the State of Connecticut's Stream Channel Encroachment Line (SCEL) program, established in the late 1950's. Under this program, proposed developments in floodplains mapped by the SCEL process required a special permit from the Connecticut DEEP. As of October 1, 2013, the SCEL program has been repealed (Connecticut Public Act 13-205) in favor of the floodplain management programs and mapping promulgated by FEMA.

While it was in existence, four sections of river in the SCCOG region had floodplains delineated by the SCEL program: The Yantic River from the Bozrah / Norwich municipal boundary upstream to Reservoir Road in Lebanon; The lower reaches of the Yantic River from the Bozrah / Norwich municipal boundary downstream to the Falls Mill Dam No. 2 (Upper Dam) located south of Sherman Street; The Shetucket River from the Occum Pond Dam in Norwich located upstream of Bridge Street upstream to the location of the former Baltic Dam in Sprague upstream of Scotland Road (Route 97); and the Shetucket River from the Greenville Dam (upstream of 8th Street) to the confluence with the Thames River.

Local Land Trusts

Local land trusts are charged with keeping an inventory of all open space land and often advise the local communities concerning open space acquisitions and the appropriate use of existing land holdings. State law also enables certain trusts to accept donations of land, easements and other grants in furtherance of these purposes. Many SCCOG communities have identified land within SFHAs that could be converted to open space. Grant funding under the HMA programs can be used for this purpose provided the project is cost-effective.

Education and Outreach

SCCOG communities provide education and outreach to their residents. Information is available on local websites, local libraries, the SCCOG website, and in pamphlets available at local community buildings. Information includes a variety of potential measures for protecting personal property from flooding.

Emergency Response

The National Weather Service issues a flood watch or a flash flood watch for an area when conditions in or near the area are favorable for a flood or flash flood, respectively. A flash flood watch or flood watch does not necessarily mean that flooding will occur. The National Weather Service issues a flood warning or a flash flood warning for an area when parts of the area are either currently flooding, highly likely to flood, or when flooding is imminent.

Local emergency management personnel are responsible for monitoring local flood warnings. SCCOG jurisdictions can access the National Weather Service website at http://www.weather.gov/ to obtain the latest flood watches and warnings before and during precipitation events.

SCCOG communities receive regular weather updates through DESPP email alerts and can also access the United States Geological Survey website (https://waterdata.usgs.gov/ct/nwis/rt) to monitor real-time precipitation totals and river stage changes.

When flooding occurs, local communities respond to flooding as necessary by closing roads, pumping out basements, or rescuing stranded motorists. During extreme flood events, inter-municipal and regional coordination is essential as widespread areas may be damaged. Local communities follow their Emergency Operations Plans as much as possible. Many SCCOG communities also have a bridge scour monitoring program that goes into effect during heavy rainstorms.

Structural Projects

Property protection projects can address hazards at individual or multiple structures. Such measures can include acquiring floodprone properties and converting the parcel to open space, elevating or floodproofing floodprone structures, constructing flood detention basins, enlarging culverts and bridges to prevent backwater flooding, or large scale projects such as constructing levees or flood control dams. Small scale projects are discussed in Section 3.6. The discussion below focuses on the large-scale flood protection projects that have been constructed to reduce inland flooding in the SCCOG region. Each annex will have more information regarding projects in that community.

There have been several structures built to reduce flooding in the SCCOG region. These structures are described in the 2013 Revised FEMA FIS for New London County, as well as the 1998 FEMA FIS for the Town of Windham:

- The USACE constructed the Mansfield Hollow flood control dam on the Natchaug River following the 1938 floods. The dam was finished in 1952. The dam is designed to reduce the volume of the 1938 flood by approximately half. Though the reservoir reduces the frequency and severity of floods, there still remains a flood hazard on downstream floodplains.

- Several small detention and water supply reservoirs in the upper portions of the Willimantic River basin have a minor effect on flood peaks downstream along the Willimantic and Shetucket rivers.
- The USACE constructed flood control dams in the upper Quinebaug River basins through the mid-1960s. Dams are located at Hodges Village Lake in Oxford, Massachusetts; Buffumville Lake at Oxford and Charlton, Massachusetts; Westville Lake at Southbridge, Massachusetts; East Brimfield Lake at Fiskdale, Massachusetts; and West Thompson Lake at North Grosvenordale, Connecticut.

- The USACE constructed a 0.36-mile levee in Pawcatuck, Connecticut (a part of Stonington near Westerly, Rhode Island) in 1962 and 1963. The levee, pictured to the right, protects an industrial area and surrounding residential area located on Mechanic Street (approximately 28 total acres). However, the levee does not protect against the 1% annual chance flood event.
- Two small reservoirs were constructed by the Soil Conservation Service (now the Natural Resources Conservation Service, NRCS), in 1963 and 1964 on Spaulding Pond Brook in Norwich. These reservoirs provide moderate control of upland runoff.
- The USACE completed the Shetucket River Channel Improvement Project in January 1959. A 700-foot reach of the Shetucket River was deepened and widened, and the raising of the Laurel Hill Avenue Bridge (Route 12) in Norwich significantly improved the flood-carrying capacity of the river below the Greenville Dam.

CRS Fact sheet

3.4.3.1.4 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk to flooding within the SCCOG region. Inland flooding problems are widespread throughout the region. As shown in the historic record, inland flooding can be caused from a variety of sources and can impact a variety of river corridors and cause severe damages in the region. Inland flooding due to poor drainage, ice jams and other factors is also a persistent hazard in the region and can cause minor infrastructure damage, expedite maintenance, and create nuisance flooding of yards and basements.

Flood risk is typically determined through a review of historic events; however, research increasingly points to "non-stationarity" in hydrologic patterns. For example, a 2016 paper (Barrett and Salis, 2016) finds that flow rates during peak annual floods, as well as floods with recurrence intervals of 5, 10- and 20- years, have been increasing between 1962 and 2012. Average observed rates of increasing magnitude are from 0.9 to 1.8 percent per year. Therefore, when planning for inland flood hazards, it is essential to consider not just the past and present, but also potential future conditions.

Vulnerability of Private Properties

Extreme events along defined floodplains often result in damage to insured structures. The most extreme damage associated with inland flooding has historically occurred to homes and businesses along the Yantic River, Mystic River and Latimer Brook corridors resulting from extreme rainfall events. Significant flooding can also take place within the floodplain of smaller tributaries throughout the region. In addition, inland areas can be flooded as a result of coastal storms when flooding passes the initial velocity zone (Zone VE, see Section 3.4.2.1). The potential impacts of flooding in all jurisdictions in the region are high with potential dollar damages as a result of serious flooding being very significant.

Buildings located in SFHAs include residential, commercial, industrial, and critical facility structures. Most of the structures that are threatened by flooding are located within the 1% annual chance floodplain, but some are also in the coastal velocity zone. Location in the velocity zone poses an increased threat to structures due to high wind and potential wave damage, as well as inundation by flood waters. Maps depicting the 1% and 0.2% annual chance SFHAs are included in each community annex.

According to the 2013 and 2020 Revised FEMA FIS for New London County and the 1998 FEMA FIS for the Town of Windham, a total of 73.38 square miles of land in the SCCOG region is located within areas susceptible to flooding from the 1% or 0.2% annual chance flood. Table 3-47 summarizes the total area of land within each FEMA-delineated floodplain area.

Table 3-48 Area of SFHAs in the SCCOG Region

Flood Zone	Area (acres)
0.2% Annual Chance Flood Hazard	17,800.07
1% Annual Chance Flood Hazard – Floodway	7,142.29
1% Annual Chance Flood Hazard – Zone A	21,621.71
1% Annual Chance Flood Hazard – Zone AE	16,183.89
1% Annual Chance Flood Hazard – Zone AH	8.60
1% Annual Chance Flood Hazard – Zone VE	14,850.72
X – Protected by Levee	37.01
Total	**78,192.14**

The software platform *ArcGIS* was utilized along with 2022 municipal tax and parcel data and to determine the number of properties located within the various SFHAs within the SCCOG region. Table 3-48 summarizes the number of parcels at risk of flooding in each SCCOG jurisdiction based on the 1% and 0.2% annual chance floodplain mapped by FEMA, along with the exposed property values.

Table 3-49 Number of Parcels within the 1% and 0.2% Annual Chance Floodplains and Exposure Values

	1% Annual Chance	Total Exposed Property Value in 1%	0.2% Annual Chance*	Total Exposed Property Value in 0.2%
Bozrah	170	$32,900,430	300	$51,197,020
Colchester	484	$150,487,560	502	$151,367,260
East Lyme	1,662	$9,500,120	2,511	$15,459,850
Franklin	170	$33,518,070	184	$36,093,850
Griswold	619	$141,074,840	694	$152,058,250
Jewett City	64	$10,552,420	74	$11,591,710
Groton, City of	274	$486,812,610	421	$532,901,530
Groton, Town of	1,751	$1,816,704,290	2,907	$2,189,466,300
Lebanon	605	$96,396,260	635	$97,146,870
Ledyard	787	$169,788,416	984	$191,156,864
Lisbon	216	$30,570,750	221	$44,134,220
Mashantucket Pequot Tribal Nation	56	$116,580,900	56	$116,580,900
Mohegan Tribe	8	$72,193,930	9	$72,201,070
Montville	535	$175,614,980	936	$271,188,480
New London	459	$548,922,141	837	$687,724,671
North Stonington	608	$120,189,140	822	$150,805,755
Norwich	1,320	$266,674,780	1,546	$317,755,780
Preston	467	$87,398,019	663	$116,466,175
Salem	82	$21,873,510	344	$82,025,260
Sprague	280	$37,737,208	349	$44,147,888
Stonington, Borough	520	$280,671,620	653	$256,245,420
Stonington, Town	2,917	$816,286,320	3,587	$991,886,691
Waterford	1,287	$466,536,694	2,207	$827,724,674
Windham	386	$75,533,280	634	$242,263,240
Total	**14,165**	**$5,981,965,868**	**22,002**	**$7,637,998,018**

0.2% Annual Chance Numbers are Cumulative

Over 14,000 properties in the region are at risk of being affected by a 1% annual chance inland flood, and over 22,000 from the 0.2% annual chance flood. It is important to note however that this does not necessarily mean structures, but parcels and their relative values. Many of the jurisdictions in the region will benefit from pursuing and encouraging potential mitigation measures for floodprone properties. Note that some of the structures on these properties may not actually be at risk based on elevation, though they lie within the SFHA boundary. Nevertheless, this information provides an important context for understanding the extent of flood risk at a regional level.

The list of repetitive loss properties (RLPs) in the SCCOG region was obtained from Connecticut DEEP. There are a total of 115 repetitive loss properties (RLPs) in the SCCOG region, with 51 of these being associated with inland flooding. The remaining 64 RLPs are affected by coastal flooding. are. The majority of these properties are residential with the remainder being commercial properties. The greatest numbers of RLPs affected by inland flooding are located along the Yantic River in Norwich. The majority of the structures are mapped within the 1% annual chance floodplain except for a few properties that appear to be affected by poor drainage or urban flooding. Such properties are mapped within the 0.2% annual chance floodplain or are located outside of mapped floodplains.

Table 3-50 Inland Flooding Repetitive Loss Properties in the SCCOG Region

(As of June 19, 2022*)

Town	Number of Properties			Total Payments
	Total	Residential	Non-Residential	
East Lyme, Town of	23	23	0	$1,512,677.31
Franklin, Town of	2	2	0	$47,836.72
Groton, City of	4	4	0	$125,781.10
Groton, Town of	6	6	0	$152,365.66
Groton Long Point Assoc.	5	5	0	$142,899.99
Ledyard, Town of	3	3	0	$35,226.66
Montville, Town of	2	2	0	$42,778.98
New London, City of	17	16	1	$1,270,461.41
North Stonington, Town of	2	2	0	$36,691.99
Norwich, City of	21	10	11	$1,475,790.11
Stonington, Borough of	2	2	0	$141,398.29
Stonington, Town of	18	16	2	$1,027,451.30
Waterford, Town of	10	10	0	$223,559.01
Total	**115**	**101**	**14**	**$6,234,918.53**

SCCOG recognizes that many private properties may suffer flood damage that is not reported because the structures are not insured under the NFIP, or because the owners fear an increase in flood insurance rates if they report a claim (a misconception because flood insurance is federally subsidized). These

residents and business owners are likely repairing structures on their own. Flood mitigation as recommended in this plan will likely help many of these property owners.

Loss Estimates

Below is a summary of loss estimates based on several different sources including FEMA HAZUS-MH, NFIP, FEMA Public Assistance reimbursements, and the 2019 Connecticut Hazard Mitigation Plan.

HAZUS-MH

HAZUS-MH is FEMA's loss estimation methodology software for flood, wind, and earthquake hazards. The software utilizes year 2020 U.S. Census data and a variety of engineering information to calculate potential damages (specified in year 2020 United States Dollars or USD) to a user-defined region. The software was utilized to perform a basic analysis to generate potential damages in the SCCOG region from a 100-year riverine flood event within each jurisdiction. The coastal flooding module of *HAZUS-MH* was not run for inland communities and results can be found in Section 3.4.2.1.4

Note that the HAZUS-MH software was only utilized for those streams in each jurisdiction that include AE Zones, as shown on a DFIRM. As shown in Table 3-2, many streams in the region are mapped through approximate methods (Zone A), so the software did not generate data for these streams. Windham does not have a DFIRM, so the software was not utilized in that community.

Hydrology and hydraulics for the streams and rivers were generated using the default HAZUS methodology. The model uses default hazard data, including Hydraulic Unit Codes and USGS regression equations and gage records to determine discharge frequency. Summary reports for the 1% annual chance flood event in each jurisdiction are included in Appendix F. The following paragraphs discuss the results of the *HAZUS-MH* analysis.

Each jurisdiction was run separately in *HAZUS-MH*. FEMA default values were used for each census tract in each *HAZUS-MH* simulation. Note that for communities with coastal flooding areas the 1% annual chance coastal floodplain was run independently of the riverine analysis. *HAZUS-MH* distinguishes between riverine and coastal reaches, and therefore these were distinctly different scenarios. However, this does not mean that riverine and coastal flooding sources are distinctly different in each community. It is challenging to determine where exactly a riverine floodplain ends, and coastal floodplain begins. Therefore, these delineations of floodplains may vary in reality compared to what is experienced on the ground. The individual model runs are summarized throughout this section.

Table 3-50 presents the expected damages for each SCCOG jurisdiction. The *HAZUS-MH* simulation estimates that during a combined 1% annual chance riverine flood event more than 900buildings will be damaged in the region from inland flooding. Comparing the number of damaged buildings to the building counts in Table 3-6, this suggests that **approximately two-thirds (66%) of the buildings in the riverine and coastal 1% annual chance floodplain will *not* be damaged during the 1% annual chance event**. It is expected that one **third (34%) of the buildings would experience at least minor (1% to 10%) damage**. There are possible reasons for the discrepancy, including:

- The DEM used is based on the 2000 LiDAR flight and may be more accurate than the USGS topographic maps originally utilized to generate the SFHA boundaries as modified by the MapMod program. Thus, areas that would be flooded based on the mapped floodplain may actually be elevated above the 1% annual chance flood elevation and therefore would not be simulated as being damaged by *HAZUS-MH*.
- The HAZUS-MH software may be underestimating the potential flooding damage in the region.

Table 3-51 HAZUS-MH Flood Scenarios – Building Stock Damages

SCCOG Jurisdiction	1-10% Damage	11-20% Damage	21-30% Damage	31-40% Damage	41-50% Damage	Substantial Damage	Total
Bozrah	12	16	5	1	0	0	34
Colchester	4	3	0	0	0	0	7
East Lyme	48	42	4	0	0	0	94
Franklin	3	3	0	0	0	0	6
Griswold	56	61	21	6	3	0	147
Groton, City of	0	0	0	0	0	0	0
Groton, Town of	34	7	0	0	0	0	41
Lebanon	6	3	0	0	0	0	9
Ledyard	8	10	0	0	0	0	18
Lisbon	19	12	5	4	3	0	43
Mashantucket Pequot Tribal Nation	N/A						
Mohegan Tribe	N/A						
Montville	8	2	0	0	0	0	10
New London	2	0	0	0	0	0	2
North Stonington	9	3	0	0	0	0	12
Norwich	40	97	60	22	8	14	241
Preston	6	8	1	2	3	6	26
Salem	3	1	0	1	0	0	5
Sprague	3	4	1	0	0	0	8
Stonington, Borough of	Coastal analysis available in previous section						0
Stonington, Town of	22	3	0	0	0	0	25
Waterford	28	32	1	0	0	0	61
Windham	78	36	13	8	5	4	144
Total	**389**	**343**	**111**	**44**	**22**	**24**	**933**

HAZUS-MH utilizes a *subset* of critical facilities known as "essential facilities" that are important following flooding events. These include EOCs, fire stations, hospitals, police stations, and schools. Not all SCCOG jurisdictions are expected to have damage to essential facilities following a 1% annual chance flood event. In the SCCOG region, *HAZUS-MH* identified a total of 237 essential facilities.

- EOC: 22
- Fire Station: 62
- Hospital: 6
- Police Station: 30
- Schools: 117

Of these 237 facilities, none of them are expected to have loss of use due to a 1% annual chance flood.

The *HAZUS-MH* software estimated the amount of debris that would be caused by inland flooding. Debris material includes items such as drywall and insulation, structural items include materials such as wood and brick, and foundations include materials such as concrete slabs, blocks, and rebar. Results are presented in Table 3-51. The *HAZUS-MH* simulation estimated that a significant amount of debris (over one-thousand tons) would be generated in Griswold, Lisbon, Norwich, and Windham.

Table 3-52 HAZUS-MH Flood Scenarios – Debris Generation (Tons)

SCCOG Jurisdiction	Total Debris (Tons)	Estimated Cleanup Truckloads (25 Tons / Truck)
Bozrah	529	21
Colchester	32	1
East Lyme	252	10
Franklin	4	1
Griswold	2,388	96
Groton, City of	180	7
Groton, Town of	225	9
Lebanon	26	1
Ledyard	852	34
Lisbon	1,149	46
Mashantucket Pequot Tribal Nation	-	-
Mohegan Tribe	-	-
Montville	73	3
New London	27	1
North Stonington	140	6
Norwich	19,560	782
Preston	732	29
Salem	72	3
Sprague	115	5
Stonington, Borough of	-	-
Stonington, Town of	394	16
Waterford	420	17
Windham	11,987	479
Total	**39,157**	**1,566**

HAZUS-MH calculated the potential sheltering requirement for the 1% annual chance flood event. Results are presented in Table 3-52. The model estimates that over 14,000 individuals will be displaced due to a 1% annual chance flood affecting watercourses in the region; this is approximately 4,700 households. Displacement includes households evacuated from within or very near to the inundated areas. Of those displace, over 2,500 will seek temporary shelter in a community or regional shelter.

Table 3-53 HAZUS-MH Flood Scenarios – Shelter Requirements

SCCOG Jurisdiction	Short-Term Sheltering Need (Number of People)	Displaced Population	Community Sheltering Capacity (Table 2-6)
Bozrah	6	316	>100
Colchester	26	124	800
East Lyme	103	736	2,300
Franklin	1	31	318
Griswold	225	1,771	525
Groton, City of	31	47	250
Groton, Town of	264	1,029	1,400
Lebanon	23	219	*
Ledyard	99	453	>100
Lisbon	25	386	150
Mashantucket Pequot Tribal Nation	-	-	400
Mohegan Tribe	-	-	50
Montville	56	212	>100
New London	73	215	3,750
North Stonington	19	218	>100
Norwich	627	3,503	33,000
Preston	57	247	100
Salem	19	69	>100
Sprague	23	174	600
Stonington, Borough of			0
Stonington, Town of	112	800	1,300
Waterford	171	686	5,500
Windham	556	2,889	*
Total	**2,516**	**14,125**	**50,943**

The predicted sheltering requirements for inland flood damage have been compared to the shelter information described in Section 2.11 to determine adequacy. In general, communities have sufficient sheltering capacity based on the comparison of HAZUS-MH shelter requirements and existing shelter capacities, however, these are the requirements for a 1% annual chance riverine flood. If this event were to coincide with a coastal flood event, or tropical storm or hurricane, sheltering needs may be higher than stated in this table. Sheltering capacities in Lebanon and Windham are not quantified. Lebanon's sheltering capacity is likely sufficient given the small number of people estimated to require shelter under these flood conditions. Windham however may face sheltering capacity challenges in the event of a 100-year flood event depending upon their actual capability. Emergency managers within these communities have worked to identify sheltering capacities that are believed appropriate for accommodating the populations that are understood to likely require shelter during a flood event.

HAZUS-MH also calculated the predicted economic losses due to the 1% annual chance flood event. Economic losses are categorized between building-related losses and business interruption losses. Building-related losses (damages to building, content, and inventory) are the estimated costs to repair or replace the damage caused to the building and its contents. Business interruption losses are those

associated with the inability to operate a business because of the damage sustained during the flood and include lost income, relocation expenses, lost rental income, lost wages, and temporary living expenses for displaced people. Results are presented in Table 3-53, with the majority of losses occurring in Norwich, Windham, and New London.

Table 3-54 HAZUS-MH Estimated Direct Losses from Flooding Scenarios

	Direct Losses (Millions of Dollars)		
SCCOG Jurisdiction	**Estimated Total Building Losses**	**Estimated Business Interruption Losses**	**Estimated Total Losses**
Bozrah	$35,960,000	$40,990,000	**$76,950,000**
Colchester	$6,820,000	$9,760,000	**$16,580,000**
East Lyme	$23,210,000	$43,890,000	**$67,100,000**
Franklin	$6,130,000	$11,830,000	**$17,960,000**
Griswold	$80,150,000	$110,240,000	**$190,390,000**
Groton, City of	$380,000	$1,370,000	**$1,750,000**
Groton, Town of	$9,610,000	$48,170,000	**$57,780,000**
Lebanon	$11,310,000	$7,060,000	**$18,370,000**
Ledyard	$11,590,000	$43,020,000	**$54,610,000**
Lisbon	$40,290,000	$39,890,000	**$80,180,000**
Mashantucket Pequot	-	-	-
Mohegan	-	-	-
Montville	$5,350,000	$10,180,000	**$15,530,000**
New London	$150,780,000	$301,180,000	**$451,960,000**
North Stonington	$10,700,000	$34,210,000	**$44,910,000**
Norwich	$482,220,000	$505,780,000	**$988,000,000**
Preston	$15,460,000	$11,110,000	**$26,570,000**
Salem	$14,240,000	$18,190,000	**$32,430,000**
Sprague	$3,820,000	$4,270,000	**$8,090,000**
Stonington, Borough of	-	-	-
Stonington, Town of	$17,200,000	$40,880,000	**$58,080,000**
Waterford	$26,290,000	$70,900,000	**$97,190,000**
Windham	$268,470,000	$183,240,000	**$451,710,000**
Total	**$1,219,980,000**	**$1,536,160,000**	**$2,756,140,000**

A 1% annual chance riverine flood, as simulated by HAZUS-MH, would generate more than $2.7 billion in flooding-related damages in the SCCOG region. Approximately half of the losses are related to building damage, while the other half are related to business interruption. Although business related losses account for about half of the total economic impacts, they can cause ripple effects throughout the economy putting small businesses at risk of closure.

Public Assistance Reimbursements

Loss estimates for flooding can also be generated from the value of Public Assistance grants received by municipalities and other entities within the SCCOG region. According to information from the FEMA Public Assistance Funded Projects Summary (Open Government Initiative), there was one flood event since 2012 that resulted in federal disaster declarations in southeastern Connecticut. This event

resulted in reimbursement requests from five communities. These expenses included debris removal, emergency protective measures, and repairs to damaged infrastructure and buildings experienced by local governments and non-profits. A summary for the SCCOG region is presented in Table 3-54 below.

Table 3-55 Public Assistance Reimbursements Related to Flooding since 2012

SCCOG Jurisdiction	Federal Share	Project Amount
Colchester	$45,044	$60,058
Franklin	$23,389	$30,698
Lebanon	$299,633	$399,511
Norwich	$10,831	$16,118
Sprague	$127,595	$167,469
Total	**$506,492**	**$673,853**

Between 1999 and 2017 there were four flood events that that resulted in disaster declarations for southeastern Connecticut. These events resulted in over 11 million dollars in damages. Reimbursement figures for these events can be found in Table 3-55.

Table 3-56 Public Assistance Reimbursements Related to Flooding between 1999 and 2017

SCCOG Jurisdiction	Local Government Cost	Other Local Agency Cost*	Total Cost
Bozrah	None	None	None
Colchester	$119,668.69	$9,912.25	$129,580.94
East Lyme	$534,625.41	$446,999.07	$1,001,624.48
Franklin	$36,467.80	None	$36,467.80
Griswold	$364,657.13	None	$364,657.13
Groton, City of	$793,923.80	$308,129.81	$1,102,053.62
Groton, Town of	$655,207.05	$234,409.38	$889,616.44
Jewett City, Borough of	$9,912.25	None	$9,912.25
Lebanon	$37,848.71	None	$37,848.71
Ledyard	$207,670.17	$53,100.83	$260,771.00
Lisbon	$30,246.24	None	$30,246.24
Mashantucket Pequot Tribal Nation	$295,317.80	None	$295,317.80
Mohegan Tribe	$7,556.34	None	$7,556.34
Montville	$400,063.05	$17,069.59	$417,132.64
New London	$384,770.29	$76,006.01	$457,776.30
North Stonington	$2,357,743.20	$4,100.00	$2,361,843.20
Norwich	$1,455,203.16	$58,157.92	$1,513,361.08
Preston	$78,578.47	$36,031.24	$114,609.71
Salem	$86,826.72	None	$86,826.72
Sprague	$230,081.29	None	$230,081.29
Stonington, Borough of	$28,894.91	$17,768.11	$46,663.01
Stonington, Town of	$520,739.20	$94,955.35	$615,694.55
Waterford	$1,643,152.54	$16,341.05	$1,659,493.60
Windham	$36,729.88	$11,360.32	$48,090.20
Total	**$10,315,884.10**	**$1,384,340.93**	**$11,717,225.05**

*Other agencies = Fire Districts, Schools, Housing Authorities, and other Non-Profit Agencies

Superstorm Sandy, Tropical Storm Isaias, and Extratropical Storm Ida caused both flooding and wind damage. An exact breakdown is not immediately available. The damage values (Table 3-21) are assumed to be one-third flooding related and two-thirds wind related.

Note that federal reimbursement of PA-eligible projects is only typically 75% of the cost. The figures presented in Table 3-54 show both the total costs of projects, and the federal amount received by each community. Damages to private property are not part of the Public Assistance information, so use of these figures alone is likely to underestimate losses.

Losses incurred during these disaster events were caused by both coastal and inland flooding. The relative proportions of damages caused by each flood source during each event cannot be effectively extracted and vary from storm to storm. This vulnerability analysis does not attempt to differentiate between coastal and inland storm damages in this case, and reports flood loss estimates as one category.

Based on the information in Table 3-54, flooding losses reimbursed through the FEMA Public Assistance Program have totaled $675,853 for the SCCOG region since 2012. The annualized loss due to flooding for the SCCOG region over the 18 years of record in the Public Assistance report is therefore $650,956.95.

NFIP Payments

Based on the information from the NFIP presented in section 3.4.1 and, a total of $20,728,454.80 has been paid out to NFIP-insured properties since (1978) (39 years). The annualized loss due to flooding based on this data is $531,498.84.

Potential Losses Based on Connecticut Natural Hazards Mitigation Plan

An additional estimate of regional impact has been determined based on the data presented in the 2019 CT NHMP. The percentage of the population of each SCCOG community as compared to the population of its county (New London or Windham) was used to adjust the flood losses historical record of flood losses reported to the NCEI in Table 2-46 of the 2019 CT NHMP. The annualized loss estimates for flooding based on the NCEI damages is presented in Table 3-56.

Table 3-57 Loss Estimates Based on 2019 CT NHMP Based on NCDC Damages

Community	Loss Estimate	Community	Loss Estimate
Bozrah	$3,136.31	**Montville**	$23,741.18
Colchester	$20,084.52	**New London**	$35,336.10
East Lyme	$24,136.28	**North Stonington**	$6,648.36
Franklin	$2,405.49	**Norwich**	$51,809.15
Griswold	$14,722.19	**Preston**	$6,182.24
Groton city	$11,809.26	**Salem**	$5,439.80
Groton	$35,443.27	**Sprague**	$3,830.97
Lebanon	$9,221.71	**Stonington borough**	$1,151.74

Ledyard	$19,890.84	**Stonington**	$23,674.04
Lisbon	$5,416.56	**Waterford**	$25,269.95
Mashantucket	$151.07	**Windham**	$9,089.01
Mohegan	$61.98		
Total			**$338,652**

3.4.3.2 Drought

Drought is defined as a period of abnormally dry weather sufficiently prolonged for the lack of water to cause serious hydrologic imbalance in the affected area. Drought is a natural climatic condition caused by an extended period of limited rainfall beyond that which occurs naturally in a broad geographic area. High temperatures, high winds and low humidity can worsen drought conditions, and can make areas more susceptible to wildfire. Human demands and actions can also hasten drought-related impacts.

Droughts are frequently classified as one of following four types: meteorological, agricultural, hydrological or socio-economic. Meteorological droughts are typically defined by the level of "dryness" when compared to an average, or normal amount of precipitation over a given period of time. Agricultural droughts relate common characteristics of drought to their specific agricultural-related impacts. Hydrological drought is directly related to the effect of precipitation shortfalls on surface and groundwater supplies. Human factors, particularly changes in land use, can alter the hydrologic characteristics of a basin. Socio-economic drought is the result of water shortages that limit the ability to supply water-dependent products in the marketplace.

3.4.3.2.1 Hazard Assessment

While this region of the country is not typically associated with droughts, these events are becoming more frequent and flashier due to climate change. In the SCCOG region, all are vulnerable to drought either in a direct or indirect way. A drought can be severely disruptive to agricultural operations, drinking water supplies, ecosystems, and recreation. These events are also more challenging as they are typically much more prolonged than most other hazards such as tropical storms, floods, or severe snow storms.

Droughts are monitored extensively for progression and severity. The most commonly used index is the Palmer Drought Severity Index (PDSI), shown in Table 3-57. The PDSI measures the difference between water supply (precipitation and soil moisture) and water demand (amount needed to replenish soil moisture and keep larger bodies of water at normal levels). It primarily reflects long-term drought and has been used extensively to initiate drought relief.

Table 3-58 Palmer drought severity index

PDSI Value	Classification
+4.0 or above	Extremely Moist
+3.0 to +3.9	Very Moist Spell
+2.0 to +2.9	Unusual Moist Spell
-1.9 to +1.9	Near Normal

-2.0 to -2.9	Moderate Drought
-3.0 to -3.9	Severe Drought
-4.0 or less	Extreme Drought

Source: National Oceanic and Atmospheric Administration

The Standardized Precipitation Index (SPI) is another tool used to monitor meteorological droughts. The index uses historical precipitation levels to calculate the probability of precipitation, and how far current levels deviate from the climatological average. The U.S. Drought Monitor, hosted by NOAA and the National Integrated Drought Information System (NIDIS), is a drought status map updated weekly to show stages of drought around the country. Several tools, including SPI and PDSI are used to monitor and classify droughts. The Drought Monitor scale has five different stages of drought. Below are those stages and the typical impacts experienced in Connecticut:

- D0 - Abnormally Dry: crop growth stunted, planting is delayed, dire danger is elevated, spring fire season starts early, lawns brown early, gardens wilt.
- D1 – Moderate Drought: irrigation use increases, hay and grain yields are lower than usual, hone production declines, wildfires and ground fires increase.
- D2 – Severe Drought: specialty crops are impacted in both yield and fruit size, producers begin feeding cattle, hay prices are high, warnings are issued on outdoors burns, air quality is poor.
- D3 – Extreme Drought: crop loss is widespread, Christmas tree farms are stressed, dairy farmers are struggling financially, well drillers and bulk water haulers see increased business, water recreation and hunting are modified, wildlife disease outbreak is observed.
- D4 Exceptional Drought: Due to few exceptional droughts, impacts have not been observed, however the above impacts can all be expected to amplify during an extended exceptional drought.

3.4.3.2.2 Historic Record

NOAA historical records (Drought Monitor) indicate that there have been 27 periods of extreme to exceptional droughts in the region since 1895, as listed in Table 3-58**.** There have been other short periods of time where the region was classified as extreme or exceptional, however, these were not as prolonged as those identified below. Those that are bold are events that lasted at least six months.

Table 3-59 Periods of Extreme and Exceptional Drought since 1895

Drought Date Range	Drought Severity
5/1905-7/1905	Extreme
1/1910-7/1910	**Extreme**
9/1914-12/1914	Extreme
1/1925-6/1925	Extreme
1/1930-7/1930	**Extreme**
8/1930-12/1930	**Exceptional**
1/1931-4/1931	**Extreme**
4/1932-7/1932	Extreme
9/1941-11/194	Extreme
1/1944-8/1944	**Extreme**
3/1947-7/1947	Extreme
10/1949-3/1950	Extreme

7/1957-11/1957	Exceptional
7/1963-12/1963	Extreme
6/1964-12/1964	**Extreme**
1/1965-8/1966	**Exceptional**
1/1981-9/1981	**Extreme**
3/1985-7/1985	Extreme
6/1990-8/1990	Extreme
3/2002-5/2002	Exceptional
3/2013-5/2013	Exceptional
7/2013-11/2013	Extreme
3/2014-6/2014	Exceptional
7/2014-10/2014	Extreme
4/2015-11/2015	**Exceptional**
1/2016-12/2016	**Extreme**
6/2022-8/2022	Extreme

The United States Department of Agriculture (USDA) Secretary of Agriculture is authorized to declare and designate counties as disaster areas in relation to drought, and other natural hazard events. Over the years, the process for declaring a drought disaster has evolved and is also the most widely used designation across the country. The USDA Declarations for New London and Windham Counties since 2012 can be found in Table 3-59.

Table 3-60 USDA Emergency Drought Declarations Since 2012

Year	Designation Number	New London County	Windham County	Approval Date	Description of Disaster
2022	S5292	X		9/26/2022	Drought – FAST TRACK
2022	S5287	X		9/21/2022	Drought – FAST TRACK
2022	S5280	X		9/7/2022	Drought – FAST TRACK
2022	S5267, S5271	X	X	8/22/2022	Drought – FAST TRACK
2022	S5255, S5257	X	X	8/15/2022	Drought – FAST TRACK
2020	S4827, S48732	X	X	10/15/2022	Drought – FAST TRACK
2020	S4814, S4808, S4803	X	X	10/14/2022	Drought – FAST TRACK
2016	S4076	X	X	10/19/2016	Drought
2016	S4055	X	X	9/28/2016	Drought – FAST TRACK
2016	S4045, S4047	X	X	9/21/2016	Drought – FAST TRACK
2016	S4032		X	9/7/2016	Drought – FAST TRACK
2014	S3775	X	X	12/10/2014	Drought - FAST TRACK

Within the past five years, drought has become somewhat of a more common, or understood event. In 2016, 2020, and 2022 the state and region experienced relatively extended and stressful droughts.

- **2016 –** A statewide drought that lasted almost two years and peaked in 2016, resulted in water conservation efforts throughout the southeastern part of the region, elevated fire risks in some areas, and was noted as the 11th driest spring on record.
- **2020 –** From June to December, New London County experienced a moderate to severe drought, with the county being declared a Stage 3 by the Connecticut Interagency Drought Work Group.
- **2022 –** During the development of this plan, the region was in an ongoing drought, with severe drought conditions in August 2022. New London County was declared a Stage 3 drought emergency on August 18, 2022, and Windham Count a Stage 2 on the same day.

3.4.3.2.3 Existing Capabilities

In addition to the U.S. Drought Monitor, the PDSI and SPI, the State of Connecticut has developed a State Drought Plan which is implemented and administered by the Interagency Drought Workgroup (IDW). The IDW is a collection of State agency representatives, which also helped developed the State Drought Plan. The Drought Plan provides a framework for response, guidance for action levels, and works to preserve balance between water usage and supply.

The drought plan identifies five stages of drought that increase in severity, each of which have specific thresholds for stage criteria. The IDW discusses drought stages throughout the state and review relative data to determine Connecticut's response and needs to the event. This includes information such as the Drought Monitor, stream gauge levels, and reservoir levels. The stages identified in the State Drought Plan are described below in Figure 3-7.

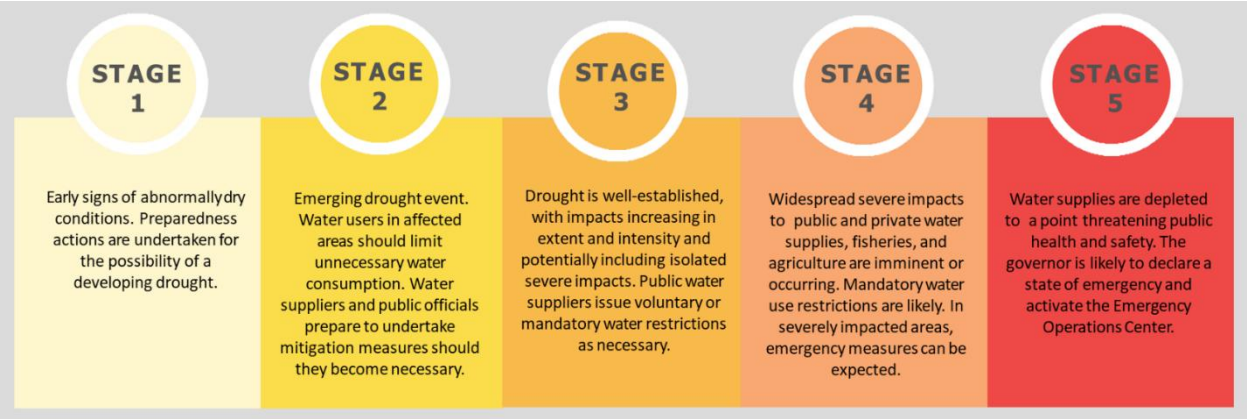


Figure 3-8 The Five Stages of Drought as Identified in the State Drought Plan

Many of the communities in the SCCOG region do not have specific drought related capabilities aside from those emergency response capabilities discussed in previous hazards. Some communities are working to implement regulations that aid in water conservation, impervious coverage reduction, and smart planting. These can be reviewed in each community annex.

3.4.3.2.4 Vulnerabilities and Risk Assessment

With the entire planning area susceptible to drought, vulnerability varies depending upon things such as land use or drinking water source. Agricultural operations including crop growers and livestock facilities, may face challenges during drought periods by way of reduced irrigation or herd watering capabilities.

Those that are in more rural areas and rely on smaller, local farms may also see a reduction in fresh produce availability during growing seasons due to reduced yield.

Drinking water sources may also become stressed during periods of drought. Private well owners could potentially face wells running dry or becoming contaminated as groundwater levels drop. Those that rely on public water supply are typically more resilient as sources are more redundant, however, these systems may impose water restrictions for residents during droughts.

Loss Estimates

Losses from droughts are not often as evident as other events. Losses may go unreported from farming operations or drinking water companies. Private well owners may need to resuscitate wells or drill deeper; these losses again may go unreported. However, because the USDA provides emergency funding for agricultural operations in the wake of emergency declarations, these numbers are available for New London and Windham Counties. Since 2012, five different agricultural operations, some in different years, received over $50,000 in emergency funding. A total of nine payments have been made since 2012 with the average payment being $5,570. The Breakdown of payments can be found in Table 3-60.

Table 3-61 USDA Payments Made from Drought Declarations to SCCOG Community Agricultural Operations

Community	Sum of Disbursement Amount
Bozrah	$1,062
East Lyme	$29,799
Lebanon	$479
Lisbon	$1,496
Norwich	$17,290
Total	**$50,126**

According to the 2017 USDA Census of Agriculture, New London is the second largest farm county (by acres farmed), and Windham is the fourth. As of 2017 New London County had 823 farms covering 60,122 acres. The total market value of products sold was $135,786,000. Windham County had 646 farms covering 51,990 acres. The total market value of products sold from these farms was $45,091,000.

Table 3-62 USDA Agricultural Statistics for Connecticut

County	Number of Farms	Acres Farmed	Total Market Value of Products Sold	Farm-related Income
New London	823	60,122	$135,786,000	$15,775,000
Windham	646	51,990	$45,091,000	$2,743,000

3.4.3.3 Dam Failure

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 often occur during flooding when the dam breaks under the additional force of floodwaters. In addition, a dam failure can cause a chain reaction where the sudden release of floodwaters causes the next dam downstream to fail. With over 250 registered dams and potentially several other minor dams scattered throughout the SCCOG municipalities and two tribal affiliates, dam failure has the potential to occur in any part of the region. While flooding from a dam failure generally has a limited geographic extent, the effects are potentially catastrophic depending on the downstream impact area. Fortunately, a major dam failure is not considered a likely hazard event in any given year.

3.4.3.3.1 Hazard Assessment

The Connecticut DEEP administers the Dam Safety Section and designates a classification to each state-registered dam based on its potential hazard.

- *Class AA* dams are negligible hazard potential dams that upon failure would result in no measurable damage to roadways and structures and negligible economic loss.
- *Class A* dams are low hazard potential dams that upon failure would result in damage to agricultural land and unimproved roadways, with minimal economic loss.
- *Class BB* dams are moderate hazard potential dams that upon failure would result in damage to normally unoccupied storage structures, damage to low volume roadways, and moderate economic loss.
- *Class B* dams are significant hazard potential dams that upon failure would result in any of the following: possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, and schools; damage or interruption of the use of service of utilities; damage to primary roadways and railroads; and a significant economic loss.
- *Class C* dams are high potential hazard dams that upon failure would result in loss of life and major damage to habitable structures, residences, hospitals, convalescent homes, schools, and main highways, with great economic loss.

This HMCAP section primarily discusses the possible effects of failure of significant and high potential hazard (Class B and Class C) dams only. The Connecticut DEEP published a list of high and significant hazard dams in the State in 2007. According to the list, there were 36 Class B and 17 Class C dams in the region. A CT DEEP query from September 2022 indicated 40 Class B dams and 21 Class C dams. Class C Dams in the region are listed in Table 3-62, and locations of significant and high hazard dams are illustrated in Figure 3-8.

Figure 3-9 High and Significant Hazard Dams in the SCCOG Region

Table 3-63 High and Significant Hazard Dams in the SCCOG Region

CT Dam #	Town	Hazard Class 9/2/2022	Name	Owner
1302	Bozrah	C	Fitchville Pond Dam	Private (Commercial)
1305		B	Gardner Lake Dam	CT DEEP
2801	Colchester	C	Deep River Reservoir Dam	Norwich Public Utilities
4501	East Lyme	B	Powers Lake Dam	CT DEEP
4502		B	Darrow Pond	Town of East Lyme
4503		B	Gorton Pond	CT DEEP
4505		B	Pataguanset Lake	CT DEEP
5801	Griswold	C	Glasgo Pond Dam	CT DEEP
5802		B	City Pond	CT DEEP
5803		B	Stone Hill Reservoir	Private (Commercial)
5804		C	Ashland Pond Dam	CT DEEP
5805		C	Pachaug Pond Dam	CT DEEP
5807		B	Hopeville Pond Dam	CT DEEP
5811		B	Aspinook Pond Dam	Private (Commercial)
5902	Groton	B	Ledyard Reservoir	City of Groton
5904		C	Poquonnock Dam	City of Groton
5905		B	Poheganut Reservoir	City of Groton
7101	Lebanon	B	Williams Pond Dam	Town of Lebanon
7104		B	Savin Lake Dam	CT DOAG
7105		B	Brewster Pond Dam	CT DEEP
7108		B	Red Cedar Lake Dam	CT DEEP
7207		B	Morgan Pond	City of Groton
7301	Lisbon	B	Lower Blissville Pond	Town of Lisbon
7309		B	Crossing at Lisbon Detention Dam	Private (Commercial)
8601	Montville	B	Congdon Pond Dam	Private (Commercial)
8603		B	Barnes Reservoir Dam	Municipal
8606		C	Oxoboxo Lake Dam	Private (Commercial)
8607		B	Wheeler Pond Dam	Private
8613		B	Rockland Pond Dam	Private (Commercial)
8616		B	Stony Brook Reservoir Dam	Norwich Public Utilities
8639		B	Barnes Reservoir Dike	Municipal
10201	North Stonington	B	Wyassup Lake	CT DEEP
10205		B	Clark Falls Dam	Private
10403	Norwich	C	Taftville Dam #4	Private (Commercial)
10404		C	Fairview Reservoir Dam	Norwich Public Utilities
10405		C	Greenville Hydro Dam	Norwich Public Utilities
10406		B	Taftville Reservoir #1	Norwich Public Utilities

10407		B	Bog Meadow Reservoir	Norwich Public Utilities
10409		B	Taftville Reservoir #3	Norwich Public Utilities
10417		C	Spaulding Pond Dike	City of Norwich
10418		C	Spaulding Pond Site #2 Dam	City of Norwich
10419		C	Spaulding Pond Dam Site #1	City of Norwich
11401	Preston	B	Tunnel Dam	Private (Commercial)
13301	Sprague	B	Baltic Reservoir (West)	Town of Sprague
13302		C	Hanover Reservoir Dam	Private
13303		B	Paper Mill Pond	Private (Commercial)
13304		B	Versailles Pond	Private (Commercial)
13306		B	Harrington Apartments Dam	Private
13312		B	Baltic Reservoir (East)	Town of Sprague
13702	Stonington	C	Silvias Pond Upper Dam	Private
13702		C	Silvias Pond Lower Dam	Private
13703		C	Mystic Reservoir Dam	Private (Commercial)
13708		C	Deans Reservoir Dam	Private (Commercial)
15201	Waterford	C	Lake Konomoc Dam	City of New London
15204		B	Brandagee Lake Dam	City of New London
15205		B	Miller Pond	Private (Commercial)
16301	Windham	C	Scotland Dam	Private (Commercial)
16303		B	Potash Pond Dam	Private
16304		C	Big Pond Dam	Lake Association
16318		B	Robinson Pond Dam	Private

The Mashantucket Pequot Tribal Nation and the Mohegan Tribe do not have high or significant hazard dams on their reservation. Each tribal government believes that its dams are relatively low hazard in comparison with the Connecticut DEEP classifications used for other dams in the region. Tribal dams are discussed briefly in each respective tribal annex.

In addition to dams that exist within the SCCOG region, dams exist upstream of many SCCOG communities as noted in Section 3.4.3.1.3. In particular, several flood control dams have been constructed upstream on the Shetucket River and Quinebaug River; and the Mansfield Hollow Lake Dam on the Natchaug River in Mansfield impounds up to 16.1 billion gallons of water for flood control purposes.

3.4.3.3.2 Historic Record

According to the CT DEEP website, approximately 200 notable dam and reservoir failures occurred worldwide in the twentieth century and more than 8,000 people died in these disasters. The following is a listing of some of the more catastrophic dam failures in Connecticut's recent history:

- 1938 and 1955: Exact numbers of dam failures caused by these floods are unavailable, but the Connecticut DEEP believes that more dams were damaged in these events than in the 1982 or 2005 flooding events described below.
- 1961: Crystal Lake dam in Middletown failed, injuring three and severely damaging 11 homes.
- 1963: Failure of the Spaulding Pond Dam in Norwich caused six deaths and six million dollars in damage. This dam failure occurred during a moderate storm.
- June 5-6, 1982: Connecticut experienced a severe flood that caused 17 dams to fail and seriously damaged 31 others. The failure of the Bushy Hill Pond Dam in Deep River caused $50 million in damages, and the remaining dam failures caused nearly an additional $20 million in damages.

More recently, the NCDC reports that flash flooding on April 16, 1996, caused three small dams in Middletown and one in Wallingford to breach. The Connecticut DEEP reported that the sustained heavy rainfall from October 7 to 15, 2005 caused 14 complete or partial dam failures and damage to 30 other dams throughout the state. The October 2005 flooding subsequently resulted in a federal disaster declaration. A summary of damaged dams in the State is summarized in Table 3-63.

Table 3-64 Dams Damaged Due to Flooding from October 2005 Storms

Number	Name	Location	Class	Damage Type	Ownership
-----	Somerville Pond Dam	Somers	--	Partial Breach	DEEP
4701	Windsorville Dam	East Windsor	BB	Minor Damage	Private
10503	Mile Creek Dam	Old Lyme	B	Full Breach	Private
-----	Staffordville Reservoir #3	Union	--	Partial Breach	CT Water Co.
8003	Hanover Pond Dam	Meriden	C	Partial Breach	City of Meriden
-----	ABB Pond Dam	Bloomfield	--	Minor Damage	Private
4905	Springborn Dam	Enfield	BB	Minor Damage	DEEP
13904	Cains Pond Dam	Suffield	A	Full Breach	Private
13906	Schwartz Pond Dam	Suffield	BB	Partial Breach	Private
14519	Sessions Meadow Dam	Union	BB	Minor Damage	DEEP

Dam failures in Connecticut have been of primary concern to the well-being of many communities in according to an American Rivers blog posted on March 31, 2010. Overtopping of the Sylvias Pond Dam in Stonington due to heavy rainfall caused an evacuation of homes downstream in 2009. Additionally, the mayor of the town of Montville evacuated a section of town during the March 2010 floods once it become possible that the Rand-Whitney Dam in town could breach.

With many dams nearing the end of their effective lives, a significant number of dams in Connecticut, New England, and across the United States are likely to grow as potential threats to life and property. Indeed, the Association of State Dam Safety Officials has indicated that dam failures have been

documented in every state. From January 1, 2012, through January 2023, state dam safety programs reported 260 dam failures and 509 non-failure incidents requiring intervention to prevent failure.

3.4.3.3.3 Existing Capabilities

The dam safety statutes are codified in Sections 22a-401 through 22a-411 inclusive of the Connecticut General Statutes and were most recently revised with an effective date of February 3, 2016. 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.

Dam Inspection Regulations require that nearly 700 dams in Connecticut be inspected annually. The DEEP currently prioritizes inspections of those dams that pose the greatest potential threat to downstream persons and properties. Dams found to be unsafe under the inspection program must be repaired by the owner. Depending on the severity of the identified deficiency, an owner is allowed reasonable time to make the required repairs or remove the dam. If a dam owner fails to make necessary repairs to the subject structure, the DEEP may issue an administrative order requiring the owner to restore the structure to a safe condition and may refer noncompliance with such an order to the Attorney General's Office for enforcement. As a means of last resort, the DEEP Commissioner is empowered by statute to remove or correct, at the expense of the owner, any unsafe structures that present a clear and present danger to public safety.

> Dams regulated by the DEEP must be designed to pass the 100-year rainfall event with 1 foot of freeboard, a factor of safety against overtopping.
>
> Significant and high hazard dams are required to meet a design standard greater than the 100-year rainfall event.

Owners of Class C dams have traditionally been required to maintain Emergency Operation Plans (EOPs). Guidelines for dam EOPs were published by DEEP in 2012, creating a uniform approach for development of EOPs. As dam owners develop EOPs using the new guidance, DEEP anticipates that the quality of EOPs will improve, which will ultimately help reduce vulnerabilities to dam failures.

Important dam safety program changes have recently occurred in Connecticut. Public Act No. 13-197, *An Act Concerning the Dam Safety Program and Mosquito Control,* passed in June 2013 and describes new requirements for dams related to registration, maintenance, and EOPs, which will be called emergency action plans (EAPs) moving forward. This Act required owners of certain unregistered dams or similar structures to register them by October 1, 2015. The Act generally shifts regularly scheduled inspection and reporting requirements from the DEEP to the owners of dams. The Act also makes owners generally responsible for supervising and inspecting construction work and establishes new reporting requirements for owners when the work is completed.

Effective October 1, 2013, the owner of any high or significant hazard dam (Class B and C) must develop and implement an EAP after the Commissioner of DEEP adopts regulations. The EAP shall be updated every 2 years, and copies shall be filed with DEEP and the chief executive officer of any municipality that would potentially be affected in the event of an emergency. New regulations shall establish the requirements for such EAPs, including but not limited to (1) criteria and standards for inundation studies

and inundation zone mapping; (2) procedures for monitoring the dam or structure during periods of heavy rainfall and runoff, including personnel assignments and features of the dam to be inspected at given intervals during such periods; and (3) a formal notification system to alert appropriate local officials who are responsible for the warning and evacuation of residents in the inundation zone in the event of an emergency.

The Connecticut DEEP also administers the Flood and Erosion Control Board program, which can provide noncompetitive state funding for repair of municipality-owned dams. Funding is limited by the State Bond Commission. State statute Section 25-84 allows municipalities to form Flood and Erosion Control Boards, but municipalities must take action to create the board within the context of the local government such as by revising the municipal charter. More information regarding the Flood and Erosion Control Board program can be found at http://www.ct.gov/dep/lib/dep/water_inland/flood_mgmt/fecb_program.pdf.

3.4.3.3.4 Vulnerability and Risk Assessment

The failure of a Class C dam would result in any of the following: loss of life; major damage to habitable structures, residences, hospitals, convalescent homes, schools, and main highways; and a significant economic loss. Failure of a Class B dam would result in slightly less downstream damage including any of the following: possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, and schools; damage or interruption of the use of service of utilities; damage to primary roadways and railroads; and a significant economic loss.

The impacts related to the Class C dams in the region are described in each community annex. The descriptions are based on information available at the Connecticut DEEP Dam Safety Section. It is noted that the failure of any of the other dams in the region could also have impacts on human life and property although these impacts would be far lower in scope than those for the Class C and Class B dams.

Loss Estimates

The 2014 Connecticut Natural Hazard Mitigation Plan reports $44,397,208 in damage from seven dam failures in New London County, and $6,525,037 in damage from three dam failures in Windham County, since 1877. This gives countywide annualized dam failure damage estimates of $326,450 and $47,978 for New London and Windham Counties, respectively. The 2019 Connecticut Natural Hazard Mitigation Plan reports, per the National Performance of Dams Program (NPDP), $3,078,000 in damage from three dam failures in New London County, and $250,000 from one failure in Windham County since 1877.

Annualized loss estimates, based on the 2019 figures, are apportioned by the ratio of the population of each community to that of its county in Table 3-64, below. These figures are consistent with the high cost but relatively small number of dam failure events that have occurred in SCCOG.

Table 3-65 Estimated Annualized Losses from Dam Failure

Community	Estimated Annual Loss	Community	Estimated Annual Loss
Bozrah	$3,129.24	Mohegan	$125.07
Colchester	$19,139.95	Montville	$7,195.94

East Lyme	$22,821.90	New London	$23,312.67
Franklin	$2,289.46	North Stonington	$6,309.70
Griswold	$10,082.18	Norwich	$48,234.62
Groton City	$11,191.18	Preston	$5,629.54
Groton Town	$36,593.18	Salem	$4,944.61
Jewett City	$4,153.66	Sprague	$3,554.49
Lebanon	$8,705.17	Stonington Borough	$1,106.61
Ledyard	$17,928.51	Stonington Town	$20,983.90
Lisbon	$5,167.36	Waterford	$23,248.34
Mashantucket	$393.09	Windham	$10,236.67
		SCCOG TOTAL	**$296,477**

Summary

The SCCOG region, and the State of Connecticut in general, have instituted and carried out strong dam monitoring and maintenance measures. While dam failures may be high hazard events, continued dam management practices can maintain the regions risk status at a relatively low level. This is reflected in the relatively moderate annualized damage estimate of $296,477 calculated above.

3.4.4 Rising Temperatures

According to the Fourth National Climate Assessment, the average temperature has increased by 1.2 degrees Fahrenheit between 1986 and 2016. Additionally, temperature records from the past twenty years show the number of high temperature records exceeding the number of low temperature records, in addition to an extended frost-free season over the years.

It is projected that over the next few decades that annual temperature across the United States will increase by about 2.2 degrees Fahrenheit, with increase between 2.3 and 6.7 degrees under low emission scenarios and 5.4 and 11.0 degrees under high emission scenarios by late century.

It was noted that particularly in the northeast temperatures tend to be slightly higher due to the abundance of concrete and asphalt, and relative lack of vegetation. This in turn increases the urban heat island effect. During heat waves and extreme heat events, these highly impervious areas that have an increased urban heat island effect experience higher nightly temperatures than surrounding, more vegetated areas. Increased temperatures can translate to increased heat stress, poor air quality, greater risk of wildfires, and increased vulnerability due to health, occupation, and lack of air conditioning. Rising temperatures will also increase demand on electric supply as heat wave frequency increases and so does the demand for energy and air conditioning.

The greatest impact of rising temperatures is likely to be associated with human health. Air quality will likely degrade as temperatures rise, and climate change is expected to increase levels of ground-level ozone. Increased temperatures are expected to lead to an increase in heat related death, illness, emergency department visits, and hospitalizations.

3.4.4.1 Extreme Heat

According to the National Weather Service, extreme temperature (including extreme heat, humidity, and extreme cold) is the number one weather-related killer in the United States.

Extreme heat may be generally defined as temperatures that hover 10 degrees or more above the average high temperature for the region, last for prolonged periods of time, and are often accompanied by high humidity. At certain levels the human body cannot maintain proper internal temperatures and may experience severe health disorders including heat cramps, heat exhaustion or heatstroke (a life-threatening condition).

3.4.4.1.1 Hazard Assessment

The National Weather Service's Heat Index is a measure of the effects of the combined elements of air temperature and relative humidity on the human body, particularly for people in higher risk groups (elderly persons, young children, persons with respiratory difficulties, and those who are sick or overweight). Table 3-65 summarizes the extent of these effects.

Table 3-66 Effects of Extreme Heat on the Human Body

Heat Index	Heat Disorder
80–89° F	Fatigue possible with prolonged exposure and/or physical activity.
90–104° F	Sunstroke, heat cramps and heat exhaustion possible with prolonged exposure and/or physical activity.
105–129° F	Sunstroke, heat cramps or heat exhaustion likely, and heatstroke possible with prolonged exposure and/or physical activity.
130° F and Higher	Heatstroke/sunstroke highly higher likely with continued exposure.
Source: National Oceanic and Atmospheric Administration NWS	

An extreme heat wave is when temperatures and humidity are higher than normal for two to three days. This threshold is considered 90 degrees or more for the region. As temperatures and humidity rise above that threshold the risk of heat-related illness or death increases, ultimately increasing the severity of the heat wave.

3.4.4.1.2 Historic Record

NOAA historical records indicate that there have been no fatalities in the planning area due to extreme temperatures from 1995 through 2022. Table 3-66 shows the number of heat related emergency room visits and hospitalizations per 100,000 for the entire state. Between 2018 and 2021 a total of 12 extreme heat warnings and advisories were issued by the National Weather Service for various parts of the state.

Table 3-67 Emergency Department Visits and Hospitalizations per 100,000 People for the State of Connecticut

Year	Emergency Department Visits per 100,000 People	Hospitalizations per 100,000 People
2020	8.5	1.2
2019	13.8	1.3
2018	15.3	1.6
2017	10.1	1.3
Source: CDC National Environmental Public Health Tracking Network		

While summers are humid and very warm, historically, temperatures rarely exceed 100° F and only exceed 90°F on 7-8 days per year. In the summer of 1999, Connecticut experienced extreme heat for a

period of 3-5 consecutive days over 100 degrees making it the most severe heat wave on record. However, hotter days are becoming more frequent. The highest recorded ambient temperature for the region is 102°F in 2001 at the NPU Plant. In 2022 alone, the region (at the NPU Plant) experienced 21 days with temperatures above 90. Between 2017 and 2021 the region experienced 79 days over 90 degrees, with an average of 16 days per year.

Table 3-68 Annual maximum temperatures throughout the region

Year	Groton New London Airport		Norwich Public Utility Plant		Groton, CT	
	Max. Temp	No. of Days over 90	Max. Temp	No. of Days over 90	Max Temp	No. of Days over 90
2017	89	0	94	8	91	3
2018	91	2	101	21	92	1
2019	94	3	96	17	93	2
2020	92	2	96	16	92	6
2021	88	0	96	17	90	1
2022	93	N/A	96	21	N/A	N/A
Max. Recorded	101 (2010)		102 (2001)		101 (1991)	
Source: National Weather Service						

Notable occurrences in the planning area include:

- June 21 to June 23, 2012: An early summer heat wave set records across the northeast with extremely high temperatures. The NPU Plant measured highs between 96 and 98 degrees over the three days, and Groton-New London Airport record highs between 86 and 90 degrees.
- July 5 to July 21, 2013: Over the course of 17 days, the NPU plant recorded 12 of those having a high of at least 90 degrees. The shoreline recorded four days of at least 90 degrees. On July 18, Governor Malloy issued a press release urging residents to conserve energy as energy demands were reaching a seven year record per ISO-New England.
- July 23 to July 29, 216: The NPU Plant recorded a seven day stretch of over 90 degree days inland, with Groton-New London Airport recording 2 days ove2 92 degrees during this period.
- June 13 to 14, 2017: Inland temperatures reached 94°F for two days, and between 87 and 89°F by the shore.
- June 30 to July 5, 2018: The NWS issued a heat advisory along the shoreline, and an excessive heat warning for inland communities in the state. The NPU Plant reported temperatures between 90 and 101 for six consecutive days. Along the shoreline at Groton Airport temperatures ranged from 80 to 89°F.
- July 20-21, 2019 – The NWS issued an excessive heat watch for all counties in the state. The NPU Plant recorded temperatures on those two days between 95 and 96 degrees, and Groton New London Airport observed temps from 91 and 94 degrees.
- July 18-25, 2022 – On July 18 Governor Lamont activated a statewide extreme heat protocol in preparation for a heat wave. The following days were expected to reach temperatures above 95 degrees, with heat indexes over 100 degrees. NPU Recorded temperatures between 90 and 96°F

between July 20 and 25. Groton New London Airport recorded temperatures between 84 and 91°F between the same time frame.

- August 2 to 10, 2022: The Governor activated the state extreme hot weather protocol as weather reports anticipated several days of hot and humid conditions with temperatures in excess of 90 degrees. From August 2 to the 9, the Groton New London Airport reported four consecutive days at 88 degrees, and one at 91°F. The NPU facility recorded eight consecutive days over 90°F with a maximum of 94 degrees on August 10.

3.4.4.1.3 Existing Capabilities

At the state level, as mentioned above, the Governor has the ability to activate the extreme hot weather protocol. The protocol follows the State Response Framework, and several actions are initiated by DEMHS. These steps include:

- Governor's office issues a press release
- DEMHS send emails to towns
- DEMHS requests that towns submit their cooling center information in the WebEOC Daily Operations Incident
- PIO sends sound social media alerts and disseminates information to the ESF 15 Diverse Communities group to share with their contact lists
- DEMHS contacts 211 to be ready to respond to calls regarding cooling centers
- DEMHS Regional Coordinators and duty officer monitor the WebEOC in order to respond to any requests from municipalities for assistance
- DEMHS receives reports and updates from the energy utilities

In addition to the state protocol, many of the communities throughout the region have developed their own procedures for extreme heat. Specific details can be found in each annex however some general capabilities include:

- Opening cooling centers
- Providing transportation to cooling centers
- Checking on vulnerable community members

3.4.4.1.4 Vulnerability and Risk Assessment

The entire planning area is susceptible to the occurrence of extreme temperatures. In general, inland areas are more susceptible to extreme heat than coastal areas. Also, urbanized, or highly impervious areas, are also more susceptible to extreme heat, and because of this, potentially increased air pollution.

The impacts of extreme heat are primarily public health, or agriculturally related. During extreme heat waves individuals may suffer from heat related conditions or death such as heat stroke, or cardiovascular disease or disorders, respiratory disease and disorders, or kidney disorders. Hospitalizations, typically in urbanized areas or among the elderly, often increase during heat waves due to these conditions. Agricultural operations face challenges as during extreme heat waves crops may become stressed and require increased irrigation, and livestock operations may face challenges in

keeping animals cool and hydrated. In addition, critical infrastructure such as roadways or rail lines, can become stressed during extreme, extended heat waves.

Impacts also include stress on power grids during periods when there is an increased demand for heating and cooling, a rise in food prices if damage occurs to crops livestock operations, and extreme temperature events can put a strain on community resources when having to respond to individuals that are not actively mitigating personal impacts from heat or cold.

Loss Estimates

Loss estimates related to extreme heat are challenging to quantify, and not as consistently documented as other natural hazards. Losses will however be addressed in future editions of this plan as impacts are more widely assessed and documented.

3.4.4.2 Wildfires

The ensuing discussion about wildfires is focused on the undeveloped wooded, marsh, and shrub/grassland areas of the region, along with the wildland interface, which is low-density suburban-type development found at the margins of these wooded areas. Structural fires in higher density areas are not directly addressed.

3.4.4.2.1 Hazard Assessment

Wildfires are considered to be highly destructive, uncontrollable fires. Although the term brings to mind images of tall trees engulfed in flames, wildfires can occur as brush and shrub fires, especially under dry conditions. Wildfires are also known as "wildland fires."

Nationwide, humans have caused approximately 90% of all wildfires in the last decade. Accidental and negligent acts include unattended campfires, sparks, burning debris, and irresponsibly discarded cigarettes. The remaining 10% of fires are caused primarily by lightning or downed electrical wires.

Nevertheless, wildfires are a natural process in many ecosystems, and their suppression is now recognized to have created a larger fire hazard as live and dead vegetation accumulates in areas where fire has been prevented. In addition, the absence of fire has altered or disrupted the cycle of natural plant succession and wildlife habitat in many areas. Consequently, federal, state, and local agencies are committed to finding ways to reintroduce fire into natural ecosystems, such as prescribed burning, while recognizing that firefighting and suppression are still important near developed areas.

Connecticut has a particular vulnerability to fire hazards where urban development and wildland areas are in close proximity. The "wildland/urban interface" is where many such fires are fought. Wildland areas are subject to fires because of weather conditions and fuel supply. An isolated wildland fire may not be a threat, but the combined effect of having residences, businesses, and lifelines near a wildland area causes increased risk to life and property. Thus, a fire that might have been allowed to burn itself out with a minimum of firefighting or containment in the past is now fought to prevent fire damage to surrounding homes and commercial areas as well as smoke threats to health and safety of humans and wildlife in these areas.

3.4.4.2.2 Historic Record

According to the 2014 *Connecticut Natural Hazards Mitigation Plan*, Connecticut enacted its first statewide forest fire control system in 1905, when the state was largely rural with very little secondary growth forest. By 1927, the state had most of the statutory foundations for today's forest fire control programs and policies in place, such as the State Forest Fire Warden system, a network of fire lookout towers and patrols, and regulations regarding open burning. The severe fire weather in the 1940s prompted the state legislature to join the Northeastern Interstate Forest Fire Protection Compact with its neighbors in 1949.

Today, most of Connecticut's forested areas are secondary growth forests. According to the Connecticut DEEP, forest has reclaimed over 500,000 acres of land that was used for agriculture as of 1914. However, that new forest has been fragmented in the past few decades by residential development. The urban/wildland interface is increasing each year where urban sprawl extends further out from Connecticut's cities.

The technology used to combat wildfires has significantly improved since the early 20th century. An improved transportation network, coupled with advances in firefighting equipment, communication technology, and training, has improved the ability of firefighters to minimize damage due to wildfires in the state. For example, radio and mobile technologies have greatly improved firefighting command capabilities.

For the period 2002 through 2021, the National Interagency Fire Center reports that a total of 5,091 acres of land burned in Connecticut due to 3,485 non-prescribed wildfires, an average of 1.5 acres per fire (Table 3-68). In general, the fires are small and detected quickly, with most of the largest wildfires being contained to less than 10 acres in size. The number one cause of wildfires is arson, with about half of all wildfires being intentionally set.

Table 3-69 Wildland Fire Statistics for Connecticut

Year	Number of Wildland Fires	Acres Burned	Number of Prescribed Burns	Acres Burned	Total Acres Burned
2021	60	127	*	*	127
2020	586	383	*	*	383
2019	88	72	*	*	72
2018	52	40	*	*	40
2017	97	243	*	*	243
2016	268	778	3	152	930
2015	76	159	4	25	184
2014	28	69	4	34	103
2013	76	238	4	37	275
2012	180	417	4	42	459
2011	196	244	7	42	286
2010	93	262	6	52	314
2009	264	246	6	76	322
2008	330	893	6	68	961
2007	361	288	7	60	348
2006	322	419	6	56	475

2005	316	263	10	130	393
2004	74	94	12	185	279
2003	97	138	8	96	234
2002	101	184	13	106	290
Total	**3,485**	**5,091**	**88**	**1,065**	**6,718**

Source: National Interagency Fire Center

Traditionally, the highest forest fire danger in Connecticut occurs in the spring from mid-March to mid-May. The worst wildfire year for Connecticut in the past decade occurred during the extremely hot and dry summer of 1999. Over 1,733 acres of Connecticut burned in 345 separate wildfires, an average of about five acres per fire. Only one wildfire occurred between 1994 and 2003 that burned over 300 acres, and a wildfire in 1986 in the Mattatuck State Forest in the town of Watertown, Connecticut burned 300 acres.

In the dry spring of 2011, a 25-acre wildfire occurred in East Haddam just west of the SCCOG region. This fire occurred in Devil's Hopyard State Park in late March.

More recently, there were three notable occurrences of wildfires in the region. The Connecticut Department of Transportation reported a brush fire burning along Interstate 95 in Waterford on May 9, 2021. The right lane was close to traffic. No other losses or damages were reported.

On April 29, 2022, a three-acre brush fire occurred in Lisbon. The fire was in a heavily wooded area and the neighboring communities of Jewett City, Griswold, Voluntown, Baltic, and Preston City provided mutual aid.

On August 20, 2022, a three acre brush fire was detected in Norwich. The fire was extinguished in just a few hours, and no buildings or damages were reported.

3.4.4.2.3 Existing Capabilities

Existing mitigation for wildland fire control is typically focused on Fire Department training and maintaining an adequate supply of equipment. Unlike wildfires on the west coast of the United States where the fires are allowed to burn toward development and then stopped, the local Fire Departments in the region go to the fires whenever possible. This proactive approach is believed to be effective for controlling wildfires. Each local Fire Department has some water storage capability but primarily relies on the use of the fire ponds, dry hydrants, water tanks, and the local public water systems to fight fires throughout the region.

The Connecticut DEEP Division of Forestry monitors the weather each day during non-winter months as it relates to fire danger. The Division utilizes precipitation and soil moisture data to compile and broadcast daily forest fire probability forecasts. Forest fire danger levels are classified as low, moderate, high, very high, or extreme. In addition, the National Weather Service (NWS) issues a Red Flag warning when winds will be sustained or there will be frequent gusts above a certain threshold (usually 25 mph), the relative humidity is below 30 percent, and precipitation for the previous 5 days has been less than one-quarter inch. Such conditions can cause wildfires to quickly spread from their source area.

During the highest forest fire risk period the CT DEEP sends daily advisories to municipalities, fire departments and the media. The vulnerability to wildfire is reduced by the DEEP's firefighting capability. The agency maintains a trained staff of 70 firefighters for assignment to fires on state property and throughout the region. The group assigned to the Pachaug State Forest, for example, has been very helpful in mitigating the impacts of wildfires in Griswold.

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

3.4.4.2.4 Vulnerability and Risk Assessment

The most common causes of wildfires are arson, lightning strikes, and fires started from downed trees hitting electrical lines. Thus, wildfires have the potential to occur anywhere and at any time in both undeveloped and lightly developed areas. The extensive forests and fields covering the State are prime locations for a wildfire. In many areas, structures and subdivisions are built abutting forest borders, creating areas of particular vulnerability.

Wildfires are more common in rural areas than in developed areas as most fires in populated areas are quickly noticed and contained. The areas in the SCCOG region most prone to wildfire are those jurisdictions that have large contiguous tracts of forest land within their boundaries, or the wildland-urban interface (WUI) areas. The wildland-urban interface and intermix areas (Figure 3-9) are those that have development adjacent to or are interspersed throughout fire prone vegetation. Hemlocks and other coniferous trees throughout the SCCOG region provide good sources of fuel for wildfires and are often found in the WUI areas. Along the coastline, wildfires in tidal marshes have become problematic in some areas where invasive reeds *(phragmites)* have taken hold. Often fires start along the railroad tracks resulting from sparks or discarded cigarettes. While these fires have not been known to cause risk to nearby structures, the migration of *phragmites* causes the potential to increase.

The most extreme wildfires in Connecticut's recent history have burned over 300 acres. However, the likelihood of a severe and expansive wildfire developing in Connecticut is lessened by the vast network of water features in the state, which creates natural breaks likely to stop the spread of a fire. It is noted that during long periods of drought, these natural features may dry up, increasing the vulnerability of the state to extreme wildfires.

According to the Connecticut DEEP, the actual forest fire risk in Connecticut is low due to several factors. First, the overall *incidence* of forest fires is limited (An average of 174 fires occurred in Connecticut per year from 2002 to 2021, which is a rate slightly higher than one per municipality per year). Secondly, as the wildfire/forest fire prone areas become fragmented due to development, the local fire departments have increased access to those neighborhoods for firefighting equipment. Third, the problematic interface areas are site specific, such as driveways and forest access roads too narrow to permit emergency vehicles. Fourth, the containment of wildfires occurs quickly, with the average wildfire being

less than two acres in size. Finally, trained fire fighters at the local and state level are readily available to fight fires in the state, and inter-municipal and inter-state cooperation on such instances is common thanks to a variety of agreements that have been in place for decades.

Public water service is relatively extensive throughout the urbanized and suburban parts of the region. The risk of wildfire increases where significant areas of forested or brushland do not have immediate access to public water supply for firefighting. These areas are more predominant in jurisdictions that do not have public water service. Most SCCOG communities are comfortable with their ability to respond to wildfires in outlying areas because of available dry hydrants or other water bodies. Therefore, areas surrounding water bodies are also considered to be low risk areas even if public water service is not available.

Should a wildfire occur, it is reasonable to estimate that the average area to burn would be five acres during a drought period and one to two acres during wetter periods, consistent with the State averages. In the case of an extreme wildfire occurring during a drought on forested lands, it is estimated that up to 300 acres could burn before containment due to the limited access of those lands. This is also consistent with actual data in Connecticut. Residential areas bordering such lands would thus be vulnerable to wildfires.

Recall from Section 2.6 that elderly and persons with disabilities reside in the region. In comparing these figures with the wildfire risk areas described above, it is possible that large populations of the elderly and people with disabilities could reside near wildfire impact areas. Thus, it is important for the local Fire Departments to be prepared to assist these special populations during emergencies, including wildfires.

Figure 3-10 Wildfire Risk in the SCCOG Region

Loss Estimates

The *2019 Connecticut Natural Hazards Mitigation Plan Update* does not provide annual estimated losses by county for wildfires however there are figures for the number and value of at-risk state-owned facilities New London County has 107 facilities within the wildland-urban interface and intermix and Windham County has 140 facilities. The total value of at-risk facilities in New London County is $50,498,186, and $234,948,678 in Windham County.

The Town of Mansfield, Connecticut, reports in the 2015 Former WinCOG HMP Update that wildfires cost the Town approximately $2,000 per acre affected. This figure is used here to estimate wildfire-related damage to each SCCOG community based on the number of acres in the wildland-urbane interface and intermix versus the total number of WUI acres in the SCCOG region. In addition, the average number of fire events in the state, 174, was used as a factor along with the average fire size, which is 1.46 acres.

Table 3-69, below, lists annual estimated wildfire losses for the SCCOG region, as well as for each SCCOG community, calculated as described above.

Table 3-70 Estimated Annualized Losses from Wildfires

Community	Estimated Annual Costs	Community	Estimated Annual Costs
Bozrah	$139.83	Montville	$379.25
Colchester	$410.11	New London	$40.40
East Lyme	$205.87	North Stonington	$342.53
Franklin	$159.30	Norwich	$256.13
Griswold	$273.76	Preston	$279.22
Groton City	$1.65	Salem	$214.63
Groton Town	$192.35	Sprague	$122.36
Lebanon	$463.97	Stonington Borough	$6.58
Ledyard	$306.24	Stonington Town	$331.82
Lisbon	$161.28	Waterford	$251.16
Mashantucket	$28.92	Windham	$236.85
Mohegan	$2.80		
		SCCOG TOTAL	**$5,081**

Summary

Open space areas, and populated areas adjacent, are considered most at-risk from wildfires. Areas that are not served by public water supplies and not adjacent to large bodies of water may be particularly at-risk of wildfire damages due to firefighting challenges.

Based on these factors, low-risk areas are concentrated around significant population areas, especially along the Thames River and New London Harbor, Niantic Bay, Mystic Harbor, Pawcatuck, Norwich, the Mashantucket Pequot Tribal Nation reservation, Jewett City, Lebanon Town Center, and the region's major highway corridors. More rural and forested areas farther from these centers are designated as moderate risk. Overall, the SCCOG region has an annualized loss estimate for wildfires of $5,081.

3.4.5 Non-Climate Driven

3.4.5.1 Earthquakes

Even though earthquake damage has the potential to occur anywhere both in the region and in the northeastern United States, the effects may be felt differently in some areas based on the type of geology. In general, earthquakes are considered a hazard that may occur and would likely cause effects to a large area of the region. Furthermore, the Virginia earthquake of August 2011 reminded the nation that earthquake effects are transmitted great distances on the east coast.

3.4.5.1.1 Hazard Assessment

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; result in dam failures; and often cause landslides, flash floods, fires, avalanches, and tsunamis. Earthquakes can occur at any time without warning.

The underground point of origin of an earthquake is called its focus; the point on the surface directly above the focus is the epicenter. The magnitude and intensity of an earthquake is determined by the use of the Richter scale and the Mercalli scale, respectively.

The Richter scale defines the magnitude of an earthquake. Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of earthquake waves recorded on instruments that have a common calibration. The magnitude of an earthquake is thus represented by a single, instrumentally determined value recorded by a seismograph, which records the varying amplitude of ground oscillations.

The magnitude of an earthquake is determined from the logarithm of the amplitude of recorded waves. Being logarithmic, each whole number increase in magnitude represents a tenfold increase in measured strength. Earthquakes with a magnitude of about 2.0 or less are usually called microearthquakes and are generally only recorded locally. Earthquakes with magnitudes of 4.5 or greater are strong enough to be recorded by seismographs all over the world.

The effect of an earthquake on the Earth's surface is called the intensity. The Modified Mercalli Intensity Scale consists of a series of key responses such as people awakening, movement of furniture, damage to chimneys, and total destruction. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It is an arbitrary ranking based on observed effects. A comparison of Richter magnitude to typical Modified Mercalli intensity is presented in Table 3-70.

Table 3-71 Comparison of Earthquake Magnitude and Intensity

Richter Magnitude	Typical Maximum Modified Mercalli Intensity
1.0 to 3.0	I
3.0 to 3.9	II - III
4.0 to 4.9	IV - V
5.0 to 5.9	VI - VII
6.0 to 6.9	VII - IX
7.0 and above	VIII - XII

According to the Northeast States Emergency Consortium, earthquakes in the northeast do not necessarily occur along fault lines. Connecticut is located near the middle of the North American tectonic plate. As such, earthquakes with epicenters in Connecticut are referred to as intraplate activity.

The following is a description of the 12 levels of Modified Mercalli intensity from the USGS:

i. Not felt except by a very few under especially favorable conditions.
ii. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
iii. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck. Duration estimated.
iv. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
v. Felt by nearly everyone; many awakened. Some dishes and windows broken. Unstable objects overturned. Pendulum clocks may stop.
vi. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
vii. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
viii. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
ix. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
x. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
xi. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
xii. Damage total. Lines of sight and level are destroyed. Objects thrown in the air.

Bedrock in Connecticut and New England in general is highly capable of transmitting seismic energy; thus, the area impacted by an earthquake in Connecticut can be four to 40 times greater than that of California. In addition, population density is up to 3.5 times greater in Connecticut than in California as a whole, potentially putting a greater number of people at risk.

The built environment in Connecticut includes old, non-reinforced masonry that is not seismically designed. Those who live or work in non-reinforced masonry buildings, especially those built on filled land or unstable soils are at the highest risk for injury due to the occurrence of an earthquake.

3.4.5.1.2 Historic Record

Connecticut has the oldest record of earthquakes in the United States. The earliest settlers learned of seismic activity from the Native Americans dating back to 1568 in Moodus. According to the Northeast States Emergency Consortium and the Weston Observatory at Boston College, there were 139 recorded earthquakes in Connecticut between 1668 and 2011. Of those closest to the southeastern region, more

than 60 were in the Moodus/East Haddam area in south-central Connecticut. The vast majority of these earthquakes had a magnitude of less than 3.0. As shown in the historic record below, strong, damaging earthquakes are relatively infrequent in Connecticut.

The most severe earthquake in Connecticut's history occurred at East Haddam on May 16, 1791. Stone walls and chimneys were toppled during this quake and the USGS has estimated the damage as being an Intensity VII. Additional instances of seismic activity occurring in and around Connecticut are provided below based on information provided in USGS documents, the Weston Observatory, the 2010 *Connecticut Natural Hazard Mitigation Plan Update*, other municipal hazard mitigation plans, and newspaper articles.

- A devastating earthquake near Three Rivers, Quebec on February 5, 1663, caused moderate damage in parts of Connecticut.
- Strong earthquakes in Massachusetts in November 1727 and November 1755 were felt strongly in Connecticut.
- In April 1837, a moderate tremor occurred at Hartford, causing alarm but little damage.
- In August 1840, another moderate tremor with its epicenter 10 to 20 miles north of New Haven shook Hartford buildings but caused little damage.
- In October 1845, an Intensity V earthquake occurred in Bridgeport. An Intensity V earthquake would be approximately 4.3 on the Richter scale.
- On June 30, 1858, New Haven and Derby were shaken by a moderate tremor.
- On July 28, 1875, an early morning tremor caused Intensity V damage throughout Connecticut and Massachusetts.
- The second strongest earthquake to impact Connecticut occurred near Hebron on November 14, 1925. No significant damage was reported.
- The Timiskarning, Ontario earthquake of November 1935 caused minor damage as far south as Cornwall, Connecticut. This earthquake affected one million square miles of Canada and the United States.
- An earthquake near Massena, New York in September 1944 produced mild effects in Hartford, Marion, New Haven, and Meriden, Connecticut.
- An Intensity V earthquake was reported in Stamford in March 1953, causing shaking but no damage.
- On November 3, 1968, another Intensity V earthquake in southern Connecticut caused minor damage in Madison and Chester.
- Recent earthquake activity has been recorded near New Haven in 1988, 1989, and 1990 (2.0, 2.8, and 2.8 in magnitude, respectively), in Greenwich in 1991 (3.0 magnitude), and on Long Island in East Hampton, New York in 1992.
- The most recent noticeable earthquake to occur in Connecticut happened on March 11, 2008. It was a 2.0 magnitude with its epicenter three miles northwest of the center of Chester.
- A magnitude 5.0 earthquake struck at the Ontario-Quebec border region of Canada on June 23, 2010. This earthquake did not cause damage in Connecticut but was felt by residents in Hartford and New Haven Counties.
- A magnitude 3.9 earthquake occurred 117 miles southeast of Bridgeport, Connecticut on the morning of November 30, 2010. The quake did not cause damage in Connecticut but was felt by residents along Long Island Sound.

- A magnitude 5.8 earthquake occurred 38 miles from Richmond, Virginia on August 23, 2011. The quake was felt from Georgia to Maine and reportedly as far west as Chicago. Many residents of Connecticut experienced the swaying and shaking of buildings and furniture during the earthquake although widespread damage was constrained to an area from central Virginia to southern Maryland. According to Cornell University, the August 23 quake was the largest event to occur in the east central United States since instrumental recordings have been available to seismologists.
- An earthquake with a magnitude 2.1 was recorded near southeastern Connecticut on November 29, 2013. The earthquake did not cause damage but was felt by residents from Montville to Mystic.
- A magnitude 2.7 quake occurred beneath the town of Deep River on August 14, 2014.
- A series of quakes hit Plainfield, Connecticut on January 8, 9, and 12, 2015. These events registered magnitudes of 2.0, 0.4, and 3.1, respectively. Residents in the Moosup section of Plainfield reported minor damage such as the tipping of shelves and fallen light fixtures.
- A magnitude 3.0 occurred southeast off the coast of Sagaponack, NY on April 9, 2019. The event was reportedly felt in New London, Norwich, and Groton.
- On September 9, 2020, a 3.1 magnitude earthquake occurred in Marlboro, New Jersey. This event was felt in Groton, along with Virginia, Massachusetts, and Rhode Island.
- A 3.6 magnitude earthquake occurred near Bliss Corner, Massachusetts on November 8, 2020. Residents throughout the SCCOG region reportedly felt very weak shaking from this event.

3.4.5.1.3 Existing Capabilities

The Connecticut Building Code and the International Building Code include design criteria for buildings specific to each municipality as adopted by BOCA. These include the seismic coefficients for building design in each jurisdiction. Tribal governments use similar coefficients from their building codes. Each jurisdiction has adopted these codes for new construction, and they are enforced by local Building Officials.

Due to the infrequent nature of damaging earthquakes, land use policies in the SCCOG region do not directly address earthquake hazards.

3.4.5.1.4 Vulnerability and Risk Assessment

According to Cornell University, the earth's crust is far more efficient at propagating seismic waves in the eastern United States than in the west, so even a moderate earthquake can be felt at great distances and over a larger region. The cause of intraplate earthquakes remains a fundamental mystery and this, coupled with the large areas affected, results in the August 2011 earthquake in Virginia to be of particular interest to seismologists.

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. In addition, artificial fill material has the potential for liquefaction. When liquefaction occurs, the strength of the soil decreases, and the ability of soil to support building foundations and bridges is reduced.

Liquefaction is a phenomenon in which the strength and stiffness of a soil are reduced by earthquake shaking or other rapid loading. It occurs in soils at or near saturation and especially in finer textured soils.

Increased shaking and liquefaction can cause greater damage to buildings and structures and a greater loss of life.

As explained in Section 2.2, a notable area of the region is underlain by sand and gravel deposits. Figure 2-3depicts surficial materials in the region. Structures in these areas are at increased risk from earthquakes due to amplification of seismic energy and/or collapse. The best mitigation for future development in areas of sandy material is the application of the most stringent building codes or the possible prohibition of new construction. However, many of these areas occur in floodplains associated with the major rivers and streams in the region so they are already regulated. The areas that are not at increased risk during an earthquake due to unstable soils are the areas in Figure 2-3underlain by glacial till.

During a strong earthquake, ground shaking can result in areas of steep slopes to collapse resulting in landslides. Seismic activity can also break utility lines, such as water mains and 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 3.4.3.3.

The potential damage from an earthquake in the region is also high as a result of the age and type of many buildings, making them vulnerable. Older, poorly designed buildings are more at risk of experiencing damage from an earthquake than newer, well-designed buildings.

According to the 2019 *Connecticut Natural Hazard Mitigation Plan Update*, Connecticut is at a low or moderate risk for experiencing an earthquake of a magnitude greater than 3.5 and at a moderate risk of experiencing an earthquake of a magnitude less than 3.0 in the future. No earthquake with a magnitude greater than 3.5 has occurred in Connecticut within the last 40 years, and the USGS currently ranks Connecticut 43rd out of the 50 states for overall earthquake activity. Thus, it is generally believed that the State is a low-risk area.

Earthquake probability maps were generated using the interactive web-based mapping tools hosted by the USGS. These maps were used to determine the probability of an earthquake greater than magnitude 5.0 or greater than magnitude 6.0 damaging the region. Results are presented in Table 8-2 below.

Table 3-72 Probability of a Damaging Earthquake in the Vicinity of the SCCOG Region

Time Frame (Years)	Equal or Greater than a Magnitude 5.0	Equal or Greater than a Magnitude 6.0
50	3.00%	0.30%
100	8.00%	0.50%
250	20.00%	1.50%
350	20.00%	2.00%

Based on the historic record and the probability maps generated from the USGS database, the state of Connecticut has areas of seismic activity. It is likely that Connecticut will continue to experience minor

earthquakes (magnitude less than 3.0) in the future. While the risk of a major earthquake affecting the region is relatively low over the short term, long-term probabilities suggest that a damaging earthquake (magnitude greater than 5.0) could occur within the region.

Two methods of estimating potential losses due to earthquake damage are considered herein. The first is based upon a statewide loss analysis conducted by FEMA. The 2019 CT NHMP also defined four "maximum plausible scenarios" for earthquake damage for use with the *HAZUS-MH* software. Loss estimates based on these methods are described in the following sections.

Loss Estimates

In the FEMA P-366 report, *HAZUS Estimated Annualized Earthquake Losses for the United States* (April 1, 2017), FEMA used probabilistic curves developed by the USGS for the National Earthquakes Hazards Reduction Program to calculate Annualized Earthquake Losses (AEL) for the United States. Based on the results of this study, FEMA calculated the AEL for Connecticut to be **$6,755,000**. This value placed Connecticut 34th out of the 50 states in terms of AEL. The magnitude of this value stems from the fact that Connecticut has a large building inventory that would be damaged in a severe earthquake and takes into account the lack of damaging earthquakes in the historical record.

The statewide AEL was utilized to determine annualized losses due to earthquake damage for the SCCOG region based on the ratio of the population of each SCCOG jurisdiction to the population of the state. Note that this analysis does not translate well to the two tribal nations which have significant commercial development but limited residential population. Table 3-72 presents the annualized loss estimates for the SCCOG region based on the AEL published by FEMA.

Table 3-73 Annualized Loss Estimates for Earthquakes from Statewide AEL

SCCOG Jurisdiction	Annualized Loss Estimate	SCCOG Jurisdiction	Annualized Loss Estimate
Bozrah	$4,550	Montville	$34,444
Colchester	$29,139	New London	$51,266
East Lyme	$35,018	North Stonington	$9,646
Franklin	$3,490	Norwich	$75,166
Griswold	$21,359	Preston	$8,969
Groton, City of	$17,133	Salem	$7,892
Groton, Town of	$51,422	Sprague	$5,558
Lebanon	$13,379	Stonington, Borough of	$1,671
Ledyard	$28,858	Stonington, Town of	$34,347
Lisbon	$7,858	Waterford	$36,662
Mashantucket Pequot Tribal Nation	$219	Windham	$45,755
Mohegan Tribe	$90		
Total			**$523,893**

Potential Losses Based on Connecticut Natural Hazards Mitigation Plan

The Connecticut State Natural Hazard Mitigation Plan utilized HAZUS-MH to develop potential losses for four earthquake scenarios: Portland, Haddam, East Haddam, and Stamford. The details for each scenario are found below.

- Magnitude 5.7, epicenter located in Portland
- Magnitude 5.7, epicenter located in Haddam
- Magnitude 6.4, epicenter located in East Haddam
- Magnitude 5.7, epicenter located in Stamford

Downscaled losses for the region were calculated using the statewide estimated direct losses from the Connecticut 2019 HMP HAZUS. These estimated losses can be found below in Table 3-73.

Table 3-74 Earthquake Loss Estimates Based 2019 CT NHMP

	Portland	Haddam	East Haddam	Stamford
Bozrah	$411,412,411	$118,392,806	$322,856,865	$252,187,885
Colchester	$2,634,631,560	$758,172,129	$2,067,533,363	$1,614,978,405
East Lyme	$3,166,131,003	$911,122,572	$2,484,628,812	$1,940,777,327
Franklin	$315,546,036	$90,805,187	$247,625,500	$193,423,643
Griswold	$1,931,216,268	$555,749,188	$1,515,526,545	$1,183,798,378
Groton city	$1,549,105,770	$445,788,640	$1,215,664,426	$949,572,002
Groton	$4,649,349,812	$1,337,950,816	$3,648,588,288	$2,849,961,891
Lebanon	$1,209,677,827	$348,110,919	$949,297,543	$741,509,210
Ledyard	$2,609,225,277	$750,860,923	$2,047,595,723	$1,599,404,843
Lisbon	$710,529,051	$204,470,079	$557,589,358	$435,540,624
Mashantucket	$19,816,901	$5,702,741	$15,551,360	$12,147,379
Mohegan	$8,130,011	$2,339,586	$6,380,045	$4,983,540
Montville	$3,114,302,185	$896,207,711	$2,443,956,024	$1,909,007,260
New London	$4,635,291,668	$1,333,905,282	$3,637,556,127	$2,841,344,520
North Stonington	$872,113,012	$250,969,353	$684,392,754	$534,588,480
Norwich	$6,796,180,736	$1,955,747,778	$5,333,318,946	$4,165,927,901
Preston	$810,968,557	$233,373,716	$636,409,498	$497,108,107
Salem	$713,577,805	$205,347,424	$559,981,875	$437,409,452
Sprague	$502,536,280	$144,615,667	$394,366,537	$308,045,061
Stonington Borough	$151,082,697	$43,477,309	$118,562,505	$92,610,783
Stonington	$3,105,494,674	$893,673,159	$2,437,044,309	$1,903,608,425
Waterford	$3,314,842,447	$953,917,502	$2,601,330,470	$2,031,934,578
Windham	$4,136,989,769	$1,190,508,149	$3,246,512,530	$2,535,895,052

HAZUS-MH Vulnerability Analysis

One earthquake scenario was used to simulate potential damages in the SCCOG region. The scenario was based on the East Haddam 1791 event. Simulation details include:

- Longitude of Epicenter: -72.40
- Latitude of Epicenter: 41.50
- Magnitude: 6.4
- Depth (km): 10

The results for each *HAZUS-MH* earthquake simulation are presented in Appendix F. These results are considered appropriate for planning purposes for the region. The range of potential impacts from any earthquake scenario is very large, ranging from minor impacts to the maximum possible impacts generated by *HAZUS-MH*. Note that potentially greater impacts could also occur.

Table 3-74 presents the total number of buildings damaged by the East Haddam earthquake scenario. A significant percentage of building damage is to single-family residential buildings while other building types include agriculture, commercial, education, government, industrial, other residential, and religious buildings. The exact definition of each damage state varies based on building construction. See Chapter 5 of the HAZUS-MH *Earthquake Model Technical Manual*, available on the FEMA website, for the definitions of each building damage state based on building construction. The East Haddam event, in particular, would cause significant damage in Colchester, Salem, and other towns in the western portion of the SCCOG region.

Table 3-75 HAZUS-MH Earthquake Scenarios – Total Number of Buildings Damaged

Epicenter Location and Magnitude	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Total
East Haddam – 6.4	23,188	14,591	6,446	4,388	48,613

The *HAZUS* simulations consider a subset of critical facilities termed "essential facilities," which are important during emergency situations. The list of essential facilities in the SCCOG region includes 22 EOCs, 62 fire stations, 30 police stations, 117 schools, and six hospitals. As shown in Table 3-75 , minimal damage to essential facilities is expected for each earthquake scenario.

Table 3-76 HAZUS-MH Earthquake Scenarios – Essential Facility Damage

Epicenter Location and Magnitude	Emergency Operation Centers (Total of 22)	Fire Stations (Total of 62)	Police Stations (Total of 30)	Schools (Total of 117)	Hospitals (Total of 6)
East Haddam – 6.4	11 with at least moderate damage, two completely destroyed, five functional after one day.	28 with at least moderate damage, six completely destroyed, only 11 functional after one day	16 with at least moderate damage, three completely destroyed, only five functional after one day	70 with at least moderate damage, six completely destroyed, only 11 functional after one day	five with at least moderate damage, none completely destroyed, and none are functional after day 1.

Table 3-76 presents potential damage to utilities and infrastructure based on the various earthquake scenarios. The region's transportation network and utility network were assumed by *HAZUS-MH* to include the following items:

- Highway: 425 major roadway bridges and 276 important highway segments
- Railway: 80 important railway bridges, four facilities, and 76 important railway segments
- Light Rail: None assumed;
- Bus: No bus facilities;
- Ferry: Two ferry facilities;
- Port: 80 port facilities;
- Airport: Two airport facilities and four runways;
- A potable water system consisting of 2,699 miles of distribution lines
- A sanitary sewer system consisting of 1,619 miles of distribution lines
- A total of 49 miles of natural gas distribution lines;
- A total of 23 electrical power facilities
- A total of 15 communication facilities.

Table 3-77 HAZUS-MH Earthquake Scenarios – Utility and Infrastructure Damage

Epicenter Location and Magnitude	Transportation Network	Utilities
East Haddam – 6.4	Minor damage (no loss of service) to railways, light rail, ferry, port, and airport infrastructure. • Highway: At least 91 bridges with moderate damage, 13 completely destroyed, with functionality greater than 50% after day 1, and 385 after day 7. $212.27 million in bridge damages. • Railway: $2.28 million in facility damage • Light rail: No estimates for facility damage. • Bus: No estimates for facility damage. • Ferry: $0.55 million in facility damage • Port: $51.18 million in facility damage • Airport: $3.26 million in facility damage	Moderate damage to facilities and potential loss of service to many areas. • Potable Water: • Waste Water: Two out of 15 facilities with at least moderate damage, totaling $261.57 million. • Natural Gas: 628 leaks and 157 main breaks totaling $2.82 million; • Electrical: More than 54,000 households without electricity at incident, more than 20,000 still without electricity after one week, more than3,600 households without electricity for more than one month, more than 70 households without power after three months. System damages total an estimated $605.14 million. • Communication: At least moderate damage to seven facilities totaling $0.47 million.

As shown in Table 3-76, The East Haddam scenario would cause significant damages throughout the SCCOG region. The wastewater system, electrical system, and communication network will experience damages and service loss in some areas.

Table 3-77 presents the estimated tonnage of debris that would be generated by earthquake damage during each *HAZUS-MH* scenario. As shown in Table 3-77, the East Haddam scenario would result in catastrophic damages that would require an extensive cleanup.

Table 3-78 HAZUS-MH Earthquake Scenarios – Debris Generation (Tons)

Epicenter Location and Magnitude	Brick / Wood	Reinforced Concrete / Steel	Total	Estimated Cleanup Truckloads (~25 Tons / Truck)
East Haddam – 6.4	990,000	2,420,000	3,410,000	136,400

Table 3-78 presents the potential sheltering requirements based on the earthquake event simulated by *HAZUS-MH*.

Table 3-79 HAZUS-MH Earthquake Scenarios – Shelter Requirements

Epicenter Location and Magnitude	Number of Displaced Households	Short-Term Sheltering Need (Number of People)
East Haddam – 6.4	6,644	3,448

The predicted sheltering requirements for earthquake damage (not including any resultant fire damage) are relatively high for the East Haddam event. Approximately 1.2% of the regional population would be seeking short-term shelter after an event of this magnitude. However, it is possible that an earthquake could also produce a dam failure (flooding) that could increase the overall sheltering need in the region. As noted in Section2.6.2, estimated capacity of the existing sheltering facilities was more than 50,000 as of 2022. Displacement due to earthquake damage alone could likely be handled by the existing shelters. However, it is possible that sheltering capacity in the SCCOG region may be insufficient during an event such as the East Haddam scenario when one considers damage from the earthquake, fires, and potential dam failures. It is likely that regional shelters will be needed since communities closer to the epicenter of the earthquake will likely have damaged shelters or insufficient space to meet demand.

Table 3-79 presents the casualty estimates generated by *HAZUS-MH* for the earthquake scenario. Casualties are broken down into four severity levels that describe the extent of injuries. The levels are as follows:

- Severity Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life threatening.
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

Table 3-80 HAZUS-MH Earthquake Scenarios – Casualty Estimates

Epicenter Location and Magnitude	Overnight (2 AM)				Afternoon (2 PM)				Rush Hour (5 PM)			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Commercial	41.81	12.06	1.83	3.59	2,753.82	794.42	121.16	236.02	1,901.79	549.20	84.68	162.17
Commuting	0.16	0.23	0.36	0.07	1.43	2.03	3.28	0.64	30.34	42.98	69.51	13.61
Educational	0	0	0	0	1,059.22	315.24	51.34	100.17	112.23	32.90	5.40	10.44
Hotels	1.41	0.42	0.07	0.14	0.27	0.08	0.01	0.03	0.42	0.13	0.02	0.04
Industrial	28.05	8.40	1.31	2.57	207.60	62.10	9.72	18.91	129.75	38.81	6.07	11.82
Other-Residential	848.96	241.16	37.47	73.65	272.88	77.62	12.32	23.36	331.21	94.26	14.94	28.32
Single Family	351.26	74.15	8.81	17.10	110.35	23.98	3.03	5.56	139.50	30.44	3.86	7.07
Total	**1,272**	**336**	**50**	**97**	**4,406**	**1,275**	**302**	**385**	**2,645**	**789**	**184**	**233**

The casualty categories include commuters, educational, hotels, industrial, other-residential, and single-family residential and are accounted for during the night, in the early afternoon, and during afternoon rush hour. As shown in Table 8-8, the East Haddam scenario would produce significant casualties requiring a significant amount of people to be hospitalized with many deaths, particularly an afternoon event. It is likely that the hospitals in the region would be overwhelmed with people requiring medical attention and that assistance would be needed in relocating patients to other hospitals in Connecticut, Massachusetts, and Rhode Island.

Table 3-80 and Table 3-81 present the total estimated losses and direct economic impact that may result from the four earthquake scenarios created for the region as estimated by the *HAZUS-MH* software. Capital damage loss estimates include the subcategories of building, contents, and inventory damages. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building or its contents. Business interruption loss estimates include the subcategories of lost income, relocation expenses, and lost wages. The business interruption losses are associated with the inability to operate a business due to the damage sustained during a hurricane and also include temporary living expenses for those people displaced from their homes because of the storm. Note that these damages do not include transportation, utility, or fire damage in Table 3-76.

Table 3-81 HAZUS-MH Estimated Income Losses from Earthquake Scenarios (Millions of Dollars)

Epicenter Location and Magnitude	Wage Losses	Capital-Related Losses	Rental Losses	Relocation Losses	Total Income Losses
East Haddam – 6.4	$908.40	$606.23	$480.30	$921.25	$2,916.20

Table 3-82 HAZUS-MH Estimated Capital Stock Losses from Earthquake Scenarios (Millions of Dollars)

Epicenter Location and Magnitude	Structural Losses	Non-Structural Losses	Content Losses	Inventory Losses	Total Capital Stock Losses
East Haddam – 6.4	$2,175.57	$6,724.47	$2,753.23	$380.49	$12,033.76

Table 3-82 sums the total losses resulting from the East Haddam scenario. Note again that this does not include estimates for fire damages caused by the earthquake as this module is being updated. The total economic impact for the East Haddam scenario is approximately $16.0 billion including income, capital stock, transportation, and utility losses.

Table 3-83 HAZUS-MH Estimated Building-Related Losses from Earthquake Scenarios (Millions of Dollars)

Epicenter Location and Magnitude	Total Income Losses	Total Capital Stock Losses	Total Transportation Losses	Total Utility Losses	Total Economic Impact
East Haddam – 6.4	$2,916.20	$12,033.76	$278.86	$867.17	$16,095.99

3.4.5.1.5 Summary

Despite the low probability of occurrence, the potential damage caused by a significant earthquake would result in significant devastation to the region. The annualized loss estimate of $501,918 calculated from the statewide analysis is therefore used herein to estimate potential earthquake damages for the region. However, it is very unlikely that the SCCOG region would be at the epicenter of such a damaging earthquake.

3.4.6 Future Loss Estimates

The preceding sections identified numerous loss figures for the hazards identified in the HMCAP. Table 3-83 summarizes those figures and provides a planning level figure that represents loss estimates for that hazard.

Table 3-84 Future Loss Estimates for the SCCOG Region

Hazard	Source of Loss Estimate	Annualized/Loss Estimate
Hurricanes/Tropical Storms	HAZUS (100-year event)	$6,103,852
Hurricanes/Tropical Storms	FEMA PA	$920,164
Tornadoes and High Winds	NCEI Direct Calculation	$380,795
Tornadoes and High Winds	2019 CT HMP Downscaled Calculation (NCEI)	$99,000
Severe Winter Storms	FEMA PA	$502,030
Severe Winter Storms	2019 CT HMP Downscaled Calculation (NCEI)	$122,914
Severe Winter Storms	NCEI Direct Calculation	$11,570
Coastal Flooding	HAZUS (1oo-year event)	$54,189,040
Riverine and Pluvial Floods	FEMA PA	$67,385
Riverine and Pluvial Floods	NFIP	$452,915
Riverine and Pluvial Floods	IA (Ida)	$103,285
Riverine and Pluvial Floods	NCEI Direct Calculation	$97,624
Riverine and Pluvial Floods	HAZUS	$27,845,920
Drought	USDA	$5,013
Drought	2019 CT HMP Downscaled Calculation (NCEI)	$109,952
Dam Failure	2019 CT HMP Downscaled Calculation (NPDP)	$20,971
Extreme Heat	See NRI table below	
Wildfire	2019 CT HMP Downscaled Calculation using WUI Acreage	$5,081
Earthquake	FEMA P-366	$523,893

In addition to the resources outlined above, the FEMA National Risk Index (NRI) was used for comparison purposes. The NRI losses, found in Table 3-84, are relatively synonymous with those used to determine losses throughout the HMCAP. In addition, the NRI includes extreme heat losses which are more difficult to quantify.

Table 3-85 National Risk Index Annualized Loss Estimates

Community	Hurricanes and Tropical Storms	Tornadoes and High Winds	Severe Winter Storms	Coastal Flooding	Riverine Floods	Extreme Heat	Wildfires	Earthquakes
Bozrah	$14,650.94	$22,035.22	$8,397.57	$5.25	$12,685.96	$457.70	$104.20	$2,939.30
Colchester	$18,944.99	$117,571.91	$35,697.84	$0.37	$37,719.72	$2,221.29	$489.29	$24,963.96
East Lyme	$8,407.73	$126,935.73	$28,006.20	$20,347.29	$144,774.43	$1,257.48	$850.29	$29,968.31
Franklin	$30,235.80	$16,992.82	$6,064.15	$0.10	$7,676.16	$494.55	$47.41	$2,757.15
Griswold & Jewett City	$31,941.64	$54,586.45	$18,187.06	$10.06	$39,552.90	$1,798.27	$252.86	$10,589.37
Groton Town	$4,851.13	$139,100.91	$22,536.90	$64,564.92	$260,350.52	$1,928.31	$606.99	$59,802.65
Groton City	$465.44	$47,768.68	$7,552.65	$22,351.08	$80,333.96	$669.51	$293.09	$14,767.52
Lebanon	$87,436.39	$61,749.04	$19,707.75	$0.00	$49,074.01	$1,655.17	$131.79	$8,046.17
Ledyard & MPTN	$14,258.01	$68,381.48	$17,322.65	$4,140.64	$50,735.31	$2,052.07	$1,288.76	$29,981.99
Lisbon	$9,512.14	$25,577.49	$8,261.07	$0.76	$22,676.45	$635.71	$49.11	$3,371.30
Montville & Mohegan Tribe	$9,966.86	$121,058.27	$32,240.83	$2,048.54	$46,048.25	$2,593.69	$688.37	$24,619.64
New London	$1,302.21	$151,768.20	$29,381.82	$14,090.17	$77,614.13	$1,759.82	$0.00	$48,994.80
North Stonington	$47,676.44	$26,897.13	$10,445.77	$2.24	$26,895.48	$1,071.20	$576.21	$3,890.52
Norwich	$13,968.65	$278,084.44	$90,722.62	$10,110.74	$273,641.96	$5,321.81	$56.76	$86,485.58
Preston	$36,838.28	$25,400.79	$8,757.11	$1,692.58	$26,927.66	$909.17	$204.51	$7,152.04
Salem	$16,349.45	$29,050.64	$8,012.61	$3.41	$7,987.29	$660.43	$97.82	$6,057.52
Sprague	$10,110.16	$20,135.45	$6,220.73	$7.58	$51,128.29	$466.47	$50.51	$3,532.22
Stonington Town & Borough	$32,221.28	$91,074.31	$17,081.85	$116,382.07	$480,164.87	$1,317.29	$3,526.52	$42,707.61
Waterford	$6,708.86	$127,702.27	$27,584.50	$18,753.11	$127,970.29	$1,278.84	$341.48	$30,086.70
Windham	$57,881.49	$102,841.76	$50,197.38	$0.00	$33,945.67	$3,307.15	$379.06	$33,409.79
Total	**$453,727.88**	**$1,654,712.99**	**$452,379.07**	**$274,510.91**	**$1,857,903.30**	**$31,855.93**	**$10,035.05**	**$474,124.14**

4. Existing Capabilities

4.1. Federal

There are several federal programs and resources in place to mitigate the effects of natural hazards and for climate adaptation. In addition to grant funding programs and technical resources, many programs that contribute to disaster management are discussed below.

4.1.1 National Flood Insurance Program (NFIP)

Currently, the NFIP is one of the best methods of property protection for property owners and renters. While purchasing insurance does not prevent flooding, insurance payouts assist property owners and renters in recovering and restoring their properties after an event.

The NFIP offers insurance. To homeowners, renters, and business owners if their community participates in the NFIP. Those communities that do participate adopt and enforce flood related ordinances that either meet or exceed federal requirements. As shown in Table 4-1, each of the SCCOG communities and tribal nations participate in the NFIP. Each community also plans on participating in the program for the foreseeable future using the Flood Insurance Rate Maps (FIRMs) developed by FEMA. Each community in the SCCOG region has appointed a department to implement the NFIP; specifics for each community can be found in Section 5.2.2 of each annex document, and the designated floodplain managers are listed in Table 4-2. Each community also has developed implementation methods for substantial damage and substantial improvement provisions. This information was presented in Table 3-46.

Table 4-1 SCCOG Community NFIP Status

Community or Tribe[1]	Initial NFIP Map Identified	Initial FIRM Identified	Current Effective Map Date	NFIP Local Adoption		CRS Status[2]
				Regs.	FIRM	
Bozrah	05/31/1974	09/30/1981	07/18/2011	✓	✓	-
Colchester	08/02/1974	06/15/1982	07/18/2011	✓	✓	-
East Lyme	09/13/1974	06/15/1981	08/05/2013	✓	✓	Class 8
Franklin	11/01/1974	12/01/1981	07/18/2011	✓	✓	-
Griswold	02/28/1975	01/03/1985	07/18/2011	✓	✓	-
Jewett City, Borough of	12/10/1976	04/03/1985	07/18/2011	✓	✓	-
Groton, City of	02/21/1975	05/15/1980	08/05/2013	✓	✓	-
Groton, Town of	02/21/1975	04/15/1977	08/05/2013	✓	✓	-
Groton Long Point Association	04/11/1975	03/18/1980	08/05/2013	✓	✓	-
Noank Fire District	02/21/1975	09/17/1980	08/05/2013	✓	✓	-
Lebanon	01/24/1975	06/06/1988	07/18/2011	✓	✓	-
Ledyard	02/21/1975	04/01/1981	08/05/2013	✓	✓	-
Lisbon	01/31/1975	02/15/1985	07/18/2011	✓	✓	-
Mashantucket Pequot Tribal Nation	02/21/1975	04/01/1981	07/18/2011	✓	✓	-
Mohegan Tribe	10/18/1974	07/02/1980	07/18/2011	✓	✓	-
Montville	10/18/1974	07/02/1980	08/05/2013	✓	✓	-
New London	06/28/1974	05/02/1977	08/05/2013	✓	✓	-
North Stonington	09/13/1974	04/03/1985	04/03/2020	✓	✓	-
Norwich	05/31/1974	06/15/1978	07/18/2011	✓	✓	Class 8
Preston	08/16/1974	03/04/1985	07/18/2011	✓	✓	-

Salem	02/21/1975	02/03/1982	07/18/2011	✓	✓	-
Sprague	05/10/1974	01/03/1985	07/18/2011	✓	✓	-
Stonington, Borough of	11/29/1977	11/01/1979	08/05/2013	✓	✓	Class 8
Stonington, Town of	10/18/1974	09/30/1980	04/03/2020	✓	✓	Class 7
Waterford	07/26/1974	02/04/1981	08/05/2013	✓	✓	-
Windham	04/12/1974	02/03/1982	11/06/1998	✓	✓	-

1 Tribal lands are identified along with their surrounding communities as initial FEMA designations occurred prior to their lands being identified as sovereign.

2 Class as of October 1, 2016. A "Class 9" rating in the CRS indicates that residents in the SFHA in that community gain a 5% discount on flood insurance, a "Class 8" rating gives a 10% discount, etc.

Table 4-2 Designated Floodplain Managers

Community or Tribe	Responsible Department According to State NFIP Coordinator and FEMA	Individual Currently Responsible Based on Staffing as of 2023
Bozrah	Land Use	First Selectman
Colchester	Public Works	Town Engineer
East Lyme	Land Use	Zoning Official
Franklin	Land Use	First Selectman
Griswold	Land Use	First Selectman
Jewett City, Borough of	Land Use	Borough Warden
Groton, City of	Building	Building Official
Groton, Town of	Planning and Development	Director of Office of Planning and Development
Groton Long Point Association	Building	Building Official
Noank Fire District	Clerk	Clerk
Lebanon	Land Use	Town Planner
Ledyard	Land Use	Mayor
Lisbon	Land Use	First Selectman
Mashantucket Pequot Tribal Nation	-- [Tribal Council oversees]	--
Mohegan Tribe	-- [Tribal Council oversees]	--
Montville	Land Use	Town Planner
New London	Building	Building Official
North Stonington	Land Use	First Selectman
Norwich	Planning and Development	Director of Office of Planning and Development
Preston	Land Use	Town Planner
Salem	Building	First Selectman
Sprague	Land Use	First Selectman
Stonington, Borough of	Land Use	Zoning Enforcement Officer
Stonington, Town of	Land Use	Borough Warden
Waterford	Land Use	Zoning Enforcement Officer
Windham	Planning and Development	Town Engineer

Home and businesses in high risk flood areas, which are defined by FEMA and known as special flood hazards areas (SHFAs) or the 1% annual chance flood hazard area, are required to carry flood insurance if the building is mortgaged from a federally regulated or insured lender. Those properties in the 0.2% annual chance flood hazard area and of minimal flood risk are not typically required to have such insurance. Property owners and renters in these reduced flood risk areas can opt to purchase flood insurance via a preferred risk policy. The NFIP estimates over 20% of all NFIP claims and over 30% of federal disaster payouts for flooding come from properties outside of SFHAs.

Because flooding is not covered under standard homeowner's insurance, the NFIP works with over 80 private insurance companies to offer flood insurance. Rates for flood insurance are set nationally, and do not differ between companies. Rate also do not increase when claims are made. Owners and renters are encouraged to submit claims when damages occur as this can increase eligibility of the property for various mitigation grant programs.

4.1.2 FEMA Community Rating System (CRS)

The FEMA CRS is a voluntary program that provides flood insurance premiums discount as incentives for communities that undertake activities beyond minimum flood insurance standards. These activities include:

- Public outreach and information
- Mapping and regulations
- Open space protection
- Stormwater mitigation
- Warning and response
- Flood damage reduction

Currently, four SCCOG communities participate in the CRS program: East Lyme, Norwich, Stonington Borough, and Stonington Town. With public information activities an important component of the CRS, the public participation requirements and recommendations of this HMCAP regarding public education and awareness can be implemented through the CRS program.

4.1.3 NOAA National Weather Service (NWS)

The NWS issues advisories, watches, and warnings for several different types of natural hazards. For flooding, the NWS typically issues a flood advisory, flood or flash flood watch, and a flood or flash flood warning.

- **Flood advisory** is issued when a specific weather event that is forecast to occur may become a nuisance. A Flood Advisory is issued when flooding is not expected to be bad enough to issue a warning. However, it may cause significant inconvenience, and if caution is not exercised, it could lead to situations that may threaten life and/or property.
- **Flood watch** is issued when conditions are favorable for a specific hazardous weather event to occur. A Flood Watch is issued when conditions are favorable for flooding. It does not mean flooding will occur, but it is possible.
- **Flood warning** is issued when the hazardous weather event is imminent or already happening. A Flood Warning is issued when flooding is imminent or occurring.

- **Flash flood warning** is issued when a flash flood is imminent or occurring. If you are in a flood prone area move immediately to high ground. A flash flood is a sudden violent flood that can take from minutes to hours to develop. It is even possible to experience a flash flood in areas not immediately receiving rain.

The NWS also issues alerts and advisories related to winter weather. These include warnings, watches, and advisories for blizzards, winter storms, ice storms, and wind chills. When events are forecast these warnings enable communities and residents to prepare for impending events.

Due to the relatively unpredictable nature of severe storms and tornadoes, warning is the primary mitigation for these events. The NOAA NWS again issues various warnings when severe weather has or is likely to develop. The NWS may issue a **severe thunderstorm warning** when a severe system has been detected by radar or spotters, or a **severe thunderstorm watch** for a larger area when a thunderstorm is near or possible in the watch area. A **tornado watch** may also be issued when tornadoes are possible within a larger area, and a **tornado warning** is issued when a tornado has been sighted or detected on radar.

When conditions are likely to spark or spread a wildfire, the NWS issues a **red flag warning** when conditions are ongoing or expected to occur, or a **watch** to alert land managers and the public of the upcoming weather conditions that could result in wildfire occurrence or extreme fire behavior.

4.1.4 United States Army Corps of Engineers (USACE)

USACE has designed, constructed, and operates flood protection projects in a variety of communities across Connecticut. The USACE oversees levee certification for Shaw's Cover Levee system in New London, and the Pawcatuck River Levee system in the Town of Stonington.

- The Shaw's Cove levee system in New London was constructed in 1985. The system protects over $171 million in property values and over 1,500 residents.
- The Pawcatuck River levee system in the Town of Stonington was built in 1963, is approximately 0.57 miles long, and is in front of $21.5 million in property value. The system is currently not accredited, therefore the protected properties behind the system are mapped in the SFHA, and will be until the system is accredited.

4.1.5 National Integrated Drought Information System (NIDIS)

The NOAA NIDIS (Home | Drought.gov) is a multi-agency partnership that coordinates drought monitoring, forecasting, planning, and information at the national, state, and local levels. There are numerous resources available through NIDIS including historic drought conditions, outlooks, and information on how droughts are related to public health, agriculture and wildfire management.

4.1.6 Federal Emergency Management Agency (FEMA) Existing Capabilities

The FEMA website provides several resources for different natural hazards.

- There is a fact sheet which addresses seismic building code provisions for improving earthquake resilience in new structures.[10]

[10] https://www.fema.gov/sites/default/files/2020-10/fema_seismic-building-code-provisions-new-buildings-create-safer-communities_fact-sheet.pdf

- FEMA has developed a two-page fact sheet on the potential risks of dam failure in a community.[11]
- The FEMA Building Sciences division has developed snow load safety guidance for understanding the signs of overstressed structures, and safety measures during winter storms.[12]

4.1.7 National Risk Index (NRI)

The FEMA National Risk Index (NRI) illustrates the risk to 18 natural hazards for communities across the country. The NRI, which includes an interactive mapping component, utilizes several datasets to help better understand what is driving natural hazard risk in a community. The NRI was used to develop annualized loss estimates for SCCOG communities; results can be found in Table 3-84.

4.2. State

There are several state agencies and organizations that contribute to natural hazard mitigation and climate adaptation. The Connecticut DEEP Office of Climate Planning, DESPP, DEMHS, CTDOT, and CIRCA are among those that provide funding and technical assistance related to mitigation and adaptation. There are also several programs and initiatives that contribute to local and regional mitigation. These are all described below.

4.2.1 Multiple Hazards

Hazard Mitigation Planning

The State HMP (2019 CT NHMP) is updated every five years by Connecticut DEMHS as required by FEMA. The document examines statewide impacts of natural hazards, compares impacts between counties, examines state capabilities, and outlines new initiatives for hazard mitigation planning at the state level that is to be enacted at the local level over the next five years.

The Connecticut State Colleges and Universities have also prepared a HMP for its campuses. In the Region, the 2014 Multi-Campus Hazard Mitigation Plan covered Eastern Connecticut State University in Willimantic, and Three Rivers Community College in Norwich. However, this plan has expired.

Codes and Design Standards

The Connecticut Department of Administrative Services, Division of Construction Services includes the Office of the State Building Inspector (OSBI). This office maintains the current (2022) state building code (SBC) and establishes the building, electrical, mechanical, plumbing and energy code requirements of the SBC, necessary to promote the health and safety of the people of Connecticut. Each SCCOG municipality has adopted the Connecticut Building Code as its building code, and literature is generally available regarding design standards in each local Building Department office. The code includes design standards for wind, snow load, earthquakes, and other hazards. The State Building Code applies to most buildings and some other structures, being newly constructed new, being altered or added to, or undergoing a change of use.

[11] https://www.fema.gov/sites/default/files/2020-08/fema_dam-safety_aware-community_fact-sheet_2016.pdf

[12] https://www.fema.gov/sites/default/files/2020-07/fema_snow_load_2014.pdf

The current State Building Code obtained legislative approval on September 27, 2022, and went into effect on October 1, 2022. The 2022 Connecticut State Building Code is based on the International Code Council's widely adopted 2021 International Codes (I-Codes) and applies to projects with permit applications filed from October 1, 2022. Specifically, the 2022 SBC adopts the following model codes:

- 2021 International Building Code
- 2021 International Existing Building Code
- 2021 International Plumbing Code
- 2021 International Mechanical Code
- 2021 International Residential Code
- 2021 International Energy Conservation Code
- 2021 International Swimming Pool and Spa Code
- 2020 National Electrical Code (NFPA 70)
- 2017 ICC A117.1 Accessible and Usable Buildings & Facilities

Along with the adoption of stronger model codes, two notable resiliency measures have been incorporated into the 2022 SBC, including (1) new requirements for elevated homes, so the elevated homes won't fall off their new elevated foundations; and (2) new requirements for roof shingles, so water damage doesn't occur as frequently if shingles are blown off.

In addition, adherence to the State Building Code requires that the foundation of structures will withstand flood forces and that all portions of the building subject to damage are above or otherwise protected from flooding. It requires 1 foot of freeboard in all A, AE, and VE zones (VE zones have a risk of significant wave action and tend to be found along coastlines). Coastal A zones (A or AE zones occurring waterward of the limit of moderate wave action) are regulated like VE zones in certain cases; flood openings are required in breakaway walls; and essential facilities must be elevated 2 feet above the BFE or to the 0.2% annual chance flood elevation.

Even before the most recent update to the State Building Code, Connecticut and its municipalities have been recognized for strong building codes. In its most recent "Rating the States" report11F11F[13], the Insurance Institute for Business and Home Safety (IBHS) ranked Connecticut among its Top 5 States (scoring 89 out of a possible 100 points on the IBHS scale). Now in its fourth edition, IBHS's 2021 report evaluates the 18 states along the Atlantic and Gulf coasts, all vulnerable to catastrophic hurricanes, based on building code adoption, enforcement, and contractor licensing. Connecticut's 2021 scores were based on the 2018 State Building Code and will likely only improve during the next IBHS assessment scheduled for 2024 based on the State's adoption of the 2021 editions of the I-Codes.

Monitoring and Alert Systems

DESPP maintains the statewide "CT Alert" Emergency Notification System. This system uses the State's Enhanced 9-1-1 database for location-based notifications to the public for life-threatening emergencies. Emergency notification systems are extremely useful for natural hazard mitigation, as a community warning system that relies on radios and television is less effective at warning residents during the night

[13] https://ibhs.org/public-policy/rating-the-states/

when the majority of the community is asleep. Each of the SCCOG municipalities receives regular weather updates through DEMHS Region 4 email alerts as well as watches and warnings issued by the NWS. DEMHS is a division of DESPP.

DEMHS administers the FEMA HMA grant programs in Connecticut and also oversees the statewide hazard mitigation planning process. This includes both the State HMP and the development of local and regional plans including this Plan update.

The CTDOT has implemented the Statewide Roadway Weather Information System (RWIS). Each of the 13 RWIS sites communicate real-time and historical weather information to CTDOT staff and weather services. This information is used to monitor the impacts of heavy rainfall and to inform a variety of winter maintenance activities. An additional 23 additional priority sites have been identified to expand the system from the existing 13 sites.

State-Sponsored Grant Programs

The Connecticut Office of Policy and Management manages the Small Town Economic Assistance Program (STEAP) which provides grant funding through the State Bond Commission for projects such as constructing, reconstructing, or repairing roads access ways, and other site improvements. STEAP-eligible communities in the Region include all municipalities except Groton, New London, Norwich, and Windham. Example hazard mitigation projects that have been funded since 2005 include construction and renovation of facilities to also be used as shelters, bridge and culvert replacements, road reconstructions, water main replacements, critical facility upgrades including generators, solar power arrays, and drainage improvements.

The Local Transportation Capital Improvement Program (LOTCIP) administered by CTDOT provides state funds to municipal governments in urbanized areas in lieu of Federal funds otherwise available through Federal transportation legislation. This program has fewer constraints and requirements than currently exist when using certain types of federal funds.

The Connecticut Farm Services Agency provides a variety of programs to assist the state's agricultural producers. The Supplemental Revenue Assistance or "SURE" program provides crop disaster assistance to eligible producers on farms that have incurred crop protection or crop quality losses due to natural disasters. The Emergency Assistance for Livestock, Honey Bees & Farm-Raised Fish or "ELAP" program covers losses from disaster not adequately covered by other disaster programs. The Livestock Indemnity Program or "LIP" provides 75% market value in benefits to livestock producers for livestock deaths in excess of normal mortality caused by adverse weather. The Noninsured Crop Disaster Assistance Program or "NAP" provides financial assistance to producers of non-insurable crops when low yields, loss of inventory, or prevented planting occurs due to natural disasters. Emergency Farm Loan funds are also available for counties receiving a presidential disaster or emergency declaration.

The Connecticut DEEP has recently established the Climate Resilience Fund (DCRF) to provide grants to communities working to initiate planning and develop projects to become more resilient to the effects of climate change. The DCRF aims to support projects at the municipal, regional, and neighborhood-level, and those projects needing assistance with scoping and development. More information can be found on the DCRF Fact Sheet in Appendix G.

Open Space Acquisition

The permanent preservation of undeveloped land can help support natural hazard mitigation efforts by preventing development in areas prone to natural hazards such as floodplains and wildland/urban interfaces. The State of Connecticut has established a goal of preserving 21 percent (or 673,210 acres) of the state's land area for open space for public recreation and natural resource conservation and preservation by 2023. According to the Connecticut Council on Environmental Quality (CEQ), to date, the state has preserved 264,000 acres throughout Connecticut as state land. In addition, a review by the CEQ in 2015 of published landholdings of land trusts showed nearly 111,3000 acres held in fee and, and municipalities held approximately 84,100 acres as open space. The 2021 CEQ annual report indicates that Connecticut is not on track for meeting its open space preservation goal. Full counts of open space assets are not presently available in Connecticut but should be made available in an upcoming statewide Open Space Plan.

The statute governing open space preservation, CGS Section 23-8, divides responsibility for meeting this goal between the state (10% or 320,576 acres) and municipalities, nonprofit land conservation organizations, and water utilities (11% or 352,634 acres). The state provides financial assistance to municipalities, conservation organizations, and water utilities to help them acquire land under a competitive grant program. Funding through the Connecticut DEEP Open Space and Watershed Land Acquisition Grant Program is usually available every 2 years. According to the CEQ 2021 Annual Report, in 2021, State grants helped municipalities and land trusts acquire 1,189 acres, which is slightly less than the 10 year average of 1,272 acres. SCCOG assists municipalities and land trusts in their efforts to secure grants by writing letters of support on their behalf to the Connecticut DEEP.

The state grant program requires a local match be provided. Some municipalities have passed bond referenda, and some local trusts have established fundraising programs to provide local resources for open space acquisition. These resources are used to provide the local match for the state grant or are used to acquire lands without state assistance.

Sustainable CT

Sustainable CT is a voluntary certification program created by the Connecticut Conference of Municipalities (CCM) to recognize thriving and resilient Connecticut communities. Sustainable CT is an independently funded, grassroots, municipal effort designed to support all Connecticut municipalities, regardless of size, geography, or resources. Sustainable CT empowers municipalities to create high collective impact for current and future residents.

Sustainable CT provides a wide-ranging menu of best practices for building sustainable municipalities. Municipalities choose Sustainable CT actions from this “Master Action List,” implement them, and earn points toward certification. Many actions are consistent with the goals of hazard mitigation and, if accomplished, may demonstrate progress with hazard mitigation. One such action is to conduct a Climate Vulnerability Assessment, identifying how climate change will impact the community.

Sustainable CT also provides opportunities for grant funding to help communities promote economic wellbeing and enhance equity, all while respecting the finite capacity of the natural environment. The

initiative specifically encourages consideration of low-income residents and their vulnerability to extreme weather events.

Resilient Connecticut

The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) began the Resilient Connecticut initiative in 2018. Resilient Connecticut aims to establish resilient coastal communities through the Resilience Framework, which includes:

- Supporting healthy buffering ecosystems
- Fostering critical infrastructure that is adapted to withstand occasional flooding Establishing resilient and strong connections between critical services, infrastructure, and transport hubs.
- Increasing investment in identified "Resilience Zones" that will increase economic resilience by strongly tying-back to regional transportation networks and economic opportunities.

Since 2018, and upon the completion of the second of three phases, the program has been expanded statewide as Resilient Connecticut 2.0" (stylized as *Resilient Connecticut*) https://circa.uconn.edu/2022/02/23/resilient-connecticut-expands-statewide/. The ultimate goals of the *Resilient Connecticut* program are to develop vulnerability assessments that would not otherwise be completed (i.e., the flood and heat CCVI tools) and to identify and advance complex projects that address unmet needs. These complex projects fundamentally address types of flooding (whether coastal or riverine or related to stormwater) but some of them also address extreme heat vulnerabilities. More information on the program can be found at https://resilientconnecticut.uconn.edu/about/. Resources, including the flood and heat CCVI, can be found at https://resilientconnecticut.uconn.edu/resources/.

Historic Resources

Recognizing that historic and cultural resources are increasingly at risk to natural hazards and climate change, SHPO embarked on a resiliency planning study for historic and cultural resources beginning in 2016. Working with the state's Councils of Government and municipalities throughout the planning process, numerous examples were identified where historic and cultural resources were specifically at risk now, could be at risk in the future, and could help generate consensus for resiliency actions. Historic resources are difficult to floodproof, elevate, or relocate without potential loss of their historicity. Therefore, a thorough understanding of the site-specific options for each set of historic resources is necessary prior to disasters that could damage these resources in order to avoid damage during recovery.

The five coastal COGs in Connecticut hosted historic resources resiliency planning meetings in June 2016. During winter 2016-2017, individual meetings were held with the shoreline communities. Reports were issued to these communities in late 2017 based on the COG meetings and the local meetings. These reports outline eight strategies that can be employed to make historic and cultural resources more resilient. They are:

- Identify Historic Resources
- Revisit Historic District Zoning Regulations
- Strengthen Recovery Planning

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

A best practice guide for planning techniques to make historic resources more resilient was distributed in 2018. This guide can be used by all jurisdictions in Connecticut when undertaking development of hazard mitigation plans. Resiliency concepts were added to the update of the State Historic Preservation Plan in 2017-2018, with the goal of helping all of the state's communities making historic resources more resilient.

State Climate Departments

In recent years CT DEEP and the DOT have both developed offices specific for climate change planning, sustainability, and resilience. The CT DEEP Office of Climate Planning works to develop legislation related to climate, works to develop educational information and materials, and is a vital member of the Governor's Council on Climate Change. The DOT Sustainability and Resiliency Unit works with all DOT offices and teams to create more energy efficient transit networks, to reduce carbon footprints across all sectors, and to reduce waste and the cost of government operations. All of these and other efforts are to prepare for future climate change impacts on the State's transportation network.

4.2.2 Flooding

Ice Jam Monitoring

The Connecticut DEEP monitors the occurrence of ice jams throughout the state. Ice jam flooding last occurred in Connecticut in 2018. Ice jams are a relatively infrequent occurrence in the region.

Codes and Design Standards

The CTDOT has standards for the design of culverts and bridges on State roads, and these standards are often used by local communities. CTDOT uses the NOAA published Volume 10, Version 3.0 of the "NOAA Atlas 14, Precipitation-Frequency Atlas of the United States" for the northeastern states for its runoff calculations. Connecticut Public Act 18-182 updated the flood design standards for state-funded critical facilities. This Public Act requires use of the most updated sea level rise scenarios (such as those developed by CIRCA or others) to be considered under local and regional planning in the state. Example facilities covered by the act include schools, elderly housing facilities, residences, and hazardous waste facilities. The base flood elevation for such facilities is the 0.2% annual chance flood elevation. Furthermore, for critical facilities within the coastal boundary, any floodproofing must exceed the base flood elevation by two feet plus any increase necessary to account for the most recent sea level rise scenario.

Stormwater and Erosion Control

Per Connecticut General Statute Section 22a-325 – 22a329, all municipalities in Connecticut are required to adopt regulations pertaining to soil erosion and sediment control, and all applications for proposed development that will disturb more than a half-acre must include a soil erosion and sediment control

plan. The Connecticut DEEP has guidelines that serve as the technical standard for compliance with the statute. The Connecticut Stormwater Quality Manual provides guidance on site planning, source control, and stormwater practices, including the design, construction, and maintenance of stormwater systems, to protect the quality of Connecticut waters. The practices detailed in the manual aim to reduce the volume of urban runoff and pollutant discharges, recharge groundwater, and control peak flows. These types of stormwater best practices not only protect water quality but also minimize flooding risks. The Connecticut Guidelines for Erosion and Sedimentation Control also detail specific measures that can reduce the damages and pollution associated with erosion and sedimentation while simultaneously reducing flooding risks.

The Stormwater Quality Manual and the Guidelines for E&S Control were updated by DEEP and its consultant in 2022, with drafts published in winter 2023. The new guidance is expected to be adopted in 2023. The updated editions support the transition to new precipitation intensities that will be consistent with new NOAA Atlas 14/15 numbers.

In 2012, the Connecticut DEEP updated the manual and guidelines to incorporate appendices on Low Impact Development (LID). LID manages stormwater by designing with nature in mind. LID techniques seek to retain stormwater close to where it falls thus keeping runoff out of pipes that drain to waterways. SCCOG encourages its member municipalities to adopt and enforce regulations that would require new development to implement these types of best practices in as far as is possible.

LID and the use of green infrastructure are often considered first by the urban and suburban communities of a region. LID is also useful for rural communities. With funding from CIRCA, the Northwest Hills Council of Governments conducted a study of how LID can be used for advancing resilience in rural communities and commissioned the development of a LID design manual.

The *Low Impact Sustainable Development Design Manual* developed for the Town of Morris by Trinkaus Engineering, LLC with funding from CIRCA presents techniques designed to help properly capture, infiltrate, and manage stormwater, which in turn recharges groundwater, reduces erosion, and protects sensitive habitats. The manual provides a framework to improve water quality through engineering specifications, enforcement tools and development standards to reduce erosion and impacts from pollution on aquatic and natural environments.

The development of the manual focuses on strategies achievable by rural municipalities, which tend to have different challenges as compared to urban communities. Rural municipalities across the state, including SCCOG region, can benefit from using the manual to guide implementation of stormwater runoff mitigation actions.

Helping Small Businesses Mitigate Impacts

According to FEMA, 40% of businesses affected by disaster never reopen, and 25% that do reopen fail; other studies show that 90% of businesses fail within two years of being struck by a disaster. Natural disasters can result in property damage, loss of inventory, and business interruption; another important risk that many small businesses face is that of environmental contamination and legal liabilities resulting from toxic chemical releases into the environment during or following a disaster.

In an effort to assist small business with natural hazard mitigation, Connecticut DEEP has proposed strategies for towns to implement education and awareness programs with recommendations for best management practices (BMPs) to help business owners and municipalities prevent commercial pollutants from entering the environment. Such education and awareness programs may help small businesses and the municipalities in which they are located avoid expensive cleanups, reduce legal liability challenges, mitigate potential risks to public health, and accelerate business recovery and reopening – reducing negative impacts to the municipality's economic base.

The municipalities of the region can benefit from mitigation actions related to mitigating flood impacts to small businesses that use toxic chemicals. All communities, excluding the two tribes, included an action requiring staff to take DEEP chemical management training to reduce risks of spills during floods.

4.2.3 Winter Storms

The CTDOT is responsible for maintenance and plowing along state roadways, and local communities coordinate with the CTDOT when problems need to be addressed.

The amended Connecticut Building Code specifies that a pressure of 30 to 40 psf be used as the base "ground snow load" for computing snow loading for different types of roofs. The psf is set by municipality, with shoreline municipalities in the Region being assigned 30 psf and inland municipalities assigned 35 psf. The International Building code specifies the same pressure for habitable attics and sleeping areas and specifies a minimum pressure of 35 psf for all other areas.

4.2.4 Tropical Cyclones and Hurricanes

Wind loading requirements are addressed through the state building code. The 2018 Connecticut State Building Code specifies the design wind speed for construction in all the Connecticut municipalities, with the addition of split zones for some towns. The ultimate design wind speed is assigned by municipality, and within the Region depending on the risk category of the structure.

PURA piloted a "micro-grid" program following storms Irene, Alfred, and Sandy designed to provide backup power supplies to small areas critical to public supply distribution such as supermarkets, gas stations, and pharmacies. These infrastructure improvements will allow for small areas of the power grid to be isolated and operated independently through emergency generators. In 2020 PURA reviewed three policy tracks which considered reliability and system resilience metrics and targets, non-wire alternatives, and the state's clean and renewable energy program as part of its review of grid modernization efforts.

4.2.5 Tornadoes and Thunderstorms

According to the 2019 CT NHMP, the occurrence of tornadoes in Connecticut is not considered frequent enough to justify the construction of tornado shelters at this time. Instead, the state has provided NOAA weather radios to all public schools as well as many municipalities for use in local government buildings. These radios provide immediate notification of a weather watch or warning such that the community can advise students or residents to take appropriate precautions. In addition, the Connecticut State Building Code includes guidelines for the proper grounding of buildings and electrical boxes.

4.2.6 Wildfires

Connecticut enacted its first statewide forest fire control system in 1905, when the state was largely rural with very little secondary growth forest. By 1927, the state had most of the statutory foundations for today's forest fire control programs and policies in place such as the State Forest Fire Warden system, a network of fire lookout towers and patrols, and regulations regarding open burning. The severe fire weather in the 1940s prompted the state legislature to join the Northeastern Interstate Forest Fire Protection Compact with its neighbors in 1949.

There are procedures in place for requesting assistance or other resources to aid in responding to all hazards including forest and wildland fires. The first responding authority would be the local jurisdiction. If there is a need for additional aid or resources beyond the local capabilities, the Intrastate Mutual Aid Compact (Connecticut General Statute Sec. 28-22a) outlines the process for requesting assistance. If regional resources are depleted, Connecticut DEEP's Division of Forestry may be requested to assist local fire departments in suppressing wildland fires.

The Forestry Division maintains an active forest fire prevention program and a specially trained force of firefighting personnel to combat fires that ravage an average of 1,300 acres of forestland per year. During the spring fire season and at other times of high or above fire danger, the division broadcasts daily predictions of fire danger and issues advisories to state park staff, municipalities, fire departments, and the media. The division also has crews ready to assist the U.S. Forest Service in controlling large fires across the nation.

The Forestry Division at the Connecticut DEEP keeps close watch over areas with below normal precipitation and utilizes precipitation and soil moisture data to compile and broadcast daily forest fire probability forecasts. Forest fire danger levels are classified as low, moderate, high, very high, or extreme.

Connecticut DEEP has an Open Burning Program for municipalities. The program requires individuals to be nominated by the Chief Executive Officer in each municipality that allows open burning. Nominees must take an online training course and exam to become certified by the Connecticut DEEP as a local “Open Burning Official.” Permit template forms were also revised that provides permit requirements so that the applicant / permittee is made aware of the requirements prior to, during and after the burning activity. The regulated activity is then overseen by the certified local official.

4.2.7 Drought

The State of Connecticut maintains a website at https://portal.ct.gov/Water/Drought/Drought-Home that is the drought information center maintained by the Interagency Drought Work Group. Links are provided to various information sources such as the U.S. Drought Monitor; groundwater, streamflow, and reservoir levels; and the Palmer Drought Severity Index. As such, State officials are well-positioned to track the occurrence of droughts in Connecticut and assist local communities.

As a planning mitigation effort developed after the 2002 drought that affected the state, the National Drought Mitigation Center through the Interagency Drought Workgroup (IDW) prepared a “Connecticut Drought Preparedness and Response Plan”. The purpose of this plan is to help assess and reduce the impact a drought has over an area by conserving essential water use during water shortages. These two mitigation practices may make the difference in the severity of a period of drought across the region.

The Connecticut Drought Preparedness and Response Plan was last updated in 2022 using the lessons learned during the 2015-2016 drought and continuing to advance planning and emergency management protocols. The Water Planning Council is continuously working with the IDW to review the Plan and incorporate amendments and additions as needed. Proposed revisions to the Drought Plan are expected in April 2023.

The Connecticut Department of Public Health completed the Water Utility Coordinating Committee process in 2018 and prepared a Statewide Coordinated Water System Plan. This process identified future public water supply needs in Connecticut and the utilities best suited to meet those needs. The impacts of drought on the availability of water supply (and to a lesser extent, control of wildfires through evaluation of fire protection) is listed as one of the top ten considerations for the State's public water suppliers.

The Forestry Division at the Connecticut DEEP keeps watch over areas exhibiting below normal precipitation, because of the increased risk of fires in times of drought. The Connecticut Farm Services Agency manages the Livestock Forage Disaster Program or "LFP" which provides compensation to eligible livestock producers that have suffered grazing losses for covered livestock on land that is native or improved pastureland with permanent vegetative cover or is planted specifically for grazing. The grazing losses must be due to a qualifying drought condition as measured by the U.S. Drought Monitor during the normal grazing period for the county.

The Connecticut Farm Services Agency manages the Livestock Forage Disaster Program "LFP", which provides compensation to eligible livestock producers that have suffered grazing losses for covered livestock on land that is native or improved pastureland with permanent vegetative cover or is planted specifically for grazing. The grazing losses must be due to a qualifying drought condition as measured by the U.S. Drought Monitor during the normal grazing period for the county.

4.2.8 Earthquakes

CTDOT has indicated that one of its long-term goals is to design and retrofit earthquake resistant roads and bridges. In addition, the 2022 Connecticut State Building Code includes seismic design criteria for buildings. New construction in each of the SCCOG municipalities is required to meet the requirements of Seismic Design Category B or C depending on site soil class.

4.2.9 Dam failure

The Dam Safety Section of the Connecticut DEEP Inland Water Resources Division is charged with the responsibility for administration and enforcement of Connecticut's dam safety laws. The existing statutes require that permits be obtained to construct, repair, or alter dams and that existing dams be inventoried and periodically inspected to assure that their continued operation does not constitute a hazard to life, health, or property.

The dam safety requirements are codified in Sections 22a401 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 and set requirements for the registration, classification, and inspection of dams. Connecticut Public Act 83-38 (incorporated into Connecticut General Statute 22a-401 through 22a-411) required that the owner of a dam or similar structure provide information to the Commissioner of Connecticut DEEP by registering their dam by July 1, 1984.

Important dam safety program changes have occurred in Connecticut over the past decade. Act No. 13-197, An Act Concerning the Dam Safety Program and Mosquito Control, passed in June 2013 and implemented new requirements for dams related to registration, maintenance, and EAPs. This act required owners of certain unregistered dams or similar structures to register them by October 1, 2015. The Act generally shifts regularly scheduled formal inspection and reporting requirements from the Connecticut DEEP to the owners of dams (Table 4-2). The act also makes owners generally responsible for supervising and inspecting construction work and establishes new reporting requirements for owners when the work is completed.

Table 4-3 Dam Inspection Schedule per CT DEEP

Dam Hazard Class	Inspection Frequency
AA	At least once
A	Every 10 years
BB	Every 7 years
B	Every 5 years
C	Every 2 years

Dams found to be unsafe under the inspection program must be repaired by the owner. Depending on the severity of the identified deficiency, an owner is allowed reasonable time to make the required repairs or remove the dam. If a dam owner fails to make necessary repairs to the subject structure, the Connecticut DEEP may issue an administrative order requiring the owner to restore the structure to a safe condition and may refer noncompliance with such an order to the Attorney General's Office for enforcement. As a means of last resort, the Connecticut DEEP Commissioner is empowered by statute to remove or correct, at the expense of the owner, any unsafe structures that present a clear and present danger to public safety.

EAPs are used in the event of a breach to reduce damage and loss of life by having a set plan of response for the event. Effective October 1, 2013, the owner of any high or significant hazard dam (Class B and Class C) must develop and implement an EAP. The EAP shall be updated every two years, and copies shall be filed with Connecticut DEEP and the chief executive officer of any municipality that would potentially be affected in the event of an emergency. Regulations adopted by the Connecticut DEEP established the requirements for such EAPs, including but not limited to (1) criteria and standards for inundation studies and inundation zone mapping; (2) procedures for monitoring the dam or structure during periods of heavy rainfall and runoff, including personnel assignments and features of the dam to be inspected at given intervals during such periods; and (3) a formal notification system to alert appropriate local officials who are responsible for the warning and evacuation of residents in the inundation zone in the event of an emergency.

To date, dam failure analyses have been prepared for many of the high hazard dams, and these are included in the EAPs. The inundation limits portrayed in the dam failure analysis maps represent a highly unlikely, worst case scenario flood event and should be used for emergency action planning only. As such, they are appropriate to identify properties for which contact information should be included in the local emergency notification database. These analyses should not be interpreted to imply that the dams evaluated are not stable, that the routine operation of the dams presents a safety concern to the public,

or that any particular structure downstream of the dam is at imminent risk of being affected by a dam failure.

The Connecticut DEEP also administers the Flood and Erosion Control Board program, which can provide noncompetitive state funding for repair of municipality owned dams. Funding is limited by the State Bond Commission. CGS Section 25-84, as of July 2021, allows municipalities to form a Flood Prevention, Climate Resilience and Erosion Control Board (formerly Flood and Erosion Control Boards), but municipalities must take action to create the board within the context of the local government such as by revising the municipal charter. In addition, two or more municipalities may elect to enter into an agreement to jointly exercise through a joint Flood Prevention, Climate Resilience and Erosion Board. In many cases (particularly for small towns), a Town's Flood and Erosion Control Board is the Board of Selectmen.

4.3. Regional

Although most hazard mitigation and adaptation activities take place at the local level, SCCOG and other regional entities also play an important role in reducing vulnerabilities and increasing mitigation capacity. Descriptions of regional projects, plans, and efforts are below.

4.3.1 Regional Hazard Mitigation Planning

SCCOG and its precursor agencies have long promoted hazard mitigation planning in the region. It is generally expected that SCCOG will help to facilitate HMP maintenance and also coordinate the next regional HMP update prior to the expiration of this Plan.

4.3.2 Regional Emergency Planning Team and Emergency Support Functions

SCCOG communities are part of Connecticut DEMHS Region 4 which includes Regional Emergency Planning Teams that facilitate emergency management and hazard mitigation efforts in those areas. The DEMHS regions utilize areas representatives with a diverse variety of experience to comprise Emergency Support Functions that support overall DEMHS goals while providing in-depth insight and guidance for certain emergency areas. For example, ESF-6 deals with all emergency operations as it relates to regional mass care. The chairs of ESF-6 are responsible for providing and ensuring adequate amounts of regional assets are available in the event of an emergency, for providing annual training and exercises for volunteer staff and municipalities and ensuring emergency preparedness at the regional level.

4.3.3 Reginal Plan of Conservation and Development

The Regional POCD 2017-2027 encourages mitigation and resilience with specific goals for more resilient homes and businesses, ecosystems, and infrastructure. The document includes a discussion on climate change (including sea level rise and the potential effects on stormwater management, surface water quality, erosion and sedimentation, and other issues. The POCD notes that many FIRMs are already obsolete because of changing rainfall patterns.

4.3.4 Regional Viewer

SCCOG maintains a Regional Viewer consisting of property data and aerial imagery, FEMA flood zones, hurricane inundation, coastal barrier resource systems, and wetland data. All of this information is useful in evaluating the potential effects of hazards.

4.3.5 Municipal Stormwater Utility Feasibility Study (2023)

SCCOG worked with four municipalities, Ledyard, Preston, Stonington, and Waterford, with funding from CIRCA, to assess the feasibility of establishing a stormwater utility in each of the communities. The implementation of a utility will allow for a more equitable way of fundings stormwater system improvements.

4.3.6 Regional Wastewater Management Plan (2019)

In 2019, SCCOG began assessing the region's wastewater infrastructure to help determine future needs and service challenges. The study also identified alternatives for inter- and intra-system expansion, cooperation, and improvement.

4.3.7 Regional Water Committee

The Regional Water Committee works to discuss, plan for, and implement measures across the Southeastern Region as they relate to water quality and quantity. One of the most notable, recent accomplishments of the Committee is the regional interconnected system which provides emergency connections to public water systems on the east and west side of the Thames River.

4.3.8 Eastern Water Utility Coordinating Committee (WUCC)

SCCOG staff participate in the Eastern WUCC, which is a planning body comprised of all public water systems in eastern Connecticut. The WUCC works to promote cooperation among public water systems throughout the region.

5. Hazard Mitigation Strategies

5.1. Regional Hazard Mitigation Goals and Objectives

This HMCAP includes new goal statements that are aligned with *Resilient Connecticut* and the efforts of the GC3. The primary goal of the previous edition of the HMP was to "*prevent or minimize the loss of or damage to life, property, infrastructure, and natural, cultural, and economic resources from natural disasters. This includes the reduction of public and private damage costs. Limiting losses of and damage to life and property will also reduce the social, emotional, and economic disruption associated with a natural disaster."*

The five new goals developed for this HMCAP were developed with cooperation from CIRCA in the *Resilient Connecticut* planning process, and are:

- 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.

The previous goal was associated with eight objectives that ranged from seeking funding for hazard mitigation projects, to public education, to natural resource protection, to supporting CRS efforts. The previous objectives are cross-referenced to the five new goals in the table below.

Table 5-1 SCCOG HMCAP New Hazard Mitigation and Climate Adaptation Goals

Objectives from last edition of this hazard mitigation plan	***New Hazard Mitigation and Climate Adaptation Goals***				
	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.**
Increase access to and awareness of funding sources for hazard mitigation projects. Certain funding sources, such as the PDM and HMGP, may continue to be available if the HMP is in place and approved. Many of the SCCOG communities have limited budgets. Some potential mitigation activities are expensive and cannot be performed by SCCOG communities without outside assistance and grant funding.	FEMA and other funding sources may be accessed for critical facilities	FEMA and other funding sources may be accessed for addressing extreme heat.	FEMA and other funding sources may be accessed for addressing flood and erosion risks.	FEMA and other funding sources may be accessed for addressing other hazards.	FEMA and other funding sources may be accessed for addressing transportation and transit protection.
Identify mitigation initiatives to be implemented if and when funding becomes available. This HMP will update the mitigation recommendations, which can then be prioritized and acted upon as funding allows.	Actions were developed for critical facilities	Actions were developed to address extreme heat	Actions were developed to address flood and erosion risks.	Actions were developed to address other hazards.	Actions were developed to help foster resilient corridors.
Connect hazard mitigation planning to other community planning efforts. This HMP can be used to guide development in the SCCOG region through regional and inter-municipal coordination as well as interdepartmental coordination within SCCOG communities.	Updated discussions about shelters and cooling centers will be helpful in community planning	New discussions about extreme heat can be used in local planning	New discussions about intense flooding and sea level rise can be used in local planning	New discussions about droughts and other hazards can be used in local planning	The concept of fostering resilient corridors may be helpful in local planning
Improve the mechanisms for pre-disaster and post-disaster decision making efforts. This plan emphasizes actions that can be taken now to reduce or prevent future disaster damages. If the actions identified in this plan are implemented, damage from future hazard events can be minimized, thereby easing recovery and reducing the cost of repairs and reconstruction. Like many communities, SCCOG communities have historically focused on hazard preparation and response rather than mitigation.	Actions supported by this plan will reduce future losses	Actions supported by this plan will reduce future losses.	Actions supported by this plan will reduce future losses.	Actions supported by this plan will reduce future losses.	Actions supported by this plan will reduce future losses.
Improve the ability to implement post-disaster recovery projects through development of a list of mitigation alternatives ready to be implemented.	In some cases, actions in this plan can guide improved recovery	In some cases, actions in this plan can guide improved recovery	In some cases, actions in this plan can guide improved recovery	In some cases, actions in this plan can guide improved recovery	In some cases, actions in this plan can guide improved recovery
Enhance and preserve natural resource systems. Natural resources, such as wetlands and floodplains, provide protection against disasters	--	Some actions that help reduce extreme heat	Flood risk reduction efforts may include	Natural and green infrastructure can help	--

such as floods and hurricanes. Proper planning and protection of natural resources can provide hazard mitigation at substantially reduced costs.		are aligned with natural resource restoration	setting aside open space and acquiring properties to remove structures	manage droughts and other hazards	
Educate residents and policy makers about natural hazard risk and vulnerability. Education is an important tool to ensure that people make informed decisions that complement the region's ability to implement and maintain mitigation strategies. It is a preventive pre-disaster measure that is less costly than most structural projects.	Shelter and cooling center awareness is a key part of public education, especially given that not all cooling centers are equally accessible; and some shelters are in adjacent towns	Extreme heat is emerging as a severe public health threat, and public education is critical for reducing injuries and deaths	More than ever, flood risk communication is needed to ensure that private and public investments are reducing risks; and that people understand how to be safe during flood events	An all-hazards approach to public education fosters community responses to wildfires, droughts, and severe storms	Helping community members understand why investment is directed at resilient corridors will help them make choices about preparing for floods and other events
Complement future Community Rating System (CRS) efforts. Implementation of certain mitigation measures may increase a community's rating with the NFIP program and thus the benefits that it derives from FEMA.			Flood risk reduction strategies and actions can help foster CRS success		Investment in flood-resilient corridors can help with several aspects of CRS success

5.2. Types of Strategies

Hazard mitigation strategies vary depending on the community, the capacity to implement the action, and the goal of mitigation. Many hazard mitigation actions are also critical for climate adaptation, however, not all mitigation actions are necessarily representative of climate adaptation.

Six recognized mitigation action categories have been recognized in previous editions of this plan; these six have corresponding benefits to CRS point distributions for those communities participating. Some actions and strategies may fit in multiple categories, while others are clearly one type of strategy. The categories are:

- Prevention
- Property Protection
- Emergency Services
- Public Education and Awareness
- Natural Resource Protection
- Structural Projects

For this HMCAP, a seventh category has been added to encompass complex water and sewer/wastewater utility projects that have elements of prevention, property protection, emergency services, and structural projects. For example, water main extensions are structural projects that provide fire protection and supply resiliency during droughts.

Examples of each are outlined below. Communities in the SCCOG region should consider some of these mitigation strategies when feasible and appropriate.

5.2.1 Prevention

Prevention strategies are typically related to regulatory and planning actions. These strategies work to *prevent* damages and losses before they occur by way of smart planning and development regulations.

Example preventative mitigation strategies can include:

- Increasing freeboard requirements for new and substantially improved structures in the FEMA designated flood zones.
- Develop and/or strengthen stormwater management regulations and programs, such as reducing allowed stormwater runoff from new development.
- Join FEMA's CRS program.
- Prohibit or limit new construction and redevelopment in areas prone to chronic flooding.

5.2.2 Property Protection

Property protection strategies can be implemented at a more local level to limit and prevent damages to private properties, or municipally owned. Some examples can include:

- Elevating and floodproofing homes, municipal buildings, and critical facilities.
- Inspection and maintenance of trees (in conjunction with utility when necessary) along power lines and near vulnerable structures.
- Relocate utilities underground.

- Developing snow removal plans or protocols for flat roofs or installing heating coils to prevent collapse.
- Perform wind retrofits such as shutters, wind-resistant windows, and upgrading roofs.
- Harden critical facilities and infrastructure, particularly those identified in the Southeastern Critical Facilities Assessment.
- Install surge protection on critical electronics.

5.2.3 Emergency Services

Emergency services can include strategies for critical for immediate natural hazard response, or for support after an event. Some examples can include:

- Relocate critical facilities outside of floodprone and storm surge areas.
- Require new municipal and critical facilities to comply with State of Connecticut design standards for critical facilities regardless of funding source.
- Upgrade and/or install generators at critical facilities to ensure adequate backup power.
- Purchase or upgrade equipment to aid in brush and wildfire response in remote areas.
- Install dry hydrants or cisterns in areas where public water supply is not available.

5.2.4 Public Education and Awareness

Educating the public on the risks associated with natural events is critical to ensuring private property protection and reduced damages and losses. Some examples can include:

- Perform target outreach in areas of high flood risk, sea level rise, and floodprone neighborhoods.
- Educate residents and renters on the importance of purchasing flood insurance.
- Hold workshops to distribute and provide information on assistance programs.
- Add natural hazard prevention and preparation information to municipal websites.
- Distribute hazard related information to areas that are at higher risk, i.e., dam failure inundation areas, wildland-urban interface, or storm surge areas.

5.2.5 Natural Resource Protection

Natural resource protection can often go hand in hand with prevention and property protection. Some examples can include:

- Acquire properties at risk of flooding and designate land as conservation or open space.
- Promote and pursue the protection and restoration of natural flood mitigation features such as wetlands, riverbanks, and dunes.
- Implement smart tree plantings throughout the community.
- Implement beach nourishment programs.

5.2.6 Structural Projects

A structural project often involves the hardening or bracing of a facility or critical infrastructure. Examples of structural projects can include:

- Increase the capacity of stormwater drainage systems.
- Increase the capacity of detention and retention ponds and basins.

- Elevate roadways, bridges, and other infrastructure above the base flood elevations and/or future sea levels.

5.3. Regional Strategies and Actions

5.3.1 Status of Regional Mitigation Strategies

The general regional strategies and actions from the previous HMP are listed in Table 5-2. These strategies and actions were reviewed with SCCOG to discuss related projects completed to date and the future applicability of the recommendation. Results are presented below.

Table 5-2 Status of Regional Mitigation Strategies and Actions from 2017 HMP

Regional Strategy or Action	Status
Local communities are required to conduct an annual meeting to review the status of their HMP annex, such that progress in meeting the goals of the plan can be measured, and so the meeting minutes and notes can be used to inform the next HMP update. Few SCCOG communities conducted annual meetings over the last five years. SCCOG should host an annual meeting for local communities to report on their local annual meeting and progress to date.	SCCOG has been unable to complete this action due to limitations in the time available during the COG meetings (chief elected officials) and subcommittee meetings. In lieu of carrying this action forward, a new approach has been developed for plan maintenance and updates. Refer to the materials in Appendices I and J.
Survey respondents requested that a study be conducted to identify ways to make it easier for residents, businesses, and organizations to take their own actions to mitigate for hazards and become more resilient to disasters. SCCOG should host a workshop to bring in experts from various fields to discuss ways to improve and promote individual resiliency efforts.	In lieu of holding a workshop, SCCOG participated in other efforts to advance resiliency at the regional, local, and neighborhood level. Examples include the Water Utility Coordinating Committee (WUCC) Coordinated Water System Plan (2018), the Regional Wastewater Management Plan (2019), community resilience planning in the City of Groton (2021) and the Town of Groton (2022), *Resilient Connecticut* (2022-2023), and business resiliency planning with seCTer (2023). This action has been retired.
One of the findings of the historic resources resiliency study of 2016-2017 was that areas of future risk may arise as structures age and are designated as historic. Using the products of the SHPO grant, SCCOG will conduct a review of (1) historic structures in flood risk zones and (2) structures that are not yet designated as historic but could be in the future, and are also at risk of flooding and sea level rise.	SCCOG has been unable to complete this action due to priorities related to other hazard mitigation and climate adaptation efforts, such as the stormwater utility feasibility study completed in 2022 using a grant from CIRCA. However, the City of Norwich completed this action between 2018 and 2023, demonstrating that local municipalities possess this capability. This action has been retired from the SCCOG list of actions.

5.3.2 Summary of Region-Wide Mitigation Actions

This section offers two actions that could be completed by SCCOG to contribute to the reduction of losses from natural hazards.

1. Building Permit Digitization	
Action Description	Assist with the digitization of building permits and building code-related actions as recommended in the report from the Digitization of Building Code Records Working Group (January 2023).
Lead	SCCOG
Priority	Medium
Status	New
Estimated Cost	High
Potential Funding Source (s)	FEMA BRIC, SCCOG Regional Services Funds
Timeframe	7/2024 to 6/2027

2. Work with Tribes to Establish Heat Respite	
Action Description	Partner with the Mohegan Tribe to formally make sections of Mohegan Sun available for extreme heat respite during NWS heat watches and heat warnings.
Lead	SCCOG
Priority	Medium
Status	New
Estimated Cost	Low
Potential Funding Source (s)	SCCOG Special Projects; DEEP Climate Resilience Fund; CIRCA Resilient Connecticut
Timeframe	7/2023 to 6/2025

3. Corridor Study for Lantern Hill Road	
Action Description	Work with 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.
Lead	SCCOG
Priority	High
Status	New
Estimated Cost	High
Potential Funding Source (s)	SCCOG Special Projects; DEEP Climate Resilience Fund; CIRCA Resilient Connecticut
Timeframe	7/2024 to 6/2025

4. Explore Water System Expansion	
Action Description	Assign to the Regional Water Supply Management team an action item to review potential for water system expansions in the region, with initial focus areas of Franklin and Montville.
Lead	SCCOG
Priority	High
Status	New
Estimated Cost	Low
Potential Funding Source (s)	SCCOG Regional Services Funds
Timeframe	7/2023 to 6/2024

5.Explore MyCoast Program	
Action Description	Evaluate the costs and benefits of enrolling communities into the MyCoast program.
Lead	SCCOG
Priority	Low
Status	New
Estimated Cost	Low
Potential Funding Source (s)	SCCOG Regional Services Funds
Timeframe	7/2023 to 6/2024

6. Stormwater Utility Feasibility Study	
Action Description	Repeat Stormwater Utility Feasibility Study for addition towns using the CIRCA MRG-funded study (2022) as a template.
Lead	SCCOG
Priority	Medium
Status	New
Estimated Cost	Moderate
Potential Funding Source (s)	DEEP Climate Resilience Fund
Timeframe	7/2023 to 6/2024

7. Flooding and Heat Adaptation and Resilience Study	
Action Description	Work with CIRCA to scope a complex climate adaptation and resilience study and concept design that addresses flooding and extreme heat events.
Lead	SCCOG
Priority	Medium
Status	New
Estimated Cost	Low
Potential Funding Source (s)	DEEP Climate Resilience Fund
Timeframe	4/2023 to 12/2024

8. seCTer Small Business Risk Assessment	
Action Description	Support seCTer in its evaluation of risks to small businesses and determine appropriate actions for the HMCAP, which can be amended to the HMCAP in 2024-2025
Lead	SCCOG
Priority	High
Status	New
Estimated Cost	Low
Potential Funding Source (s)	SCCOG Regional Services Funds
Timeframe	7/2024 to 6/2025

5.4. Community Hazard Mitigation and Climate Adaptation Actions

All jurisdictions participating in the plan update and conversion to a HMCAP were provided with an array of actions that address the top climate-driven and hazard loss challenges in each community. For the most part, these actions were facilitated from the planning meetings held with each jurisdiction in spring and summer 2022; and they consistent with the challenges reported, and the potential strategies cited, on the summary sheets in Appendix E. Additionally, some actions were carried forward from the previous HMP and revised as needed to reflect updated needs.

The sole "requirement" from the planning process is that every jurisdiction was compelled to include at least one action identifying a new cooling center, calling for standby power for an existing cooling center, and/or calling for enhanced transit or transportation to cooling centers. This focus on cooling centers is consistent with direction from the GC3 and Connecticut DPH.

In general, all hazards profiled in this plan are addressed by at least one action per jurisdiction, although previous overly-prescribed approaches (e.g., actions about lightning rods and actions about bracing equipment that could fall during an earthquake) have been retired in favor of infrastructure and critical facility actions that address losses from groups of hazards. Note the following:

- Cooling center actions were mapped to any hazard that could disrupt the power grid, because vulnerable populations would lose whatever air conditioning they relied upon, and would need to use cooling centers.
- Shelter actions were mapped to all hazards except drought, as most hazards could affect the need for sheltering.
- Water and sewer infrastructure projects involving generators were mapped to hazards that could cause power outages.
- Water infrastructure projects that do not involve floodproofing or standby power were mapped to droughts and wildfires, as these hazards require rapid and unrestricted access to water.
- Chicken and livestock facility actions were mapped to all hazards that could disrupt the power grid or reduce water supplies, because these facilities need uninterrupted power and water supplies.
- Dam-related actions about EAPs and tabletop exercises were mapped to floods, hazards that can cause floods, dam failure, and hazards that can cause dam failure such as earthquakes.

Some of the hazards addressed by proposed actions are not obvious. For example, the Bean Hill Substation in Norwich is responsible for providing power to the Norwichtown Well (a backup supply used by NPU during droughts).

Actions were not needed for coastal flooding and shoreline change if the jurisdiction was not coastal or abutting the tidal Thames River. An action for dam failure was not needed for Stonington Borough, as the borough is not downstream of any dams.

5.5. Prioritization Methods for Hazard Mitigation and Climate Adaptation Actions

To prioritize recommended hazard mitigation actions, it is necessary to determine how effective each measure will be in reducing or preventing damage. The STAPLEE method was also used in the previous two edits of this plan and has been used again for consistency. To help further evaluate proposed actions in a climate adaptation framework, CIRCA's "PERSISTS" methodology was utilized. And finally, the State's Environmental Justice mapping was used for a third method of screening. These are described below.

STAPLEE Prioritization Process

A set of criteria commonly used by public administration officials and planners was applied to each proposed strategy and action in this regional plan and in each annex. The method, called STAPLEE, is outlined in FEMA planning documents such as Developing the Mitigation Plan (FEMA 386-3) and Using Benefit-Cost Review in Mitigation Planning (FEMA 386-5). STAPLEE stands for the "Social, Technical, Administrative, Political, Legal, Economic, and Environmental" criteria for making planning decisions.

Benefit-cost review was emphasized in the prioritization process. Criteria were divided into potential benefits (pros) and potential costs (cons) for each action. The following questions were posed about each proposed action:

- Social:
  - Benefits: Is the proposed action socially acceptable to the jurisdiction?
  - Costs: Are there any equity issues involved that would mean that one segment of the region could be treated unfairly? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower-income people? Is the action compatible with present and future community values?
- Technical:
  - Benefits: Will the proposed action work? Will it reduce losses in the long term with minimal secondary impacts?
  - Costs: Is the action technically feasible? Will it create more problems than it will solve? Does it solve the problem or only a symptom?
- Administrative:
  - Benefits: Does the project make it easier for each community to administer future mitigation or emergency response actions?
  - Costs: Does each community have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained? Can the community perform the necessary maintenance? Can the project be accomplished in a timely manner?

- Political:
  - Benefits: Is the action politically beneficial? Is there public support both to implement and maintain the project? Is there a local champion willing to see the project to completion? Can the mitigation objectives be accomplished at the lowest cost to the community (grants, etc.)?
  - Costs: Have political leaders participated in the planning process? Do project stakeholders support the action enough to ensure success? Have the stakeholders been offered the opportunity to participate in the planning process?
- Legal:
  - Benefits: Is there a technical, scientific, or legal basis for the mitigation action? Are the proper laws, ordinances, and resolutions in place to implement the action?
  - Costs: Does SCCOG or the individual municipality have the authority to implement the proposed action? Are there any potential legal consequences? Will the community be liable for the actions or support of actions, or for lack of action? Is the action likely to be challenged by stakeholders who may be negatively affected?
- Economic:
  - Benefits: Are there currently sources of funds that can be used to implement the action? What benefits will the action provide? Does the action contribute to community goals, such as capital improvements or economic development?
  - Costs: Does the cost seem reasonable for the size of the problem and the likely benefits? What burden will be placed on the tax base or local economy to implement this action? Should the considered action be tabled for implementation until outside sources of funding are available?
- Environmental:
  - Benefits: Will this action beneficially affect the environment (land, water, endangered species)?
  - Costs: Will this action comply with local, state, and federal environmental laws and regulations? Is the action consistent with community environmental goals?

Each proposed mitigation action presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria from a range of 0 to 2:

- 0 = none or low
- 1 = medium
- 2 = high

Rather than providing a generic description of score assignment as in the previous two edits of this plan, the current approach is provided below.

Social:

- Benefits
  - Shelters and cooling centers were given a 2 (high).
  - Water and sewer infrastructure projects were given a 2 (high).
  - All other actions were given a 1 (medium), as they all have a base level of social benefits.
  - Zeroes were not identified, as all the actions have social benefits.
- Costs
  - All were scored as zero (none or low). This plan purposely does not include actions with adverse social costs.

Technical:

- Benefits
  - Standby power projects were given a 2 (high).
  - Acquisitions and elevations to reduce flood damage were given a 2 (high).
  - Water and sewer infrastructure projects were given a 2 (high).
  - Projects that require a few discrete efforts to work well, such as partnering with a State agency or completing a study, were given a 1 (medium). However, studies that result in prioritization of specific outcomes were given a 2 (high).
  - Zeroes were not identified, as all the actions are believed potentially effective.
- Costs
  - Most were scored as zero (none or low), as they are all believed feasible.
  - However, actions that suggest large scale flood protection systems were given a 1 (medium) for potential feasibility challenges that could be uncovered in study phases.

Administrative:

- Benefits
  - Regulatory, ordinance, policy, and guidance improvements were given a 2 (high) because they will lead to more straightforward beneficial outcomes.
  - All other actions were given a 1 (medium).
  - Zeroes were not identified, as all the actions have administrative benefits even if they are not immediately realized.
- Costs
  - All were scored as a 1 (medium) except for annually conducted exercises which were scored as a 2 (high).
  - Zeroes were not identified because all actions have administrative costs; none can be conducted without some level of staff and elected official intervention.

Political:

- Benefits
  - All actions were given a 1 (medium), as they all provide moderate benefits to elected officials, commissions, and agencies; they will all involve a local champion; and many will involve some level of grant funding.
- Costs
  - All were scored as zero (low or none). This plan purposely does not include divisive and controversial actions with adverse political costs.

Legal:

- Benefits
  - Regulatory, ordinance, policy, and guidance improvements were given a 1 (medium) because they help grant authority and provide backing in the face of potential legal challenges.
  - Actions that result in formal recognition of a shelter or cooling center were given a 1 (medium) because they help reduce uncertainty and confusion around which facilities are available and appropriate.

- All other actions were given a 0 (low to none).

- Costs
  - All were scored as zero (low to none). This plan purposely does not include actions with adverse legal costs where liability could be increased. Future stages of phased projects will be re-evaluated relative to legal costs.

Economic:

- Benefits
  - Actions that reduce financial losses and damage to property and infrastructure were given a 1 (medium) or 2 (high).
  - The score of 2 (high) was often used for extension of water and sewer systems – especially when fire protection can be provided from water systems – and for other actions that enable smart growth or redevelopment in low-risk areas.
  - Actions related to shelters, cooling center, and critical facilities were generally scored as zero (low). This does not mean economic benefits are absent; instead, the function of the action is more to directly protect people.
  - All other actions were given a 0.
- Costs
  - Ranges from zero to $10,000 were ranked lowest (0).
  - Ranges from $10,000 to $500,000 were ranked moderate (1).
  - Ranges from $500,000 and upward were ranked high (2).

Environmental:

- Benefits
  - Actions that reduce flooding or flood damage were given a 1 (medium) or 2 (high) because floods are a significant cause of water quality impairment in developed areas.
  - Zeroes (low to none) were used mainly for critical facility actions.
- Costs
  - All were scored as zero (low to none) with the exception of a few large-scale diking alternatives that will be explored by a few communities. These actions were given a 1 (medium) for environmental cost. Nevertheless, these actions are for study phases only.

Technical and economic criteria were double weighted (x2) in the final sum of scores. The total benefit score and cost score for each action were summed to determine each final STAPLEE score.

PERSISTS Prioritization Process

According to CIRCA, PERSISTS is a multi-criteria framework developed in collaboration with stakeholders during the Resilient Connecticut Phase I workshop of May 2019. PERSISTS helps project developers evaluate climate resilience actions and strategies for their potential to balance multiple goals and priorities among stakeholders. PERSISTS is comprised of eight categories:

- Permittable – Can be authorized through necessary Federal, State, and local permits
- Equitable – Ensures that benefits are equitable among populations
- Realistic – Can be realistically engineered and is plausibly fundable

- Safe – Reduces risks to people and infrastructure
- Innovative – Process has considered innovative options
- Scientific – Apply and improve on the best available science
- Transferrable – Can serve as model for other communities
- Sustainable – Socially, economically, and ecologically sustainable and supported by the public and leadership

A PERSISTS fact sheet can be found as Appendix H. Although PERSISTS has been deemed appropriate by various Connecticut State Agencies for use in evaluating climate adaptation projects, the methodology is more geared towards complex sets of solutions that address multiple climate-driven challenges. PERSISTS does not work as well for individual components of projects that have multiple phases. For example, the end result of a project may not be permittable as initially scoped, but the study phases needed to reach that point are not in need of permits. Overall, the points awarded in the PERSISTS evaluation are as follows:

- 0 = no or none
- 1 = uncertain or minimally
- 2 = somewhat
- 3 = very

Environmental Justice Prioritization Process

Each action is provided with a statement about its nexus to EJ populations. The choices are:

- Located in EJ tract
- Yes – distressed municipality (considered EJ in Connecticut pursuant to the discussion in Section 2.5.1)
- Federally recognized tribe
- Benefits the EJ tract (i.e., a nearby shelter)
- Serves EJ census tracts (i.e., a sewer pumping station)
- No – does not serve, does not benefit, and is not located in an EJ tract or distressed municipality

These statements can be used by decisionmakers to help allocate grant funds for studies and projects.

Use of Evaluation Criteria

The STAPLEE and PERSISTS scores were multiplied for a final score. In general, scores above 100 are considered beneficial, more aligned with the principles of climate adaptation, and mentioned in the annexes for each jurisdiction. However, individual community priorities are not always aligned with the highest products of STAPLEE and PERSISTS. Decisionmakers will need to look at the STAPLEE scores, PERSISTS scores, and EJ statements separately and together when determining where limited resources should be directed.

5.6. Hazard Mitigation and Climate Adaptation Action STAPLEE and PERSISTS Scores

The final STAPLEE and PERSISTS scoring matrix is found on the subsequent page in Table 5-4. Below, in Table 5-3, are the various funding sources that are identified in the STAPLEE matrix.

Table 5-3 STAPLEE and PERSISTS Matrix Funding Source Acronyms

Acronym or Name	Description
CIRCA MRG	Connecticut Institute for Resilience and Climate Adaptation (CIRCA) Municipal Resilience Grant
CWSRF	Clean Water State Revolving Fund
DEEP Climate Resilience Fund	DEEP Climate Resilience Fund - new for 2022-2023; anticipated for 2023-2024
DWSRF	Drinking Water State Revolving Fund
EPA 319	Environmental Protection Agency (EPA) grants through Section 319 water quality programs
HHMP	Rehabilitation Of High Hazard Potential Dam Grant Program
HMA	Hazard Mitigation Assistance
BRIC	Building Resilient Infrastructure and Communities
FMA	Flood Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
IIJA	Infrastructure Investment and Jobs Act
AOP	National Culvert Removal, Replacement, and Restoration Grants (Culvert AOP Program)
BIP	Bridge Investment Program
BBFP	Buses and Bus Facilities Program
RFPBR	Restoring Fish Passage through Barrier Removal Grants - may have been 2022 only
SLCGP	State and Local Cybersecurity Grant Program
LISFF	Long Island Sound Futures Fund
LOTCIP	Local Transportation Capital Improvement Program
Municipal CIP Budget	Municipal Capital Improvement Program or equivalent local program
Municipal Operating Budget	Staff time or operational budgets
NOAA/NFWF	National Oceanic and Atmospheric Administration (NOAA) grants administered by the National Fish and Wildlife Foundation
NPU	Norwich Public Utilities
Save the Sound	Save the Sound is a resource for partnering to seek grant funds; Save the Sound also has some funding available
seCTer	Southeastern Connecticut Enterprise Region
SHPO	State Historic Preservation Office
STEAP	Small Town Economic Assistance Program
Transit District	The local transit district (this can vary from community to community, such as Southeast or Windham Region)
USDA/NRCS	U.S. Department of Agriculture Natural Resources Conservation Service
WWW	Windham Water Works

Table 5-4 STAPLEE and PERSISTS Matrix

6. Plan Implementation, Maintenance, and Updates

6.1. Adoption and Implementation

SCCOG will be responsible for coordinating adoption of this HMCAP in its member communities and tribes. The SCCOG understands that this multi-jurisdictional plan will be considered current for five years from the date that the first SCCOG community adopts the plan. Thus, communities that choose to delay adoption of this plan will not impede mitigation activities of other SCCOG communities. However, communities that delay adoption will not be eligible for certain funding programs administered by FEMA until they formally adopt the plan.

Each community annex identifies the responsible party for HMCAP implementation at the local level. The SCCOG will work with local and tribal HMCAP coordinators to pursue actions at the local level by offering its expertise and assistance to identify and pursue the potential technical assistance and funding sources identified in Section 7.1.

Individual mitigation actions (listed in each community annex) of this HMP will be implemented by the municipal and tribal commissions and departments that oversee these activities. An implementation strategy and schedule are also identified for each action, detailing the responsible department and anticipated time frame for completing the mitigation action if funding is available.

Upon adoption at the local level, this HMP will be made available to other community and tribal departments as a planning tool to be used in conjunction with existing documents and regulations. It is expected that revisions to other community and tribal plans and regulations such as the Plan of Conservation and Development, department annual budgets, and Zoning and Subdivision Regulations may reference this plan and its updates. The local and tribal coordinators will be responsible for ensuring that the actions identified in each annex are incorporated into local and tribal planning activities.

Local and tribal leaders will be responsible for assigning appropriate community and tribal officials to update local planning documents, regulations, and emergency operations plans to include the provisions from this HMP if it is determined that such updates are appropriate. The local and tribal coordinators will be responsible for determining the extent of the revisions. However, should a general revision be too cumbersome or cost prohibitive, simple addendums to these documents will be added that include the provisions of this HMP. The Plan of Conservation and Development (and similar tribal plans) are the documents most likely to benefit from the inclusion of mitigation-related goals and actions.

Information and projects in this HMP will be included in the annual budget and capital improvement plans as part of implementing the projects recommended herein. This will primarily include the annual budget and capital improvement project lists maintained by each community and tribe.

6.2. Progress Monitoring

SCCOG staff will be responsible for conducting annual outreach to each participating community's chief elected official and local and tribal coordinator. This annual email, with templates found in Appendix I, will serve as a reminder to those that an annual review should be conducted to monitor the progress of

the HMP. SCCOG will also ensure that annual HMCAP reviews are an agenda item at one monthly meeting; CIRCA will attend this meeting to assist in conversations around specific actions or emerging funding sources.

The following instructions shall be followed by the local and tribal coordinators of this HMP as identified in each community and tribal annex. The local and tribal coordinators will be responsible for monitoring the successful implementation of this HMP in their community or tribe. The coordinators will provide the linkage between the multiple departments involved in hazard mitigation at the local level relative to communication and participation. As the plans will be adopted by each local and tribal government, coordination is expected to be able to occur without significant barriers.

Site reconnaissance for Specific Recommendations – Local and tribal coordinators, with the assistance of appropriate department personnel, will annually perform reconnaissance-level inspections of sites that are subject to specific recommendations. This will ensure that these actions remain viable and appropriate. Examples include building acquisitions or elevations, structural projects such as culvert replacements, roadway elevations in coastal areas, and water main extensions for increased fire suppression capabilities. The worksheet in Appendix J will be filled out for specific project-related recommendations.

The local and tribal coordinators will be responsible for obtaining a current list of repetitive loss properties in the community each year. This list is available from FEMA. These properties shall be subject to a windshield survey at least once every two years to ensure that the list is reasonably accurate relative to addresses and other basic information. Some of the reconnaissance-level inspections could occur incidentally during events such as flooding when response is underway.

Annual Reporting and Meeting – Each local and tribal coordinator will be responsible for holding an annual meeting to review the plan. Matters to be reviewed on an annual basis include the goals and objectives of the HMCAP, hazards or disasters that occurred during the preceding year, hazard mitigation and climate adaptation activities that have been accomplished to date, a discussion of reasons that implementation may be behind schedule, and recommendations for new projects and revised activities. Results of site reconnaissance efforts will be reviewed. A meeting should be conducted in spring each year, at least five to six months before the annual application cycle for pre-disaster grants under the HMA program[14]. This will enable a list of possible projects to be circulated to applicable local departments to review and provide sufficient time to develop a grant application. The local and tribal coordinator shall prepare and maintain documentation and minutes of this annual review meeting.

Post-Disaster Reporting and Metering – Subsequent to federally declared disasters in the State of Connecticut, a meeting shall be conducted by each local and tribal coordinator and representatives of appropriate departments to develop a list of possible projects for developing an HMGP application. The local and tribal coordinator shall prepare a report of the recent events and ongoing or recent mitigation

[14] BRIC and FMA applications are typically due to DEMHS in November-December of any given year.

activities for discussion and review at the HMGP meeting. Public outreach shall be solicited for HMGP applications at a *separate* public meeting.

Continued Public Involvement – Continued public involvement will be sought regarding the monitoring, evaluating, and updating of the HMCAP. Public input will primarily occur through input to web-based information gathering tools. Public comment on changes to the HMCAP may be sought through posting of public notices and notifications posted on local websites and the SCCOG website.

6.3. Plan Updates and Amendments

In the previous two editions of this plan, the narrative stated that updates to the plan would be coordinated by SCCOG; the plan would be considered current for a period of five years from the date of adoption of the first community to adopt the plan; and SCCOG would be responsible for compiling the funding required to update the plan in a timely manner such that the current plan would not expire. While these statements remain true, this HMCAP is the first edition of the SCCOG hazard mitigation plan to separate five-year updates from routine updates or "amendments" that are both desired and necessary from time to time.

Routine Updates and Amendments

Communities have generally believed that hazard mitigation plans are difficult to update, but this is not necessarily the case. The new Local Mitigation Plan Policy Guide (effective April 2023) describes the amendment process; refer to the text box to the right. In addition, adoption resolutions allow updates as needed.

SCCOG has developed a template that can be used by its member municipalities and tribes to document routine updates and amendments to this HMCAP. Refer to Appendix J for a copy. SCCOG will provide copies of this worksheet to the chief elected officials at the monthly COG meetings at least one time each year in the timeframe corresponding to the anniversary of this HMCAP approval.

From the Local Mitigation Plan Policy Guide

A mitigation plan may need to be amended after it is approved by FEMA and adopted by the local government. Amending an approved and adopted plan does not necessarily result in the need to reevaluate the entire plan against all requirements. FEMA expects local governments to conduct regularly scheduled reviews and amendments to their mitigation plan. This may result in modifications to the risk assessment or adding/removing mitigation actions, especially in preparation for submitting applications to FEMA for assistance and ensuring the project conforms with the mitigation plan. Participants are encouraged to keep the state and FEMA informed, but these amendments do not need to be reviewed and approved by the state and FEMA. If these changes identify new mitigation actions that might be eligible for FEMA assistance programs, then advise FEMA and the state. FEMA will acknowledge and note the receipt of the added action(s), where appropriate, but does not need to formally review or approve the action(s).

Five-Year Update

To update the entire HMCAP, the SCCOG or its consultant will coordinate the appropriate group of local officials consisting of representatives of many of the same departments solicited for input to this HMCAP. In addition, local business leaders, community and neighborhood group leaders, relevant private and nonprofit interest groups, and the neighboring municipalities will be solicited for

representation, including representatives from communities adjacent to SCCOG communities but not part of SCCOG.

The action worksheets prepared by the local and tribal coordinators and annual reports described in Section 1.7 above for each municipality will be reviewed. In addition, the following questions will be asked of each community and tribe:

- Do the hazard mitigation and climate adaptation goals still reflect the concerns of local residents, business owners, and officials?
- Have local conditions changed so that findings of the risk and vulnerability assessments should be updated?
- Are new sources of information available that will improve the risk assessment? For example, has CIRCA developed new vulnerability and risk assessment tools?
- Has the State of Connecticut modified any of its climate adaptation priorities? For example, extreme heat is a priority in 2022-2023, but may not be a priority in 2027-2028.
- If State priorities or risks and vulnerabilities have changed, do the goals and actions still reflect the risk assessment?
- What hazards have caused damage locally since the last edition of the HMCAP was developed? Were these anticipated and evaluated in the HMCAP, or should these hazards be added to the plan?
- Are current personnel and financial resources at the local level sufficient for implementing mitigation actions?
- For each hazard mitigation and climate adaptation action that has not been completed, what are the obstacles to implementation? What are potential solutions for overcoming these obstacles?
- For each action that has been completed, was the action effective in reducing risk?
- What hazard mitigation and climate adaptation actions should be added to the plan and proposed for implementation? For example, numerous actions about cooling centers were added in 2022-2023; these actions were absent from prior editions.
- If any proposed actions should be deleted from the plan, what is the rationale?

Future HMP updates may include deleting recommendations as projects are completed, adding recommendations as new hazard effects arise, or modifying hazard vulnerabilities as land use changes. In addition, the lists of shelters, cooling centers, and other critical facilities should be updated as necessary or at least during each HMP update.

7. Resources and References

7.1. Potential Funding Sources

The following sources of funding and technical assistance may be available for the projects listed in each community and tribal annex. More information about these agencies is presented in Section 12.2

General Hazard Mitigation

- FEMA Hazard Mitigation Grant Program (HMGP) – *funding for hazard mitigation projects following a presidentially declared disaster*.
- FEMA Building Resilient Infrastructure and Communities (BRIC) – *funding for hazard mitigation projects on a nationally competitive basis.*
- Connecticut Land Conservation Council – *can provide funding to local land trusts for open space acquisition.*
- AmeriCorps – *teams may be available to assist with landscaping projects such as surveying, tree planting, restoration, construction, and environmental education.*
- CT DEEP Climate Resilience Fund (DCRF) – *grants for Connecticut communities to plan and develop community resilience projects such as flood or extreme heat resilience.*
- Connecticut Institute for Resilience and Climate Adaptation (CIRCA) – *the CIRCA Resilient Connecticut program provides limited funding to communities for evaluating and addressing flood and extreme heat vulnerability and resilience.*

Beach Replenishment and Erosion Control

- U. S. Army Corps of Engineers – *funding for beach nourishment*.
- U.S. Department of Agriculture – *technical assistance for erosion control.*
- U.S. Fish and Wildlife National Coastal Wetlands Conservation Grant Program - *matching funds at the state level for projects that conserve, restore, and protect coastal wetlands. Nationally competitive.*
- North American Wetlands Conservation Act Grants Program – *funding for projects that support long-term wetlands acquisition, restoration, and/or enhancement. Requires a 1-to-1 funds match.*

Flood Mitigation

- FEMA Flood Mitigation Assistance (FMA) Program – *grants for pre-disaster flood hazard mitigation planning and projects such as property acquisition, relocation of residents, and flood retrofitting.*
- U.S. Army Corps of Engineers – *50/50 match funding for floodproofing and flood preparedness projects.*
- U.S. Department of Agriculture – *financial assistance to reduce flood damage in small watersheds and to improve water quality.*

Hurricane Mitigation

- FEMA State Hurricane Program - financial and technical assistance to local governments to support mitigation of hurricanes and coastal storms.
- FEMA Hurricane Program Property Protection – grants to hurricane prone states to implement hurricane mitigation projects.

Wildfire Mitigation

- Assistance to Firefighters Grant Program – pre-disaster grants to organizations such as fire departments that are recognized for expertise in fire prevention and safety programs.

7.2. Technical Resources

This section is comprised of a list of resources to be considered for technical assistance and potential financial assistance for completion of the actions outlined in this Plan. This list is not all inclusive and is intended to be updated as necessary.

Federal Resources

Federal Emergency Management Agency

Region I
220 Binney Street
Cambridge, MA 02142
(877) 336-2734
http://www.fema.gov/

FEMA Mitigation Division

The Mitigation Division is comprised of three branches that administer all of FEMA's hazard mitigation programs. The **Risk Analysis Branch** applies planning and engineering principles to identify hazards, assess vulnerabilities, and develop strategies to manage the risks associated with natural hazards. The **Hazard Mitigation Assistance Branch** promotes actions to manage and reduce risks in both the existing built developments and future development areas in both pre-disaster and post-disaster environments. The **Floodplain Management and Insurance Branch** mitigates flood losses by providing affordable flood insurance for property owners and by encouraging communities to adopt and enforce floodplain management regulations.

FEMA Response & Recovery Division

As part of the National Response Plan, this division provides information on dollar amounts of past disaster assistance including Public Assistance, Individual Assistance, and Temporary Housing, as well as information on retrofitting and acquisition/relocation initiatives. The Response & Recovery Division also provides mobile emergency response support to disaster areas, supports the National Disaster Medical System, and provides urban search and rescue teams for disaster victims in confined spaces.

The division also coordinates federal disaster assistance programs. This includes the Public Assistance Grant Program (PA), which provides 75% grants for mitigation projects to protect eligible damaged public and private nonprofit facilities from future damage. "Minimization" grants at 100% are available through the Individuals and Family Grant Program. The Hazard Mitigation Grant Program and the Fire Management Assistance Grant Program are also administered by this division.

Small Business Administration

Region I
10 Causeway Street, Suite 265A
Boston, MA 02222-1093
(617) 565-8416
http://www.sba.gov/

SBA has the authority to "declare" disaster areas following disasters that affect a significant number of homes and businesses but that would not need additional assistance through FEMA. (SBA is triggered by a FEMA declaration, however.) SBA can provide additional low-interest funds (up to 20% above what an eligible applicant would "normally" qualify for) to install mitigation measures. They can also loan the cost of bringing a damaged property up to state or local code requirements. These loans can be used in combination with the new "mitigation insurance" under the NFIP or in lieu of that coverage.

Environmental Protection Agency

Region I
5 Post Office Square, Suite 100
Boston, MA 02109-3912
(888) 372-7341

Provides grants for restoration and repair and educational activities, including:

- *Capitalization Grants for State Revolving Funds*: Low interest loans to governments to repair, replace, or relocate wastewater treatment plants damaged in floods. Does not apply to drinking water or other utilities; and
- *Clean Water Act Section 319 Grants*: Cost-share grants to state agencies that can be used for funding watershed resource restoration activities, including wetlands and other aquatic habitat (riparian zones). Only those activities that control non-point pollution are eligible. Grants are administered through the CT DEEP, Bureau of Water Management, Planning and Standards Division.

U.S. Department of Housing and Urban Development

20 Church Street, 19th Floor
Hartford, CT 06103-3220
(860) 240-4800
http://www.hud.gov/

The U.S. Department of Housing and Urban Development offers *Community Development Block Grants (CDBG)* to communities with populations greater than 50,000, who may contact HUD directly regarding CDBG. One program objective is to improve housing conditions for low and moderate income families. Projects can include acquiring floodprone homes or protecting them from flood damage. Funding is a 100% grant and can be used as a source of local matching funds for other funding programs such as FEMA's "404" Hazard Mitigation Grant Program. Funds can also be applied toward "blighted" conditions, which is often the post-flood condition. A separate set of funds exists for conditions that create an "imminent threat." The funds have been used in the past to replace (and redesign) bridges where flood damage eliminates police and fire access to the other side of the waterway. Funds are also

available for smaller municipalities through the state administered CDBG program participated in by the State of Connecticut.

U.S. Army Corps of Engineers

New England District
696 Virginia Road
Concord, MA 01742-2751
(978) 318-8238

The Corps provides 100% funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services Program (FPMS). Specific programs used by the Corps for mitigation are listed below.

- *Section 205 – Small Flood Damage Reduction Projects*: This section of the 1948 Flood Control Act authorizes the Corps to study, design, and construct small flood control projects in partnership with non-Federal government agencies. Feasibility studies are 100 percent federally funded up to $100,000, with additional costs shared equally. Costs for preparation of plans and construction are funded 65 percent with a 35 percent non-federal match. In certain cases, the non-Federal share for construction could be as high as 50 percent. The maximum federal expenditure for any project is $7 million.
- *Section 14 – Emergency Streambank and Shoreline Protection:* This section of the 1946 Flood Control Act authorizes the Corps to construct emergency shoreline and streambank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and non-profit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.
- *Section 103 – Hurricane and Storm Damage Reduction Projects:* This section of the 1962 River and Harbor Act authorizes the Corps to study, design, and construct small coastal storm damage reduction projects in partnership with non-Federal government agencies. Beach nourishment (structural) and floodproofing (non-structural) are examples of storm damage reduction projects constructed under this authority. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $5 million.
- *Section 208 – Clearing and Snagging Projects:* This section of the 1954 Flood Control Act authorizes the Corps to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.
- *Section 206 – Floodplain Management Services:* This section of the 1960 Flood Control Act, as amended, authorizes the Corps to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood

warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of floodprone structures. When funding is available, this work is 100 percent federally funded.

In addition, the Corps also provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and post-flood response. Corps assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, the Corps can loan, or issue supplies and equipment once local sources are exhausted during emergencies.

U.S. Department of Commerce

National Weather Service
Northeast River Forecast Center
46 Commerce Way
Norton, MA 02766
(508) 622-3300
http://www.nws.noaa.gov/

The National Weather Service prepares and issues flood, severe weather, and coastal storm warnings. Staff hydrologists can work with communities on flood warning issues and can give technical assistance in preparing flood warning plans.

U.S. Department of the Interior

National Park Service
Helen Mahan, Program Leader
Rivers, Trails, & Conservation Assistance
15 State Street
Boston, MA 02109
(617) 223-5123
http://www.nps.gov/rtca/

The National Park Service provides technical assistance to community groups and local, state, and federal government agencies to conserve rivers, preserve open space, and develop trails and greenways as well as identify nonstructural options for floodplain development.

U.S. Fish and Wildlife Service

New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
(603) 223-2541
http://www.fws.gov/

The U.S. Fish and Wildlife Service provides technical and financial assistance to restore wetlands and riparian habitats through the North American Wetland Conservation Fund and Partners for Wildlife programs. It also administers the *North American Wetlands Conservation Act Grants Program*, which

provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands projects in the United States, Canada, and Mexico. Funds are available for projects focusing on protecting, restoring, and/or enhancing critical habitat.

U.S. Department of Agriculture

Natural Resources Conservation Service
Connecticut Office
344 Merrow Road, Suite A
Tolland, CT 06084-3917
(860) 871-4011

The Natural Resources Conservation Service provides technical assistance to individual landowners, groups of landowners, communities, and soil and water conservation districts on land use and conservation planning, resource development, stormwater management, flood prevention, erosion control and sediment reduction, detailed soil surveys, watershed/river basin planning and recreation, and fish and wildlife management. Financial assistance is available to reduce flood damage in small watersheds and to improve water quality. Financial assistance is available under the Emergency Watershed Protection Program, the Cooperative River Basin Program, and the Small Watershed Protection Program.

Regional Resources

Northeast States Emergency Consortium

26 Princess Street, Suite 102Wakefield, MA 01880
(781) 224-9876
http://nesec.org

The Northeast States Emergency Consortium (NESEC) develops, promotes, and coordinates "all-hazards" emergency management activities throughout the northeast. NESEC works in partnership with public and private organizations to reduce losses of life and property. They provide support in areas including interstate coordination and public awareness and education, along with reinforcing interactions between all levels of government, academia, nonprofit organizations, and the private sector.

State Resources

Connecticut Department of Economic and Community Development

450 Columbus Boulevard, Suite 5Hartford, CT 06103
(860) 270-8000
http://www. https://portal.ct.gov/DECD

Connecticut Department of Energy & Environmental Protection

79 Elm Street
Hartford, CT 06106-5127
(860) 424-3000

http://www.dep.state.ct.us/

DEEP is generally responsible for flood hazard mitigation in Connecticut, including administration of the National Flood Insurance Program. Other programs within the division include:

- *National Flood Insurance Program State Coordinator*: Provides flood insurance and floodplain management technical assistance, floodplain management ordinance review, substantial damage/improvement requirements, community assistance visits, and other general flood hazard mitigation planning including the delineation of floodways;
- *Flood & Erosion Control Board Program*: Provides assistance to municipalities to solve flooding, beach erosion, and dam repair problems. Has the power to construct and repair flood and erosion management systems. Certain nonstructural measures that mitigate flood damages are also eligible. Funding is provided to communities that apply for assistance through a Flood & Erosion Control Board on a noncompetitive basis;
- *Inland Wetlands and Watercourses Management Program*: Provides training, technical, and planning assistance to local Inland Wetlands Commissions; reviews and approves municipal regulations for localities. Also controls flood management and natural disaster mitigations;
- *Dam Safety Program*: Charged with the responsibility for administration and enforcement of Connecticut's dam safety laws. Regulates the operation and maintenance of dams in the state. Permits the construction, repair, or alteration of dams, dikes, or similar structures and maintains a registration database of all known dams statewide. This program also operates a statewide inspection program;
- *Rivers Restoration Grant Program*: Administers funding and grants under the Clean Water Act involving river restoration and reviews and provides assistance with such projects;
- *Planning and Standards Division*: administers the Clean Water Fund and many other programs directly and indirectly related to hazard mitigation including the Section 319 nonpoint source pollution reduction grants and municipal facilities program, which deals with mitigating pollution from wastewater treatment plants; and
- *Former Office of Long Island Sound Programs (OLISP)*: Administers the Coastal Area Management (CAM) Act program and Long Island Sound License Plate Program.
- *Office on Climate Planning*: Administers the Connecticut Resilience Fund, and works to equitably and affordably plan for climate resilience in the state.

Connecticut Department of Energy & Environmental Protection Office of Climate Planning

79 Elm Street
Hartford, CT 06106-5127
(860) 424-3000
https://portal.ct.gov/DEEP/Climate-Change/Climate-Change

The DEEP Office of Climate Planning develops and supports forward-thinking climate-related policies and legislation, as well as participate in groundbreaking regional initiatives. Addressing climate change in a meaningful way presents residents, businesses, non-profits, and municipalities the opportunity to create, evolve, and maintain a sustainable environment, a robust economy, and a higher quality of life for current and future generations.

Connecticut Department of Emergency Management and Homeland Security

1111 Country Club Road
Middletown, CT 06457
(860) 685-8531
http://www.ct.gov/demhs/

DEMHS is the leading agency responsible for emergency management and hazard mitigation. Specifically, responsibilities include emergency preparedness, response and recovery, mitigation, and an extensive training program. DEMHS is the state point of contact for most FEMA grant and assistance programs. DEMHS administers the Earthquake and Hurricane programs described above under the FEMA resource section. Additionally, DEMHS operates a mitigation program to coordinate mitigation throughout the state with other government agencies. Additionally, the agency is available to provide technical assistance to sub-applicants during the planning process.

As the State's home of the *State Hazard Mitigation Officer,* DEMHS is charged with hazard mitigation planning and policy, oversight of administration of the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program. DEMHS has the responsibility of making certain that the State Natural Hazard Mitigation Plan is updated every five years.

Connecticut Department of Public Safety

1111 Country Club Road
Middletown, CT 06457
(860) 685-8190
http://www.ct.gov/dps/

Office of the State Building Inspector **-** The Office of the State Building Inspector is responsible for administering and enforcing the Connecticut State Building Code and is also responsible for the municipal Building Inspector Training Program.

Connecticut Department of Transportation

2800 Berlin Turnpike
Newington, CT 06131-7546
(860) 594-2000
http://www.ct.gov/dot/

The Department of Transportation administers the federal Intermodal Surface Transportation Efficiency Act (ISTEA) that includes grants for projects that promote alternative or improved methods of transportation. Funding through grants can often be used for projects with mitigation benefits such as preservation of open space in the form of bicycling and walking trails. CT DOT is also involved in traffic improvements and bridge repairs that could be mitigation related.

Connecticut Department of Transportation Sustainability and Resiliency Unit

2800 Berlin Turnpike

Newington, CT 06131-7546
(860) 594-2000
https://portal.ct.gov/DOT/Sustainability-and-Resiliency/Sustainability-and-Resiliency-Unit

The **Sustainability and Resiliency Unit** develops actionable plans to increase the sustainability of DOT's integrated multimodal transportation system. Our team works with all parts of DOT to increase energy efficiency, reduce the carbon footprint of transportation, reduce waste and reduce the cost of government operations. The Unit is also responsible for the development and implementation of adaptation strategies to ensure DOT is prepared for the impacts of climate change on the State's transportation infrastructure.

Private and Other Resources

Association of State Dam Safety Officials

239 South Limestone
Lexington, KY 40508
(859) 550-2788
http://www.damsafety.org

ASDSO is a nonprofit organization of state and federal dam safety regulators, dam owners/operators, dam designers, manufacturers/suppliers, academia, contractors and others interested in dam safety. Their mission is to advance and improve the safety of dams by supporting the dam safety community and state dam safety programs, raising awareness, facilitating cooperation, providing a forum for the exchange of information, representing dam safety interests before governments, providing outreach programs, and creating a unified community of dam safety advocates.

The Association of State Floodplain Managers (ASFPM)

8301 Excelsior Drive
Madison, WI 53717
(608) 828-3000
http://www.floods.org/

ASFPM is a professional association of state employees with a membership of over 1,000 that assists communities with the NFIP. ASFPM has developed a series of technical and topical research papers and a series of Proceedings from their annual conferences. Many "mitigation success stories" have been documented through these resources and provide a good starting point for planning. ASFPM also hosts workshops, local and online training sessions, and oversees a national certification program for floodplain managers.

Connecticut Association of Flood Managers

P.O. Box 270213
West Hartford, CT 06105
ContactCAFM@gmail.com
http://ctfloods.org/

CAFM is a professional association of local floodplain managers, consultants, state and regional officials, and staff from non-profit organizations that facilitates training and outreach regarding flood management techniques. CAFM is the local state chapter of ASFPM (above).

Connecticut Institute for Resilience and Climate Adaptation (CIRCA)

University of Connecticut: Avery Point Campus
1080 Shennecossett Rd.
Groton, CT 06340
(860) 405-9214
http://www.circa.uconn.edu
The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) is a UConn research institute that brings together experts in the natural sciences, engineering, economics, political science, finance, and law to provide practical solutions to problems arising as a result of a changing climate.

Institute for Business & Home Safety

5335 Richburg Road
Richburg, SC 29729
(803) 723-3600
http://www.ibhs.org/

A nonprofit organization put together by the insurance industry to research ways of reducing the social and economic impacts of natural hazards. The institute advocates the development and implementation of building codes and standards nationwide and may be a good source of model code language.

Multidisciplinary Center for Earthquake Engineering and Research (MCEER)

University at Buffalo
State University of New York
Red Jacket Quadrangle
Buffalo, NY 14261
(716) 645-3391
http://mceer.buffalo.edu/

A source for earthquake statistics, research, and for engineering and planning advice.

The National Association of Flood & Stormwater Management Agencies (NAFSMA)

P.O. Box 56764
Washington, DC 20040
(202) 289-8625
http://www.nafsma.org

NAFSMA is an organization of public agencies that strive to protect lives, property, and economic activity from the adverse impacts of stormwater by advocating public policy, encouraging technology, and

conducting educational programs. NAFSMA is a voice in national politics on water resources management issues concerning stormwater management, disaster assistance, flood insurance, and federal flood management policy.

National Emergency Management Association (NEMA*)*

1300 17th Street N #900
Arlington, VA 22209
(703) 841-3200
http://www.nema.org

A national association of state emergency management directors and other emergency management officials, the NEMA Mitigation Committee is a strong voice to FEMA in shaping all-hazard mitigation policy in the nation. NEMA is also an excellent source of technical assistance.

Natural Hazards Center

University of Colorado at Boulder
482 UCB
Boulder, CO 80309-0482
(303) 735-5844
http://www.colorado.edu/hazards/

The Natural Hazards Center includes the Floodplain Management Resource Center, a free library and referral service of the ASFPM for floodplain management publications. The Natural Hazards Center is located at the University of Colorado in Boulder. Staff can use key words to identify useful publications from the more than 900 documents in the library.

New England Flood and Stormwater Managers Association, Inc. (NEFSMA)

c/o MA DEM
100 Cambridge Street
Boston, MA 02202

NEFSMA is a nonprofit organization made up of state agency staff, local officials, private consultants, and citizens from across New England. NEFSMA sponsors seminars and workshops and publishes the NEFSMA News three times per year to bring the latest flood and stormwater management information from around the region to its members.

Volunteer Organizations - Volunteer organizations including the ARC, the Salvation Army, Habitat for Humanity, and the Mennonite Disaster Service are often available to help after disasters. Service organizations such as the Lions Club, Elks Club, and the Veterans of Foreign Wars are also available. Habitat for Humanity and the Mennonite Disaster Service provide skilled labor to help rebuild damaged buildings while incorporating mitigation or floodproofing concepts. The office of individual organizations can be contacted directly, or the FEMA Regional Office may be able to assist.

Flood Relief Funds - After a disaster, local businesses, residents, and out-of-town groups often donate money to local relief funds. They may be managed by the local government, one or more local churches, or an ad hoc committee. No government disaster declaration is needed. Local officials should recommend that the funds be held until an applicant exhausts all sources of public disaster assistance, allowing the funds to be used for mitigation and other projects that cannot be funded elsewhere.

AmeriCorps - AmeriCorps is the National Community Service Organization. It is a network of local, state, and national service programs that connects volunteers with nonprofits, public agencies, and faith-based and community organizations to help meet our country's critical needs in education, public safety, health, and the environment. Through their service and the volunteers they mobilize, AmeriCorps members address critical needs in communities throughout America, including helping communities respond to disasters. Some states have trained AmeriCorps members to help during flood-fight situations such as by filling and placing sandbags.

Appendix A: GC3 Crosswalk

Appendix B: Regional Workshop Materials

Appendix C: Public Meeting Materials

Appendix D: Neighboring Stakeholder Outreach Letters

Appendix E: Climate Change Summary Sheets

Appendix F: HAZUS Results

Appendix G: DCRF Fact Sheet

Appendix H: PERSISTS Criteria Fact Sheet

Appendix I: Templates for Annual Emails from SCCOG to Jurisdictions and Organizations that Serve Socially Vulnerable Populations

Appendix J: Worksheet to Document Plan Updates and Amendments